# SJRA AND THE CATAHOULA AQUIFER

There has been much public discussion and speculation lately about the feasibility of the Catahoula Aquifer as a primary water source for Montgomery County. For the record, SJRA's position on this issue follows.

## WHERE IS INFORMATION ABOUT THE CATAHOULA AND BRACKISH WATER FOUND?

A wealth of information about brackish water in Texas has been accumulated over several decades and is available to the public, scientists, water system operators, and anyone else interested in researching it. This information is not new, proprietary, or difficult to find. However, there is limited specific information regarding the Catahoula Aquifer in Montgomery County. Because the accumulated data raises many more questions and problems than it provides reliable and predictable answers, it has been largely disregarded in areas of the state where there are more reliable and cost-effective sources of water supply. Some exceptions include areas where there are no other practical alternatives, including areas of south, central, and west Texas where other groundwater or surface water supplies are either non-existent or have been utilized to the maximum. Even in these areas, the use of brackish water is feasible only when the combination of the critical factors of location, depth, quantity, quality, treatability, taste, odor, chemical stability, corrosivity, ease of disposal of resulting wastes, and feasibility of storage and distribution yields an economically affordable, aesthetically pleasing, and safe result. This is, of course, why there are so few systems in Texas, relatively speaking, using brackish water.

## WHAT IS KNOWN ABOUT THE CATAHOULA?

The Catahoula Aquifer lies beneath the Lower Jasper Aquifer, Upper Jasper Aquifer, Burkville Aquiclude, Evangeline Aquifer, and Chicot Aquifer in southeast Texas and slopes in depth from some 2,500 feet to 4,000 feet, more or less, within Montgomery County (reference Figure 1). The vertical thickness of the Catahoula in Montgomery County is not known precisely but is believed to be of less thickness than the Lower Jasper. The nature of the sands comprising the Catahoula is presumed to be less predictable than the Lower Jasper based on limited available information. Catahoula water is generally higher in total dissolved solids, salinity, and temperature than water in the upper aquifers, depending upon location and depth. There has been no long-term, concentrated pumpage of the Catahoula in Montgomery County at high rates of withdrawal to provide any reliable data as to how, if at all, the aquifer is recharged or how, if at all, the quantity and quality characteristics of Catahoula water may be affected by sustained usage.

Brackish water is generally found over most of the Gulf Coast from South Texas to Florida, although with differing quality and temperature characteristics and at varying depths that are in many instances much more shallow than the Catahoula Aquifer in

Montgomery County. Depths along the Gulf Coast and stretching into West Texas range from less than 100 feet to 800 feet or more. In trying to assess the feasibility of the use of this brackish water, it is essential to take into account location, depth, quantity, quality, temperature, reliability, and other variables.

## WHAT IS NOT KNOWN ABOUT THE CATAHOULA?

Because the Catahoula has not been extensively explored and produced in Montgomery County, there a number of critical unknowns about the aquifer that would affect a decision to explore, produce, and use the Catahoula as a primary source of supply for drinking water by either an individual water system operator or a regional supplier. Among these unknowns are:

Location: What areas of Montgomery County are reliable for locating suitable supplies of Catahoula water with the characteristics that make its use feasible? (See Figure 2 for a map of the down-dip extent of freshwater and saline sands based on analysis of geophysical logs). The cost of drilling wells at the depth of the Catahoula makes wildcat wells throughout Montgomery County almost prohibitive. The proximity of the well site to storage, treatment, blending and distribution facilities dramatically affects the overall costs of water to the end user. Are suitable well field sites and routes for collection, distribution, and disposal lines and facilities available without interference from underground utilities, above ground utilities, or other surface improvements and free from impacts to wetlands, endangered/threatened species habitat, cultural/historical resources, and similar environmentally sensitive areas?

Depth: At what depths might acceptable water be found? Depth clearly affects the cost of drilling and the cost of energy to produce the water and appears to affect both the quality and temperature of the water.

Quantity: Is water available in sufficient quantities to withstand high pumpage rates over a prolonged period of time? Is the aquifer recharged or replenished to replace the water removed by pumpage and, if so, from what source, with what quality of water and at what rate? What pumpage rate is sustainable?

Quality: What is the anticipated quality of water that will be produced from the Catahoula aquifer on which a reliable, long-term supply system can be cost-effectively planned and implemented with confidence? Are there specific sand layers within the Catahoula aquifer that provide more acceptable quality of water than others? What is the degree of groundwater mineralization, decomposition of organic matter, and reduction of the groundwater environment? Will the water produced directly from the Catahoula aquifer meet all Federal and State requirements for drinking water? Will the water require treatment and to what degree, or can it be blended with existing groundwater or surface water supplies, or both, without treatment? Relative TDS and salinity characteristics are only threshold issues that dictate how the water can be used. Because brackish water in Montgomery County is of relatively ancient origins, additional concerns about possible arsenic, metals, radioactive isotopes, and other contaminants must be addressed. Can all contaminants be effectively treated, and if so, at what cost? Even if treatment is effective and affordable, will residual salt and TDS levels pose an increased risk to users with high blood pressure issues or health conditions?

Disposal of Wastes: If the groundwater must be treated to meet drinking water standards, what are the anticipated wastes that will be generated from the treatment process, and how will these wastes be disposed of properly? Conventional disposal in non-marine environments is by deep well injection, which can be quite costly. Is this method of disposal acceptable in Montgomery County at any cost?

Temperature: Will cooling towers or similar devices be required to bring temperatures down to acceptable levels to consumers? This additional process adds considerably to the cost and risk of acceptability of the water to consumers. How does higher water temperature affect appliances and plumbing or the acceptability of the water to consumers?

Reliability: Will the well be affected adversely by extensive pumpage or will the water deteriorate in quality or quantity with sustained usage? Are the various sand layers that contain poor or impaired water quality interconnected with other preferred sand layers such that over time, those producing sand layers will also become impaired as water moves through the aquifer due to pumpage. How will the water quality change over time as water is pumped from the aquifer?

Other Considerations: Will Catahoula water, whether treated or untreated, have a corrosive or other undesirable effect on existing facilities and lines? Will blending of Catahoula water with other groundwater or treated surface water produce any undesirable chemical consequences? Will the resulting blend be acceptably free of taste and odor? Will consumers be satisfied with the overall results?

Regulatory Constraints: Will the required level of reduction in groundwater withdrawal from the Gulf Coast Aquifer be increased in the future? Little is yet known about how the 30% reduction currently in effect will benefit the Gulf Coast Aquifer over time, particularly with the expectation that Montgomery County and surrounding counties that share the same aquifer will continue to experience rapid growth and corresponding increases in the demand for water. If further reductions are required, will the increased reductions affect the feasibility of non-treatment, minimal treatment, cooling or blending of Catahoula water? Will the Catahoula Aquifer become regulated by Lone Star Groundwater Conservation District in the future? To date, LSGCD has assumed that the Catahoula Aquifer is not effectively connected to the Lower Jasper Aquifer and that pumpage of the Catahoula will not adversely affect the upper aquifers. This determination may change over time and with more data and experience, resulting in possible restriction of the use of the Catahoula and possible pumpage fees for withdrawal of water from the Catahoula. If pumpage from the Catahoula Aquifer begins to impact neighboring counties, state law may require the LSGCD to coordinate with affected groundwater districts and may require regulation. A water system operator relying upon the Catahoula incurs all of the risks of future regulatory constraints and the resulting costs.

Costs and Funding: Last, but certainly not least, will the resulting water cost to the consumer in both the short and long runs be the lowest obtainable under the circumstances? The initial capital investment in the Catahoula, the costs for operation, maintenance, repair and replacement, and the useful life of system facilities producing and distributing the water are not known with any certainty. What sources are available for funding facilities associated with an unproven source of water? How will the unknown long-term reliability of this water supply impact financing costs? What is the financial impact to consumers if utilization of Catahoula water is not successful and an additional source of water must also be developed and financed? Will other alternative supplies be available at that time?

HOW ARE THE QUESTIONS CONCERNING CATAHOULA WATER ANSWERED?

Data relating to the upper aquifers has been compiled, mostly by trial and error, over many decades. There are few remaining unknowns associated with drilling and producing the Chicot, Evangeline, and Jasper Aquifers. On the other hand, there is little local data that is reliable and predictable about the Catahoula. As stated in the *Guidance Manual for Brackish Groundwater Desalination in Texas*, (TWDB, April 2008), "Much of the engineering feasibility is dependent on the quality, quantity and reliability of groundwater available for project implementation. Thus the collection, review, and preliminary analysis of existing data are critical." And "One of the most important aspects of planning a brackish groundwater desalination facility is that of accurately characterizing the groundwater source to be used….Even so, the location, quantity and quality of the brackish groundwater resources in Texas vary widely and must be evaluated individually." To gather this scientific data, one of two approaches must be employed: experience through trial and error over several decades until sufficient data is available to make reliable predictions, or an accelerated systematic, scientific exploration and production approach requiring the risk of enormous amounts of capital investment in both pilot and production wells, the possible wasting of water, and a firm commitment by the water community. The latter approach would require ten years or more of intensive study and tens of millions of public dollars in investment.

WHAT HAS SJRA DONE TO EVALUATE THE FEASIBILITY OF THE CATAHOULA?

The SJRA has consistently advocated the accelerated scientific approach to spare the smaller, less financially able water system owners the costs and risks of wildcat wells and has taken a number of steps to attempt to advance the known science of the Catahoula. First, the GRP contract among the GRP Participants allows any Participant to explore for alternative water supplies with its own funds and to use such alternative supplies, including Catahoula water, without pumpage fees or restrictions so long as the Participant continues to take the planned amount of treated surface water, if any, from the GRP program.

Secondly, the SJRA has taken steps to explore the Catahoula in a responsible and measured manner. Two proposals to incorporate the use of groundwater withdrawn from the Catahoula presented by two GRP Participants, the City of Willis and Montgomery County Utility District No. 2, have been reviewed and approved for incorporation into the GRP Program. The City of Willis is awaiting funding approval from the Texas Water Development Board.

SJRA is also currently evaluating the potential to utilize groundwater extracted from the Catahoula for industrial use in the Lake Conroe area. It is anticipated that a demonstration well will be constructed and placed into production in 2012, thus providing significant operational, water quality, and water quantity data with limited risks to the public.

The SJRA has evaluated the potential use of groundwater withdrawn from the Catahoula for use at the GRP water treatment plant site during construction; however, it was determined not to be nearly as cost effective as alternative options. The SJRA is currently evaluating the opportunity to construct a pilot test well into the Catahoula aquifer in The Woodlands as a part of the construction of a water well into the Jasper aquifer. Evaluation of the test results would be made or monitored by the USGS. (See Figure 3)

Additionally, SJRA has discussed with LSGCD staff a coordinated effort between these two largest and most financially-capable water agencies in Montgomery County to conduct this exploration and study in an effort to expedite the science of this aquifer. To date, LSGCD has not determined to pursue this effort pending completion of LSGCD's current modeling effort for the Catahoula, while SJRA has been accused of attempting to “monopolize” the Catahoula Aquifer for suggesting such an undertaking. In this regard, it should be noted that the GRP contracts require SJRA to diligently search for alternative water supplies and, so long as these efforts are approved by the GRP Review Committee, to pass through the results of any searches for additional sources at actual cost to the GRP Participants.

Regardless of the approach taken in evaluating the Catahoula, a tremendous investment of public funds and an extended period of time will be required to come to any reliable conclusions as to the feasibility of using the Catahoula Aquifer on a broad scale as either a primary or secondary source of supply in Montgomery County. Since the groundwater reduction mandate is currently only 30%, the remaining 70% of the County’s water supply will continue to be dependent upon the upper aquifers. Given the present state of overpumpage of these upper aquifers, it seems extremely dangerous to assume that these aquifers will tolerate continued overpumpage for another ten years or more without permanent damage to our main source of supply.

HOW IS THE FEASIBILITY OF CATAHOULA WATER DIFFERENT FROM THE USE OF BRACKISH WATER IN OTHER AREAS OF THE STATE?

Comparisons between brackish water projects based upon the cost of water to the consumer are of little value when each project has radically different conditions. The ultimate cost to the consumer is dependent upon, among other matters, the proximity of the well to the storage and distribution system of the operator, the depth of the well, the cost of energy required for production, the quality, temperature, treatability, consumer acceptability and safety of the water, the method and location of disposal of wastes, the size and complexity of the project, the long-term cost of operation and maintenance of the project, the likelihood that water can be blended with other sources, the effects of the water on existing water sources, facilities, distribution lines and plumbing, the need for additional storage and pumping, the current and future regulatory conditions, and the availability of state or federal funding to defray all or a portion of the costs of construction or operation of the project. With all of these conditions being at feasible levels, there still remains the question of the reliability of the water source as to both quality and quantity. In the final analysis, the acceptability of the final cost of water to the consumer may ultimately be determined by the lack of any practical alternative water source.

> The SJRA Phase I GRP Project using Lake Conroe water to yield 30 mgd of potable water is estimated to cost $1.41 per 1,000 gallons after treatment and an additional $1.04 per 1,000 gallons for pressurization and distribution, or a total of $2.45 per 1,000 gallons.
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> By way of comparison, the San Antonio Water System recently completed an evaluation of a brackish groundwater desalination program with a capacity of 10.5 mgd that included production wells approximately 1,000 feet deep, salinity of approximately 1500 ppm (Total Dissolved Solids), monitoring wells, a well collection system, a treatment facility, and an onsite waste injection well for a total capital cost of approximately $121,000,000 and a unit cost of approximately $4.77/1,000 gallons at the point of treatment and prior to delivery. While there are some potential similarities with the SJRA GRP, there are also some key differences between the SJRA GRP and the SAWS project, including the fact that wells in Montgomery County will be considerably deeper.
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> The City of El Paso recently constructed a 27.5 mgd brackish desalination supply system that included the rehabilitation/repair of 16 existing wells that will feed a 15.5 mgd water treatment plant, 17 new wells whose water will be blended with the finished water of the new water treatment plant, and an off-site, deep-well injection disposal well. The wells are screened at intervals between 400 and 900 feet in depth and the salinity of the groundwater ranges from 900 to 1800 ppm (TDS). The total cost was approximately $93,000,000, and the unit cost for the treated water, before delivery, was approximately $2.56/1,000 gallons. Again, wells in Montgomery County will be considerably deeper, disposal would require

higher pressure, and much less is known about the reliability of our local source of supply.

A study was recently completed for the Aqua Water Supply Corp. in Bastrop. The 2 mgd plant included a feed water of approximately 1400 ppm and disposal using either underground injection or surface disposal. The total capital cost is estimated at approximately $14,000,000, with a unit cost for treated water of approximately $3.08/1,000 for deep well injection or $2.59/1,000 for surface discharge.

In 2009, Montgomery County MUDs No. 8 and 9 submitted a report to the Region H Water Planning Group regarding the feasibility of brackish groundwater desalination in the Walden area. The proposal was included as an alternate water management strategy in the Region H Water Plan, and a technical memorandum on the project was included in Chapter 4. According to the technical memorandum, the proposed plant had a capacity of 2 mgd and utilized brackish water from the Catahoula Aquifer at a depth of 1,700 to 2,800 feet. For purposes of the study, salinity was estimated to be between 1,000 and 5,000 ppm. The total capital cost was estimated at approximately $12,000,000, with a unit cost for treated water of approximately $2.66/1,000 (The Region H Technical Memo incorrectly cites this cost as $3.60 per 1000 gallons. Region H confirmed that $2.66 is the correct cost.). The memorandum did not identify a method of concentrate disposal.

Finally, based on a review of preliminary water quality data from the pilot test wells in Bentwater (MUD 18) and April Sound (UD 3), a preliminary engineering analysis for a 10 mgd output from the same sources indicates the need for eight 1500 gpm production wells approximately 3000 feet in depth, a 10 mgd conventional treatment plant, a 5 mgd reverse osmosis plant to treat one-half of the finished water from the conventional plant, cooling towers and deep well injection disposal wells at an estimated cost of approximately $83,500,000, with a unit cost of approximately $4.52/1,000 gallons of water treated. The need for the conventional water treatment plant and the RO plant are due to potential concerns for addressing aluminum, corrosivity, iron, manganese, radionuclides, and TDS.

As noted above, over 40% of the SJRA total water cost involves the construction and operation of a new pressurization and pipeline distribution system, while the comparable systems are assumed to have existing pressurization and distribution systems at no additional costs. SJRA's total delivered cost and treated costs only are compared in Figure 4.

HOW IS THE FEASIBILITY OF CATAHOULA WATER DIFFERENT BETWEEN AN INDIVIDUAL WATER SYSTEM OPERATOR AND A REGIONAL WATER SYSTEM OPERATOR?

In a near perfect situation, where the critical elements of location, depth, quality, quantity, temperature, and regulatory environment are close to optimum, it may be feasible for an individual water system operator to achieve acceptable and affordable results with Catahoula water. Then, only long-term reliability and operation and maintenance costs remain as serious risks. In the event of failure, the damage, albeit locally catastrophic, is isolated to a single water system. Every water system operator in Montgomery County had nearly five years to follow this course of action after the proposed groundwater reduction rules of LSGCD were announced. Few did so, primarily because near perfect conditions are rare and risk taking with public funds is not what is normally expected of government. Claims of brackish water costs to the consumer in the $1.50 per 1,000 gallon range are also rare, specific to the particular conditions of that project, and of little value in Montgomery County.

By contrast, a regional operator contemplating the use of Catahoula water must not only bear the risks of long-term reliability and operation and maintenance costs, but must also count on near perfect conditions for making a huge capital investment in a number of simultaneously constructed wells, connected by an extensive network for water gathering, transportation and storage prior to treatment and/or cooling and distribution, and the construction of a regional distribution system to the participating retail water systems that can effectively accept, blend or use the water. With the costs of land, access, adequate power supplies, and communications facilities for the drilling, completion, operation, and coordinated control of numerous wells at remote sites, together with the costs of rights-of-way for and the construction of miles of well collection lines, millions of gallons of storage, pumping facilities and controls, and related items, just to bring the produced water to a centralized point for treatment, cooling, pressurization and distribution, and waste disposal by deep injection wells, the financial and operational risks are daunting. The risks of failure entail not only non-compliance with regulatory requirements, but also possible loss of opportunities to use other alternative sources, area-wide water shortage, including economic stagnation, risks to public health and to property, irreparable damage to the Gulf Coast Aquifer, and an enormous loss of invested capital.

In order to design and construct a Catahoula-based system as a primary supply for Montgomery County comparable to the proposed first phase of the SJRA GRP project, some 20 deep wells and remote well sites would be required, at an average cost of approximately $2 to 3 million each, plus the costs of the well collection line system, controls, storage and pumping facilities that would be required just to replicate a consolidated raw water supply of 30 mgd (assuming no quality or quantity issues immediately or in the long term). Further assuming that no treatment, cooling or waste disposal whatsoever would be required, the investment in the supply system alone would exceed the costs of treatment of Lake Conroe water. To these costs and the associated risks would be added the same pressurization and distribution system costs already included in the SJRA GRP project to deliver the water to participating water systems.

In sum, in an absolutely perfect scenario where no risks of quality, quantity or reliability are encountered over the long term (since it is likely that the currently available supply of water in Lake Conroe will then have been used for other purposes, if not for the GRP project), the cost of such a system would be no better than the cost of water from the proposed SJRA GRP system; the existing alternative supply of fresh water of known cost, quality, quantity, and reliability may no longer be available; and the levels of Lake Conroe would remain no better than they are now and almost entirely dependent, as now, upon nature and rainfall.

## CONCLUSIONS

As stated in the *Guidance Manual for Brackish Groundwater Desalination in Texas*, (TWDB, April 2008) "Due to limited availability of data on brackish groundwater in Texas, a phased approach to evaluating the feasibility of brackish groundwater development provides the greatest chance of ultimate success. This process allows the project to move forward incrementally so that potential risks and fatal flaws can be identified at the earliest possible time and with minimal amount of capital investment. As new information is developed, the scope of additional work can be tailored to address project needs and minimize risk."

SJRA's engineers are bound by the professional conduct and ethics of the Texas Board of Professional Engineers which states "Engineers shall be entrusted to protect the health, safety, property, and welfare of the public in the practice of their profession." and "Engineers shall not perform any engineering function which, when measured by generally accepted engineering standards or procedures, is reasonably likely to result in the endangerment of lives, health, safety, property, or welfare of the public." The SJRA decided to follow this measured and professionally responsible approach to the potential use of Catahoula water as a possible future additional source of water while protecting the health, safety, and investment of its Participants. We see no credible alternative to timely and prudently meet the water needs of Montgomery County and the regulatory requirements of LSGCD.

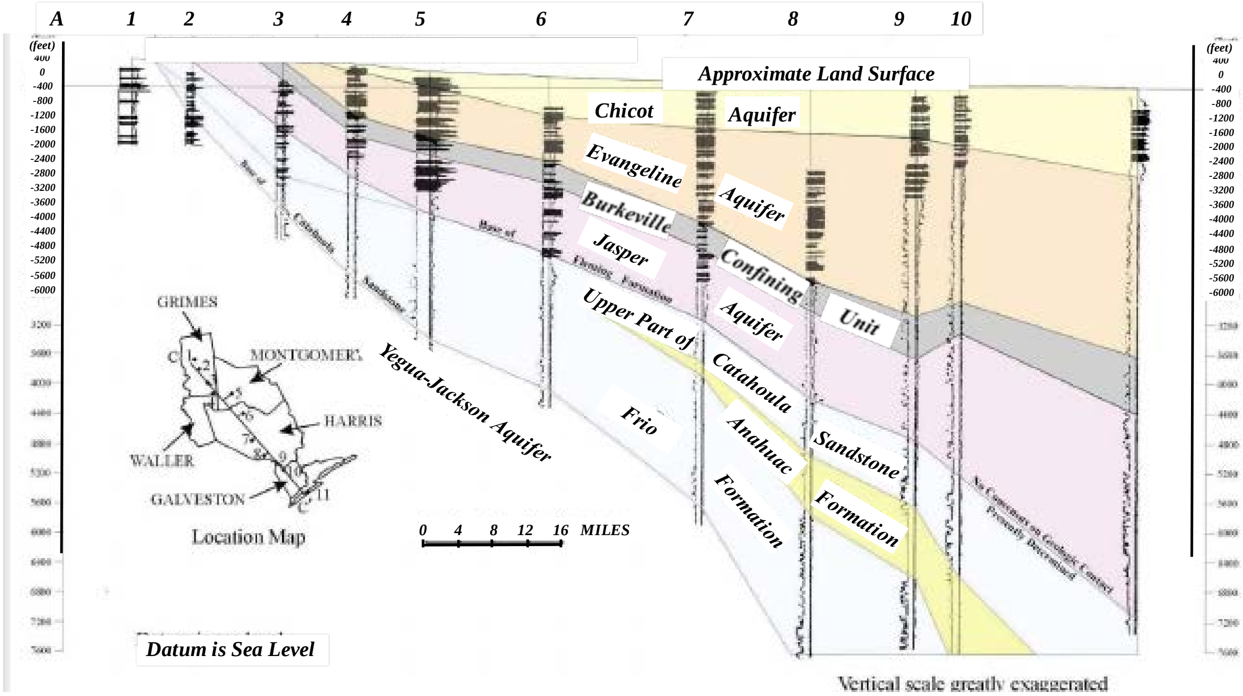


Figure 1 - Cross-Section of Aquifers

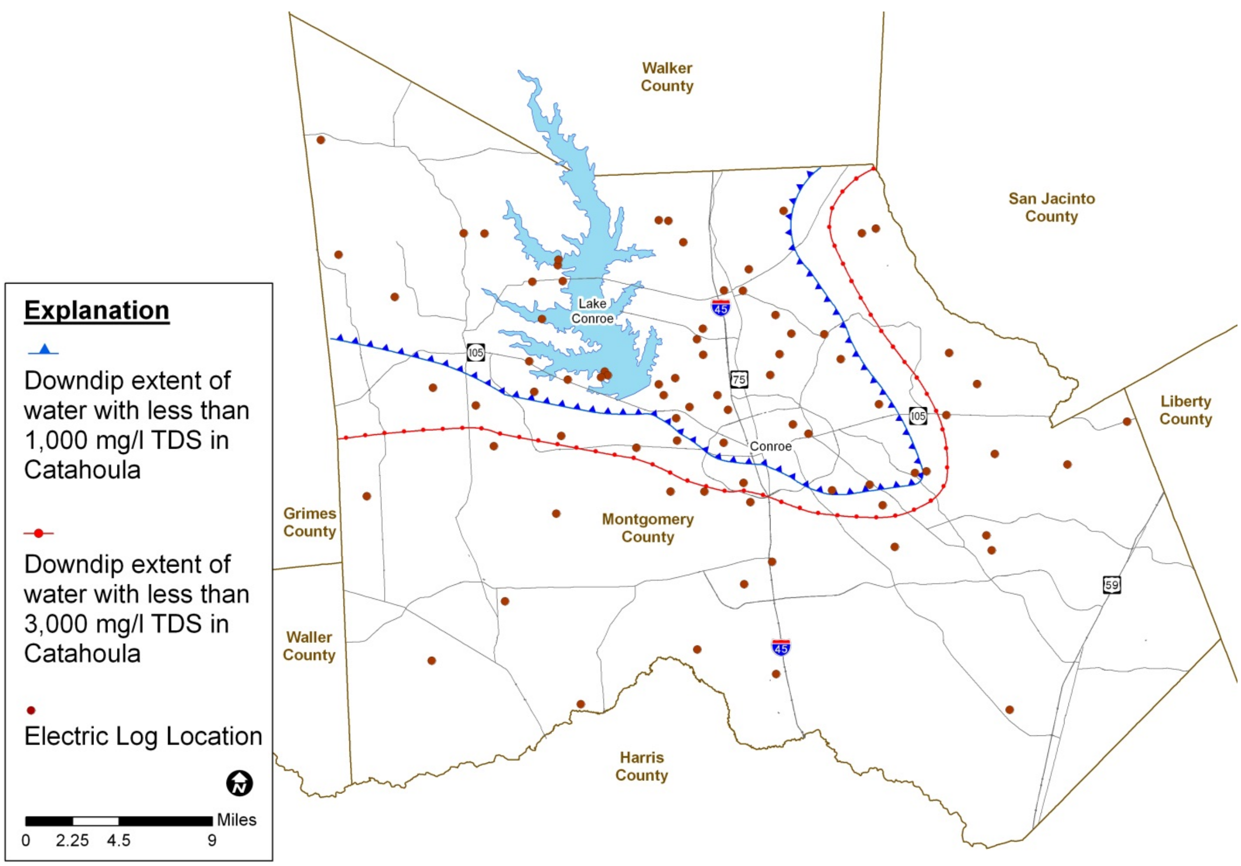


Figure 2 - Down-Dip Extent of Freshwater and Saline Sands Based on Analysis of Geophysical Logs

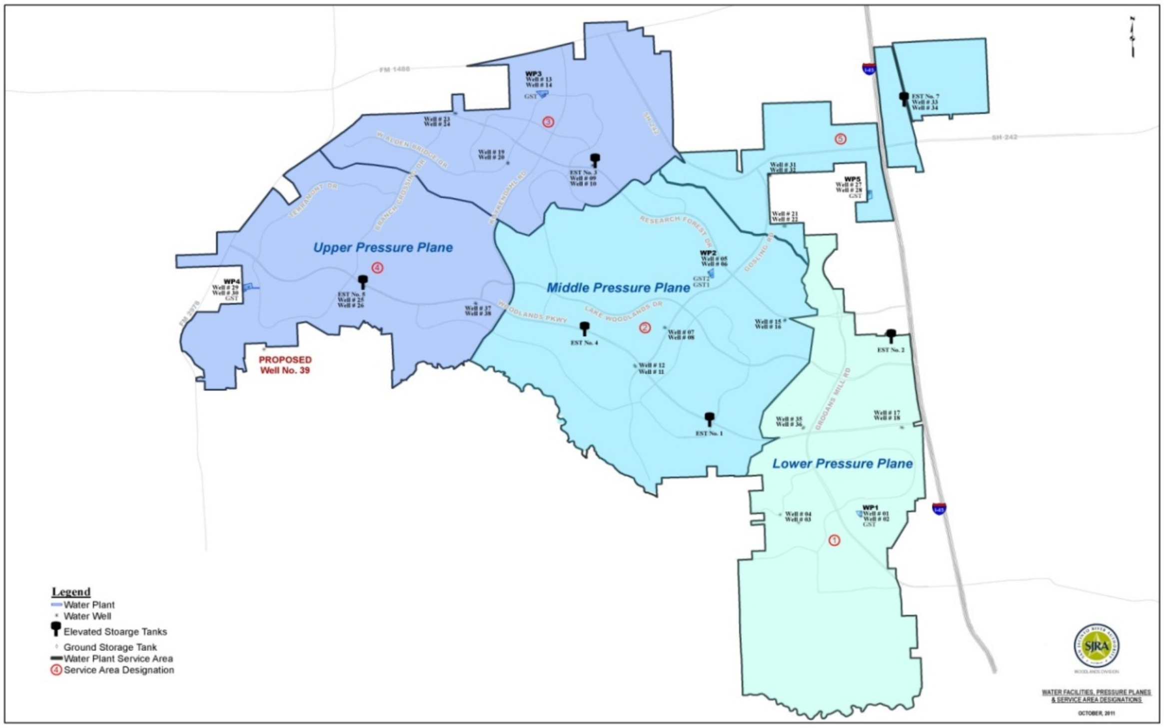


Figure 3 - Location of Proposed Water Well No. 39

| Project / Description | Capacity | Water Depth | Salinity | Disposal Method | Treatment Cost (per 1000 gal) | Delivery Cost (per 1000 gal) | Total Cost (per 1000 gal) |
|---|---|---|---|---|---|---|---|
| San Antonio Water System – brackish desalination study | 10.5 MGD | 1000 feet | 1500 ppm | Deep well injection | $4.10 | $0.67; Integration to existing distribution | $4.77 |
| El Paso Water Utility – brackish desalination project; project blends fresh water with desalinated water | 27.5 MGD | 400 to 900 feet | 900 to 1800 ppm | Deep well injection | $2.56 | Assuming no cost of integration to existing distribution system | $2.56 |
| Aqua WSC, Bastrop – brackish desalination study | 2 MGD | | 1400 ppm | Deep well injection | $3.08 | Assuming no cost of integration to existing distribution system | $3.08 |
| Montgomery Co MUD 8&9 – Region H Technical Memo summarizing 2009 brackish desalination study | 2 MGD | 1700 to 2800 feet (estimated) | 1000 to 5000 ppm (estimated) | Not stated in Tech Memo | $2.66* | Assuming no cost of integration to existing distribution system | $2.66* |
| SJRA preliminary cost analysis for brackish desalination project based on recent Catahoula samples | 10 MGD | 3000 feet | 1000 ppm | Deep well injection | $4.52 | $1.00; Assume similar to GRP distribution | $5.52 |
| SJRA Phase 1 GRP Project (surface water) | 30 MGD | N/A | N/A | N/A | $1.41 | $1.04 | $2.45 |

* The Region H Technical Memo incorrectly cites this cost as $3.60 per 1000 gallons. Region H confirmed that $2.66 is the correct cost.

Figure 4 – Summary of Project Costs for Brackish Desalination Projects