Groundwater Desalination: An Under-Projected Source of Supply?

The 2012 State Water Plan projects that groundwater desalination will account for only about 181,000 acre-feet/year of new water supply by 2060, a mere 2 % of the total new water supply envisioned by the plan. Yet, a 2003 study for the Texas Water Development Board (TWDB) indicates that Texas has 2.7 **billion** acre-feet of brackish groundwater. This post explores the apparent disconnect between the availability of brackish groundwater and its projected role in meeting water demands.

Barriers to more extensive planning for use of brackish groundwater desalination include lack of sufficient data on the resource, uncertainty about costs (including energy costs) and disposal of waste brine from the desalination process and regulatory uncertainties.

However, brackish groundwater desalination should be able provide a much great percentage of the new water supplies if these barriers can be tackled at the statewide level. Desalination of brackish surface and groundwater is being used across the state, indicating that these barriers can be overcome and that desalination is an increasingly viable alternative to unreliable or over-stretched freshwater supplies. Particularly west of Interstate 35, where the current water plan projects construction of several expensive new surface water reservoirs, brackish groundwater can be a competitive and more reliable supply alternative.

Moreover, the current state water planning process fails to provide incentives or support for increasing use of brackish groundwater. Brackish ground water could be used as an alternative to freshwater for power plant cooling, hydraulic fracturing, mining and other industries, which would allow freshwater resources to be conserved for drinking water and other essential needs.

Brackish Groundwater Resources

Over the last 15 years, with encouragement from the legislature, Texas water planners have begun to pay more attention to brackish groundwater as a potential source of supply. In 2003, TWDB commissioned an extensive study by the firm LBG-Guyton and Associates. Using data from existing well logs and other sources, LBG-Guyton mapped brackish groundwater resources by salinity level (with anything over 1000 mg/liter total dissolved solids (TDS) considered brackish) and estimated volumes of brackish water present in the various aquifers across the state. **Figure 1** shows the results of that mapping. The TWDB used this analysis to estimate the volume of brackish groundwater of less than 10,000 mg/liter TDS available by planning region (**Figure 2**).

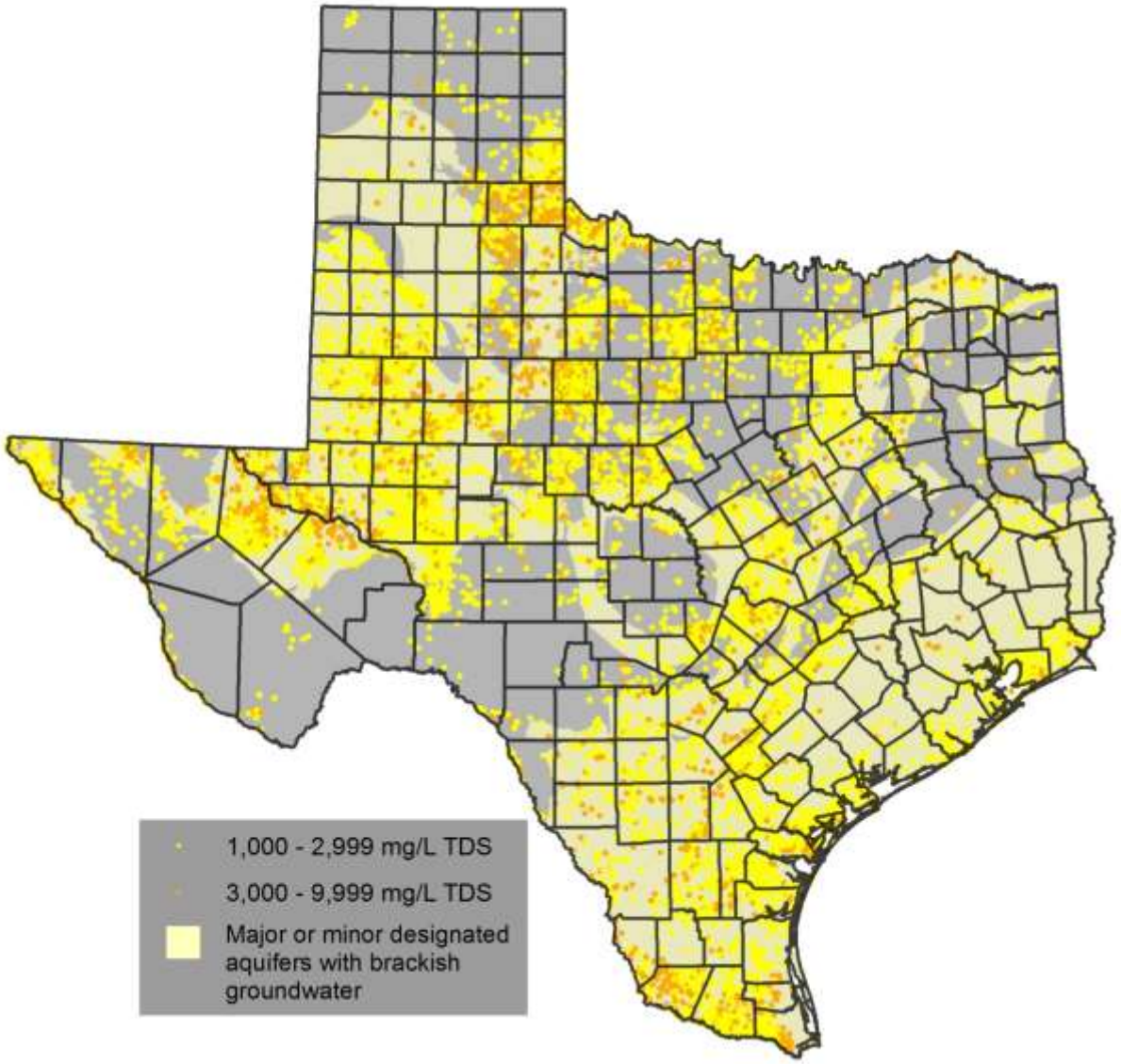

Figure 1. Brackish Groundwater Resources Map Source: Texas Water Development Board

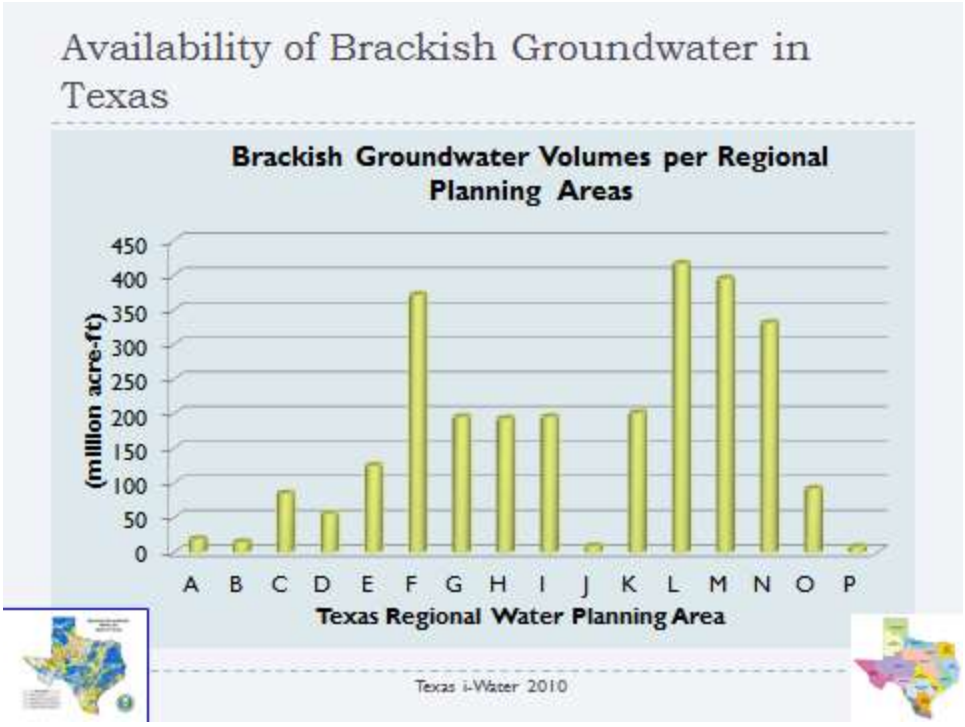

Figure 2. Brackish Resources by Region. Source: Jorge Arroyo, TWDB, The State of Brackish Groundwater Desalination in Texas, 2010 (less than 10,000 mg/liter TDS).

TWDB has also embarked on a project to provide more detailed mapping and characterization of brackish groundwater resources. The Brackish Resources Aquifer Characterization System (BRACS) uses existing geophysical log data which includes the deeper formations where brackish water is often found. It began with the Pecos Valley Aquifer and is now focused on the Queen City and Sparta Aquifers in McMullen and Atascosa counties; the Gulf Coast Aquifer in the Lower Rio Grande Valley and the Carrizo and Wilcox Aquifers in Central Texas.

Current Use of Brackish Groundwater Desalination

Brackish groundwater desalination currently provides about 56,500 acre-feet/year of potable water supply. Existing brackish groundwater and brackish surface water desalination plants are shown in red in **Figure 3.**

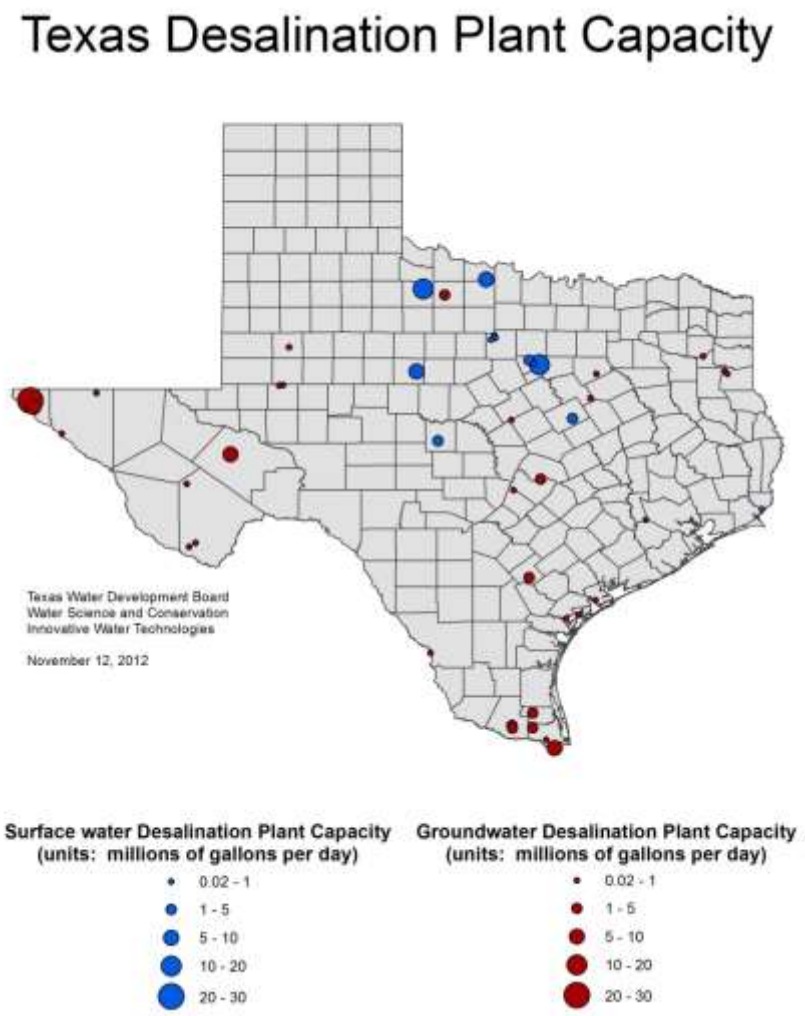

Figure 3. Texas Desalination Plant Capacity Source: Texas Water Development Board

In the 2012 State Water Plan, five planning regions (E, F, L, M and O) proposed to use brackish groundwater desalination as a new source of municipal supply (**Table 1**). Almost half of the approximately 180,000 acre-feet/year total projected 2060 capacity would be in Region M, the Lower Rio Grande Valley. With an over-appropriated Rio Grande and only brackish groundwater, Region M has few other future water supply options.

Table 1. 2012 Water Plan proposed brackish desalination water supply strategies

Region	2010	2020	2030	2040	2050	2060
E	0	1607	3304	4764	16,245	27,726
F	2004	2954	2954	15,050	15,050	15,050
L	0	14,000	26,596	33,116	38,716	40,216
M	33,951	62,239	67,170	73,955	86,409	90,915
O	0	3360	3360	3360	3360	3360

Together, Regions L and M account for about 72 % of the proposed new desalination capacity. The largest individual project is that proposed by San Antonio Water System. SAWS is proposing development of a built-out capacity of 30,525 acre-feet/year brackish desalination facility in Bexar County with an estimated capital cost of $ 300 million (the 2011 regional water plans, from Table 1 was prepared, reflect only 26,400 acre-feet/year capacity for the proposed SAWS plant. The 30,525 acre-feet/year comes from more recent descriptions of the project).

Figure 4 maps water user groups with projected unmet demands in conjunction with brackish resources and proposed projects. While the economics and viability of the use of brackish groundwater desalination for municipal needs is certainly site-specific, there are many water user groups with needs in areas with brackish groundwater resources where groundwater desalination has not been proposed as a future supply strategy.

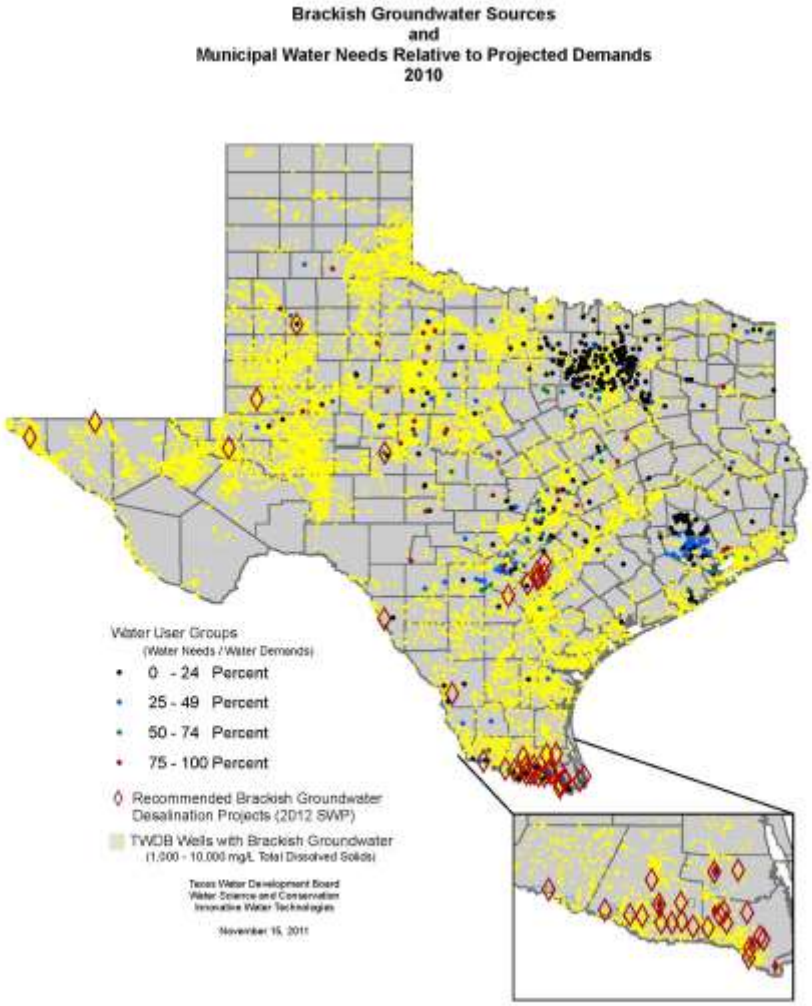

Figure 4. Water Needs relative to Brackish Groundwater Locations and 2012 SWP projects. Source: Texas Water Development Board

Other cities beginning to actively examining brackish groundwater desalination projects that are not included in the 2012 state water plan include Odessa and Corpus Christi.

None of the 2011 Regional Water Plans identified specific projects to use brackish groundwater for power plant cooling. This is a significant omission, as steam electric power freshwater is projected to increase from 733,179 acre-feet/year in 2010 to 1,620,411 acre-feet/year in 2060. (Though see our previous analysis here for a discussion of whether these projections are realistic. Brackish water is often suitable for once-through power plant cooling. In addition, where use of freshwater for hydraulic fracturing is putting pressure on local aquifer levels, planners could look to more aggressive use of brackish water. State legislation in the 1980's required oil companies to evaluate the use of brackish

groundwater as an alternative to fresh water for secondary recovery. Costs for use of brackish water proved not to be a barrier to this use in many areas of west Texas.

Brackish Groundwater Desalination v. Reservoirs for Municipal Supply

As recent years have shown, reservoirs west of IH-35 are extremely vulnerable to drought and higher temperatures. Reduced inflows and increased evaporation have brought major supply reservoirs in this area, such as Lakes Ivie, Spence, Meredith, Fisher, Abilene and more , to 10 % or less of normal storage capacity, and most others are near 25% capacity (maps).

Despite the clear unreliability of reservoirs as a water supply strategy in this part of the state, the 2012 Plan proposed 7 new surface water reservoirs west of IH-35 (**Table 2**), with a total yield of about 126,500 acre-feet/year and a total projected capital cost of $ 895,000,000. Most of these projects are targeted to municipal water supply, though the proposed Cedar Ridge Reservoir near Abilene was also justified on the basis of a proposed new power plant (a plant that has since been cancelled).

Table 2. Reservoirs Proposed in 2012 State Water Plan for West of IH-35

Region	Reservoir	Capital Cost (millions)	Yield (acre-feet/year)
B	Lake Ringgold	$ 382.9	27,000
G	Cedar Ridge	285.2	23,380
	Coryell	51.9	6,730
	Turkey Peak	50.3	7,600
	Miller's Creek new dam augmentation	47.0	17,582
O*	Jim Betram 7	68	17,650
	Post	110	25,720

*Both Region O Reservoirs are proposed to store a significant amount of reclaimed water discharged from the City of Lubbock's sewage treatment plants. Also, the yields reported in the Region O plan are substantially higher than those in the City's 2013 Water Resources Plan.

For example, in the 2012 plan, Wichita Falls in Region B proposes development of Lake Ringgold, which would purportedly supply about 27,000 acre-feet/year in 2050 at an estimated cost of $382,900,000. This potential reservoir site was first identified in the early 1980s. It was not included as a proposed supply strategy in either the 2002 or the 2007 Region B plan, though it was included in the "unique reservoir site" designations recommended by TWDB in the 2007 State Plan and in the subsequent list of unique reservoir sites listed in Senate Bill 3, which was passed by the legislature in 2007.

Wichita Falls overlies the Seymour Aquifer. The 2003 LBG-Guyton report characterizes brackish groundwater availability from that aquifer in Region B as "moderate" and as having "low" production costs. Yet, the 2012 Region B plan did not evaluate brackish groundwater desalination as an alternative to the Lake Ringgold site. (Region B does propose desalination of surface water stored in Lake Kemp, which is currently at about 25% capacity). The Region B plan's evaluation of Lake Ringgold fails to acknowledge the problems that have arisen with other nearby reservoirs, in terms of lack of inflows and sedimentation, even concluding that a new lake would have "good reliability." (As a side note, it is not clear that Lake Ringgold would even be needed at all, given that the 2060 supply shortfall for Wichita Falls is predicted to be less than 5,000 acre-feet/year. Thus, the Region B plan could have examined a smaller scale brackish groundwater desalination plant for comparison.)

Similarly, Region G recommends three expensive new reservoirs west of IH-35 (Turkey Peak, Cedar Ridge, and Coryell County) and a new dam for increasing the capacity of an existing reservoir for a combined total capital cost of over $ 334,000,000 and purportedly able to supply a combined total of about 56,000 acre-feet/year. Region G appears to have examined groundwater desalination alternatives only in the northeast portion of Johnson County, despite the LBG-Guyton report characterizes several areas of Region G, west of IH 35, as having moderate availability and productivity of brackish groundwater.

While the Region O reservoirs would store a significant amount of treated wastewater (vs. just rainfall run-off), their expense and potentially contentious permitting issues seem to justify a harder look at desalination. Desalination was ranked low in the city's strategic plan largely because of the lack of data on brackish groundwater resources. This may also be an area of the state where co-locating quick-start natural gas peaking power plants with desalination facilities is an attractive option.

Legal Issues

In 2011, the House Natural Resources Committee interim charges included a directive to evaluate "the status of desalination projects in Texas, including an evaluation of the regulation of brackish groundwater and whether opportunities exist to facilitate better utilization of this groundwater to meet future needs." The Committee's Report included the following recommendations:

> ***Pilot Studies and Permitting***
> *Consider the effectiveness of pilot studies and testing requirements in the development of desalination projects.*
>
> *Continue streamlining the process review for planning in order to expedite the permitting process for a desalination plant.*
>
> ***Local and Regional Planning***
> *Encourage local and regional entities to further consider desalination as an available alternative water supply to meet immediate demands, especially in times of drought.*
>
> ***Waste Disposal of Brine***
> *Continue studying the environmental impacts of brine disposal, while continuing to improve and advance more cost-effective disposal methods.*

Distinguishing Between Fresh Groundwater and Brackish Groundwater
Consider clarifying statutory language in order to distinguish fresh groundwater from brackish groundwater in the management and development of groundwater resources.

As a result of the legislative interest, the Texas Commission on Environmental Quality (TCEQ) recently addressed the pilot testing requirement by revising its guidance to allow computer modeling in place of pilot testing for most desalination projects that will provide potable water through a public water supply system, as well as making some other changes to streamline permitting.

Likewise, host of desalination bills were filed in the 2013 legislative session based on the work in 2011. One of the most comprehensive was HB 2578 by Representative Lyle Larson (R, San Antonio), a member of the House Natural Resource Committee. HB 2578 passed the House but did not make it through the Senate. As it passed the House, it would have required that each regional water planning group examine "opportunities for and the benefits of developing large-scale desalination facilities for brackish groundwater or seawater that serve local or regional brackish groundwater production zones." It would have also expanded TWDB responsibilities for feasibility studies and legislative reporting to include brackish groundwater desalination (in addition to current responsibilities for seawater desalination). It would have required groundwater conservation districts to identify "goals for the development of brackish groundwater desalination strategies in designated brackish groundwater production zones." Finally, it would have prohibited desired future conditions, which are set by groundwater management areas, from applying to brackish water zones. As *initially* filed, the bill would also have defined brackish groundwater as having a total dissolved solids content between 1,000 and 10,000 mg/liter.

The debates over HB 2578 illustrated some key legal issues that need resolution in order for brackish desalination to fulfill its potential. These include, but are not limited to:

- A statutory definition for brackish groundwater (whether it should start at 1,000 mg/liter TDS or a more concentrated level, or whether a qualitative definition linked to the need for desalination treatment before use is a better option);
- Whether desired future conditions and managed available groundwater limits for aquifer management should apply solely to freshwater or should include brackish water, and, if brackish water is included, guidance for developing separate DFCs and MAGs for brackish zones; and
- How to protect freshwater aquifers from infiltration of poorer quality water that may result in some locations if too much pumping of brackish groundwater.

Of course, the state of legal uncertainty surrounding ownership rights in and the extent that groundwater districts can regulate groundwater in Texas further complicates brackish groundwater projects that involve purchasing pumping rights from private landowners.

Conclusions

Even with improved technology (and potentially lower costs), brackish groundwater desalination will not be a silver bullet for every community's future water needs. However, it appears that there is significant potential for a more extensive use of brackish ground water through direct use or desalination. It would be a viable and sustainable strategy in areas of the state where traditional reservoir strategies are increasingly unreliable.

To ensure that brackish groundwater can play a significant role in filling future water needs, much more should be done at the state level to resolve statutory and regulatory barriers and to create incentives for its use. The new Senate Natural Resources Committee interim charges, which include a directive to examine recommendations to encourage the use of brackish resources, and the newly-established Joint Interim Committee on Desalination, provide important opportunities to move forward on these critical issues.

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