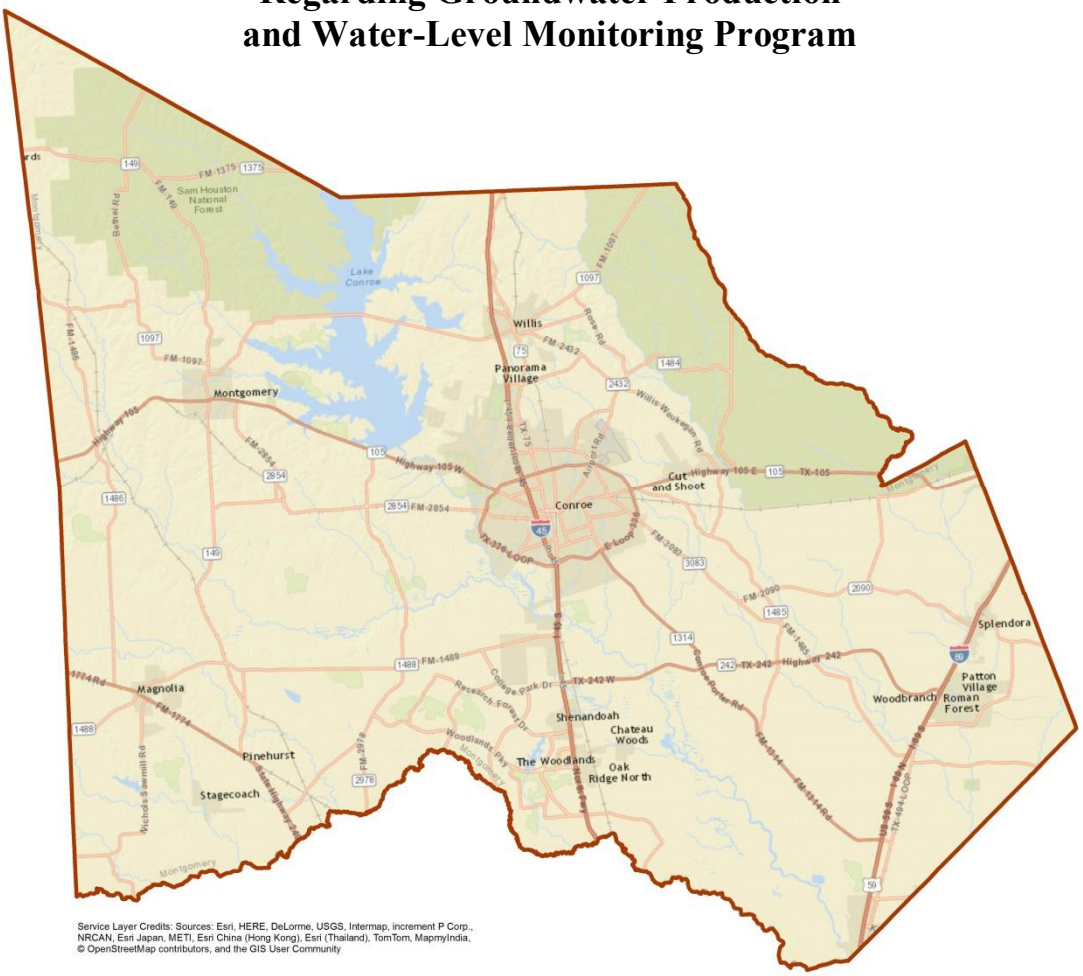
# DRAFT

## Technical Memorandum
## Regarding Groundwater Production
## and Water-Level Monitoring Program




**Prepared for**

**Lone Star Groundwater Conservation District**

**by**

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**July 2015**

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July 9, 2015

Ms. Kathy Turner Jones
General Manager
Lone Star Groundwater Conservation District
655 Conroe Park North Drive
Conroe, Texas 77303

Dear Ms. Jones:

Enclosed is a draft of our technical memorandum regarding an evaluation of well water-level monitoring and groundwater production data within the Lone Star Groundwater Conservation District. The memorandum also includes an assessment of the initial reduction in groundwater pumping in part of the North Harris County Regional Water Authority. An executive summary is included at the beginning of the report. This draft technical memorandum is presented in accordance with deliverables included in Task 1 of the Lone Star Groundwater Conservation District Strategic Water Resources Planning Study.

As you and others review the memorandum, please contact us with any questions and we shall try to address them.

Sincerely,

LBG-GUYTON ASSOCIATES

W. John Seifert, Jr., P.E.
Principal

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# EXECUTIVE SUMMARY

- A study was performed to assess the adequacy of the current groundwater water-level monitoring network and groundwater production data within the Lone Star Groundwater Conservation District (LSGCD). The study also included evaluating the response of the aquifers in the north part of Harris County to a reduction in groundwater pumping within the North Harris County Regional Water Authority (Authority).

- The collection of groundwater production data was initiated by the LSGCD in 2002-2003 and provides a good accounting of total permitted pumping. Additional effort is recommended to correlate groundwater production by well with the source of the withdrawal, whether Chicot, Evangeline or Jasper aquifers. Groundwater production from the Catahoula Aquifer started about four years ago and is identified for each well screening the aquifer.

- The areal and temporal distribution of monitoring wells encompasses the Chicot, Evangeline, Jasper and Catahoula aquifers. The areal or spatial coverage of the wells within the LSGCD has improved in the last 10 years and provides reasonably good coverage over a large amount of the LSGCD. Some areas of the county would benefit by the addition of 10 to 15 monitor wells per aquifer and/or the redistribution of monitor wells. The aquifers of interest would be the Chicot, Evangeline and Jasper. The coverage of monitor wells for the Catahoula Aquifer is adequate and should increase as the area of pumping from the aquifer expands. A total of about 20, 5-10, and 3 shallow monitor wells are recommended to be located in the outcrop areas of the Chicot, Evangeline and Jasper aquifers, respectively.

- The Authority initiated groundwater pumping reductions in 2010 at a rate of about 14.8 million gallons per day (mgd) and that rate increased to about 26.6 mgd by 2014. In general, about 79 percent of the pumping reduction was from the Evangeline Aquifer, 12 percent from the Jasper Aquifer and 9 percent from the Chicot Aquifer. The aquifer response in the area of the pumping reductions document about 20 to

possibly 60 feet of water-level recovery in the Evangeline Aquifer over an area of about 80 mi.$^2$ and a reduction in the rate of water-level decline in the Jasper Aquifer from about 15 feet per year to a much reduced rate of decline of a few feet per year. The static water levels in wells screening the Chicot Aquifer have essentially not changed since the groundwater pumping reductions were initiated. Thus, the introduction of surface water and the reduction in groundwater pumping were effective in reducing static water-level (artesian head) declines that can contribute to subsidence.

- In the future a recovery in the aquifer artesian head or water levels in wells in Montgomery County should occur locally to areas where groundwater pumping in the county is reduced. The amount of water-level recovery in each aquifer will principally be controlled by the amount of the pumping reduction in that aquifer. In Montgomery County, the initial major pumping reductions will occur from the Evangeline and Jasper aquifers and the static water-level recovery will occur principally in the south part of the county and in the City of Conroe area.

# INTRODUCTION

The Lone Star Groundwater Conservation District (LSGCD) is conducting a strategic evaluation of potential opportunities for additional development of groundwater resources while ensuring long-term viability of the aquifers in Montgomery County. The evaluation/planning process includes a review of the adequacy of the groundwater monitoring program to monitor and assess current aquifer conditions and to monitor the effects of the initial conversion to alternative water supplies in 2016. An initial phase of the study is to review the groundwater production and water-level data that have been collected over at least the past 10 years to help understand the response of the aquifers to pumping and also to gauge the areal coverage of the well water-level monitoring network and the program for collecting groundwater production data. Another objective is to evaluate the aquifersô response in terms of well water-level changes, principally within the north part of Harris County, to the initial conversion to surface water in that area where groundwater pumping was reduced beginning in 2010 when a supply of surface water was introduced. The aquifers occur under water table conditions in their outcrops and artesian conditions in the downdip areas where they provide large amounts of water. Water levels measured in wells in the downdip areas provide data on the artesian head fluctuations in the aquifers.

Some of the tasks for the technical memorandum include the collection and analysis of water-level and groundwater production data from numerous sources, both public and private, for the Chicot, Evangeline, Jasper and Catahoula aquifers. Water-level data also were collected in counties surrounding Montgomery County to help assess trends over the past decade and if wells were available to help review on a sub-regional basis static water-level changes that have occurred as pumping in the general Montgomery and Harris County areas has fluctuated (TWDB, 2015, Database Reports).

Data were compiled and analyzed for both static water levels (water levels measured while not pumping a well) and groundwater production for an area of the North Harris County Regional Water Authority (Authority) up to about 16 miles in diameter where the initial conversion to surface water occurred at a rate that ramped up from about 14.8 mgd in 2010 to

about 26.6 mgd by 2014 (NHCRWA, 2015). A map of Montgomery and surrounding counties is shown on Figure 1.

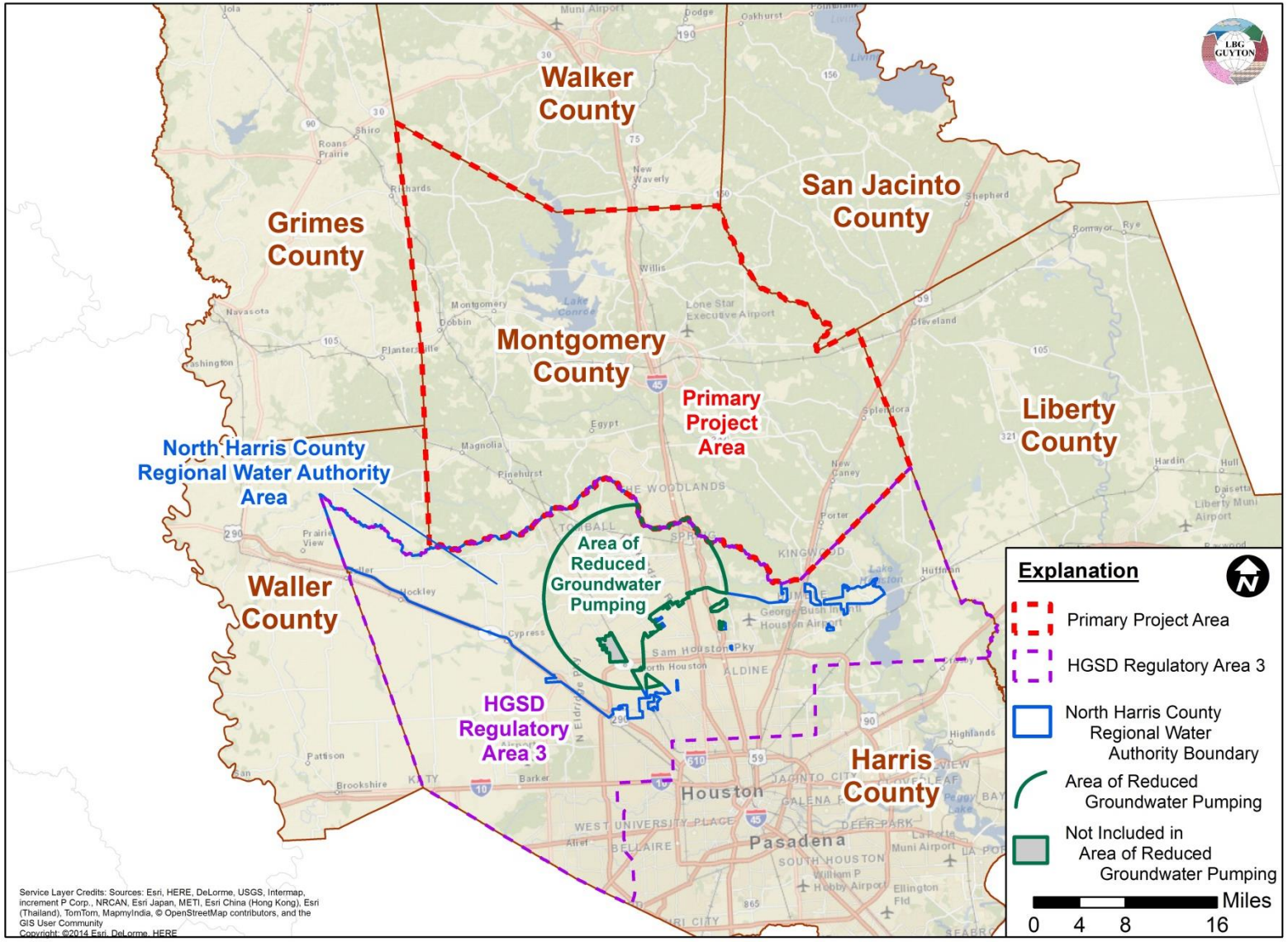


**Figure 1. Montgomery and Surrounding Counties**

# GROUNDWATER PUMPING

## Montgomery County Historical Groundwater Pumping

Montgomery County groundwater pumping data for 1984 thru 2014 are shown on Figure 2. Pumping data were collected from the Texas Water Development Board (TWDB) county pumping inventory tables for 1984 thru 2002 (TWDB, 2015, Pumping Estimates) and from the LSGCD permitted pumping production data for 2003 thru 2014 (LSGCD, 2015). The data include pumping from the Chicot, Evangeline, Jasper and Catahoula aquifers. The data show that total groundwater pumping was stable to gradually increasing until about 1992 and after that the rate of increase was substantially greater. This acceleration in the increasing rate of groundwater pumping is generally correlated with the increases in county population. The data on Figure 2 show that estimated pumping averaged about 24 mgd (26,883 ac-ft/yr) in 1984 and permitted pumping peaked at about 83 mgd (92,972 ac-ft/yr) in 2011, a year of low precipitation and high water demand. Since 2011 permitted pumping has ranged from an average of about 65 mgd (72,809 ac-ft/yr) to 69 mgd (77,298 ac-ft/yr). Pumping from the Catahoula Aquifer started in 2011 and increased from an average of 0.67 mgd (750 ac-ft/yr) in 2011, 1.48 mgd (4,681 ac-ft/yr) in 2012, 2.09 mgd (2,341 ac-ft/yr) in 2013 to 2.72 mgd (3,046 ac-ft/yr) in 2014.

Presently, a permittee in the LSGCD provides total pumping for a year and not pumping by aquifer, except for pumping from the Catahoula Aquifer. A number of permittees have multiple wells that screen either the Chicot, Evangeline or Jasper aquifers and thus report total pumping, but do not report pumping by aquifer. The LSGCD is improving its database and reviewing/revising its reporting requirements so that future pumping information will be provided by aquifer.

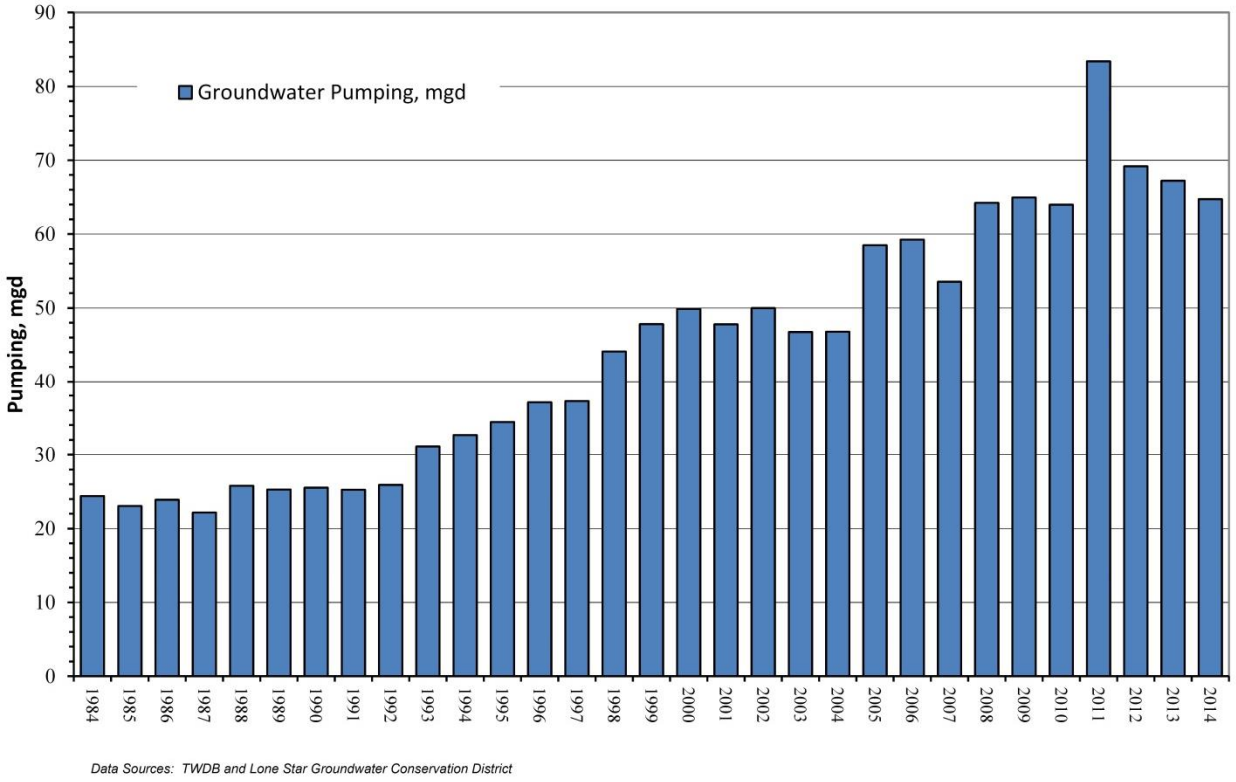


**Figure 2. Montgomery County Groundwater Pumping**

## Groundwater Pumping in Surrounding Counties

Pumping is occurring around Montgomery County from the same aquifers that provide water to users in the LSGCD. There have been variations in the quantity of water that is pumped from neighboring counties for the period from 2000 to 2013. Groundwater pumping data from the TWDB for Grimes, Walker, San Jacinto, Liberty and Waller counties available from 2000 thru 2012 are shown on Figure 3. Pumping data from the Harris-Galveston Subsidence District (HGSD) (HGSD, 2015) are presented for Regulatory Area 3 for 2000 thru 2013, as shown on Figure 4. The significance of the data are that they show whether pumping in a county has increased, decreased or has been stable over the past twelve to thirteen years and is an indication of whether the pumping in the surrounding counties would have a significant influence on the changes in well water levels over the past 12 to 13 years in the aquifers in Montgomery County. For Harris County, the pumping data are for Regulatory Area 3 and the area location is shown on Figure 1.

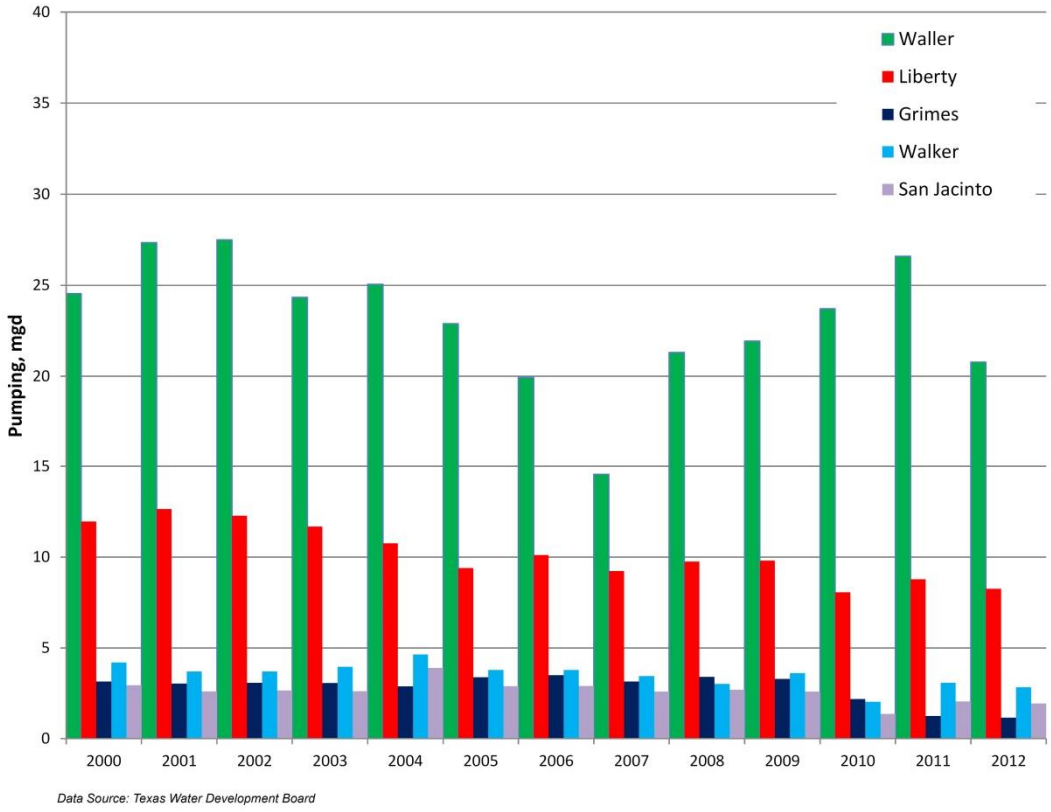


Figure 3. Groundwater Pumping by County

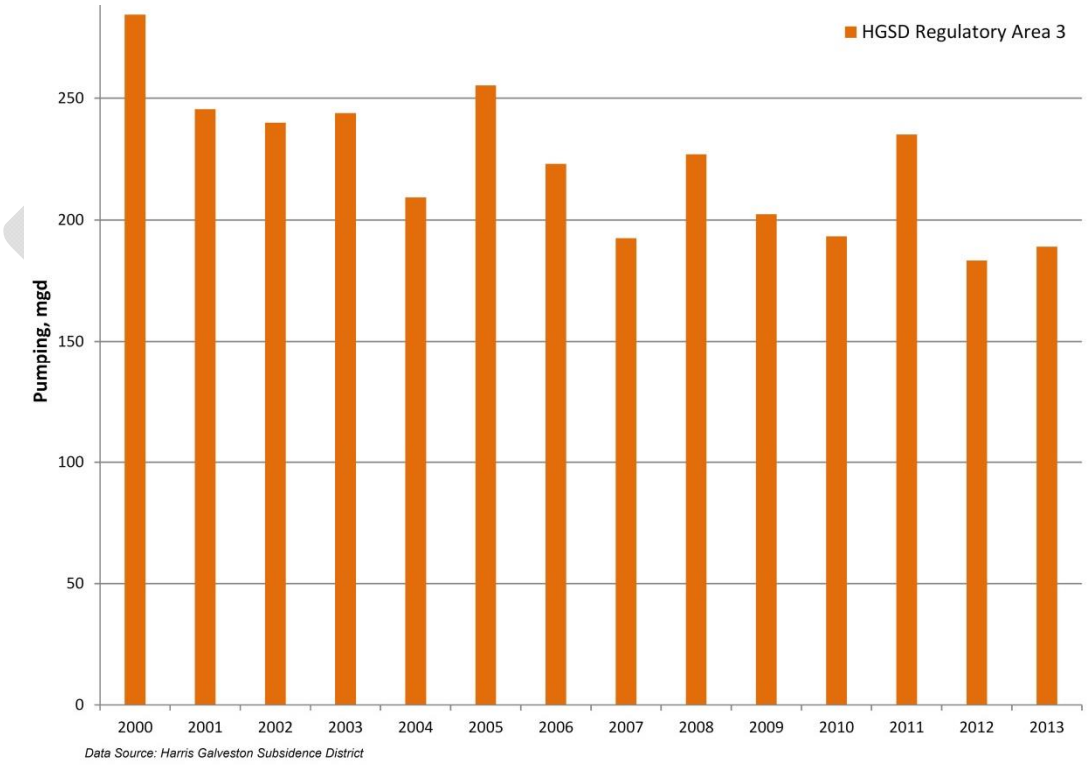


Figure 4. Groundwater Pumping in HGSD Regulatory Area 3

The data on Figure 4 show that the pumping from the Chicot, Evangeline and Jasper aquifers within Regulatory Area 3 ranged from about 284.5 mgd (318,640 ac-ft/yr) in 2000 to about 189 mgd (211,680 ac-ft/yr) in 2013. The general trend in the amount of pumping in Regulatory Area 3 is slightly downward since 2008 with the exception of 2011 when below normal precipitation resulted in increased water demand and an increase in groundwater pumping to 235.1 mgd (263,312 ac-ft/yr). A majority of the pumping in Regulatory Area 3 is from the Evangeline and Chicot aquifers with less from the Jasper Aquifer. The pumping data for Regulatory Area 3 show a general downward trend while pumping data for Montgomery County show a general upward trend.

Increases in pumping cause artesian heads in an aquifer to decline while reductions in pumping cause the artesian heads to recover. The effects of increases or decreases in pumping on artesian heads are greatest in the immediate area of the pumping and decrease with increasing distance away from the pumping. Since 2000, permitted groundwater pumping in Montgomery County has increased from about 50 mgd to about 64 to 59 mgd in 2012 and 2014, respectively, as shown on Figure 2. At the same time, groundwater pumping in Regulatory Area 3, Harris County, decreased from about 280 mgd in 2000 to about 180 to 185mgd in 2012 and 2013, respectively as shown on Figure 4. The pumping in Regulatory Area 3 over at least, the past few to several years, is estimated to have had a limited effect on water levels in wells or artesian heads in at least the Chicot and Evangeline aquifers in Montgomery County other than the effects caused by the increase in pumping in 2011.

Since 1999, about 15 wells have been constructed that screen sands of the Jasper aquifer and are located in the central and north parts of the NHCRWA. Pumping from these wells in the NHCRWA that were in service in 1999 are estimated to have had an effect on the water levels in Jasper Aquifer screened wells in the south part of Montgomery County.

Pumping for counties surrounding Montgomery County other than Harris County is shown on Figure 3. The data are combined pumping from the Chicot, Evangeline and Jasper aquifers in all of the counties. Average day pumping from all of the counties combined ranged from about 46.6 mgd (52,192 ac-ft/yr) in 2000 to 32.6 mgd (36,572 ac-ft/yr) in 2012. The data are provided in Table 1. Of the approximately 14 mgd (15,800 ac-ft/yr) of pumping

reduction from 2000 to 2012 about 4 mgd (4,480 ac-ft/yr) occurred in Waller County and about 10 mgd (11,200 ac-ft/yr) occurred from Grimes, Liberty, San Jacinto and Walker counties combined. For Waller County the pumping ranged from 24.35 mgd (27,272 ac-ft/yr) in 2002 to 20.53 mgd (22,994 ac-ft/yr) in 2012.

For Grimes County a majority of the pumping is in the west part of the county, for Walker County at or north of Huntsville and for Liberty County in the central and south parts of the county based on the location of population and irrigation acreage. For San Jacinto County, it is estimated that the limited pumping which has averaged about 3 to 4 mgd (3,360 to 4,480 ac-ft/yr), is distributed throughout the county. In Waller County the pumping is distributed through the county with the amount pumped for irrigation decreasing and the amount pumped for the increasing county population and commercial developments shifting to the south part of the county along Interstate Highway 10. The data show a downward trend in pumping for the five counties and based on general observations that a majority of the pumping is located at least 15 miles outside the LSGCD.

**Table 1. Five Surrounding Counties Pumping**

| Year | Gulf Coast Aquifer Pumping in Grimes, San Jacinto, Liberty and Walker Counties, mgd | Waller County, mgd | Total, mgd |
|---|---|---|---|
| **2000** | 22.23 | 24.35 | 46.58 |
| **2001** | 22 | 27.15 | 49.15 |
| **2002** | 21.71 | 27.30 | 49.01 |
| **2003** | 21.32 | 24.15 | 45.47 |
| **2004** | 22.16 | 24.86 | 47.02 |
| **2005** | 19.4 | 22.70 | 42.14 |
| **2006** | 20.31 | 19.74 | 40.05 |
| **2007** | 18.42 | 14.40 | 32.82 |
| **2008** | 18.78 | 21.14 | 39.92 |
| **2009** | 19.2 | 21.76 | 40.96 |
| **2010** | 9.76 | 23.47 | 33.23 |
| **2011** | 12.98 | 26.34 | 39.32 |
| **2012** | 12.03 | 20.58 | 32.61 |

In conclusion, there has not been a substantial increase, but general stability to a decrease in the groundwater pumping in the five counties over the past several years.

## WATER-LEVEL DATA

Water-level data from the United States Geological Survey (USGS) (USGS, 2015), TWDB (TWDB, 2015) and private sources (GM Services, 2015) were collected for the Chicot, Evangeline, Jasper and Catahoula aquifers in Montgomery County and surrounding counties. The USGS has a program of measuring static water levels annually in 14, 76, 91 and 7 Chicot, Evangeline, Jasper and Catahoula aquifer screened wells, respectively, in Montgomery County. The data provide an indication of the aquifers response to pumping. An illustration showing the locations of USGS measured wells is shown on Figure 5. The grid system used by the TWDB and USGS for identifying the locations of the well is superimposed on the figure. A list of the wells with their total depths and used to measure static water levels, is provided in Table 2. The wells can be located to the 2.5 by 2.5 mile grid using the well number and the grid map on Figure 5. Very few of the wells (6 -9) are shallow and constructed in the water table part of the aquifers. The remaining 179 to 182 wells monitor water levels in the artesian part of the aquifers and are from a few hundred to 2,940 feet deep, based on data in Table 2 at the end of the report.

Almost all of the wells used for monitoring also are pumped for water supply, thus when referring to monitoring wells the reference is to wells not solely used for providing water-level data.

Representative water-level hydrograph data are provided on Figure 6 for Montgomery County and on other figures for water wells in surrounding counties. The presentation of the data begins with the Chicot Aquifer and ends with the Catahoula Aquifer. The presentation of data regarding the Chicot, Evangeline and Jasper aquifers in Harris County will be provided in a later report section.

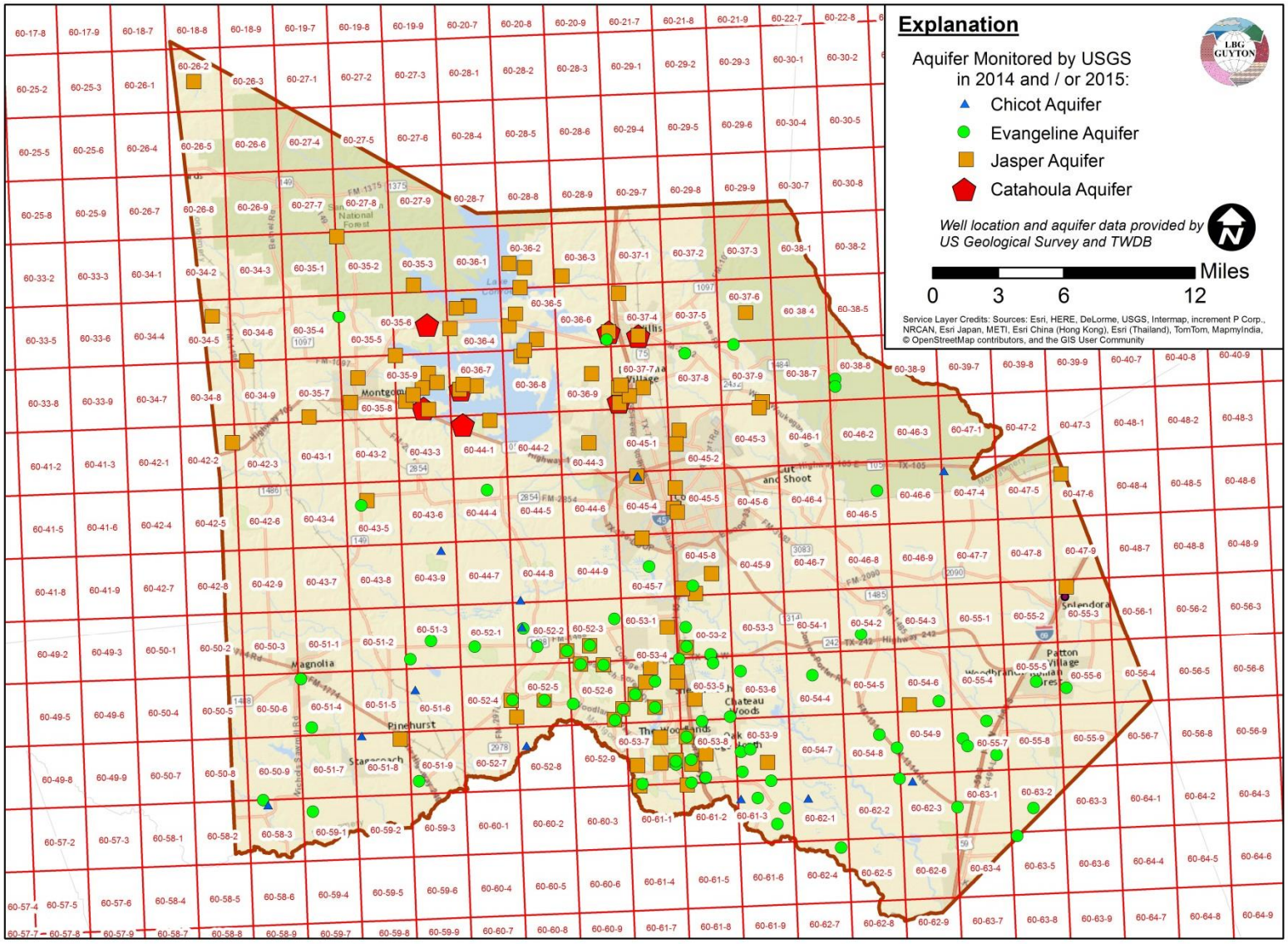


Figure 5. Areal Distribution of Monitoring Wells

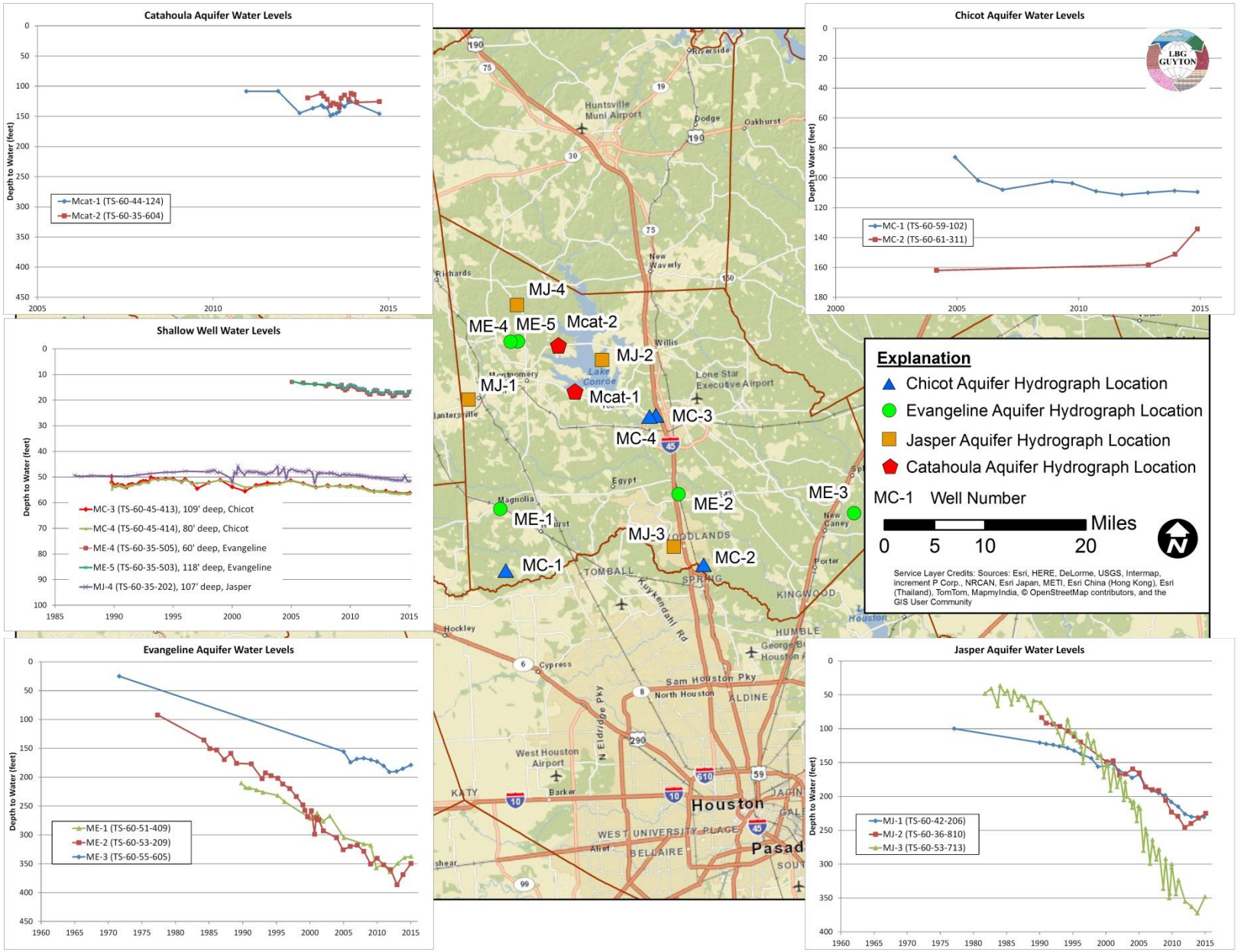


**Figure 6. Montgomery County Water-Level Hydrographs**

## Chicot Aquifer Monitoring in Montgomery County

### *Areal Distribution of Wells*

The areal distribution of wells screening the Chicot Aquifer and used for monitoring is provided on Figure 5. Shown on Figure 7 is the northwest extent of the Chicot Aquifer outcrop (Kazmarek, 2012). The distribution of the monitoring wells is about one well per 51 square miles with substantial areas of the county with no monitoring wells. Areas of the county where additional monitoring wells could be added are shown on Figure 8. The objective would be to improve the areal coverage of the wells to monitor aquifer response as pumping in the county is distributed over broader areas.

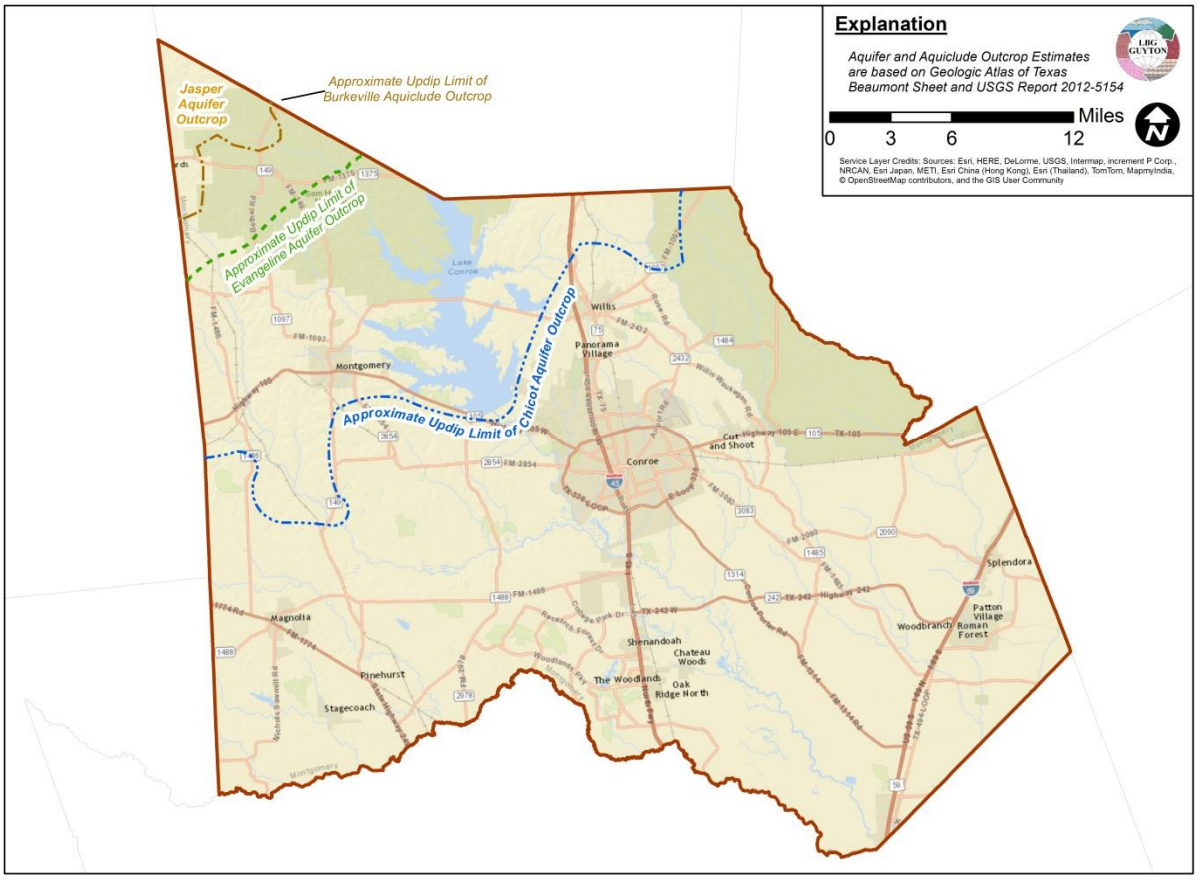


Figure 7. Aquifer Outcrops

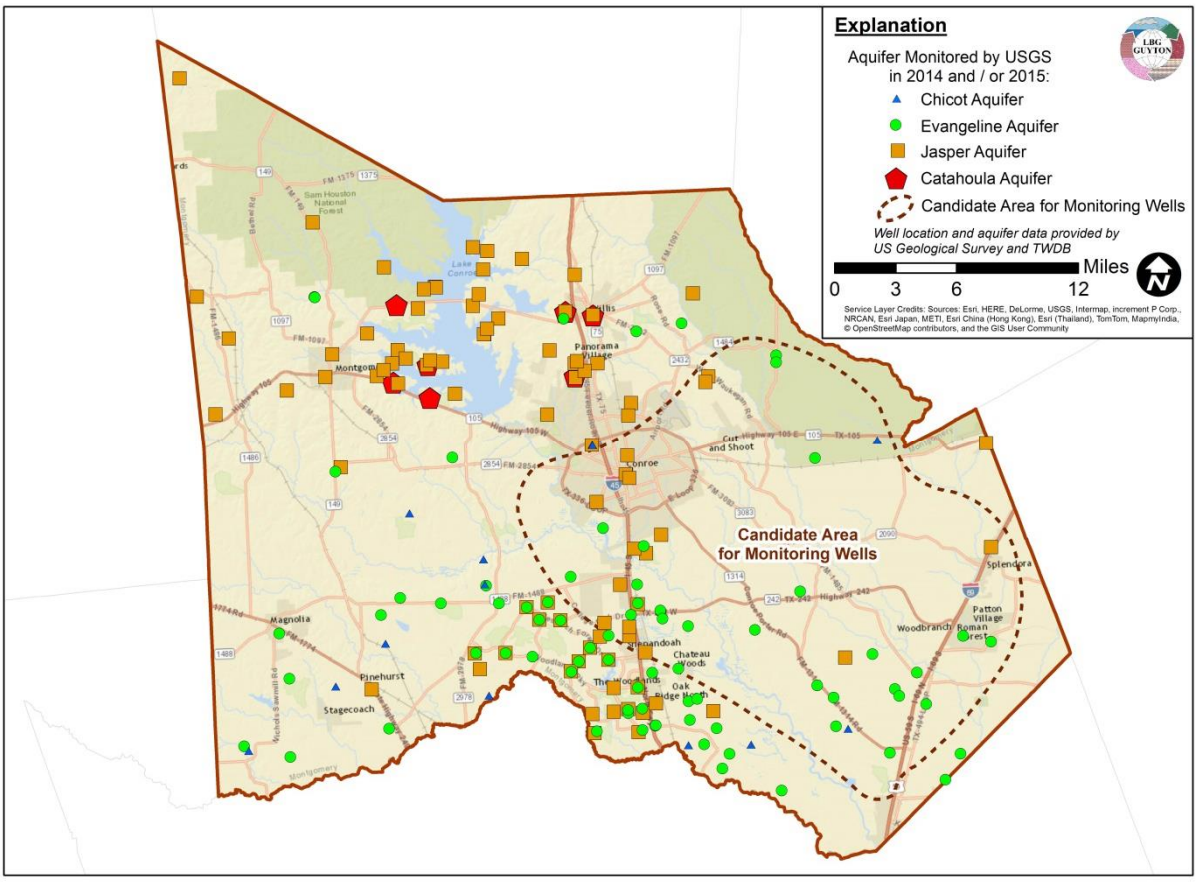


**Figure 8. Area for Additional Wells for Monitoring Water Levels in the Chicot Aquifer**

An additional 10 to 15 monitor wells spaced evenly over the area outlined would increase the density of the water level observation locations. These additional wells in the outcrop area could be important calibration/measured pumping effects targets as groundwater flow models are utilized in future water resources planning/management. The base of the Chicot Aquifer occurs at a depth of 50 feet or less at the Lake Conroe Dam and at progressively deeper depths to the southeast with the base at a depth of about 350 feet in the very southeast part of the county, thus the depth to the base of the aquifer is relatively shallow compared to the other aquifers.

Only three of the monitored wells are less than 120 feet deep and constructed in the water table part of the aquifer. Some additional monitored wells should be shallow, less than an estimated 100 feet deep, and thus represent monitoring of the water table or near water table part of the aquifer. The data could be used to monitor the water table in the aquifer outcrop. The outcrop area, as shown on Figure 7, is very expansive and it would require

probably 20 or so wells spaced over the outcrop to expand the program.

### *Water-Level Hydrographs*

There are a limited number of wells with historical water-level data available for the Chicot Aquifer in Montgomery County. The locations of wells with examples of water-level hydrographs are shown on Figure 6. The Chicot Aquifer generally occurs at depths too shallow for large-capacity wells and is mainly a source of water to 4-inch to 6-inch diameter domestic and small water system wells. The network of monitored wells in the county has increased since about 2004 as the result of an increase in cooperative efforts between the USGS, the LSGCD and well owners. As a result, data are available for Wells MC-1 and MC-2 beginning in about 2004. The static water levels in the wells show some stability to a modest rise since 2011 in one well (MC-2) and some initial decline and then water-level stability in the other well (MC-1). Recent static water levels in the wells range from about 110 to 135 feet below ground level.

Also shown on Figure 6 are water-level data for two shallow non-pumped wells, 60-45-413 and -414, with water level measurements starting in about 1990. The data show a general downward trend from 1999 to 2001 and from 2005 to 2015, indicating water withdrawn from the water table part of the aquifer in proximity to two wells. The withdrawal could be by pumping other nearby wells or by water in storage replenishing water pumped from the aquifer in other areas.

## Evangeline Aquifer Monitoring in Montgomery County

### *Areal Distribution of Wells*

Wells used to monitor water levels for the Evangeline Aquifer provide coverage in Montgomery County as shown on Figure 5. The monitor wells are spread over Montgomery County at an average density of about one well per 13 square miles. As shown on Figure 5, the distribution of monitor wells is concentrated in the south-central and southeast parts of Montgomery County where substantial urban development has occurred. The Evangeline Aquifer screened wells range in total depth from 60 to 1,315 feet. There is an area in the central and east part of Montgomery County where additional monitor wells should be

located, as shown on Figure 9. An additional 10 monitor wells spread over the area would improve the areal coverage of the network. Also, as discussed with the Chicot Aquifer, additional monitor wells in targeted areas will provide calibration/measured pumping effects targets as groundwater flow models are utilized in future water resources planning/ management. There is also the potential to discontinue using about an equal number of monitoring wells in the south-central part of the LSDCD, where the wells used for monitoring are closely spaced, and transfer those monitoring points to the areas with limited monitoring wells.

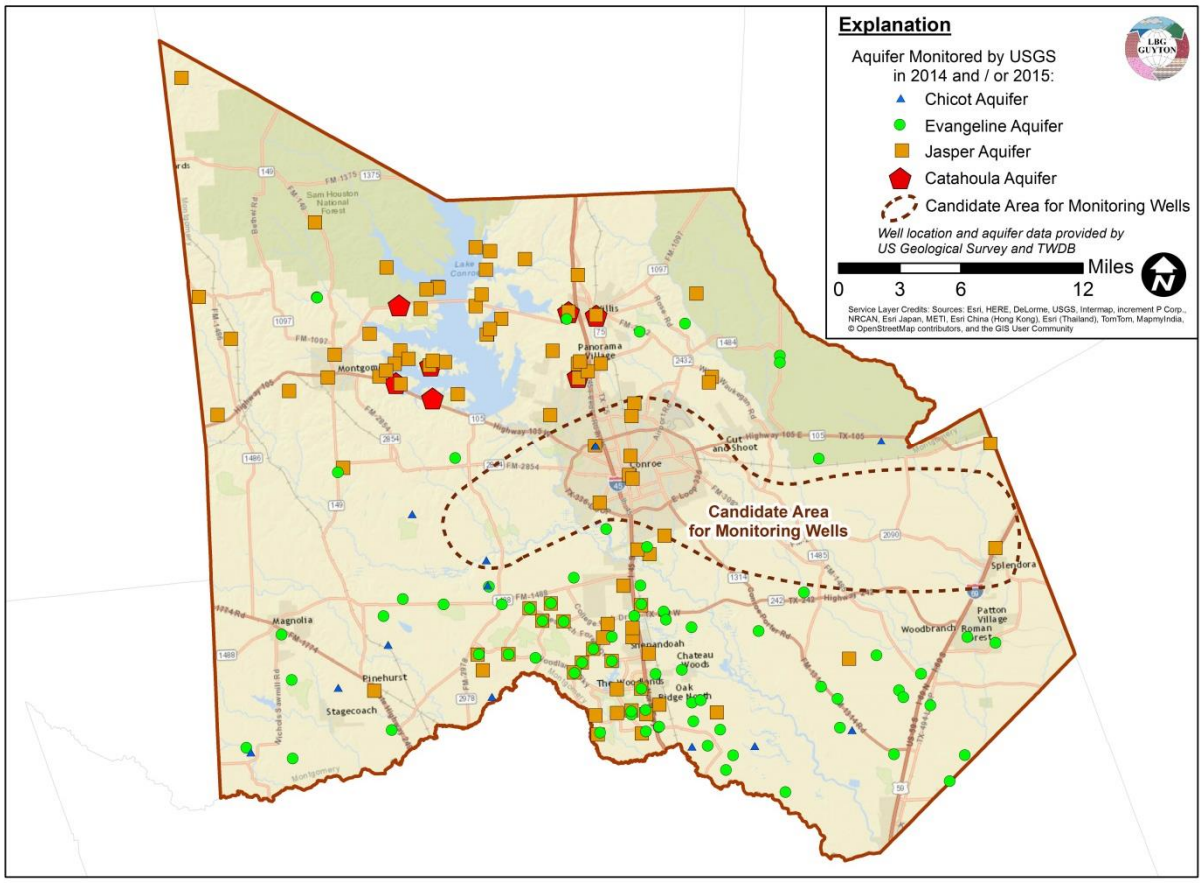


**Figure 9. Area for Additional Wells for Monitoring Water Levels in the Evangeline Aquifer**

Water-level monitoring in the outcrop of the aquifer should be expanded with additional shallow monitoring wells, probably less than 100 feet deep. Initially, about five to ten wells could be added to the two existing shallow monitored wells and spread over the outcrop area. The outcrop area is shown on Figure 7.

### *Water-Level Hydrographs*

Static water levels in wells screened in the Evangeline Aquifer in southern Montgomery County have decreased about 150 feet over the past 25 years in response to stresses caused by increased pumping, as shown on Figure 2, and from pumping outside Montgomery County. The decrease in water levels is noted in wells that screen the major sands of the aquifer, as illustrated by two Evangeline Aquifer hydrographs on Figure 6. Two hydrographs (ME-1) and (ME-2) show an overall downward trend, ranging from an average decline of about 7.7 to 8.5 feet per year (2000-2011). There has been about 30 to 40 feet of water-level recovery since 2011 in response to an overall reduction in pumping from the Evangeline Aquifer of at least a few mgd in Montgomery County and about 14 to 22 mgd in the north part of Harris County, based on data from the Authority.

Also shown on Figure 6 are water-level data for two shallow non-pumped monitored wells, 60-35-503 and -505, constructed in 2004. The data show a general downward trend from 2005 to 2015 indicating water removed from the Evangeline outcrop in proximity to them.

## Jasper Aquifer Monitoring in Montgomery County

### *Areal Distribution of Wells*

The water-level monitoring wells screening the Jasper Aquifer provide areal coverage in Montgomery County, as shown on Figure 5. The average density of the wells is about one well per 12 square miles. There are areas along the I-45 corridor and around Lake Conroe where the density is about one well per 3.5 square miles. At the same time, there is an area in the southwest and southeast part of the county with very few monitoring well screening sands of the Jasper Aquifer, as shown on Figure 10. It is recommended that a total of about 10 to 15 monitor wells be located in the two areas. These additional wells will be calibration/measured pumping effects targets as groundwater flow models are used in future water resources planning/management. Considering the density of the monitor wells along I-45 and Lake Conroe, 10 to 15 of the wells used for monitoring in those areas could be relinquished in coordination with a LSGCD review of the wells proposed and substituted for monitor wells at

new locations in the areas outlined. Water-level monitoring in the outcrop of the aquifer should be expanded with additional shallow monitoring wells probably less than 100 feet deep. Initially, about three wells are recommended spread over the Jasper Aquifer outcrop area shown on Figure 7.

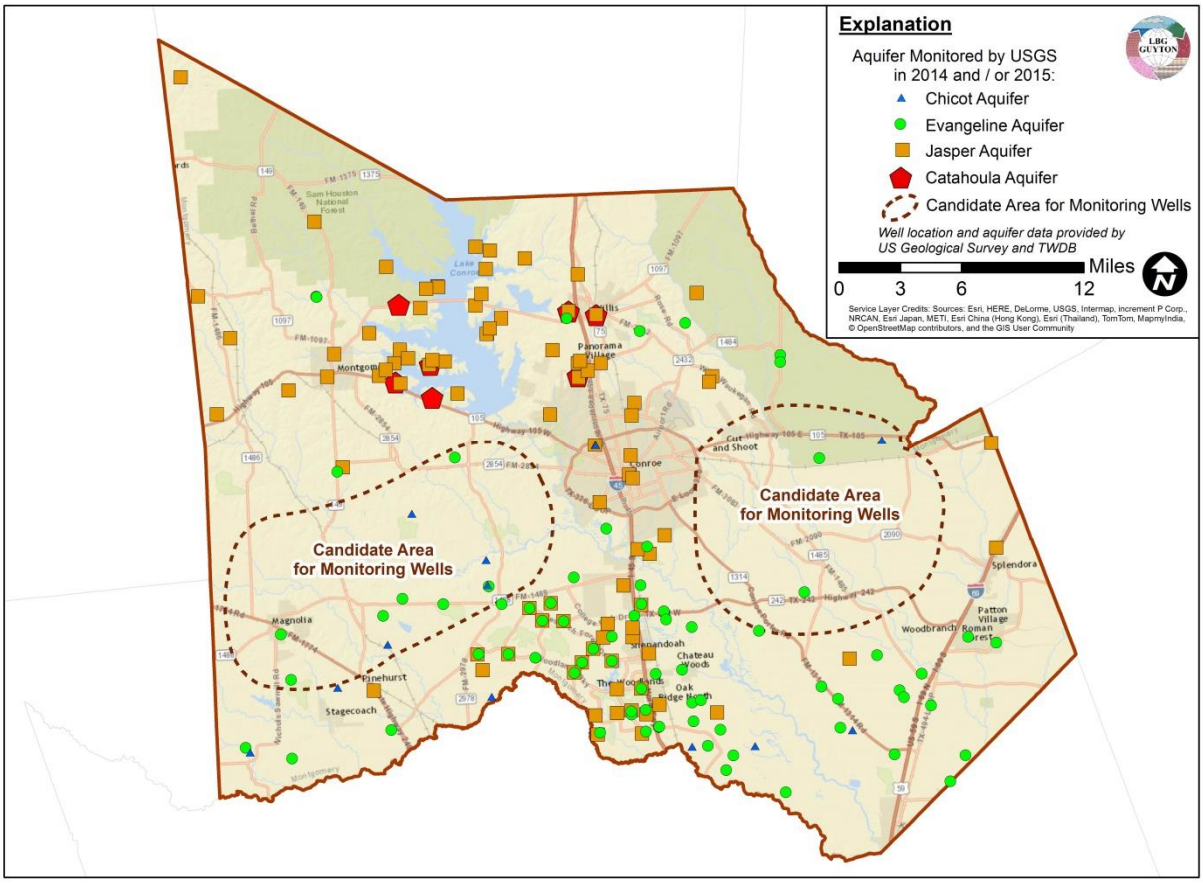


**Figure 10. Area for Additional Wells for Monitoring Water Levels in the Jasper Aquifer**

### *Water-Level Hydrographs*

Static water levels of Jasper Aquifer screened wells have been monitored for at least four decades. The static-water levels in Montgomery County have declined over time in response to stress caused by increased pumping. The decline in water levels is noted in wells that screen the major sands of the aquifer, as illustrated by the three Jasper Aquifer hydrographs of Figure 6. The hydrographs in west Montgomery County (MJ-1) and north Montgomery County (MJ-2) show a similar downward trend of about 110 to 140 feet since water levels began being measured in the wells. The water levels in south Montgomery

County have experienced a greater amount of decline, about 310 feet since 1981 and of this about 290 feet of decline since 1990, due to the larger amount of pumping in the south part of the county and in the north part of Harris County. Additional water-level decline occurred before 1990, but that is the year the USGS expanded its water-level measuring program in the county.

Water-level data are available for shallow Well 60-35-202 about 107 feet deep and reported by the USGS to screen sands of the Jasper Aquifer. The location and water-level hydrograph are shown on Figure 6. The data show that the water level in the well rose from 1985 to 2005 and has declined since then. The data show some additional water in the water table part of the aquifer and some withdrawal of water from the aquifer since 2005 in proximity to the well.

## Catahoula Aquifer Monitoring in Montgomery County

### *Areal Distribution of Wells*

Water-level monitoring in the Catahoula Aquifer is mainly in the Lake Conroe area and to the southeast of it, as shown on Figures 5 and 11, as these areas are where wells have been constructed since 2010-2011. Prior to then there were no Catahoula Aquifer screened wells in the county. The locations of wells monitoring water levels in the Catahoula Aquifer should increase as additional production wells are constructed. Additional wells constructed in the future should be equipped so that static water levels can reasonably be easily measured in them.

### *Water-Level Hydrographs*

The two hydrographs on Figure 6 show about a 40-foot reduction in the static water-level for MCat-1 since pumping began in about 2011 and approximately 10 feet of water-level decline in MCat-2 since 2012. A longer record of pumping and water-level changes will enhance the understanding of the production potential of the aquifer. Currently no regional groundwater availability models exist for the Catahoula Aquifer for use in long-term planning. In the future when such a model is developed, adequate coverage of monitor wells with water-level hydrographs of available data will be critical to the calibration of the model.

The static water levels are still relatively shallow at about 130 to 150 feet below ground level.

## Water-Level Monitoring in Surrounding Counties

### *Liberty County Water-Level Hydrographs*

The USGS monitors water levels in a number of wells in western Liberty County that screen sands of the Evangeline Aquifer and water-level records are available for some of the wells since the 1940ǿs and 1950s. The locations of the wells are shown on Figures 11 and 12. The data on Figure 12 show the water levels in the Evangeline Aquifer in Liberty County have only shown small fluctuations since about 1980 due to generally stable pumping.

### *San Jacinto County Water-Level Hydrographs*

The USGS monitors water levels in two wells in southwest San Jacinto County that screen sands of the Evangeline Aquifer and their locations are shown on Figure 12. The water-level records from the two wells date back to the mid 1970ǿs. The data on Figure 12 show the water levels in the Evangeline Aquifer in San Jacinto County have a modest decline at a rate of about 1.4 feet per year up until 2005 as shown on Figure 12. Since 2005 the static water-level in SE-1 has not stabilized, except for one measurement in 2014.

### *Walker County Water-Level Hydrographs*

Water wells in the county screening sands of the Catahoula Aquifer have a history back to 1970 based on data from the USGS and TWDB, as shown on Figure 12. The primary area of any substantial Catahoula Aquifer pumping is in the City of Huntsville where the aquifer is utilized along with surface water. This is in proximity to Well WC-3. At a distance from the City of Huntsville water-level changes in Wells WC-1 and WC-2 have been minimal.

Water-level data are available for two wells screening the Jasper Aquifer, WCJ-1 and WCJ-2, located in the very south part of the county. The data show about 30 feet of decline from about 2007 to 2012 and 10 or less feet of recovery since then.

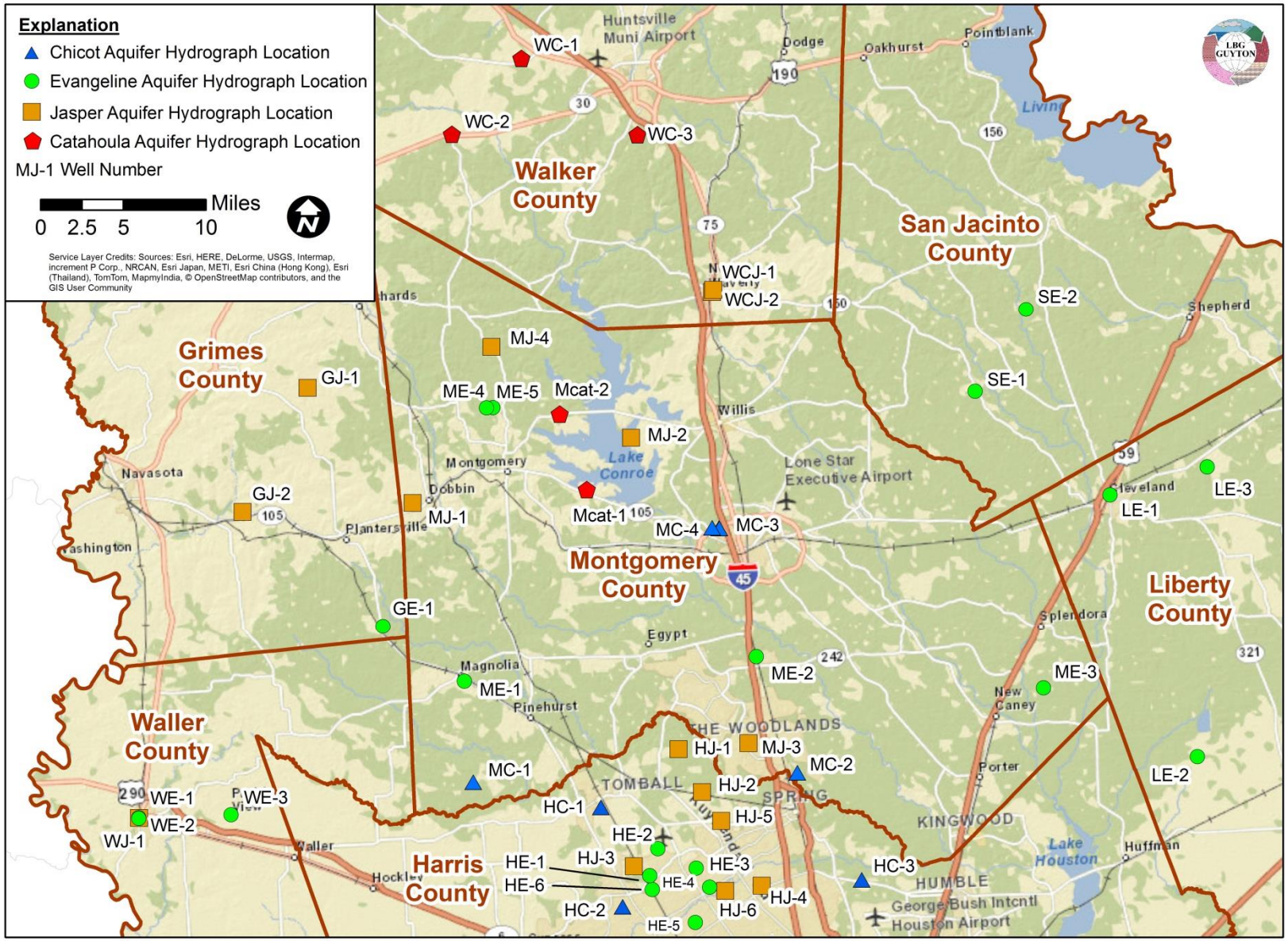


Figure 11. Static Water-Level Hydrograph Locations

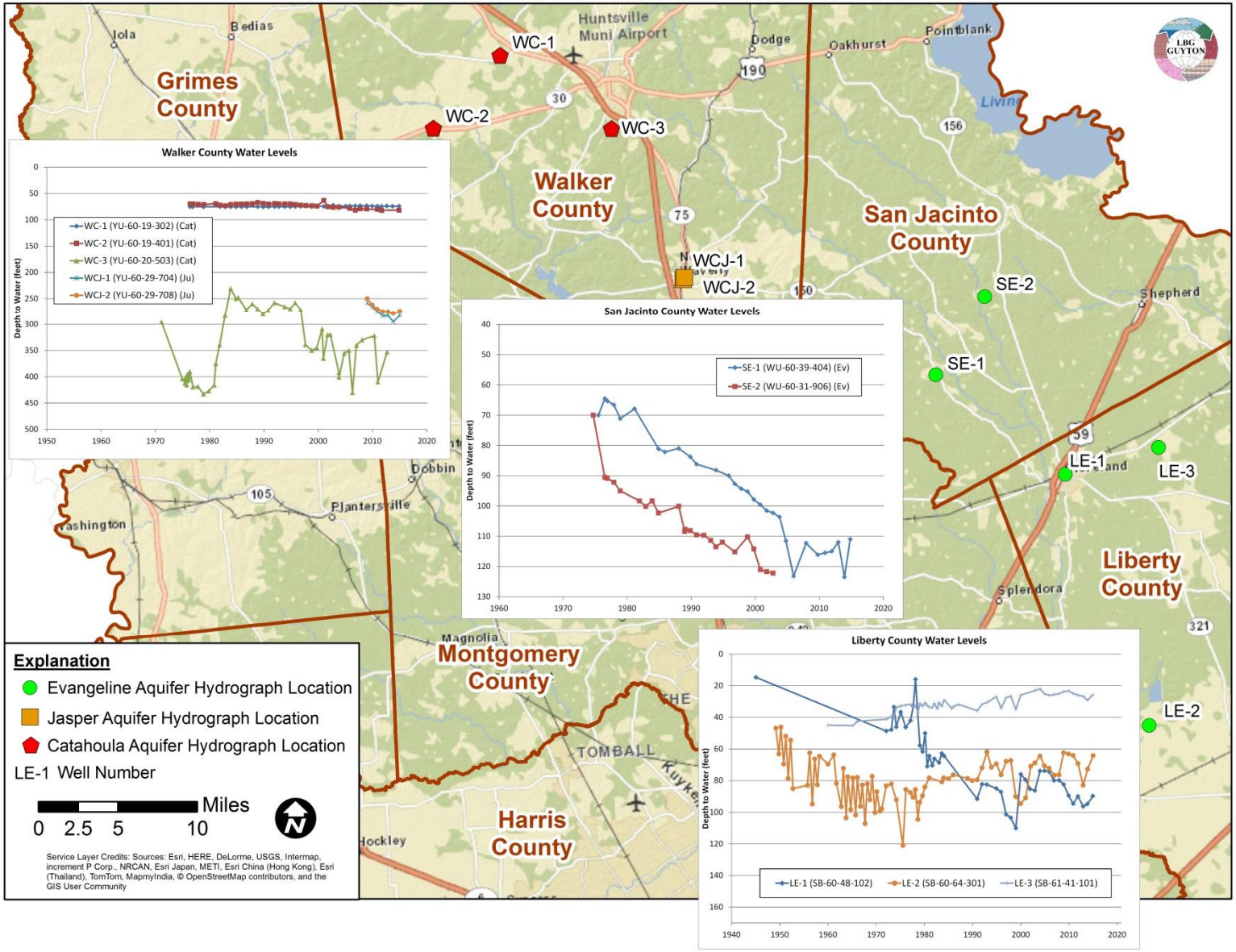


Figure 12. Liberty, San Jacinto and Walker County Static Water-Level Hydrographs

### *Waller and Grimes County Hydrographs*

To consolidate the presentation of water-level data for Waller and Grimes counties, hydrographs for the Evangeline Aquifer and Jasper Aquifer are provided in Figure 13. The USGS and/or TWDB monitor the water levels in three Evangeline Aquifer screened wells in Waller County and an additional well in Grimes County that screen sands of the Evangeline Aquifer. The hydrographs on Figure 13 for Waller County show a general downward trend in response to pumping in the county and outside the county to the east with about 85 to 100 feet of water-level decline occurring in both aquifers since 1970.

The hydrographs on Figure 13 for one well that screens sands of the Evangeline Aquifer and two wells that screens the Jasper Aquifer in Grimes County show a general downward trend in response to pumping inside and outside the county with the amount of decline ranging from about 25 to 50 feet since about 1960. The hydrographs for all of the wells show a downward trend through 2011, a higher pumping year and a smaller water-level rebound since then.

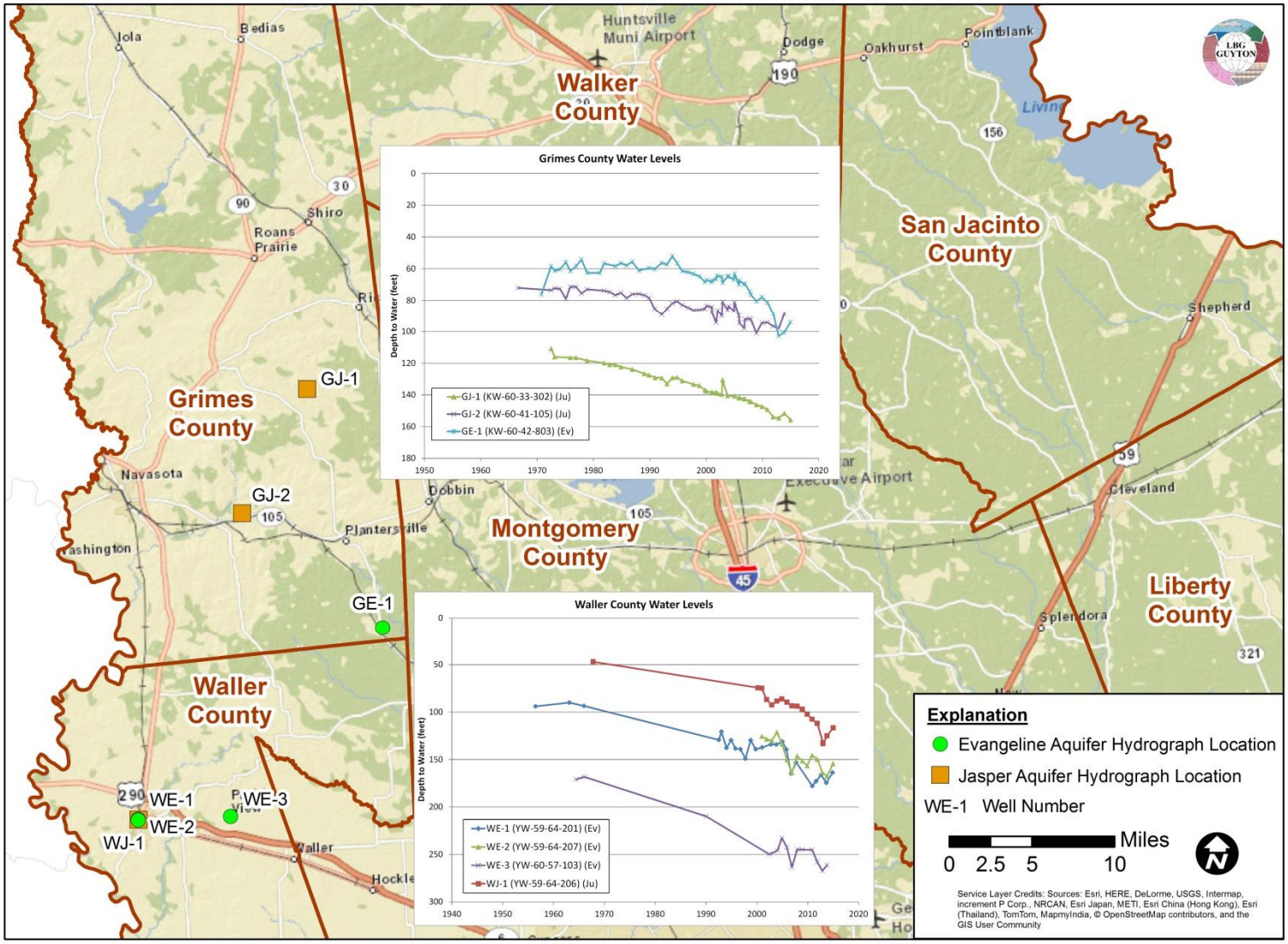


Figure 13. Waller and Grimes County Static Water-Level Hydrographs

# NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY CONVERSION TO SURFACE WATER

## History in Harris County

The Harris-Galveston Subsidence District (HGSD) was created in 1975 by the 64th State Legislature to regulate the withdrawal of groundwater within Harris and Galveston counties in an effort to prevent land subsidence that was occurring at an escalating rate. In 1999 the HGSD adopted a District Regulatory Plan which required that by 2010, the overall water demand in the northwest part of Harris County be supplied by no more than 70 percent groundwater. The North Harris County Regional Water Authority (Authority) began developing a groundwater conversion plan in 2002 so that the requirement of the District Regulatory Plan could be achieved. A map showing the area of the Authority is provided on Figures 1 and 14. The Authority achieved a goal in 2010 with surface water replacing some of the supply provided by groundwater in part of the Authority. An area up to about 16 miles wide where water districts received surface water also is shown on Figure 14. The reduction in groundwater pumping was estimated for the same area based on data from the Authority (NHCRWA, 2015). By 2025 the amount of overall demand to be satisfied by groundwater is planned to be no more than 40 percent of the total water demand.

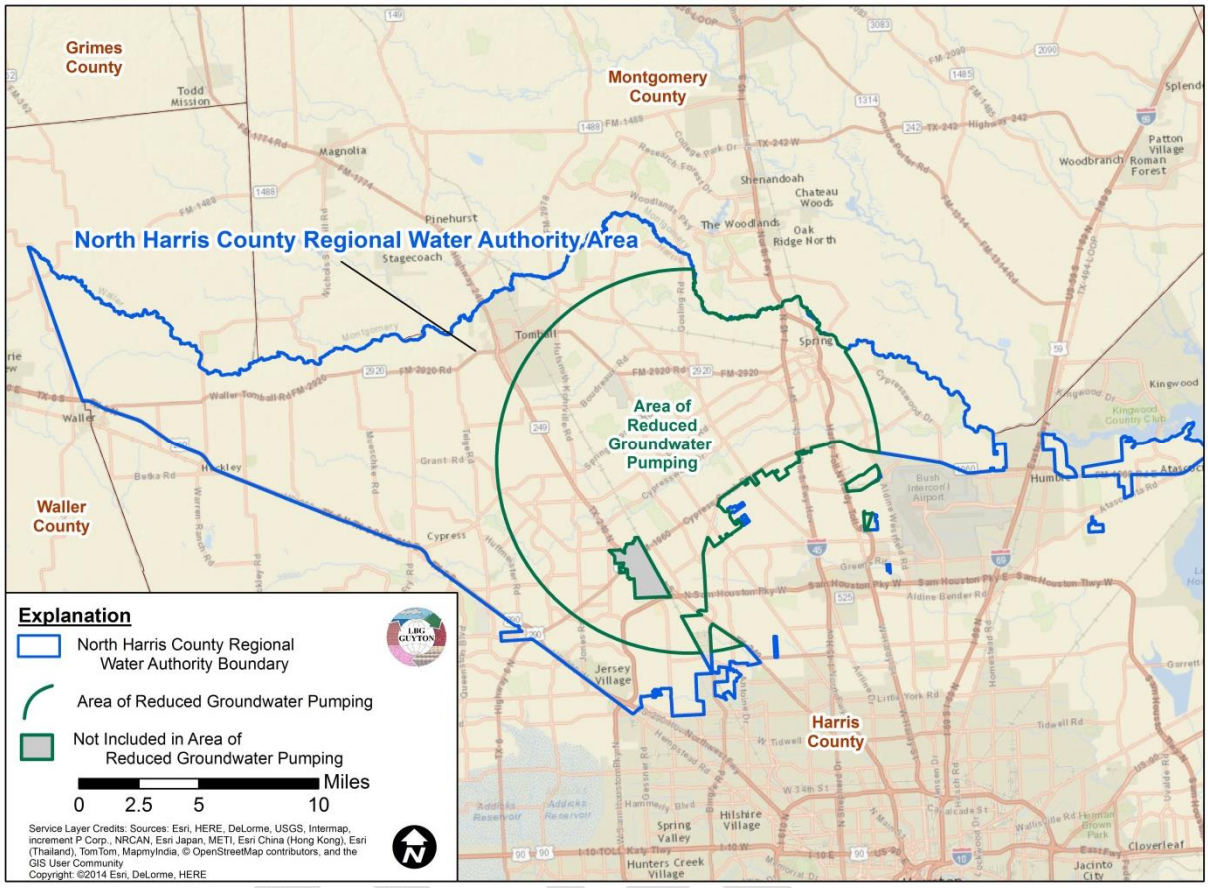


**Figure 14. Area of Reduced Groundwater Pumping**

The amount of the reduction in groundwater pumping is shown on Figure 14 and started at an average of about 16 mgd in 2010 and increased to about 29.4 mgd in 2014. An illustration showing the amount of surface water that was utilized and the decrease in groundwater production is shown on Figure 15. With the reduction in groundwater pumping and introduction of surface water in the same area, the two should be about equal to one another when the goal is to satisfy 30 percent of the water demand with surface water. The data on Figure 15 show that this is the case except in 2011 when very below normal precipitation resulted in a significant increase in demand and surface water usage and a smaller than desired decrease in groundwater pumping.

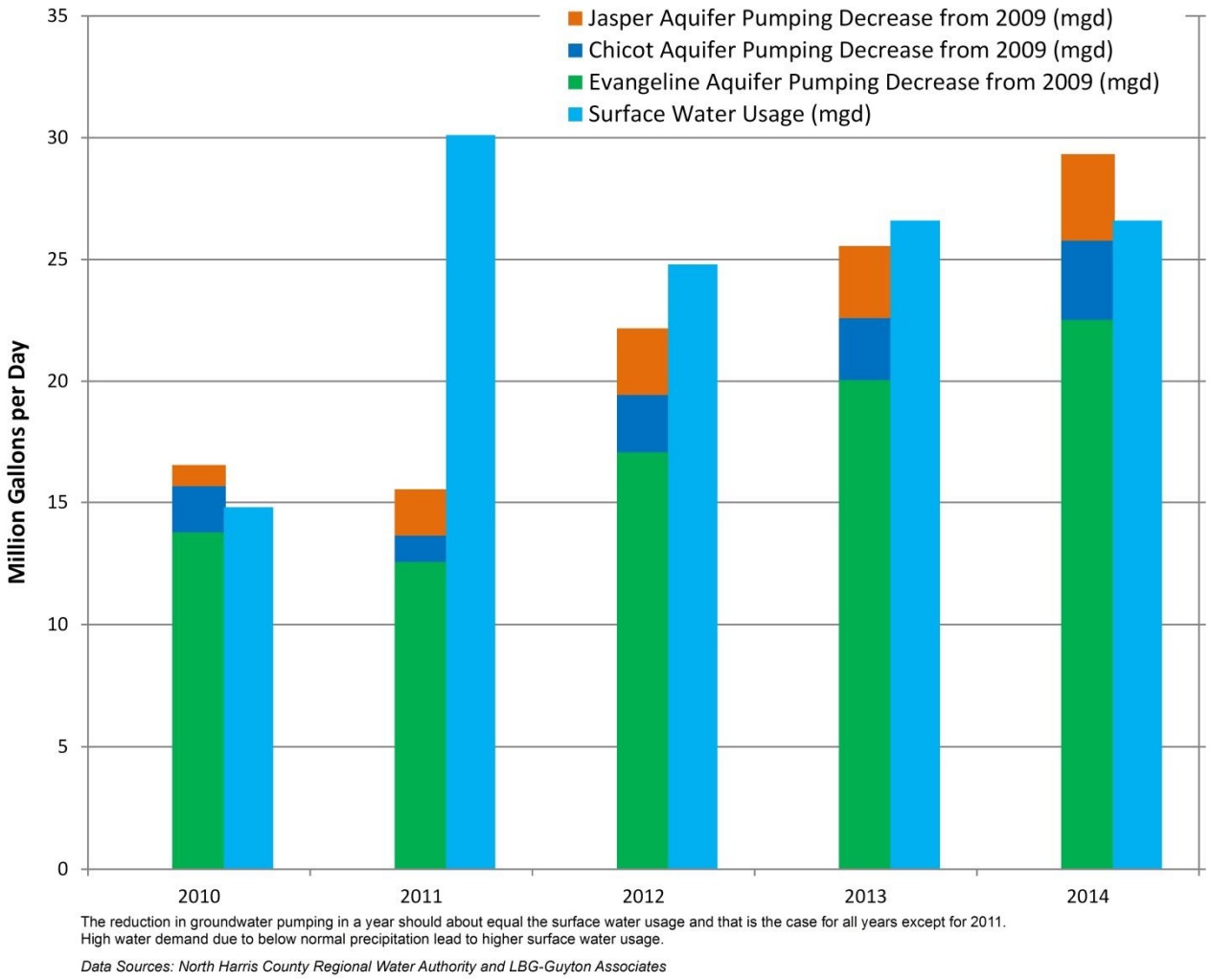


**Figure 15. Decrease in Groundwater Pumping Since 2009 and Surface Water Usage in the NHCRWA Area of Reduced Groundwater Pumping**

Groundwater pumping decreased the most by 2014 from the Chicot, Evangeline, and Jasper aquifers at an average of about 3.3 mgd, 22.5 mgd, and 3.6 mgd, respectively. In general, the reduction in groundwater pumping was about 9 percent, 79 percent, and 12 percent from the Chicot, Evangeline, and Jasper aquifers, respectively.

## Groundwater Pumping Outside Area of Surface Water Conversion

An objective of the study was to evaluate how water levels in wells screening the Chicot, Evangeline or Jasper aquifers responded to a reduction in pumping from the respective aquifers. The response of aquifers to a reduction in pumping is influenced by the amount of pumping within the area and the amount of pumping that is occurring outside the

area and if those amounts of pumping are trending upward, staying the same or trending downward. In the case of the Gulf Coast Aquifer, reasonable proximity can be described as within about 10 to 15 miles of the area. A graph of the overall groundwater pumping within Regulatory Area 3 and in the southern part of Montgomery County is provided as Figure 16. Regulatory Area 3 covers about 1050 $mi^2$ and the southern part of Montgomery County about 240 $mi^2$ with the pumping concentrated along and west of Interstate 45. There are large differences in the amounts of pumping in the areas as Regulatory Area 3 had an estimated population of 2,250,000 in 2010 and the south part of Montgomery County had a population of about 225,000 in 2010 (Freese and Nichols, 2013). Part of the population in Regulatory Area 3 has treated surface water as a supply. The graph shows that between 2010 and 2011 there was a significant increase in pumping in Regulatory Area 3 because of the substantially higher than normal water usage. The fluctuation in the pumping in Regulatory Area 3 between 2010 and 2011 and 2011 and 2012 shows that the amount of the pumping change can be substantially higher than that recorded in southern Montgomery County. The data show that the small pumping fluctuations in southern Montgomery County should have had a very minimal effect on the static water-level changes that occurred in the Area of Reduced Groundwater Pumping. The proximal area changes in pumping were considered when estimating the response of the aquifers to the reduction in pumping within the area shown on Figure 14.

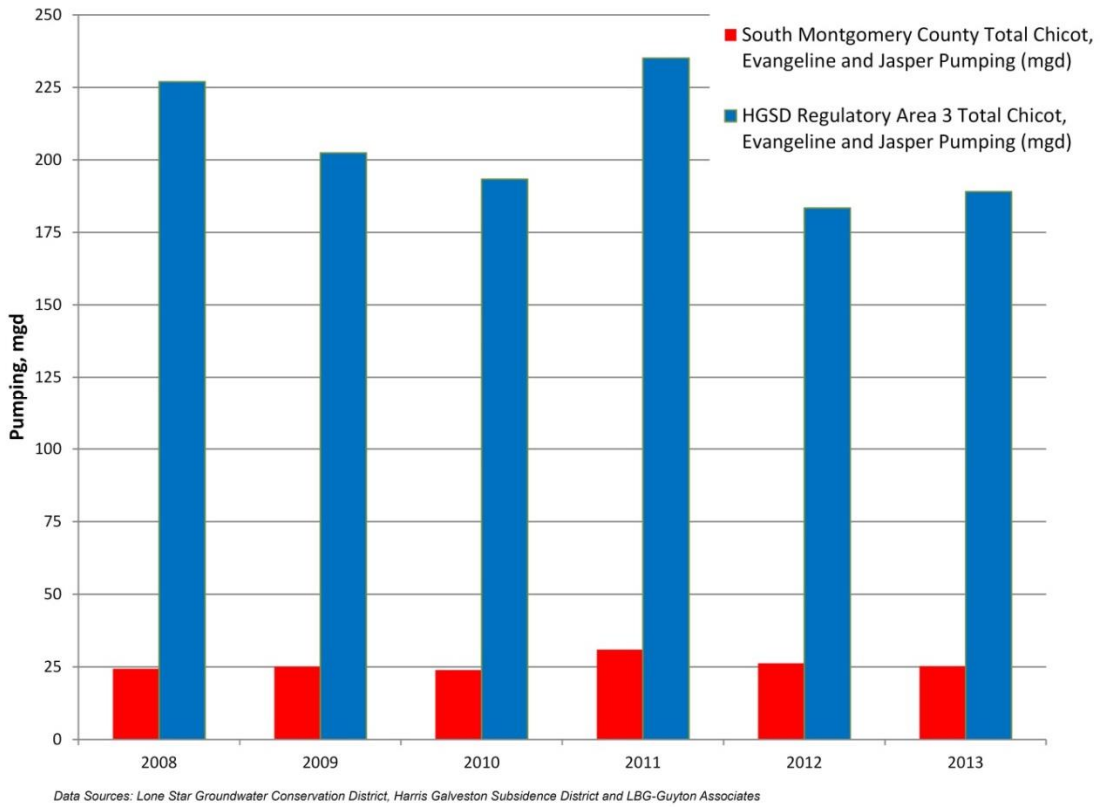


**Figure 16. HGSD Regulatory Area 3 and South Montgomery County Groundwater Pumping**

# WELL STATIC WATER-LEVEL CHANGES

## Chicot Aquifer

A limited number of hydrographs are available for wells that screen sands of the Chicot Aquifer in the area of interest. Water-level hydrographs available for three wells are shown on Figure 17 and their locations also are shown on Figure 17. The data show static water-level fluctuations, but for Well HC-1 the static water level recovered about 20 to 30 feet between 2010 and 2014. For Well HC-2 the rate of static water-level decline was arrested prior to 2010 and the static water level has remained stable. For Well HC-3 there has been a small net recovery in the static water level since about 2007. The reduced pumping from the Chicot Aquifer is estimated to have reached about 3.3 mgd by 2014. One reason for the observed static water-level response is that the observation wells are located somewhat peripherally to the area where a reduction in Chicot Aquifer pumping occurred and thus the magnitude of the water-level recovery is not as significant. This is evident when reviewing the well locations shown on Figure 17.

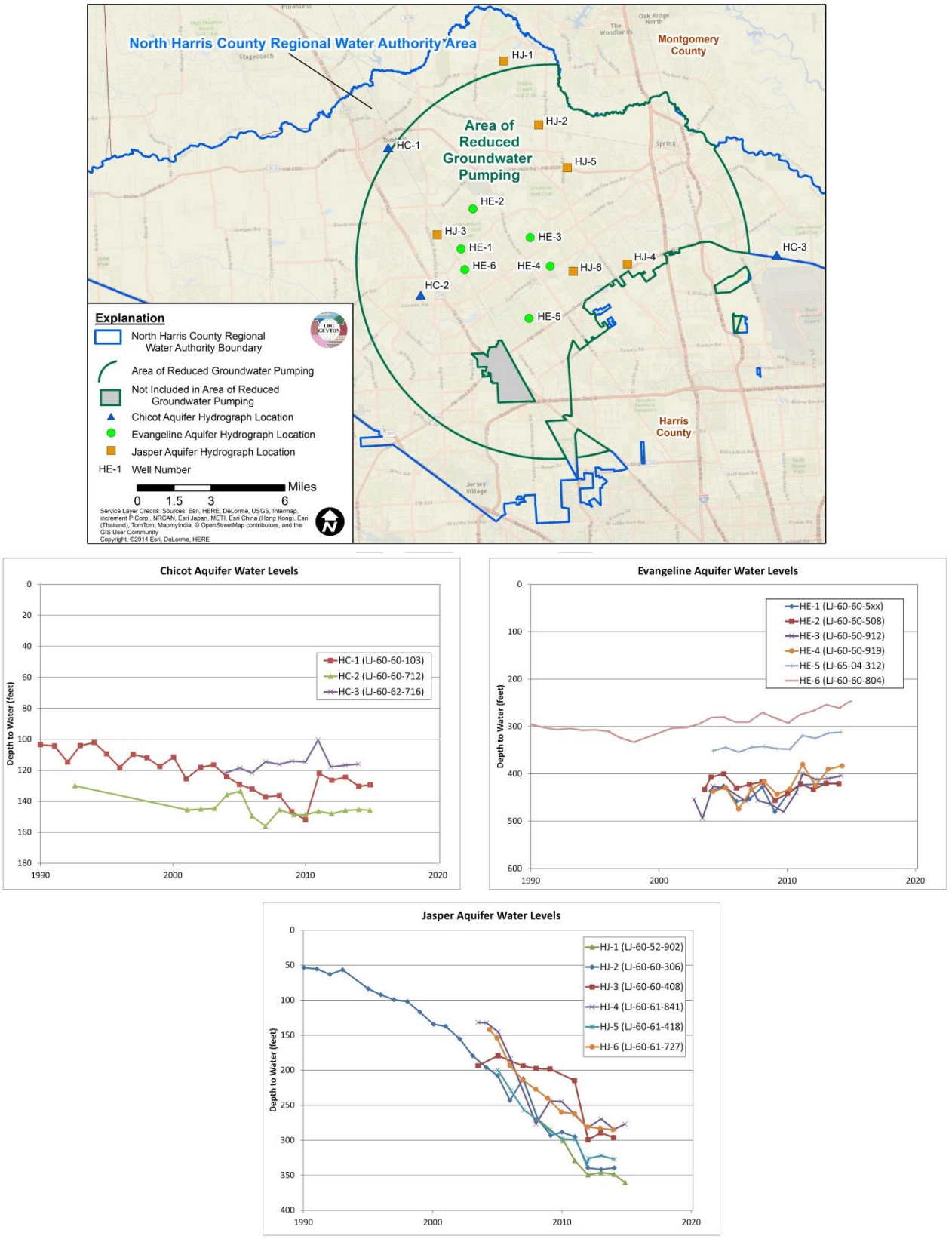


**Figure 17. Static Water-Level Hydrographs in Area of Reduced Groundwater Pumping**

## Evangeline Aquifer

The data on Figure 17 show that from about 2003 to 2010 the static water levels in the Evangeline Aquifer in the area of interest fluctuated about 10 to 40 feet and most wells showed a downward trend from 2008 to 2009. Beginning in about 2010 when groundwater pumping from the Evangeline Aquifer was reduced initially by about 14 mgd, static water-level recovery started occurring and by 2014-2015 the water levels in the wells were from about 20 to 60 feet higher. This change is attributable to reduced groundwater pumping resulting from the introduction of surface water.

The center of the reduction in pumping from the Evangeline aquifer is located about 8 to 9 miles south of Montgomery County. The effects of the reduction in pumping on static water levels in Evangeline Aquifer screened wells in Montgomery County is possibly 20 feet in the very south part of the county and smaller amounts of water-level recovery further to the north.

## Jasper Aquifer

Well locations and water-level hydrographs for wells that screen sands of Jasper Aquifer are provided on Figure 17. The data show that from about 2005 until 2011 the rate of water-level decline averaged about 15 feet per year for most all of the wells. The data on Figure 17 show that after about 2011 the rate of water-level decline substantially decreasing to no more than five feet per year for Wells 60-60-306, -408 and 60-61-418 there was essentially no static water-level decline. The reduction in the rate of static water-level decline is attributable to lower pumping from the Jasper Aquifer in the area.

# AQUIFER RESPONSE TO REDUCTIONS IN GROUNDWATER PUMPING IN THE NHCRWA

The reductions in groundwater pumping in the Authority started at about 15 mgd beginning in 2010 and were up to about 29 mgd by 2014 and resulted in a reduced rate of water-level decline or stabilization of static water levels in the Jasper Aquifer wells, the recovery of static water levels in the Evangeline Aquifer wells and some stabilization of static water levels in the Chicot Aquifer wells in the local area where the reduction in pumping

occurred. For the Jasper Aquifer screened wells the rate of annual decline decreased from 15 feet per year to either a maximum of five feet per year or stable static water levels after 2011. If the magnitude of the reduction in pumping from the Jasper Aquifer had been larger, the positive effects on water levels would have been greater. For the Evangeline Aquifer wells the rise in static water levels has been about 20 to possibly 60 feet since 2010 in the area of reduced groundwater pumping.

## FUTURE AQUIFER RESPONSE TO REDUCTIONS IN GROUNDWATER PUMPING IN MONTGOMERY COUNTY

As groundwater pumping reductions beginning in 2016 occur principally from the Evangeline and Jasper aquifers there should be a recovery in the aquifer artesian pressure or static water levels in wells in the areas of the pumping reductions. The amount of the artesian head or static water-level recovery in each aquifer will principally be controlled by the amount of the pumping reduction in that aquifer. The Chicot aquifer provides substantially less water to wells in Montgomery County compared to the Evangeline or Jasper aquifers and therefore any pumping reductions from the Chicot Aquifer should be substantially smaller than the pumping reductions that occur in the other two aquifers.

# REFERENCES


Freese and Nichols, Inc., 2013, Regional Groundwater Update Project: Harris-Galveston Subsidence District, 19 p.

G-M Services, 2015, Harris County Water-Level Data.

Harris Galveston Subsidence District, 2015, HGSD Regulatory Area 3 Groundwater Pumping Data.

Kasmarek, M.C., 2012, Hydrogeology and simulation of groundwater flow and land-surface subsidence in the northern part of the Gulf Coast aquifer system, Texas, 1891ï 2009 (ver. 1.1, December 2013): U.S. Geological Survey Scientific Investigations Report 2012ï 5154, 55 p.

Lone Star Groundwater Conservation District, 2015, Montgomery County Groundwater Pumping Data.

North Harris County Regional Water Authority, 2015, North Harris County Groundwater Pumping Data and North Harris County Surface Water Usage.

Texas Water Development Board, 2015, *Groundwater Database Reports: Well and Water Level Data*. Retrieved from: http://www.twdb.texas.gov/groundwater/data/gwdbrpt.asp.

Texas Water Development Board, 2015, *Groundwater Pumping Estimates*. Retrieved from: http://www.twdb.texas.gov/waterplanning/waterusesurvey/historical-pumpage.asp.

University of Texas, Bureau of Economic Geology, 1992, The Geologic Atlas of Texas, Beaumont Sheet, Scale 1:250,000.

U.S. Geological Survey, 2015, *Groundwater Levels for Texas*. Retrieved from:

http://nwis.waterdata.usgs.gov/tx/nwis/gwlevels.

# TABLE

# Table 2. List of Wells Used to Monitor Water Levels

| State Well Number | Total Depth (ft) | First Measurement | Most Recent Measurement |
|---|---|---|---|
| *Chicot Aquifer:* | | | |
| TS-60-43-902 | 120 | 9/20/2006 | 2/2/2015 |
| TS-60-44-805 | 161 | 2/8/2005 | 3/26/2015 |
| TS-60-45-412 | 261 | 10/19/1989 | 3/31/2015 |
| TS-60-45-413 | 109 | 10/19/1989 | 2/10/2015 |
| TS-60-45-414 | 80 | 10/20/1989 | 3/31/2015 |
| TS-60-47-408 | 210 | 6/28/2005 | 2/17/2015 |
| TS-60-51-603 | 220 | 2/16/2006 | 2/10/2015 |
| TS-60-51-816 | 210 | 6/3/2005 | 2/25/2014 |
| TS-60-52-206 | 270 | 10/21/1986 | 3/3/2015 |
| TS-60-52-811 | 143 | 9/24/2005 | 2/26/2014 |
| TS-60-58-303 | 195 | 9/30/2005 | 2/6/2015 |
| TS-60-61-311 | 300 | 5/13/2004 | 2/12/2015 |
| TS-60-62-101 | 492 | 2/1/2010 | 2/27/2015 |
| TS-60-62-306 | 260 | 9/20/2005 | 2/16/2015 |
| *Evangeline Aquifer:* | | | |
| TS-60-35-503 | 118 | 2/8/2005 | 3/31/2015 |
| TS-60-35-504 | 83 | 2/8/2005 | 1/13/2015 |
| TS-60-35-505 | 60 | 2/8/2005 | 3/31/2015 |
| TS-60-36-611 | 336 | 12/28/1977 | 1/6/2015 |
| TS-60-37-806 | 350 | 2/17/2004 | 2/17/2015 |
| TS-60-37-909 | 515 | 3/28/2000 | 12/9/2014 |
| TS-60-38-806 | 600 | 2/7/2005 | 2/11/2015 |
| TS-60-38-807 | 570 | 2/7/2005 | 2/11/2015 |
| TS-60-43-511 | 394 | 9/1/1978 | 2/6/2015 |
| TS-60-44-411 | 550 | 7/20/2006 | 1/7/2015 |
| TS-60-45-716 | 710 | 1/15/2004 | 2/25/2014 |
| TS-60-45-805 | 702 | 10/12/1964 | 2/9/2015 |
| TS-60-46-505 | 345 | 5/17/1978 | 3/12/2015 |
| TS-60-50-904 | 220 | 2/15/2006 | 3/2/2015 |
| TS-60-51-310 | 454 | 5/21/2012 | 2/16/2015 |
| TS-60-51-311 | 677 | 3/20/2013 | 2/16/2015 |
| TS-60-51-409 | 662 | 3/1/2000 | 2/24/2015 |
| TS-60-51-415 | 360 | 12/16/2009 | 2/6/2015 |
| TS-60-51-907 | 720 | 10/21/1985 | 2/13/2015 |
| TS-60-52-113 | 887 | 2/8/2011 | 2/18/2015 |
| TS-60-52-210 | 976 | 2/4/2002 | 2/16/2015 |
| TS-60-52-212 | 1,004 | 2/15/2005 | 2/6/2014 |
| TS-60-52-215 | 718 | 3/3/2007 | 1/6/2015 |
| TS-60-52-307 | 890 | 4/20/1999 | 2/16/2015 |
| TS-60-52-309 | 836 | 7/20/2012 | 2/18/2015 |
| TS-60-52-410 | 915 | 2/13/2008 | 2/16/2015 |
| TS-60-52-502 | 906 | 4/4/2001 | 2/16/2015 |
| TS-60-52-602 | 1,030 | 4/18/1999 | 2/5/2015 |
| TS-60-52-605 | 1,064 | 4/20/1999 | 2/5/2015 |
| TS-60-52-607 | 1,052 | 4/18/1999 | 2/3/2015 |
| TS-60-52-609 | 1,120 | 5/6/1999 | 2/9/2015 |
| TS-60-52-613 | 965 | 3/25/2006 | 2/17/2015 |
| TS-60-53-208 | 820 | 4/19/1974 | 2/6/2014 |
| TS-60-53-209 | 1,000 | 5/18/1977 | 2/17/2015 |
| TS-60-53-215 | 256 | 2/15/2005 | 2/24/2015 |
| TS-60-53-216 | -- | 2/16/2005 | 12/8/2014 |
| TS-60-53-407 | 1,005 | 4/18/1999 | 2/17/2015 |
| TS-60-53-409 | 1,000 | 5/9/1999 | 2/3/2015 |
| TS-60-53-417 | 1,094 | 4/26/2000 | 2/4/2015 |
| TS-60-53-516 | 807 | 2/8/2005 | 3/26/2015 |
| TS-60-53-517 | 265 | 4/22/2003 | 2/11/2015 |
| *Evangeline Aquifer (cont.):* | | | |
| TS-60-53-520 | 360 | 9/23/2008 | 2/10/2015 |
| TS-60-53-608 | 809 | 10/1/1978 | 2/19/2015 |
| TS-60-53-709 | 944 | 10/5/1973 | 2/3/2015 |
| TS-60-53-715 | 870 | 8/27/1982 | 2/12/2015 |
| TS-60-53-718 | 246 | 2/26/2006 | 3/26/2015 |
| TS-60-53-813 | 996 | 10/15/1970 | 1/20/2015 |
| TS-60-53-820 | 500 | 2/6/2001 | 1/20/2015 |
| TS-60-53-826 | 1,014 | 3/10/2000 | 3/4/2015 |
| TS-60-53-827 | 570 | 2/9/2005 | 2/16/2015 |
| TS-60-53-830 | 1,025 | 5/11/1999 | 2/3/2015 |
| TS-60-53-831 | 910 | 7/12/1999 | 1/20/2015 |
| TS-60-53-902 | 425 | 6/26/1980 | 2/13/2015 |
| TS-60-53-903 | 558 | 2/16/2005 | 2/12/2015 |
| TS-60-53-904 | 590 | 2/4/2012 | 2/12/2015 |
| TS-60-54-209 | 320 | 9/3/2012 | 2/27/2015 |
| TS-60-54-406 | 462 | 12/10/1999 | 2/19/2015 |
| TS-60-54-614 | 1,102 | 4/10/2013 | 2/19/2015 |
| TS-60-54-804 | 1,016 | 7/30/1980 | 1/20/2015 |
| TS-60-54-808 | 516 | 2/14/2005 | 1/20/2015 |
| TS-60-55-512 | 701 | 8/23/2012 | 2/16/2015 |
| TS-60-55-605 | 1,315 | 2/9/2005 | 2/17/2015 |
| TS-60-55-708 | 620 | 7/10/1984 | 2/16/2015 |
| TS-60-55-710 | 600 | 2/8/2005 | 3/26/2015 |
| TS-60-55-712 | 660 | 2/9/2005 | 2/16/2015 |
| TS-60-55-714 | 590 | 2/9/2005 | 2/16/2015 |
| TS-60-59-102 | 298 | 2/17/2005 | 2/12/2015 |
| TS-60-61-307 | 506 | 10/30/1984 | 12/5/2014 |
| TS-60-61-308 | 1,182 | 2/16/2005 | 3/4/2015 |
| TS-60-61-309 | 1,066 | 1/26/2010 | 2/12/2015 |
| TS-60-61-310 | -- | 2/21/2005 | 12/5/2014 |
| TS-60-62-201 | 634 | 2/22/2013 | 2/16/2015 |
| TS-60-62-404 | 585 | 1/15/2010 | 2/27/2015 |
| TS-60-63-109 | 777 | 2/26/1987 | 1/20/2015 |
| TS-60-63-205 | 900 | 2/9/2005 | 2/13/2015 |
| TS-60-63-507 | 1,190 | 2/1/2001 | 2/23/2015 |

## Table 2. List of Wells Used to Monitor Water Levels

| State Well Number | Total Depth (ft) | First Measurement | Most Recent Measurement |
|---|---|---|---|
| *Jasper Aquifer:* | | | |
| TS-60-26-208 | 172 | 3/3/2000 | 1/6/2014 |
| TS-60-34-503 | 795 | 1/21/2002 | 12/3/2014 |
| TS-60-34-605 | 404 | 11/3/2005 | 1/8/2014 |
| TS-60-35-202 | 107 | 11/28/1952 | 3/31/2015 |
| TS-60-35-303 | 348 | 2/20/2008 | 12/5/2014 |
| TS-60-35-703 | 763 | 1/24/1983 | 12/3/2014 |
| TS-60-35-812 | 783 | 3/2/2000 | 12/8/2014 |
| TS-60-35-813 | 665 | 7/7/2005 | 4/22/2015 |
| TS-60-35-907 | 490 | 5/14/1982 | 12/16/2014 |
| TS-60-35-908 | 495 | 3/6/2000 | 12/16/2014 |
| TS-60-35-909 | 648 | 7/1/1988 | 12/9/2014 |
| TS-60-35-910 | 640 | 11/7/1990 | 12/16/2014 |
| TS-60-35-911 | 742 | 2/13/2001 | 12/9/2014 |
| TS-60-35-912 | 575 | 2/19/2004 | 12/5/2014 |
| TS-60-35-913 | 654 | 2/13/2010 | 12/5/2014 |
| TS-60-36-205 | 530 | 9/15/1972 | 12/8/2014 |
| TS-60-36-207 | 470 | 3/17/1994 | 1/9/2015 |
| TS-60-36-210 | 365 | 9/7/2011 | 1/7/2015 |
| TS-60-36-305 | 478 | 3/10/1994 | 12/2/2014 |
| TS-60-36-409 | 605 | 2/18/1988 | 12/16/2014 |
| TS-60-36-410 | 467 | 3/27/1995 | 12/11/2014 |
| TS-60-36-412 | 682 | 2/17/2004 | 12/11/2014 |
| TS-60-36-413 | 451 | 3/1/2007 | 12/2/2014 |
| TS-60-36-505 | 640 | 5/22/1972 | 12/2/2014 |
| TS-60-36-509 | 652 | 10/1/1996 | 12/16/2014 |
| TS-60-36-513 | 504 | 8/12/2011 | 1/7/2014 |
| TS-60-36-612 | 984 | 1/12/2010 | 12/15/2014 |
| TS-60-36-705 | 750 | 7/9/1973 | 12/16/2014 |
| TS-60-36-706 | 750 | 2/15/1977 | 12/16/2014 |
| TS-60-36-709 | 755 | 1/5/2010 | 12/16/2014 |
| TS-60-36-809 | 740 | 6/22/1972 | 1/7/2015 |
| TS-60-36-810 | 734 | 6/22/1989 | 3/3/2015 |
| TS-60-36-812 | 581 | 7/6/1979 | 1/6/2015 |
| TS-60-36-908 | 1,075 | 6/10/2010 | 2/11/2015 |
| TS-60-37-402 | 912 | 12/9/1955 | 12/15/2014 |
| TS-60-37-417 | 696 | 1/31/2008 | 2/16/2015 |
| TS-60-37-603 | 1,500 | 1/17/2003 | 2/10/2015 |
| TS-60-37-711 | 1,093 | 11/9/1976 | 2/26/2015 |
| TS-60-37-714 | 1,132 | 3/9/2000 | 2/11/2015 |
| TS-60-37-715 | 1,103 | 7/8/1964 | 2/18/2015 |
| TS-60-37-716 | 882 | 4/8/1983 | 2/18/2015 |
| TS-60-37-717 | 1,090 | 2/7/2001 | 2/18/2015 |
| TS-60-37-911 | 1,056 | 2/8/2008 | 2/11/2015 |
| TS-60-42-206 | 760 | 2/18/1977 | 12/3/2014 |
| TS-60-43-514 | 1,050 | 3/9/2004 | 2/6/2015 |
| TS-60-44-122 | 872 | 1/5/2010 | 12/16/2014 |
| TS-60-44-318 | 1,184 | 5/22/1990 | 2/11/2015 |
| TS-60-45-213 | 1,260 | 9/26/2007 | 2/11/2015 |
| TS-60-45-214 | 1,290 | 6/16/2010 | 2/11/2015 |
| TS-60-45-304 | 1,070 | 2/8/2008 | 2/11/2015 |
| TS-60-45-402 | 1,150 | 1/12/1967 | 2/10/2015 |
| TS-60-45-501 | 1,280 | 1/13/1967 | 2/10/2015 |
| TS-60-45-503 | 1,332 | 4/20/1954 | 2/10/2015 |
| TS-60-45-504 | 1,221 | 6/16/1956 | 2/10/2015 |
| TS-60-45-507 | 1,280 | 12/16/1948 | 2/12/2015 |
| TS-60-45-712 | 1,245 | 3/18/1974 | 2/12/2015 |
| TS-60-45-812 | 1,260 | 4/1/1983 | 2/9/2015 |
| TS-60-45-813 | 1,366 | 4/3/1996 | 2/9/2015 |
| *Jasper Aquifer (cont.):* | | | |
| TS-60-45-814 | 1,276 | 10/1/2006 | 2/9/2015 |
| TS-60-47-602 | 1,214 | 4/14/1994 | 2/17/2015 |
| TS-60-51-815 | 1,644 | 1/22/2001 | 3/4/2015 |
| TS-60-52-209 | 1,658 | 10/19/2000 | 2/16/2015 |
| TS-60-52-306 | 1,594 | 4/19/1999 | 2/16/2015 |
| TS-60-52-409 | 1,526 | 9/24/2007 | 2/16/2015 |
| TS-60-52-411 | 1,649 | 5/12/2012 | 2/16/2015 |
| TS-60-52-501 | 1,630 | 2/4/2002 | 2/17/2015 |
| TS-60-52-603 | 1,650 | 4/18/1999 | 2/5/2015 |
| TS-60-52-604 | 1,630 | 4/20/1999 | 2/5/2015 |
| TS-60-52-606 | 1,680 | 4/18/1999 | 2/3/2015 |
| TS-60-52-608 | 1,674 | 5/6/1999 | 2/5/2015 |
| TS-60-53-111 | 1,572 | 2/9/2010 | 2/12/2015 |
| TS-60-53-217 | 1,585 | 2/25/2009 | 2/17/2015 |
| TS-60-53-406 | 1,620 | 4/18/1999 | 2/4/2015 |
| TS-60-53-408 | 1,640 | 5/9/1999 | 2/4/2015 |
| TS-60-53-416 | 1,656 | 4/26/2000 | 2/4/2015 |
| TS-60-53-418 | 1,715 | 7/24/2003 | 2/5/2015 |
| TS-60-53-420 | 1,628 | 5/2/2007 | 2/5/2015 |
| TS-60-53-422 | 1,682 | 10/19/2007 | 2/17/2015 |
| TS-60-53-519 | 1,661 | 6/3/2010 | 2/5/2015 |
| TS-60-53-712 | 1,688 | 4/21/1999 | 2/3/2015 |
| TS-60-53-713 | 1,710 | 1/20/1982 | 2/3/2015 |
| TS-60-53-722 | 1,686 | 2/8/2001 | 2/12/2015 |
| TS-60-53-726 | 1,568 | 12/2/2013 | 2/3/2015 |
| TS-60-53-829 | 1,686 | 5/11/1999 | 2/3/2015 |
| TS-60-53-832 | 1,718 | 2/9/2005 | 2/16/2015 |
| TS-60-53-834 | 1,730 | 2/5/2010 | 1/20/2015 |
| TS-60-53-905 | 1,640 | 6/13/2013 | 2/18/2015 |
| TS-60-54-613 | 1,737 | 3/9/2004 | 2/19/2015 |
| TS-60-55-313 | 1,639 | 3/7/1983 | 2/16/2015 |
| TS-60-61-104 | 1,761 | 5/24/2006 | 2/12/2015 |
| TS-60-61-214 | 622 | 11/4/2007 | 1/20/2015 |
| *Catahoula Aquifer:* | | | |
| TS-60-35-604 | 2,473 | 11/29/2012 | 12/16/2014 |
| TS-60-35-915 | 2,687 | 3/21/2013 | 12/9/2014 |
| TS-60-36-615 | 2,685 | 4/17/2013 | 12/15/2014 |
| TS-60-36-710 | 2,680 | 11/28/2012 | 12/16/2014 |
| TS-60-37-418 | 2,940 | 4/24/2013 | 12/15/2014 |
| TS-60-37-718 | 2,834 | 3/21/2013 | 2/18/2015 |
| TS-60-44-124 | 2,607 | 2/28/2011 | 12/16/2014 |