EASTERN KERR COUNTY TRINITY AQUIFER GROUNDWATER AVAILABILITY ASSESSMENT

Prepared for:

Headwaters Groundwater Conservation District

May 24, 2022

Prepared by

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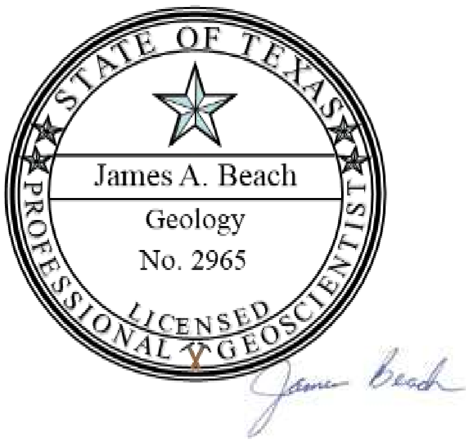

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1.0 Executive Summary

Eastern Kerr County continues to see growth and development for many reasons. As the population and water demand continue to increase in the area, almost all the water demand continues to be satisfied by groundwater development. The Headwaters Groundwater Conservation District (HGCD) is interested in continuing to implement an appropriate balance between the growing demands for groundwater and conservation and preservation of groundwater resources. Specifically, HGCD continues to develop the best available science and quantitative metrics to guide groundwater use in Kerr County.

Significant growth in groundwater demand has occurred since the Trinity Hill Country Groundwater Availability Model (THCGAM) was completed in 2000. While the Texas Water Development Board (TWDB) made a minor change in 2009 by incorporating the Lower Trinity Aquifer into the THCGAM, there were no changes in hydraulic properties or pumping distribution in the model with that modification. The current Desired Future Condition in GMA 9 and HGCD is based on work completed in 2010 during the joint groundwater planning process. A new conceptual model was developed for the THCGAM in 2018 (Green and others, 2018), but that data has not been incorporated into an updated THCGAM. Since 2000, many new wells have been drilled and documented, and the HGCD and other districts have collected significant data regarding pumping, pumping distribution, water levels, and hydraulic properties of the Trinity Aquifer. The differences between HGCD data and the THCGAM confirm the limitations of the THCGAM to address local management issues, especially in areas where development and groundwater pumping are increasing significantly. Consistent with that limitation, the DFC and MAG estimates should be seen as regional and long-term guidelines only. Because the THCGAM has limits in application on a local scale, the resulting DFCs and MAG estimates are also limited in application on a local scale.

Hydrographs in eastern Kerr County indicate that the Middle Trinity Aquifer continues to receive recharge in the area. Water levels in the Middle Trinity Aquifer indicate water level decline is generally limited to a few areas over the past 10 to 20 years. However, some Middle Trinity wells in eastern Kerr County show a continued water level decline over the past 10 to 20 years. Water levels in the Lower Trinity Aquifer indicate a more consistent water level decline. This is partially due to the concentration of the Lower Trinity monitoring wells near developing areas where pumping the Lower Trinity Aquifer has increased. Hydrographs in the Lower Trinity Aquifer indicated a more consistent pattern of water level decline in these areas. Available drawdown and aquifer properties vary in both the Middle and Lower Trinity in eastern Kerr County, and the reduction in available drawdown in some areas should be monitored closely to inform long-term groundwater availability. In addition, the district may need to assess available drawdown along with local demands to assess impacts and long-term groundwater availability for wells in certain areas on an area-by-area basis as more information becomes available.

2.0 Data Review and Approach

Starting with exported data from the HGCD well database provided by HGCD current as of November 2021, AGS assessed the level of completeness of the data with respect to parameters important to this study, including location of each well, the aquifer in which each well is completed, and the date on which each well was completed. Data gaps in these parameters were filled by estimation approaches developed by AGS as described later in this section, where possible. Based on the updated database, a map of wells completed in the Middle Trinity Aquifer (symbolized according to use) is shown in Figure 1, along with the boundary of the study area.

A map of wells completed in the Middle Trinity is presented in Figure 1, categorized by use, and with the eastern Kerr study area. Additional wells present in the HGCD database are shown outside of the study area in this and other figures due to the shape of the study area and the scale of the maps. A similar map of wells completed in the Lower Trinity is presented in Figure 2.

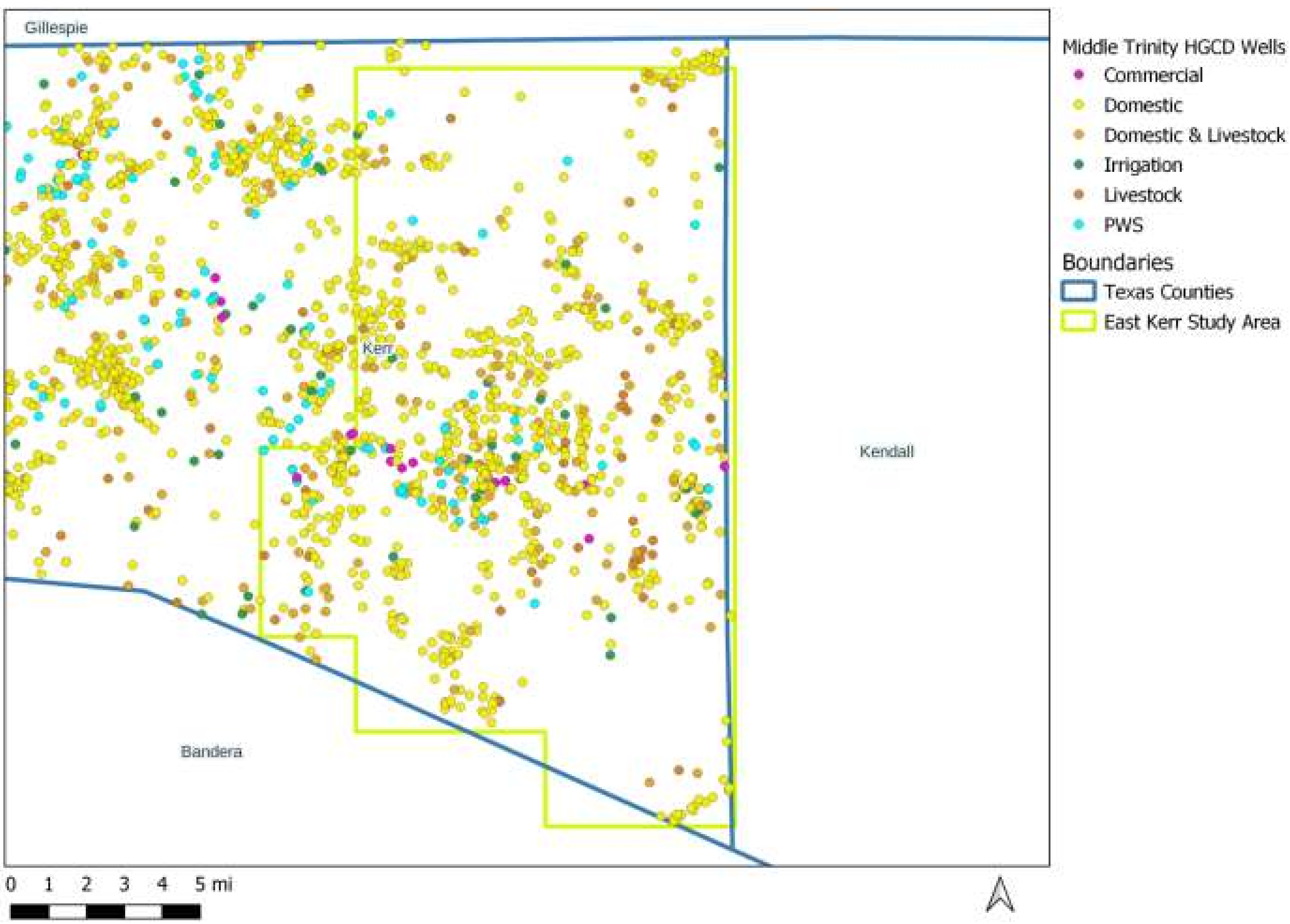

Figure 1. Headwaters GCD Middle Trinity Well Location Map by Use

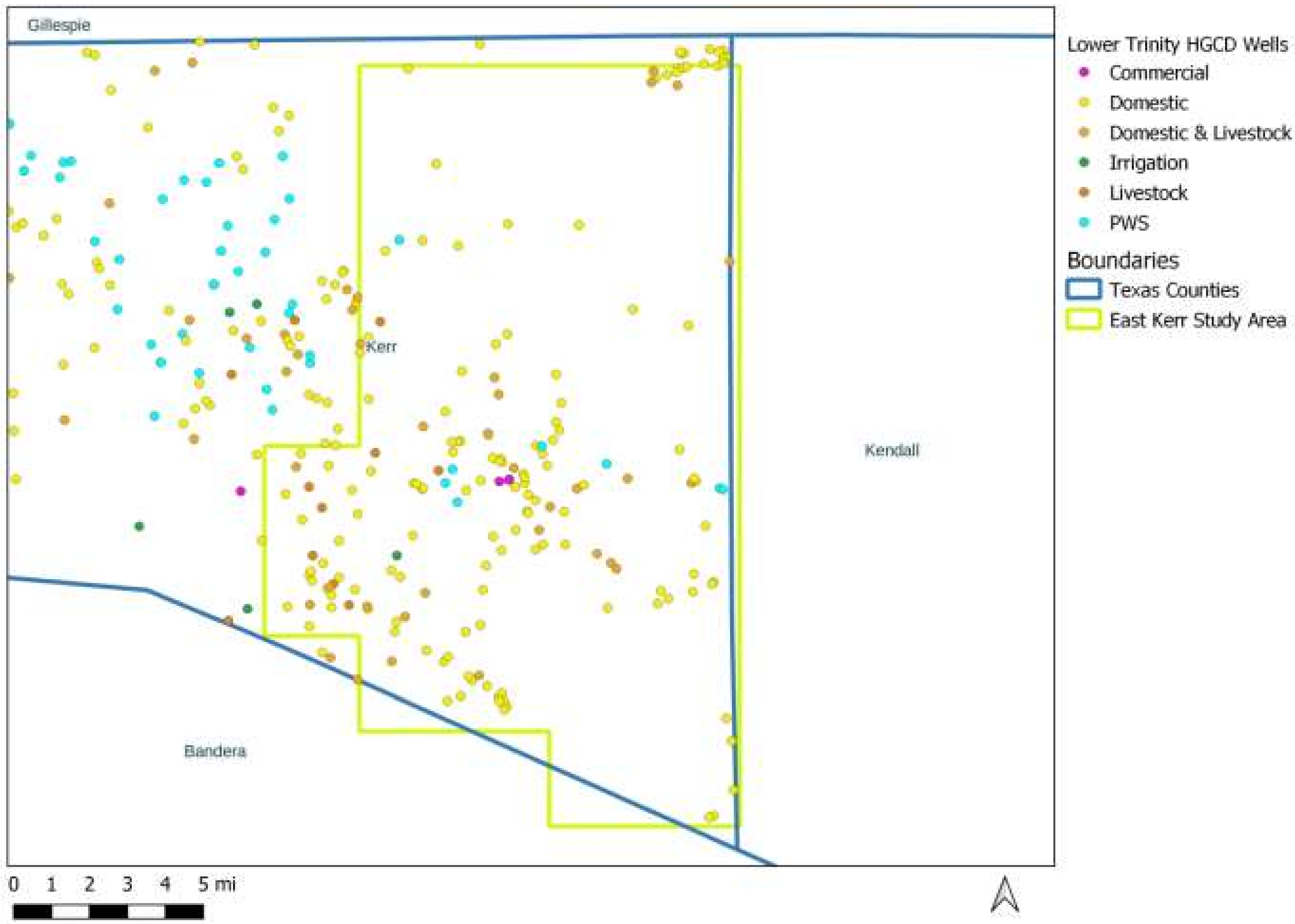

Figure 2. Headwaters GCD Lower Trinity Well Location Map by Use

The THCGAM contains four aquifer layers representing the Edwards, the Upper Trinity, the Middle Trinity, and the Lower Trinity. The geologic formations which comprise each THCGAM layer are given in Table 1.

Table 1. Geologic Formations Comprising Trinity Hill Country GAM Aquifer Layers

GAM Layer	Member Formation(s)
Edwards	Edwards Limestone
Upper Trinity	Upper Glen Rose Limestone
Middle Trinity	Lower Glen Rose Limestone
	Hensell Sand
	Cow Creek Limestone
Lower Trinity	Sligo Limestone
	Hosston Sand

Many wells in the HGCD database have a specific layer or formation of completion designated by the District, using their knowledge of the formations. Others have a more general designation such as "Trinity."

For wells in the HGCD database lacking a HGCD aquifer designation specific to the above GAM layers, AGS first gathered completion intervals (sections of the borehole that are "open hole" or "screened") for the wells for which this information was available. AGS then estimated completion aquifer layer based on completion interval elevations where available, or elevation of total depth if no completion interval was available, using layer elevations in the THCGAM.

Completion date is useful to this study for estimation of pumping for exempt wells over time, as well as for assessing general trends in development over time. Where a completion date for a well was not present in the HGCD database, the well was assumed to be an existing well with a completion date before 2000, unless it had an associated well report tracking number assigned in the TDLR database.

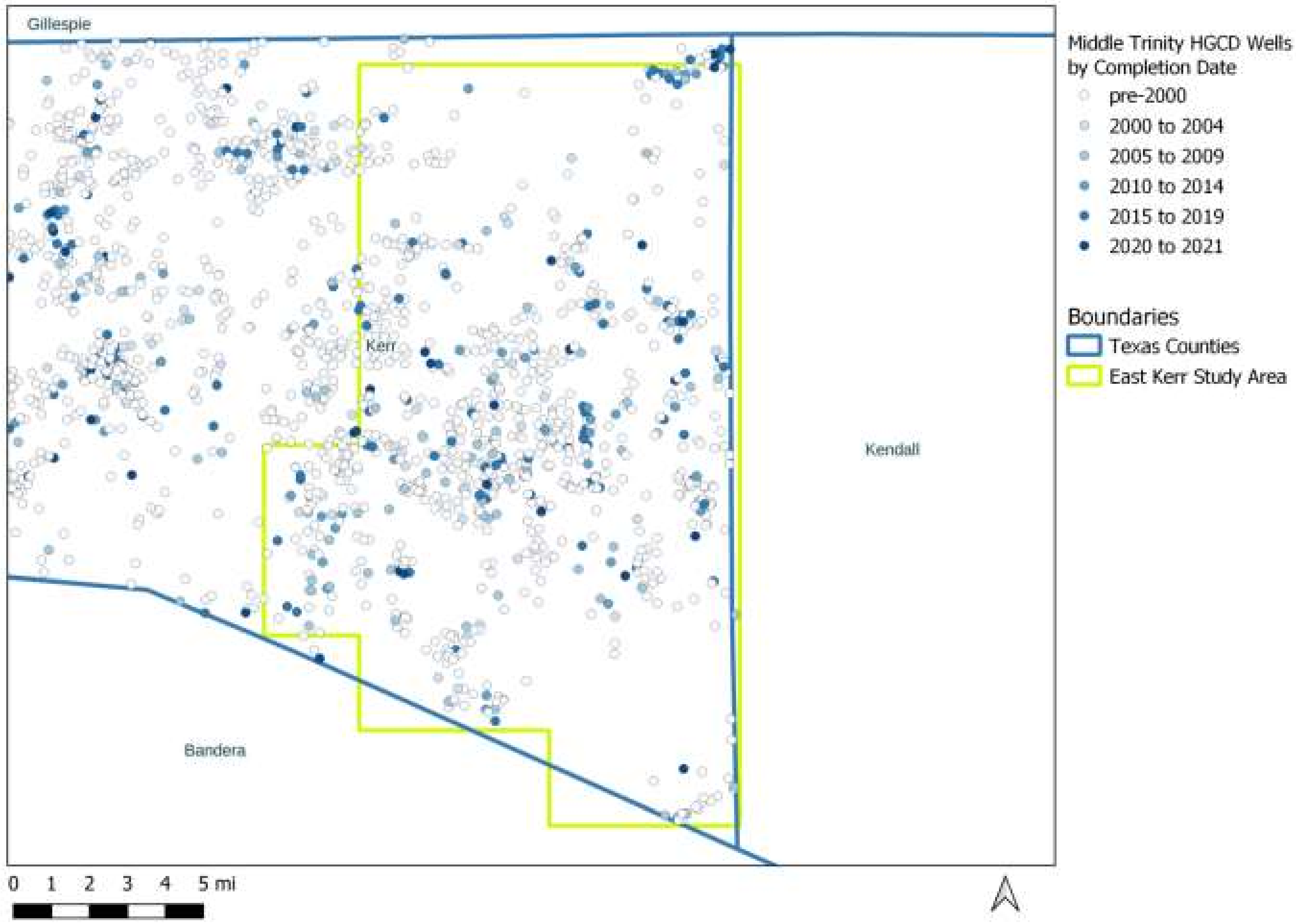

Figure 3. Middle Trinity Wells by Completion Date

Figure 3 and Figure 4 show Middle Trinity and Lower Trinity wells by completion date, respectively. Clusters of wells with similar completion dates generally align with completions of residential housing developments.

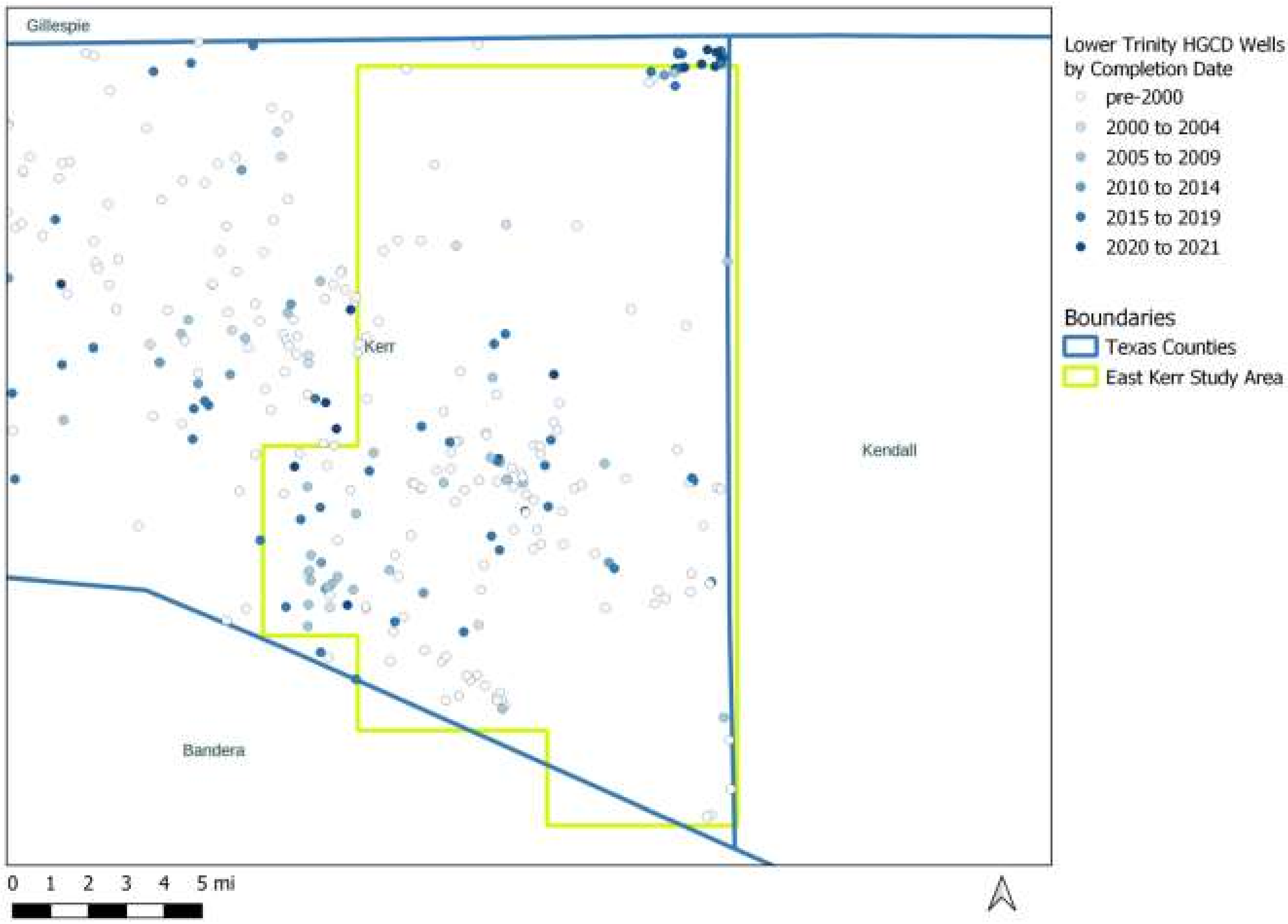

Figure 4. Lower Trinity Wells by Completion Date

3.0 Assessment of Water Level and Pumping Trends

3.1 *Water Level Trends*

To assess water level trends, AGS used a combination of water level hydrographs and estimated water level contours. This assessment was primarily based on District monitoring well data, with some additional data from Headwaters Groundwater Conservation District, Hill Country Underground Water Conservation District, and TWDB.

Hydrographs are useful for assessing trends in water levels over time, provided that the data generally represents a static level of a single aquifer (as opposed to multiple aquifers combined within a particular monitoring well), and the data record is of sufficient length. A map of locations of monitoring wells for which hydrographs were developed in this study is presented in Figure 5. As can be seen in this figure, there are more monitoring wells completed in the Middle Trinity in the eastern Kerr County study area than in the Lower Trinity. This is consistent with the overall distribution of wells by aquifer layer in Kerr County.

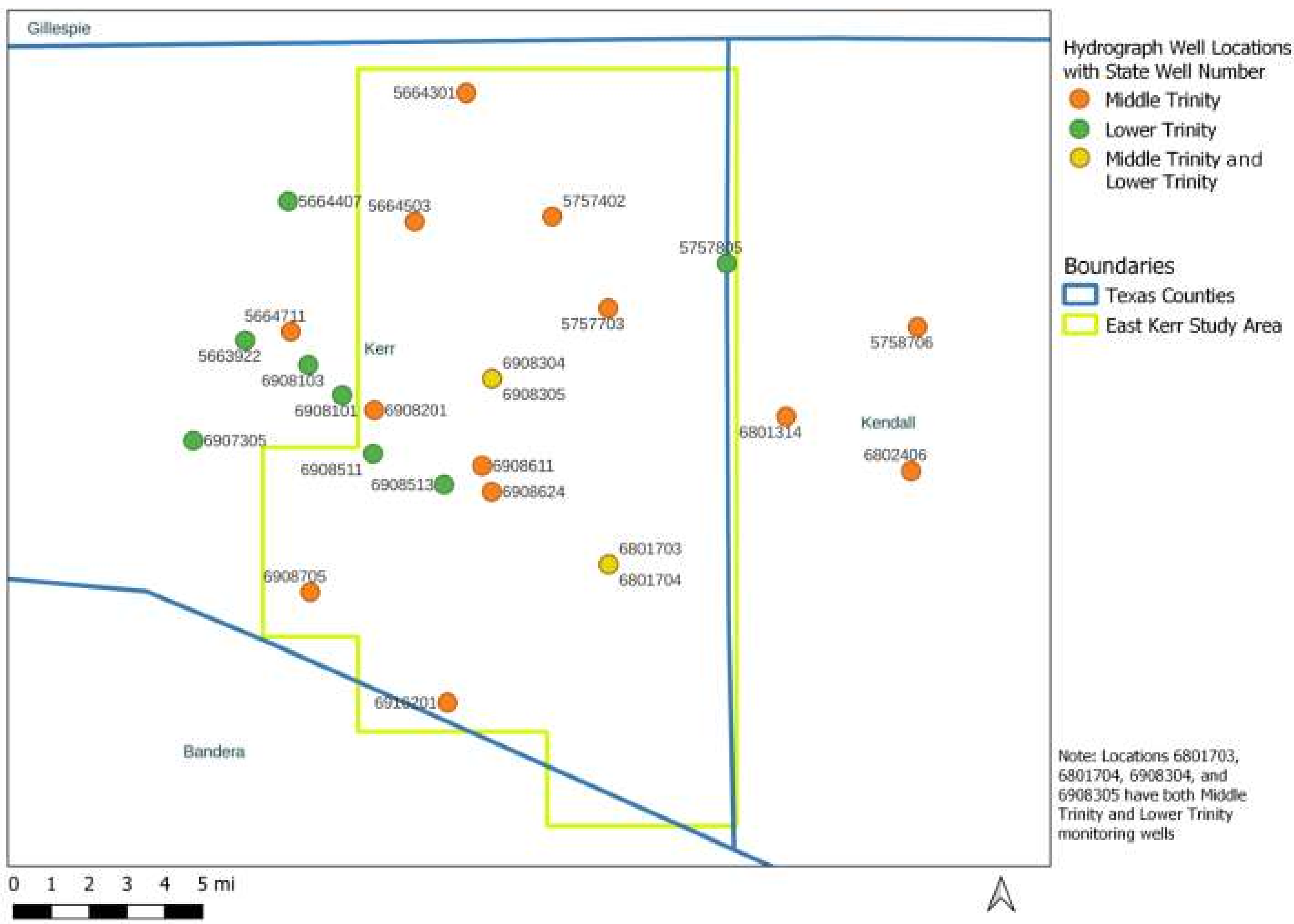

Figure 5. Location of Wells for which Hydrographs were Developed

Hydrographs developed in this study are presented in Appendix A. These hydrographs have the same time scale, from 1996 to 2021, to facilitate comparison. The elevation of the top of the aquifer layer as estimated in the THCGAM is also noted on these hydrographs (unless the information is not available). The precipitation measure shown in in the hydrographs is the 9-month Standardized Precipitation Index (SPI) for Kerr County. Broadly speaking, the SPI conditions represent the number of standard deviations by which precipitation deviates from the long-term mean. The SPI is therefore useful to characterize the duration and degree of both wet and dry precipitation conditions. Select hydrographs from Appendix A will be discussed in this section.

3.1.1 Middle Trinity Aquifer Hydrographs

The first hydrograph to be discussed is that of the "Shady Grove" HGCD monitoring well (state well number 69-08-201). This is a well completed in the Middle Trinity, in the eastern portion of the study area. As can be seen in Figure 6, water levels in this well are strongly correlated with the SPI.

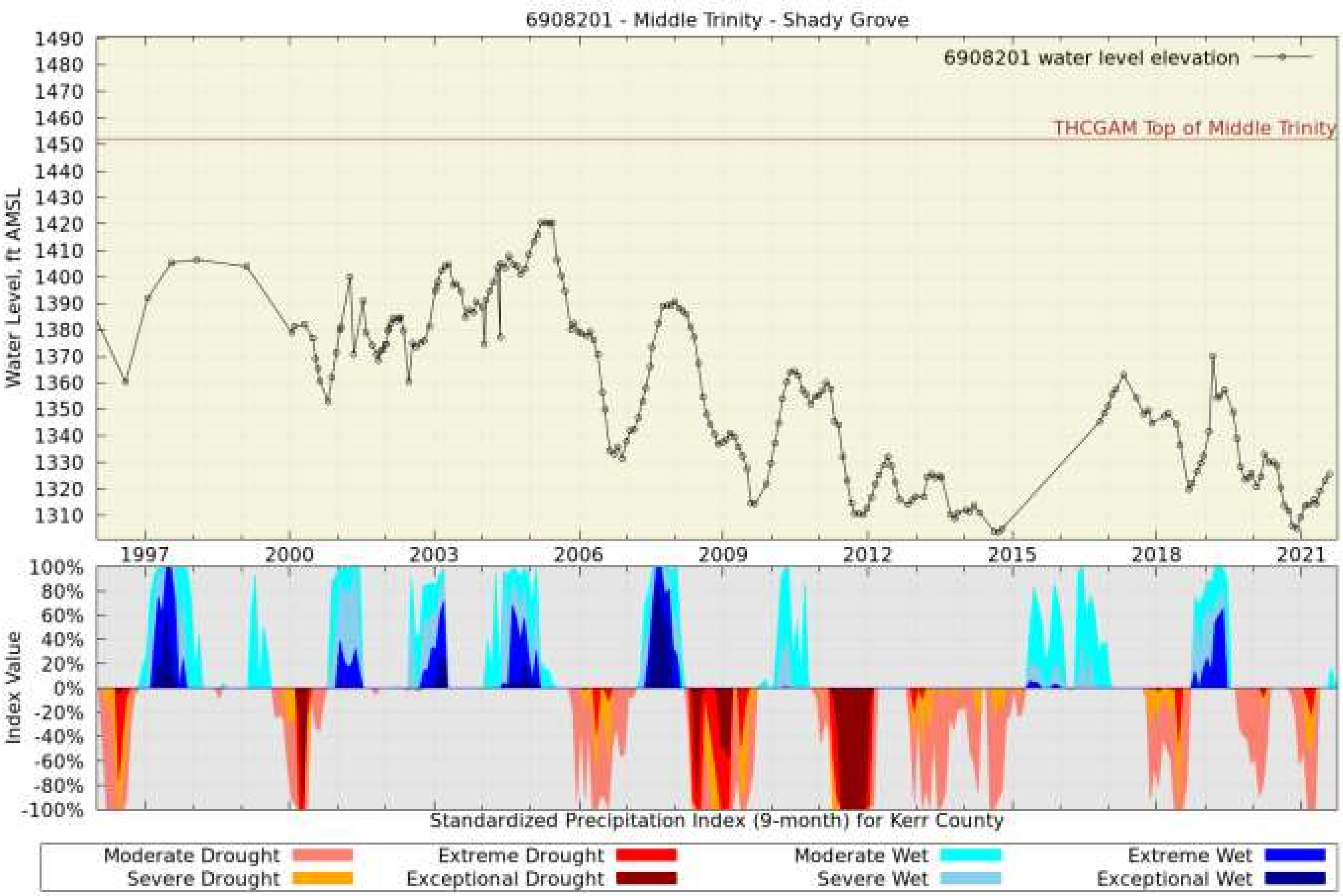

Figure 6. Long-Term Hydrograph for Middle Trinity Well 6908201 With Precipitation Index

Since the Middle Trinity does receive some recharge in this area, the correlation with precipitation likely represents a combination of both recharge and changes in pumping rates for nearby wells. Note that there was an approximately 50-foot decline in water levels from 2005-2011, which had several moderate to severe dry periods without a corresponding number of wet periods.

Figure 7 presents a hydrograph for the Niblett HGCD monitoring well (state well number 69-16-201), another well completed in the Middle Trinity with a long record of water level measurements. Although water levels in this well are also correlated with precipitation conditions, the magnitude of the changes is generally lower than in well 69-08-201. This hydrograph also exhibits the approximately 50-foot decline that occurred in the period from 2005-2011.

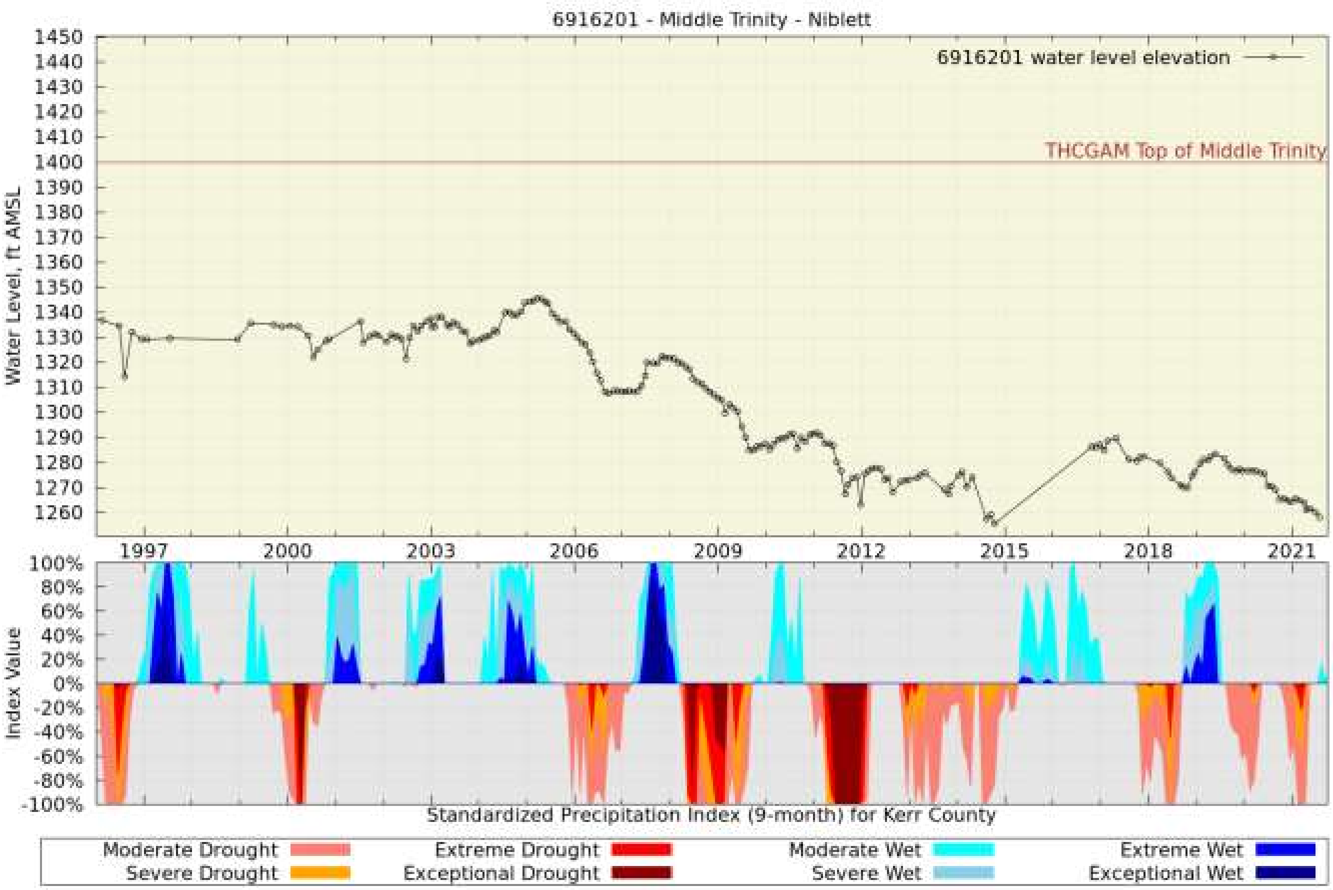

Figure 7. Long-Term Hydrograph for Middle Trinity Well 6916201 With Precipitation Index

Another common way to evaluate water level trends geographically is with contour maps. These show water levels during a particular period over a given geographic area, with estimated contour lines that represent equal (isometric) levels or changes in levels, similar to topographic contour lines. These maps can suggest geographic trends and patterns and provide insight into the general direction of groundwater flow. In aquifers with highly variable water levels (such as the Middle Trinity), these types of maps should be calculated with many data points to average out anomalous fluctuations in any one well.

The following maps focus on contours that illustrate water levels in 1999 and 2020 in various ways. These years were chosen because they have a relatively large number of monitoring wells both geographically (i.e., most of the monitoring wells were measured in both years), and they cover the period for which there is pumping data provided by the district (i.e., annual production amounts for permitted wells).

The first contour map depicts the estimated water level contours in feet relative to sea level (ft rsl) in the Middle Trinity in 1999 (Figure 8). For instance, the 1,400-ft contour line north of Center Point illustrates the estimated locations at which the water level elevation in the Middle Trinity is 1,400 feet (relative to seal level (rsl)). Actual measured water level elevations for 1999 used to prepare these estimated water level contours are shown beside the monitoring well locations in this figure. For example, the 1,400-ft estimated elevation contour is drawn between several data points with values both slightly higher and lower than 1,400 ft in elevation. Groundwater generally flows to the south-southeast in the Middle Trinity in eastern Kerr County.

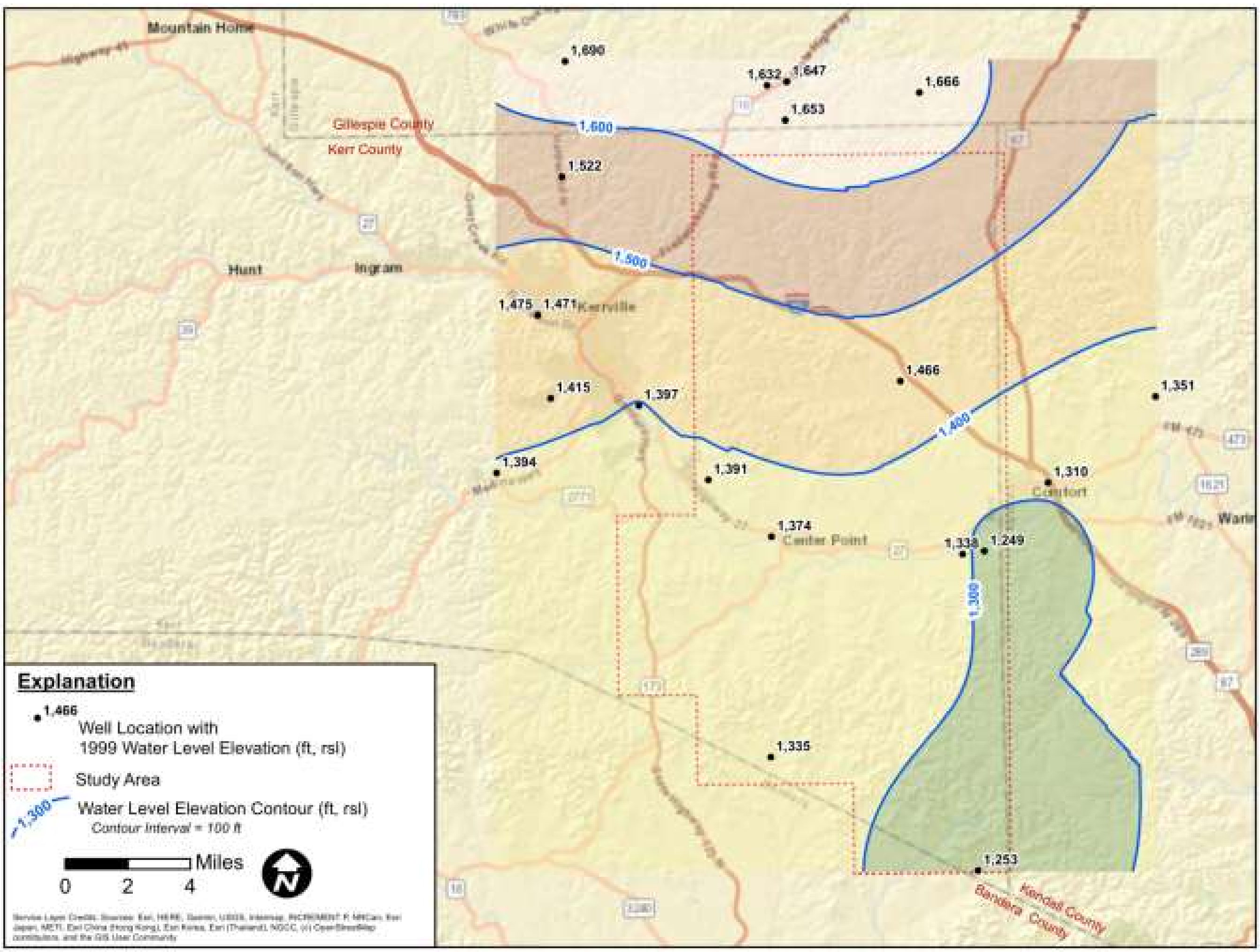

Figure 8. Water Level Elevation Contours for the Middle Trinity in 1999 in Eastern Kerr County

Figure 9 illustrates the estimated water level contours (in blue) relative to the base of the Middle Trinity for 1999. As in other contour figures, the water level measurements used in generating the contours are shown beside the monitoring well. The levels of these contours are estimates of available drawdown in the aquifer for wells that are screened to the base of the Middle Trinity (bottom of Cow Creek and assuming pumps are placed at the bottom of the screen interval). The elevation of the base of the aquifer is from the THCGAM layer, which is the base of the Cow Creek formation.

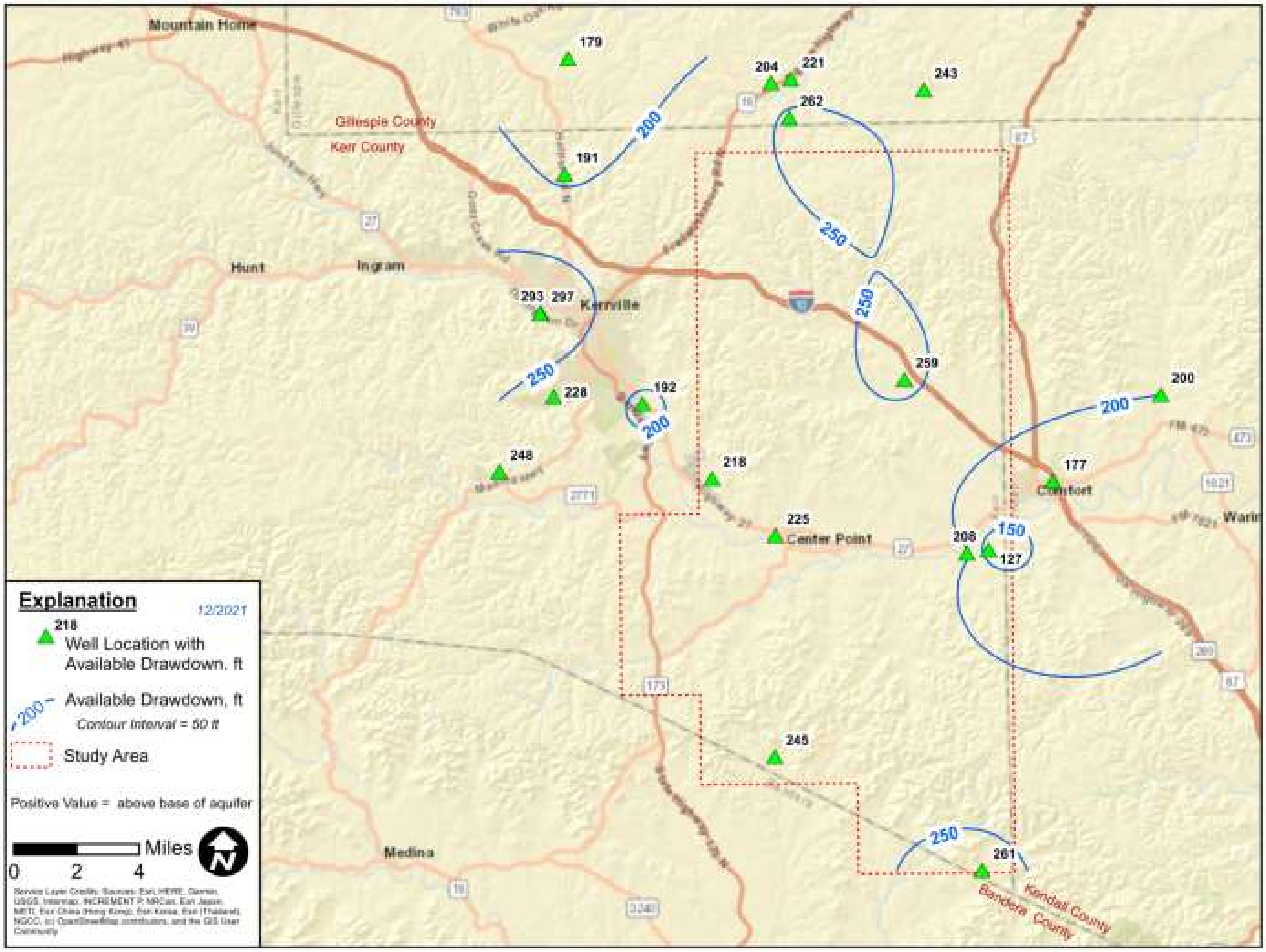

Figure 9. Available Drawdown in Middle Trinity based on Water Level Measurements for 1999

Estimated water level contours in the Middle Trinity in 2020 are shown in Figure 10. The direction of flow remains to the south-southeast, although the overall elevation is 25-50 feet lower. For example, the 1,300-ft contour has expanded since 1999 and covers much of the southern half of the study area.

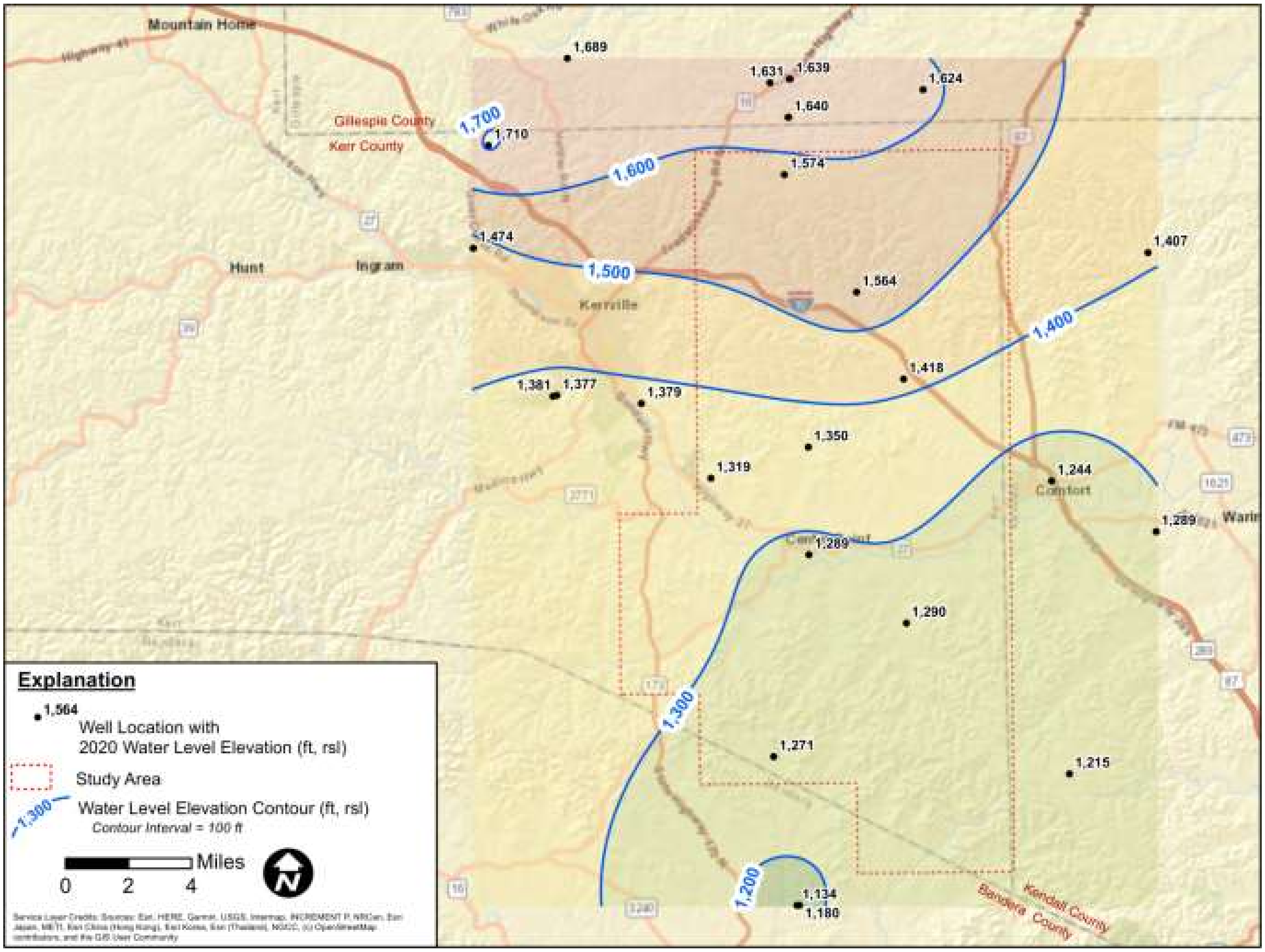

Figure 10. Water Level Elevation Contours for the Middle Trinity in 2020 in Eastern Kerr County

Estimated available drawdown contours measured from the base of the Middle Trinity for 2020 are presented in Figure 11.

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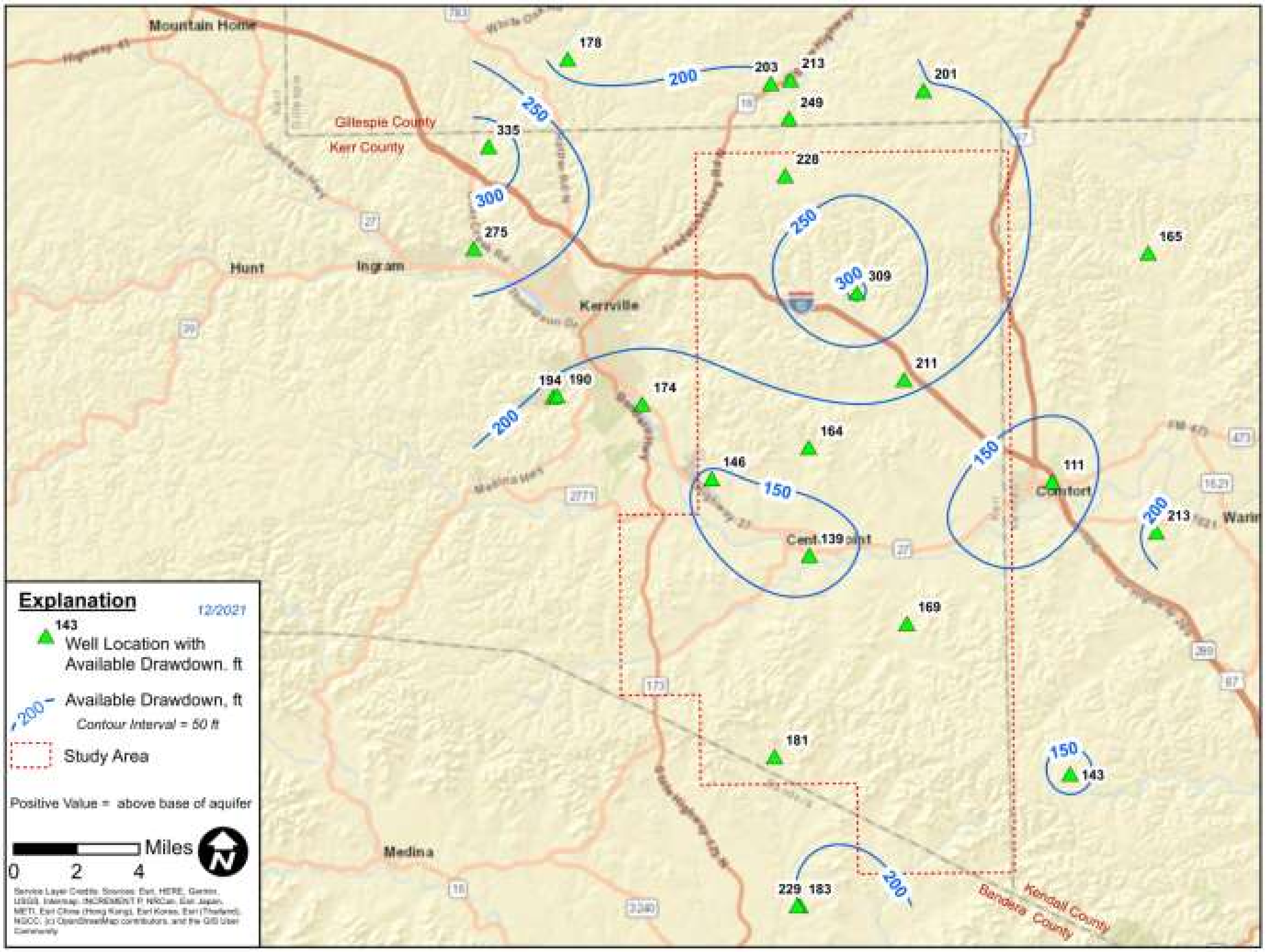


Figure 11. Available Drawdown in the Middle Trinity for 2020

Figure 12 illustrates estimated water level change contours for the Middle Trinity between the years 1999 and 2020, using data from the same wells in both time periods. As in similar figures, the actual values and locations used to prepare the estimated contours are also shown in this figure. The southern portion of the study area (Center Point and surrounding areas) has experienced approximately 50-70 feet of water level decline over this period and the northern portion of the study area has experienced less than 50 feet of water level decline.

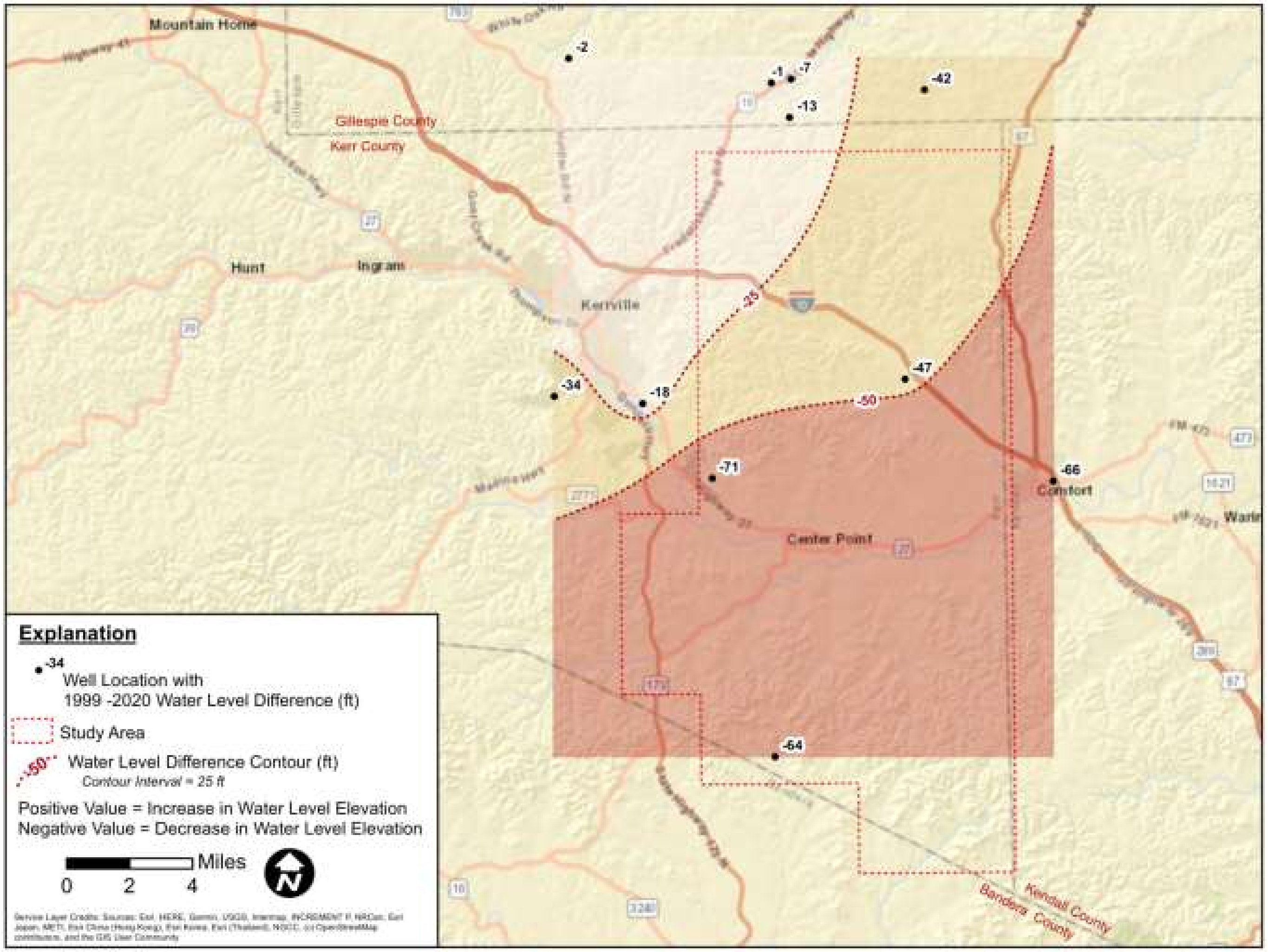


Figure 12. Contours of Water Level Change for the Middle Trinity (1999 – 2020)

Figure 13 shows estimated percent change in available drawdown from 1999-2020 (as measured from the base of the Middle Trinity Aquifer). The data points shown are calculated by dividing the water level change at that location (Figure 12) divided by the estimated available drawdown in 1999 (Figure 9). This map indicates the percentage loss in available drawdown over the 11-year period and highlights the southern portion of the study area with the greatest decrease of the 11-year period.

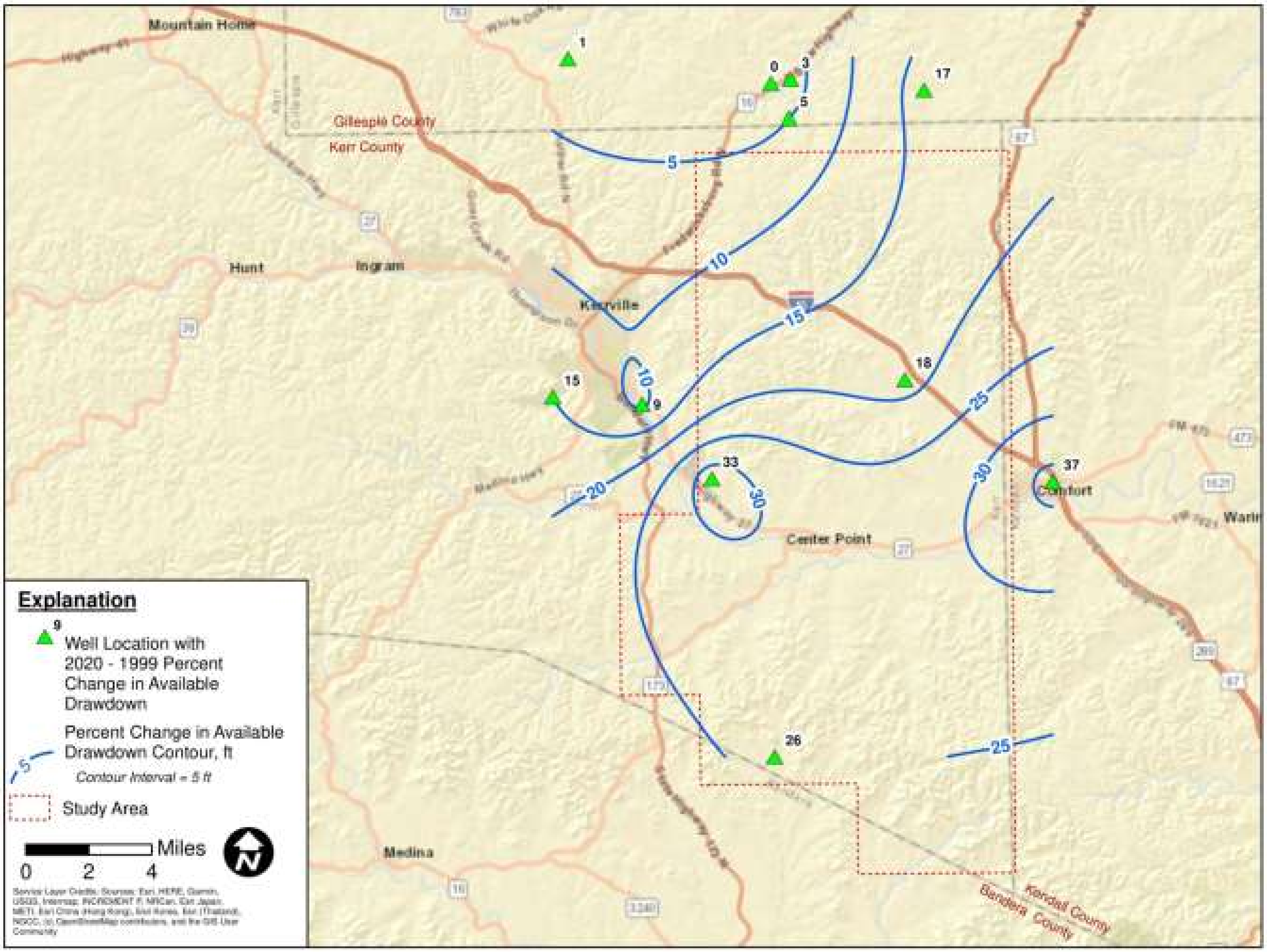


Figure 13. Percent change in Available Drawdown in the Middle Trinity Aquifer between 1999 and 2020

3.1.2 Lower Trinity Aquifer Hydrographs

There are comparatively few hydrographs for wells completed in the Lower Trinity Aquifer in the east Kerr County study area. Those that are available are included in Appendix A. One representative example of the changes in water level in the Lower Trinity in response to pumping is shown in Figure 14. This figure presents a hydrograph for the “Texas Orchards” HGCD monitoring well (state well number 69-08-511), a well completed in the Lower Trinity with a long record of water level measurements. Water levels in this well are correlated with precipitation conditions. In the Lower Trinity, this correlation is more likely dominated by changes in pumping than recharge.

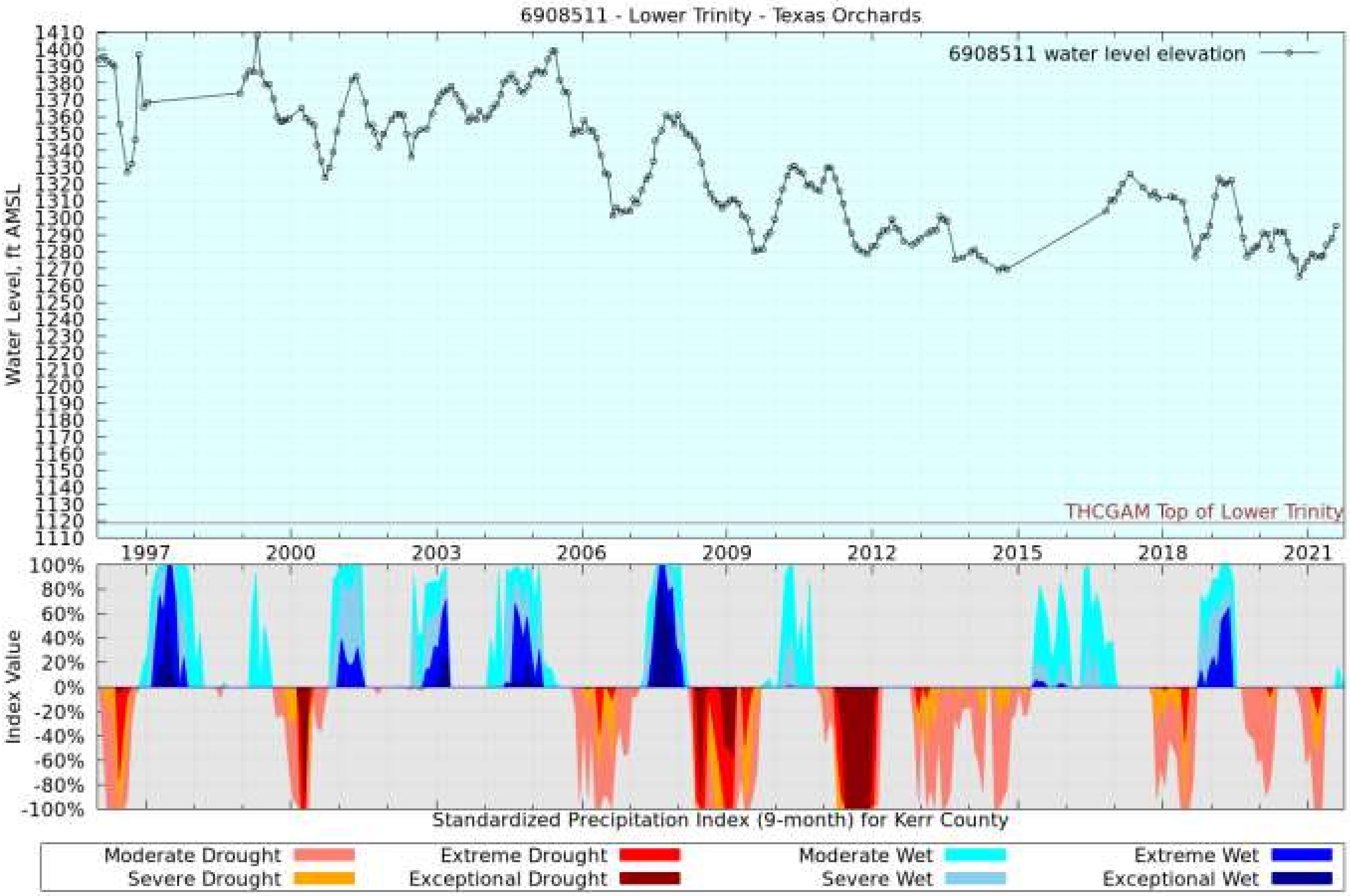


Figure 14. Long-Term Hydrograph for Lower Trinity Well 6908511 With Precipitation Index

Figure 15 presents the estimated water level contours in the Lower Trinity in 2006. As in previous figures, actual measured locations with corresponding water level measurement are shown in this figure. Water levels in the Lower Trinity are not available in the southern and northern portions of the study area, so the contours shown in Figure 15 and other water level figures for the Lower Trinity only show estimated contours in the areas with available data.

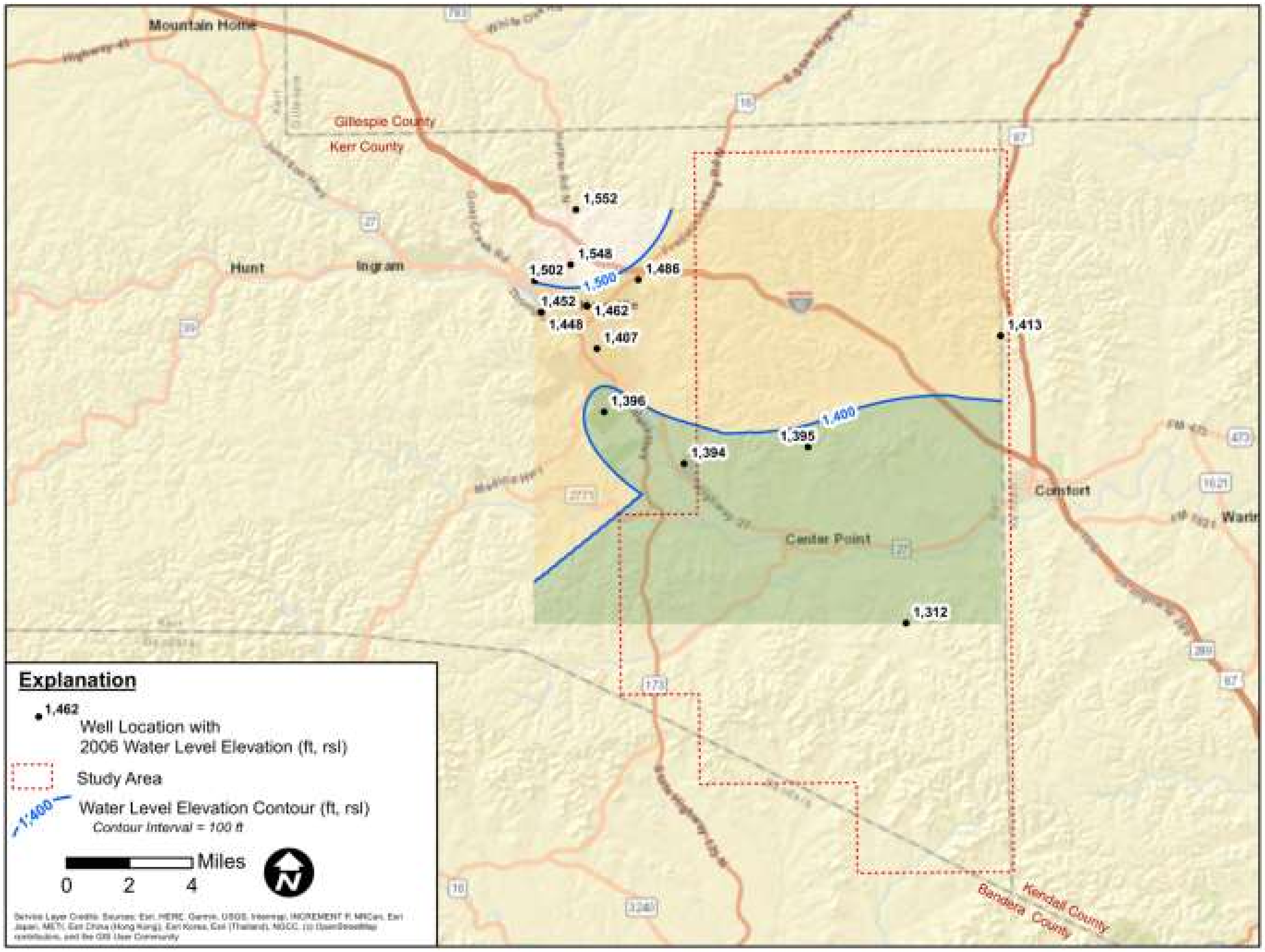


Figure 15. Estimated Water Level Elevation Contours for the Lower Trinity in 2006

Estimated available drawdown contours measured from the base of the Lower Trinity (as defined by the base elevation of Layer 4 in the THCGAM) for 2006 are presented in Figure 16. Available drawdown in the Lower Trinity ranges from about 300 to 450 feet based on the available wells and data in eastern Kerr County.

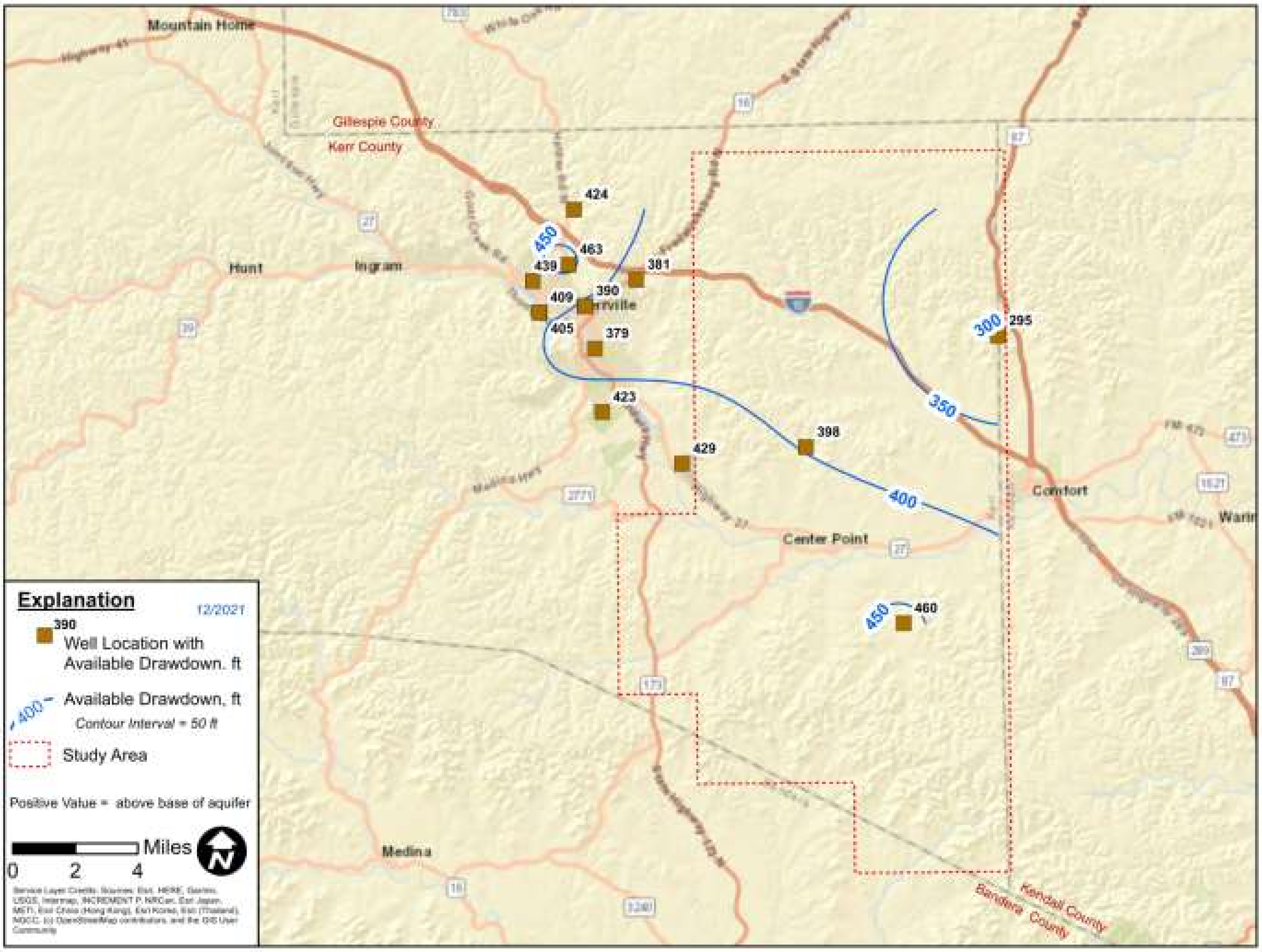


Figure 16. Available Drawdown in the Lower Trinity Aquifer in 2006 (from Base of Lower Trinity Aquifer as defined in the THCGAM)

Figure 17 presents the estimated water level contours in the Lower Trinity in 2020.

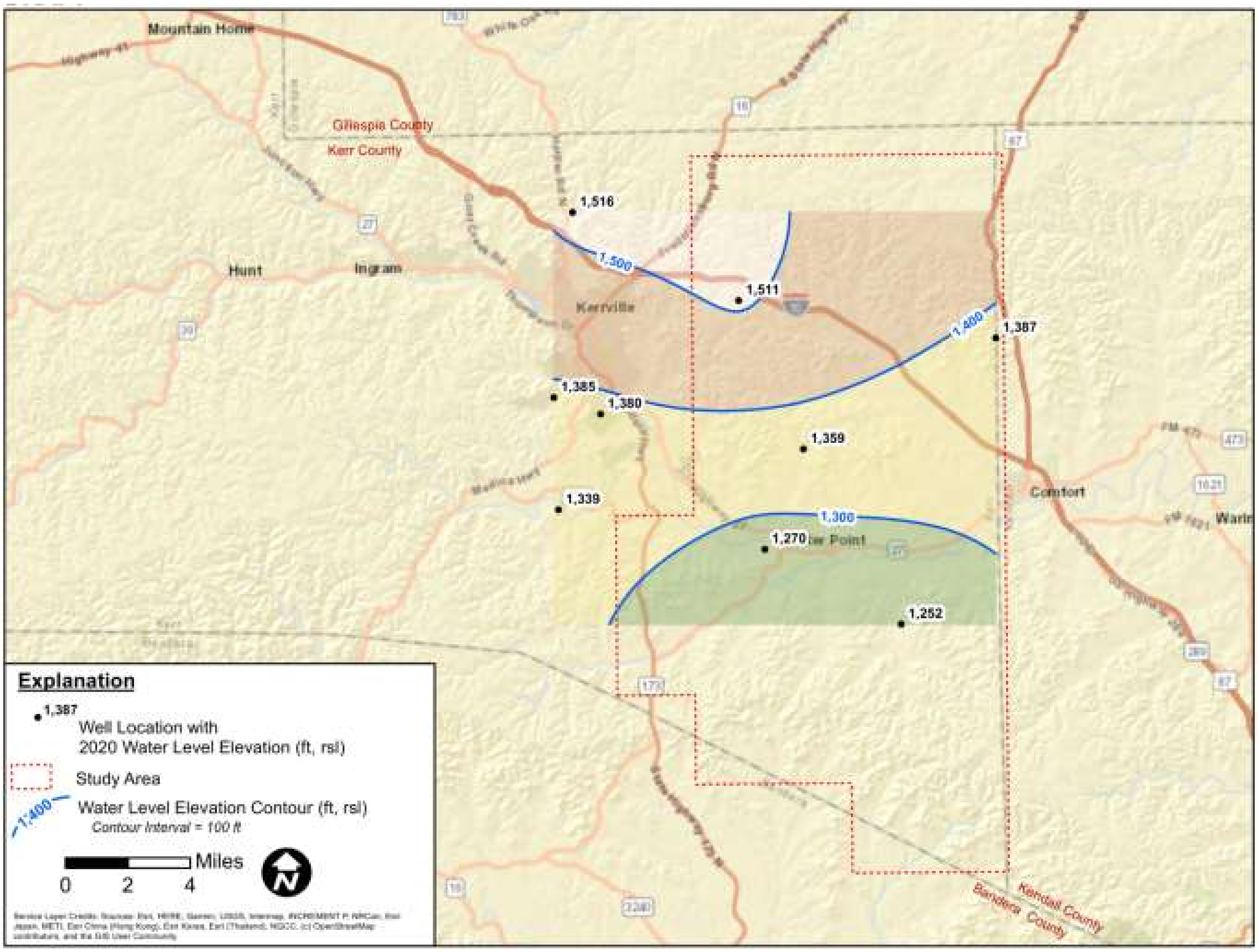


Figure 17. Water Level Elevation Contours for the Lower Trinity in 2020

Figure 18 shows the available drawdown in the Lower Trinity Aquifer in 2020 measured from the base of the Lower Trinity Aquifer.

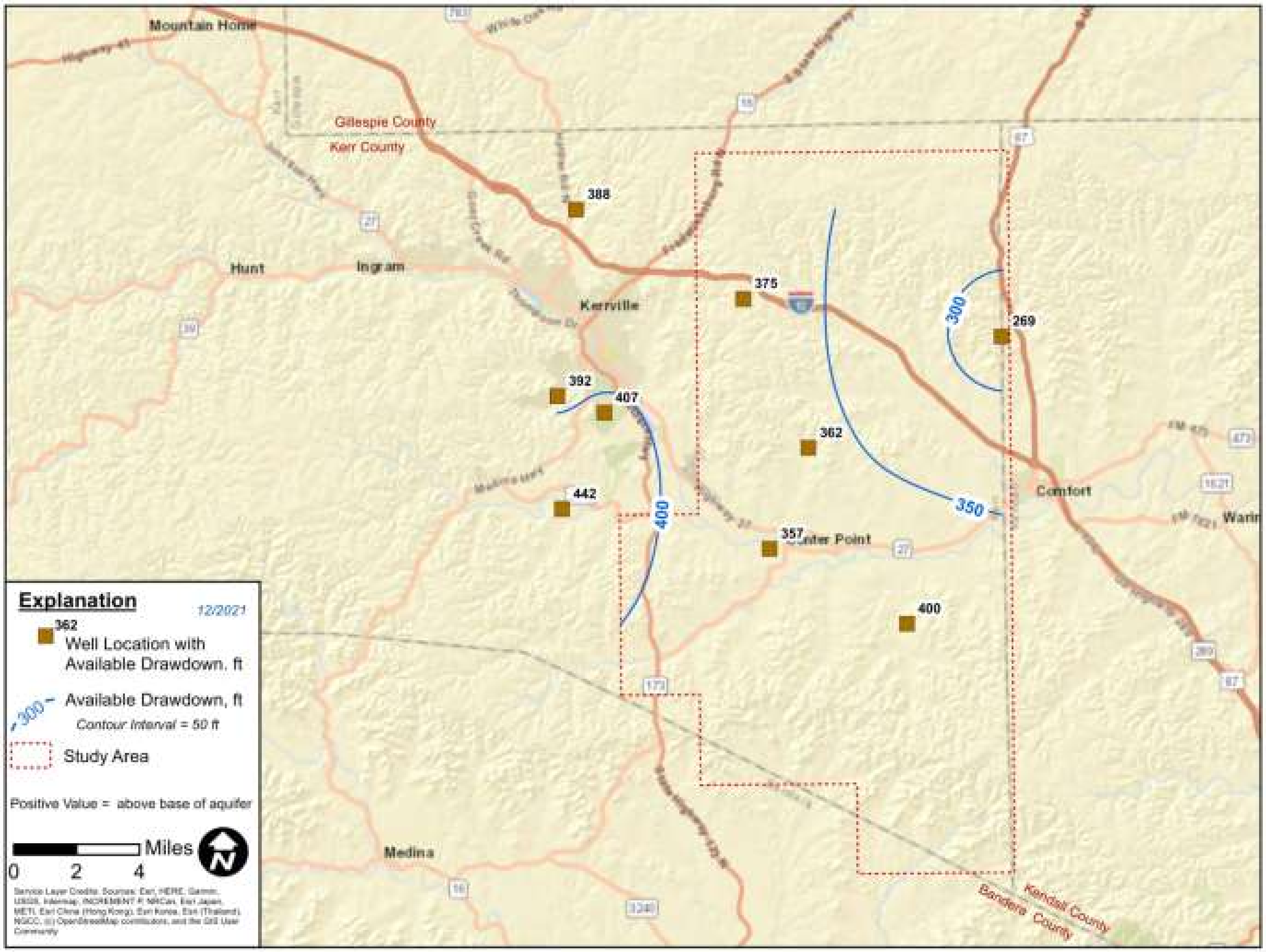


Figure 18. Available Drawdown in the Lower Trinity Aquifer in 2020 (from Base of Lower Trinity Aquifer as defined in the THCGAM)

Figure 19 illustrates estimated water level change contours for the Lower Trinity between the years 2006 and 2020, using data from the same wells in both time periods. As in similar figures, the actual values and locations used to prepare the estimated contours are also shown in this figure. The southern portion of the study area has experienced approximately 40-60 feet of water level decline over this period. This trend is similar to the Middle Trinity Aquifer, where the greatest water level decline is located in the southern portion of the study area.

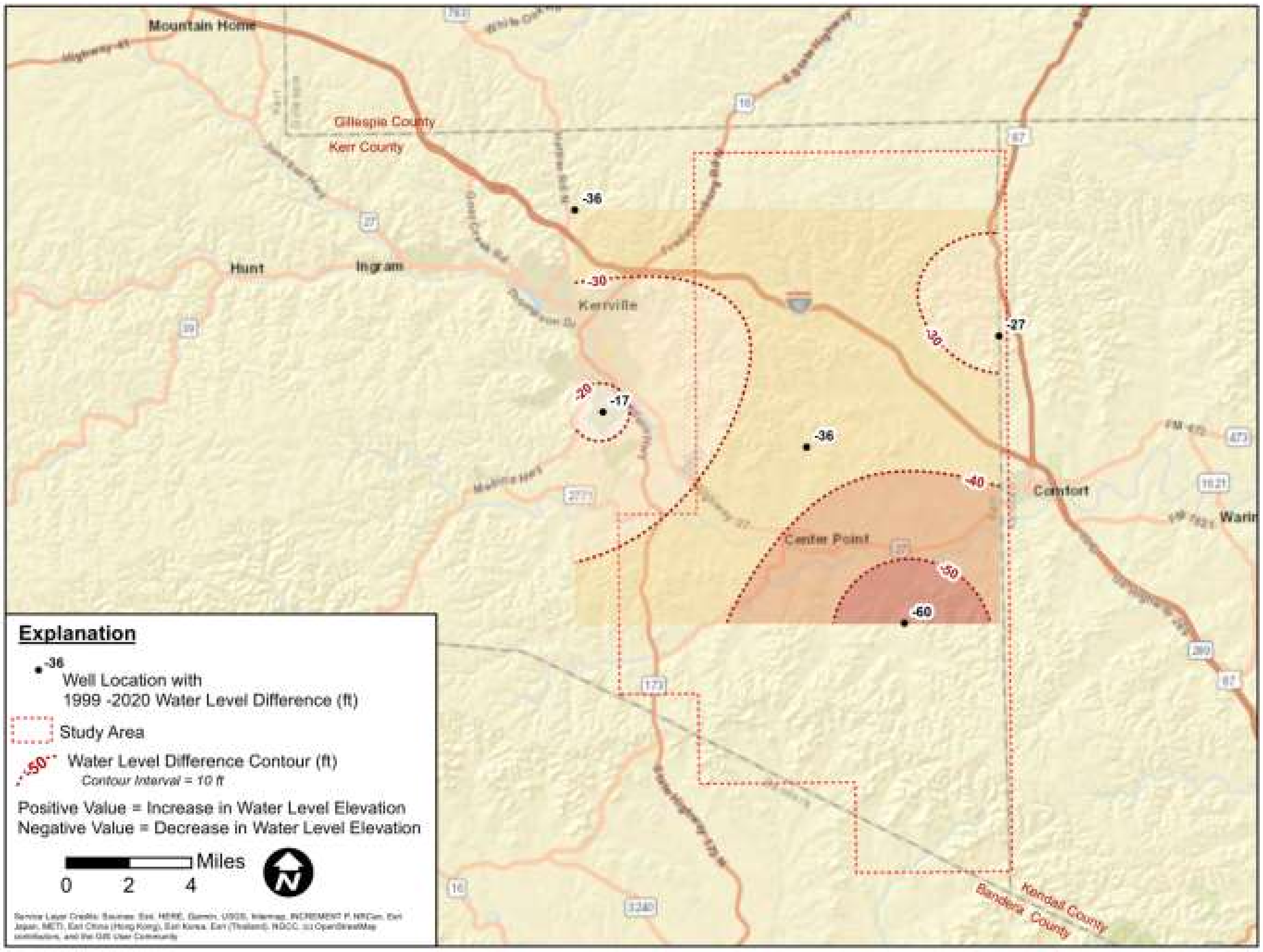


Figure 19. Contours of Change in Water Level for the Lower Trinity between 2006 and 2020

Figure 20 shows estimated percent change in available drawdown from 2006-2020 (as measured from the base of the Lower Trinity Aquifer). The data points shown are calculated by dividing the water level change at that location (Figure 19) divided by the estimated available drawdown in 1999 (Figure 16). The estimates of percent change in available drawdown also indicate the highest rate of decline in and around the Center Point area.

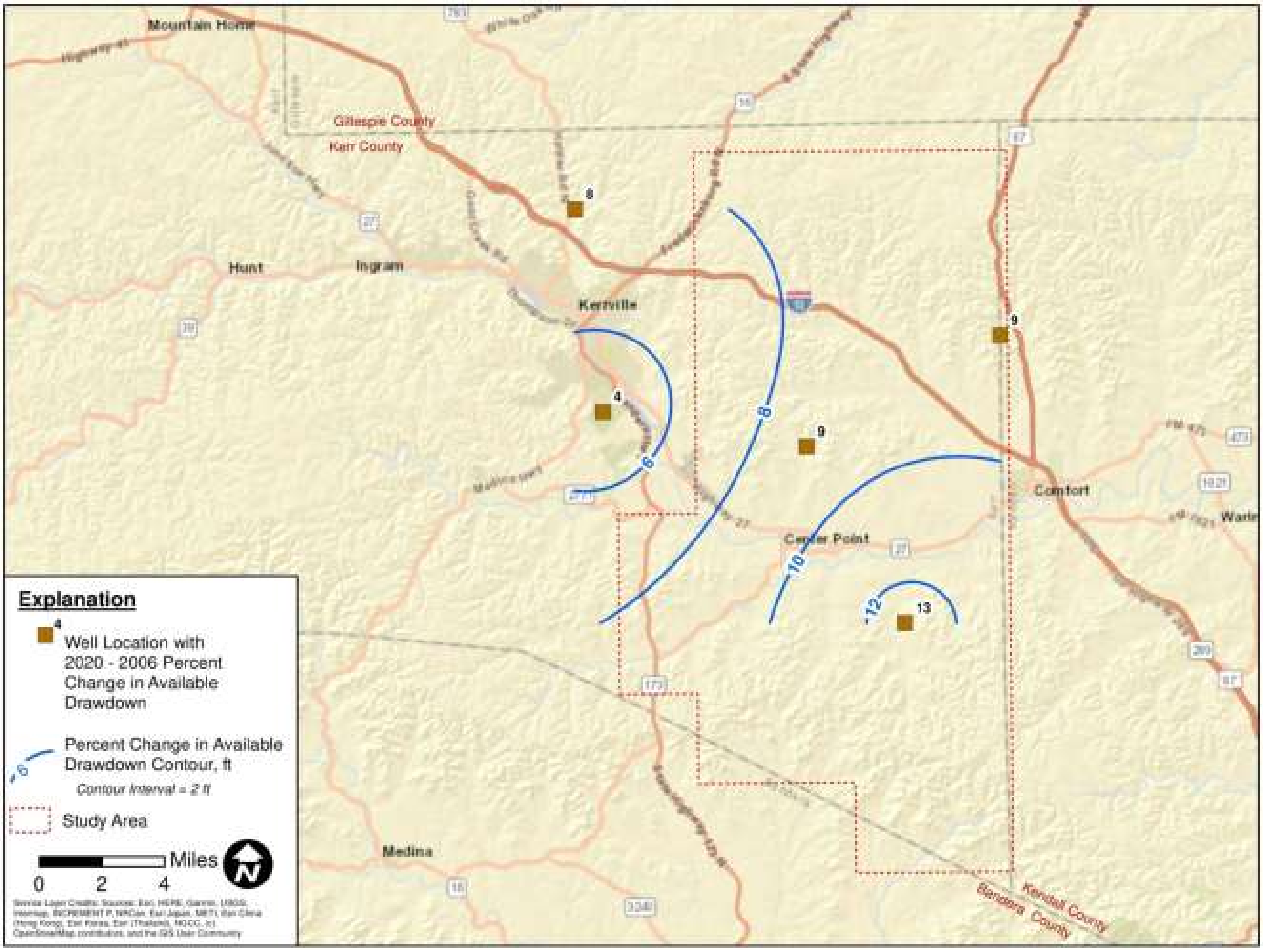


Figure 20. Percent change in Available Drawdown in the Lower Trinity Aquifer between 2006 and 2020

3.2 *Pumping Trends*

Trends in groundwater pumping for the Middle and Lower Trinity in eastern Kerr County have been assessed using a combination of District permitted well metered data and county-level data from TWDB.

The first category of historical pumping assessed was for District permitted wells. These fall into broad categories of commercial, irrigation, and public water supply. HGCD provided annual meter measurement data for permits. These data were assigned on a per-well basis, assuming equal distribution among all wells associated with a given permit. The number of metered permits reached a level suitable for analysis by 2003, and so this date was chosen as a cut off for allocating historical pumping estimates to individual wells.

The second broad category of historical pumping to be assessed is exempt wells. By their nature, exempt wells have no well-specific pumping records, unlike permitted wells. Our approach to assessing this pumping was to use county-level pumping estimates, and distribute that pumping to each exempt well in existence in the District data for the years 2010-2020.

For livestock pumping, the TWDB provides historical groundwater use estimates on an annual basis. These estimates are based on agricultural census data for Kerr County, combined with water use estimates for each class of livestock (i.e., cattle, sheep, etc.). The amount of pumping estimated by TWDB for a given year in Kerr County was distributed to each well present in the District data for that year, for the years 2010-2020.

For domestic pumping, GMA 9 estimates of Kerr County domestic pumping for 2020 (2,973 AFY) were used to derive an estimate of the number of gallons per connection per day for each registered domestic well. These county-level estimates are based on census population data. For the number of domestic wells present in District data this estimate was 406 gallons per connection per day. This amount is somewhat higher than average connection usage throughout the state, but this is likely due to the impact of unregistered domestic wells not available in the District data. This estimate was applied to all domestic wells present in each year in District data to arrive at an annual pumping for each of the years 2010-2020.

For all wells, pumping was assigned based on completion aquifer. In the case of dual-completed wells (e.g., completed in both the Middle and Lower Trinity), assigned pumping was split between the two aquifers.

A summary of Middle Trinity annual pumping for all of Kerr County in each use category for the years 2003-2020 is given in Figure 21. The scale for the pumping volume (left axis) is variable for each category in this figure because the amount of pumping for each category varies considerably. Figure 22 provides the same pumping summary for the Middle Trinity Aquifer for the eastern Kerr County study area. Pumping in the Middle Trinity over this time period follows the same general trend for each use category in the eastern Kerr County study area as it does for Kerr County as a whole.

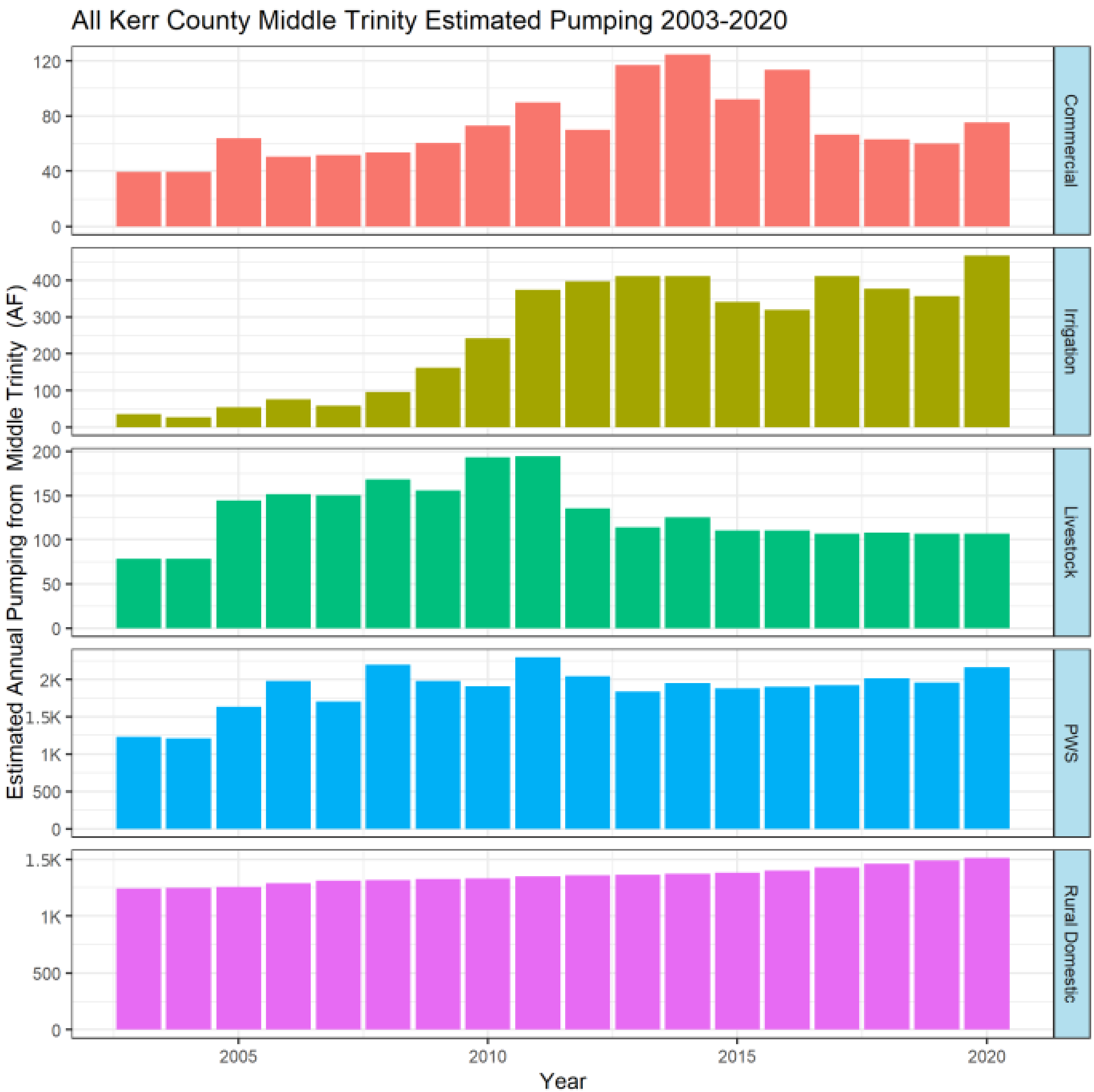


Figure 21. Estimated Pumping from the Middle Trinity for All of Kerr County by Usage Groups (2003-2020)

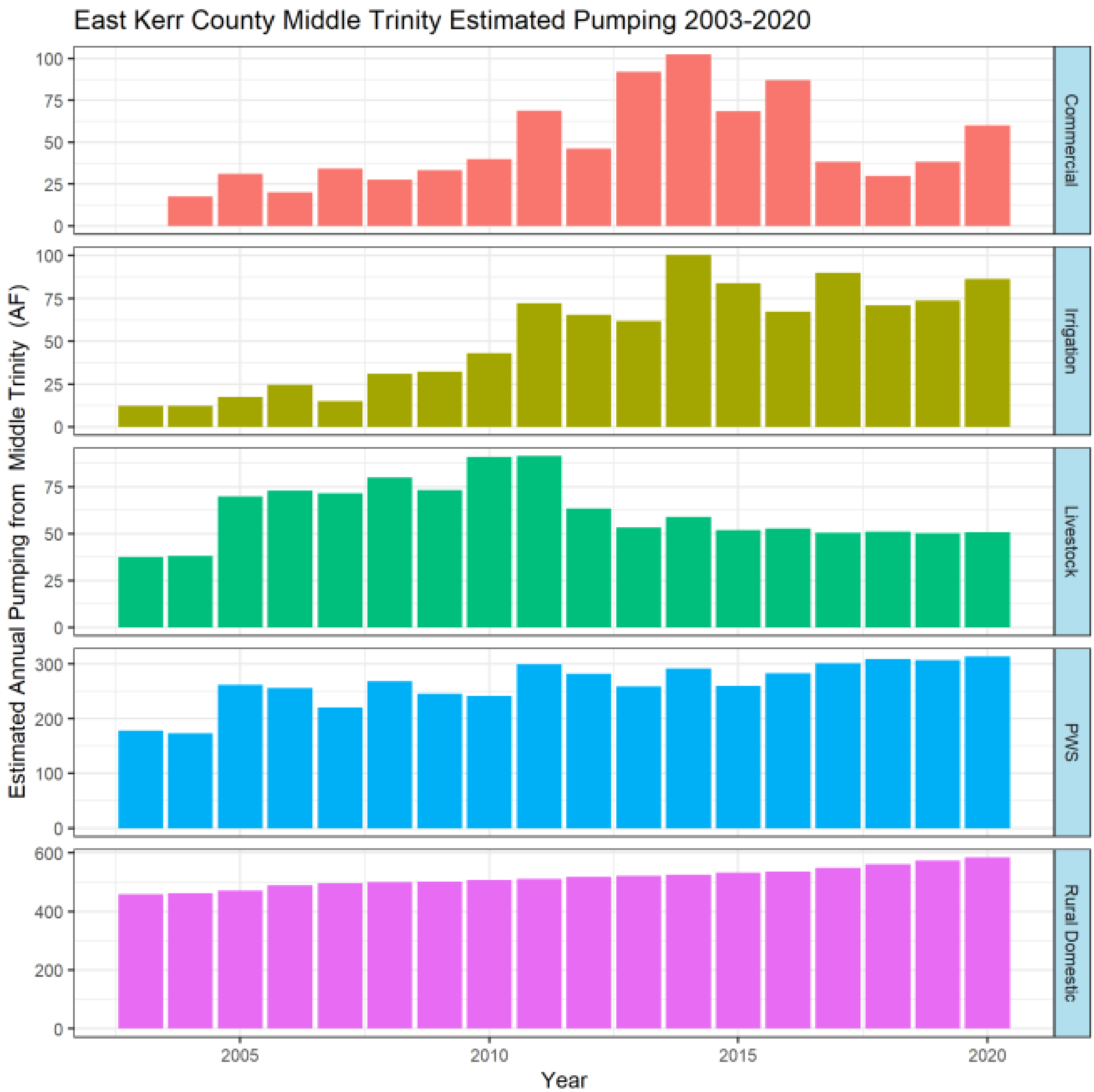


Figure 22. Estimated Pumping from the Middle Trinity Aquifer for East Kerr County by Use Categories (2003-2020)

Figure 23 shows, for all of Kerr County, 1) Middle Trinity estimated annual total pumping for this study (i.e., a total of pumping shown in Figure 21), and 2) for the pumping in the layer representing the Middle Trinity in the THCGAM. Because the MAG (Modeled Available Groundwater) pumping in the GAM is a “predictive” scenario and was based on the best estimate of future pumping to assess desired future conditions (DFCs), it is much higher than actual estimated pumping in recent years. The MAG estimate for HGCD (and all of GMA 9) was based on an increase of about 66 percent over 2008 pumping estimates. Therefore, it is not surprising that the MAG pumping is higher than recent pumping estimates from the district. Specifically, the estimated pumping in GMA 9 in 2008 was about 60,000 AFY, and the Desired Future Condition selected by GMA 9 yielded a MAG of about 100,000 AFY.

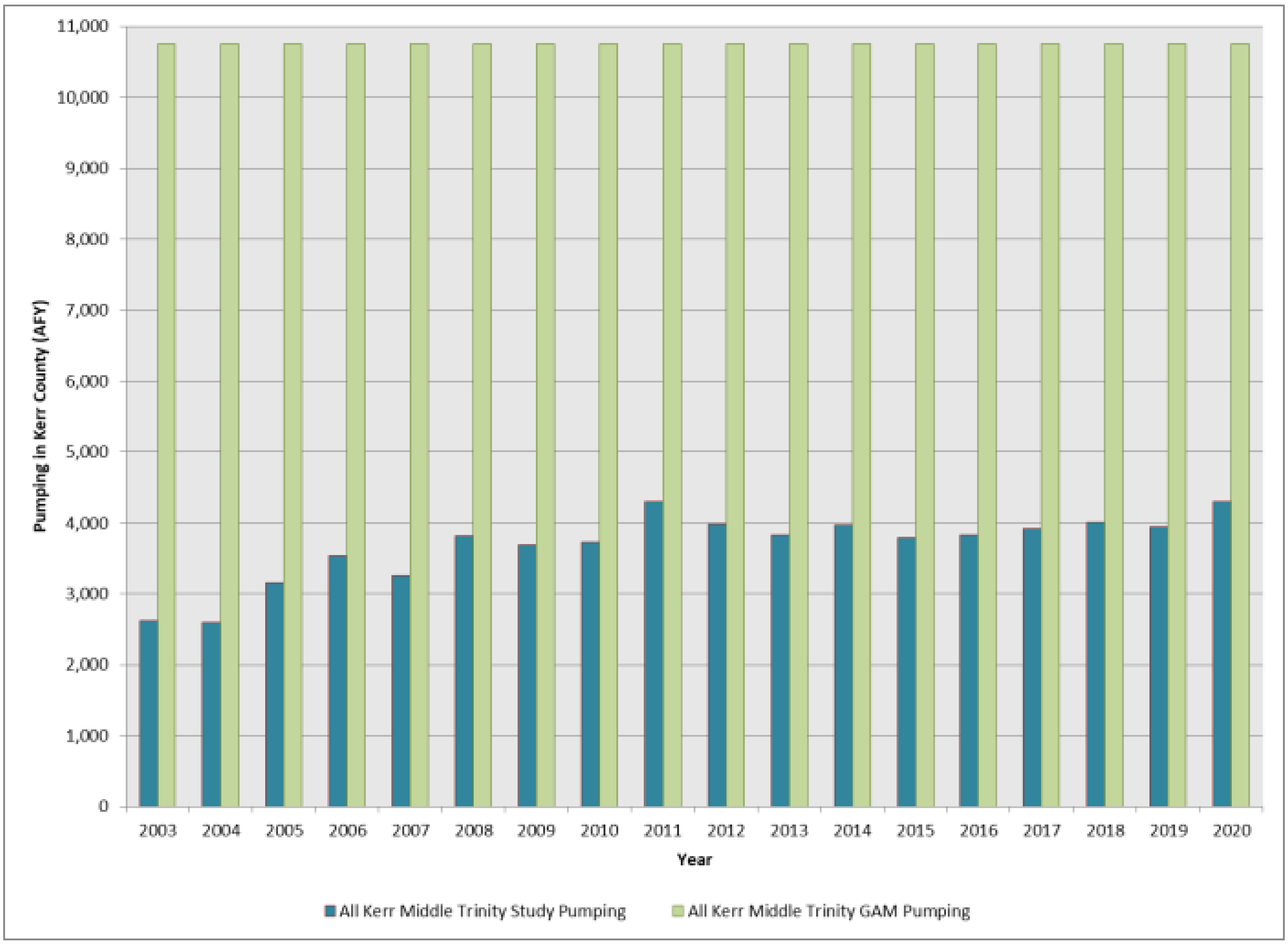


Figure 23. Comparison of Estimated Total Pumping from the Middle Trinity Aquifer and MAG Pumping in the GAM for All of Kerr County

Figure 24 shows, for the eastern Kerr County study area, 1) Middle Trinity estimated annual total pumping for the East Kerr Study Area (i.e., a total of pumping shown in Figure 22), and 2) for the pumping in the layer representing the Middle Trinity in the THCGAM in the East Kerr Study Area.

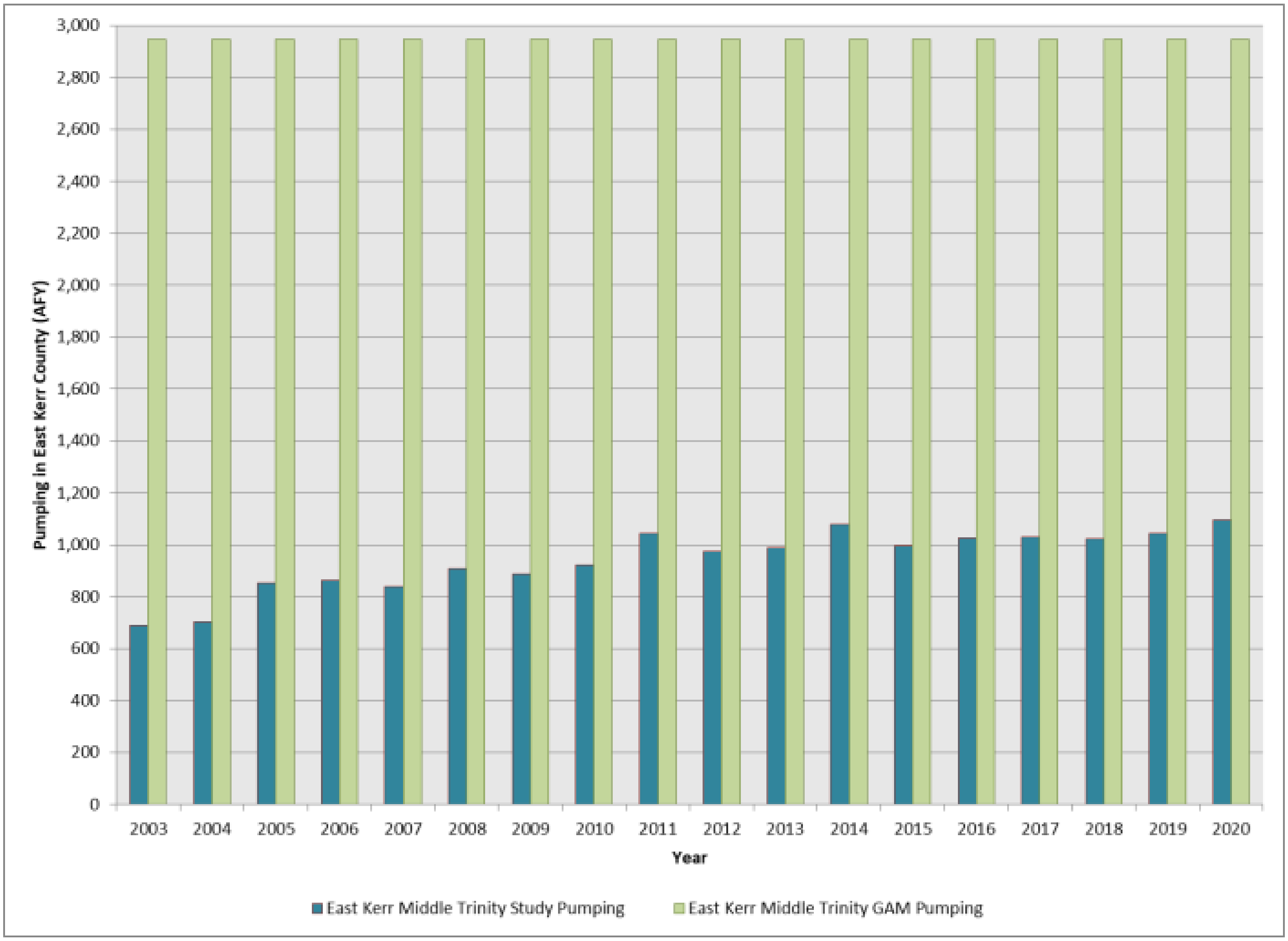


Figure 24. Comparison of Estimated Total Pumping from the Middle Trinity Aquifer and MAG Pumping in the GAM for East Kerr Study Area

A summary of estimated Lower Trinity annual pumping for all of Kerr County in each use category for the years 2003-2020 is given in Figure 25.

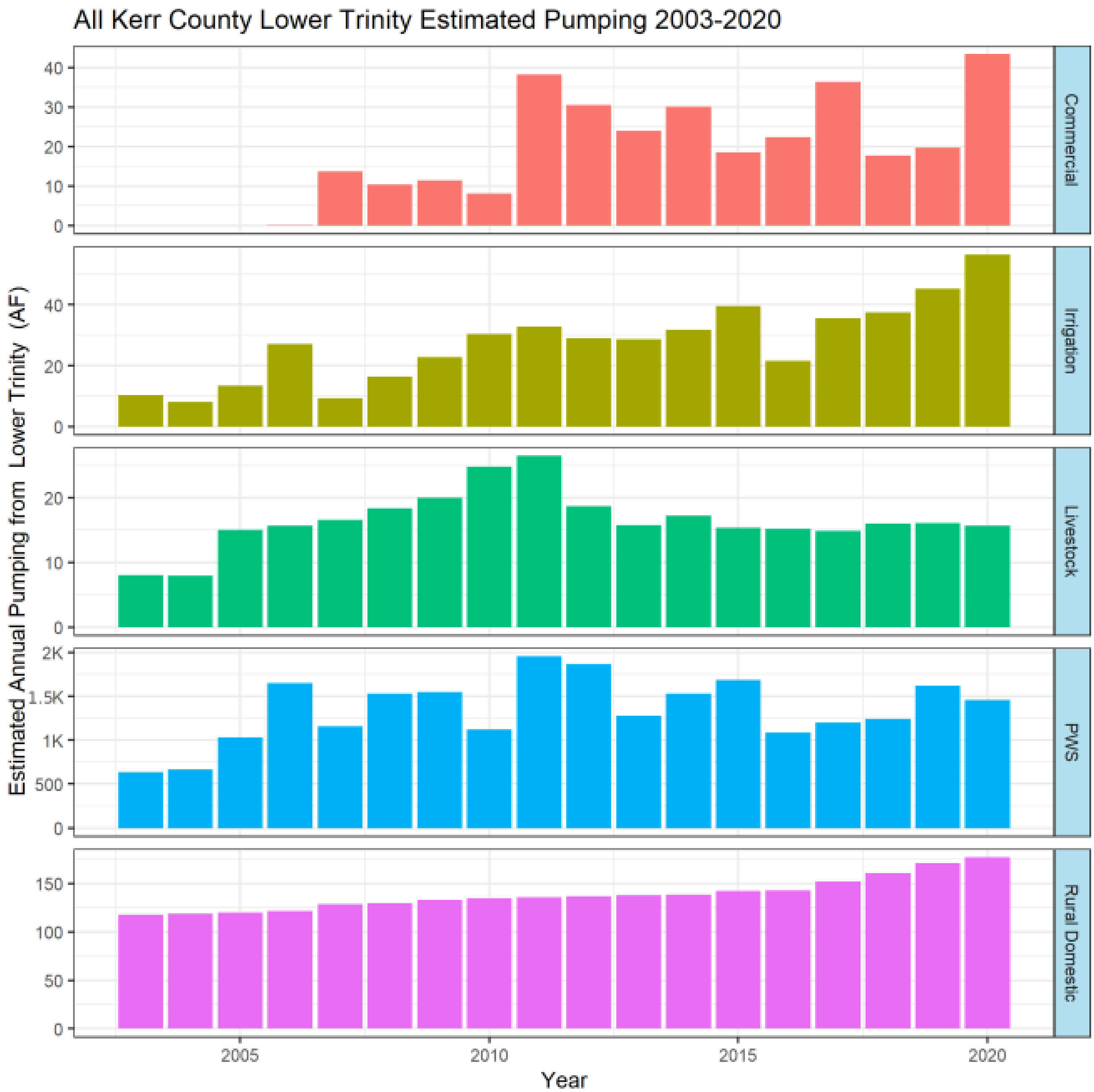


Figure 25. Estimated Pumping from the Lower Trinity for All of Kerr County by Usage Groups (2003-2020)

Figure 26 shows the same pumping data for the Lower Trinity Aquifer in the eastern Kerr County study area from 2003-2020. Estimated pumping in the Lower Trinity in the eastern Kerr study area generally follows the same trends as for Kerr County over this time period, with the exception of public supply which is a bit more consistent year-to-year than in the county as a whole.

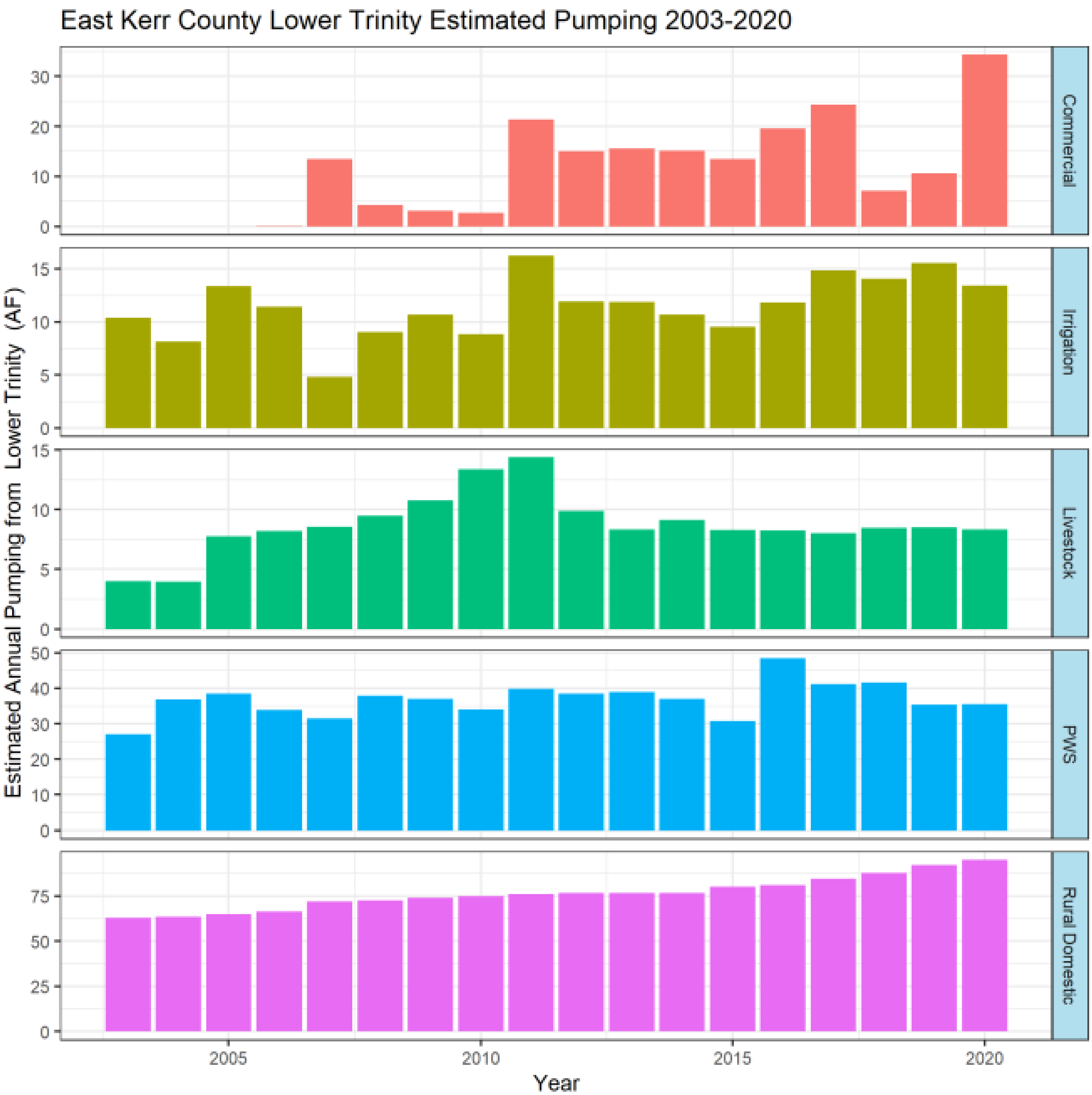


Figure 26. Estimated Pumping from the Lower Trinity for East Kerr Study Area by Usage Groups (2003-2020)

Figure 27 shows, for the East Kerr Study Area, 1) Lower Trinity estimated annual total pumping for this study (i.e., a total of pumping shown in Figure 26), and 2) for the pumping in the layer representing the Lower Trinity in the THCGAM. Again, the GAM pumping is much larger than the estimated actual pumping, as it represents a level close to the MAG.

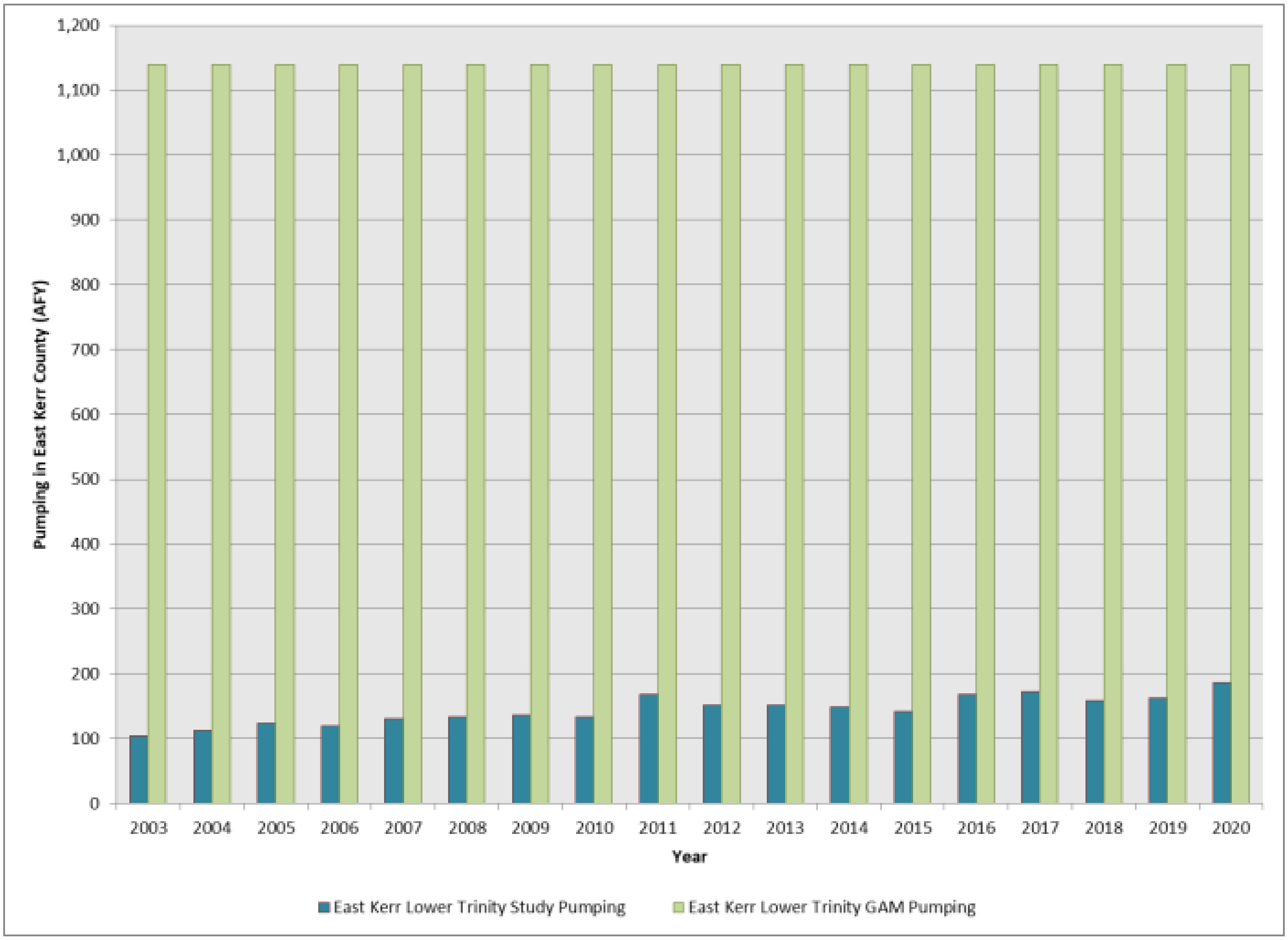


Figure 27. Comparison of Estimated Total Pumping from the Lower Trinity Aquifer and MAG pumping in the THCGAM for East Kerr Study Area

The total estimated annual pumping for the year 2020 was assigned to GAM grids according to pumped well location for the Middle Trinity (Figure 28). Actual estimated grid totals have been assigned to discrete pumping areas (gridblocks) in this figure for ease of illustration. Areas without grid cells in this figure have no estimated pumping for the year 2020. Usually this is a case of no wells being present in that gridblock. In some cases, a non-exempt well is present in a gridblock, but did not have metered records for the year 2020.

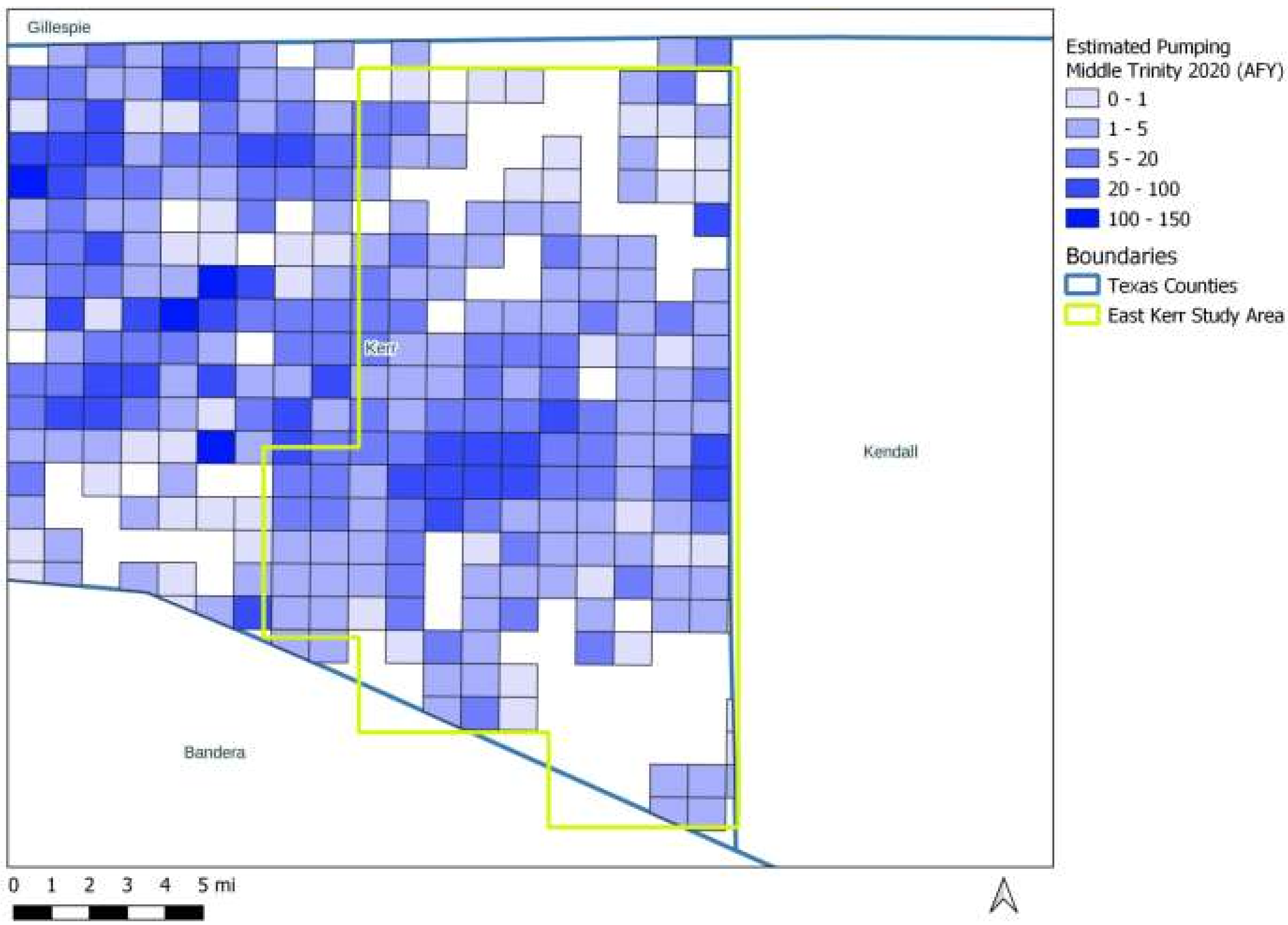


Figure 28. Middle Trinity Aquifer Pumping Distribution for 2020 as Estimated in the Eastern Kerr Study Area

The difference between the estimated actual 2020 pumping and the MAG estimate (i.e., future pumping) in the THCGAM is shown in Figure 29. The difference in pumping is illustrated within each gridblock in the THCGAM. Each gridblock measures 1-mile by 1-mile. In this figure, purple colors indicate the THCGAM pumping was higher, and orange colors indicate the actual estimated pumping was higher than the MAG estimates included in the DFC assessment. This figure illustrates that several developed areas have had more actual pumping than is in the MAG estimate in the THCGAM, while less-developed areas of northern part of the study area have had less actual pumping than is in the MAG estimate in the THCGAM. This is caused in part by different approaches used to distribute pumping in the GAM and the detailed approach used in this study which incorporated the location of specific well locations and permitted production values that were not available during the DFC and MAG analysis in 2010.

Gridblocks with large public water supply wells also generally have had less actual pumping than is in the GAM. This is likely due to the “ramp up” of pumping (in different scenarios, but not in time) that was used in the joint planning process to assess the DFC and MAG. In the ramp up process, the 2008 estimated pumping in every model gridblock was simply multiplied by a factor to estimate the future pumping. For GMA 9, the factor was about 1.66, which is the factor required to increase the entire pumping in GMA 9 from 60,000 AFY to about 100,000 AFY. With this approach, gridblocks that contain the majority of the pumping in a county (such as municipal wellfields) are “ramped up” to even larger pumping in relatively small areas. This method of increasing pumping results in the same distribution of pumping that was estimated when the THCGAM was developed in the mid-1990s. This explains why the future pumping contained in the MAG is underpredicted in some high growth rural areas of the study area as illustrated in the orange gridblocks (in and around Center Point area, for example) and overpredicted in other areas where development has not occurred (such as the northeast part of Kerr County).

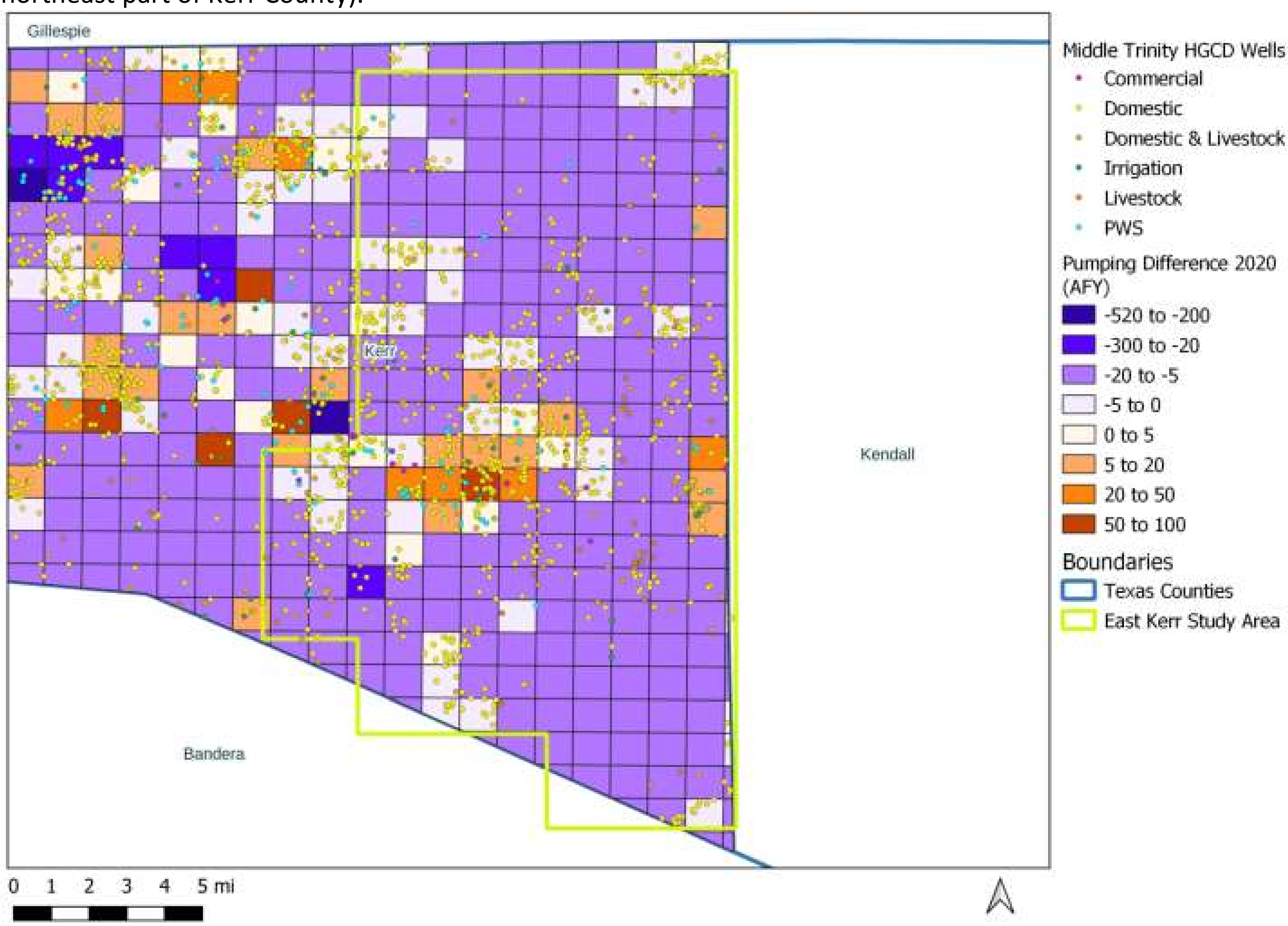


Figure 29. Difference in Middle Trinity Pumping for 2020 Between Actual Pumping and the MAG (predictive pumping) in the THCGAM

The total estimated annual pumping for the year 2020 on a per-grid basis according to pumped well location for the Lower Trinity is illustrated in Figure 30. As in Figure 28, actual estimated grid totals have been geographically assigned to discrete pumping gridblocks in this figure for ease of illustration. As with the Middle Trinity Aquifer, areas with no grids have no 2020 estimated pumping in the Lower Trinity based on the approach used in this study.

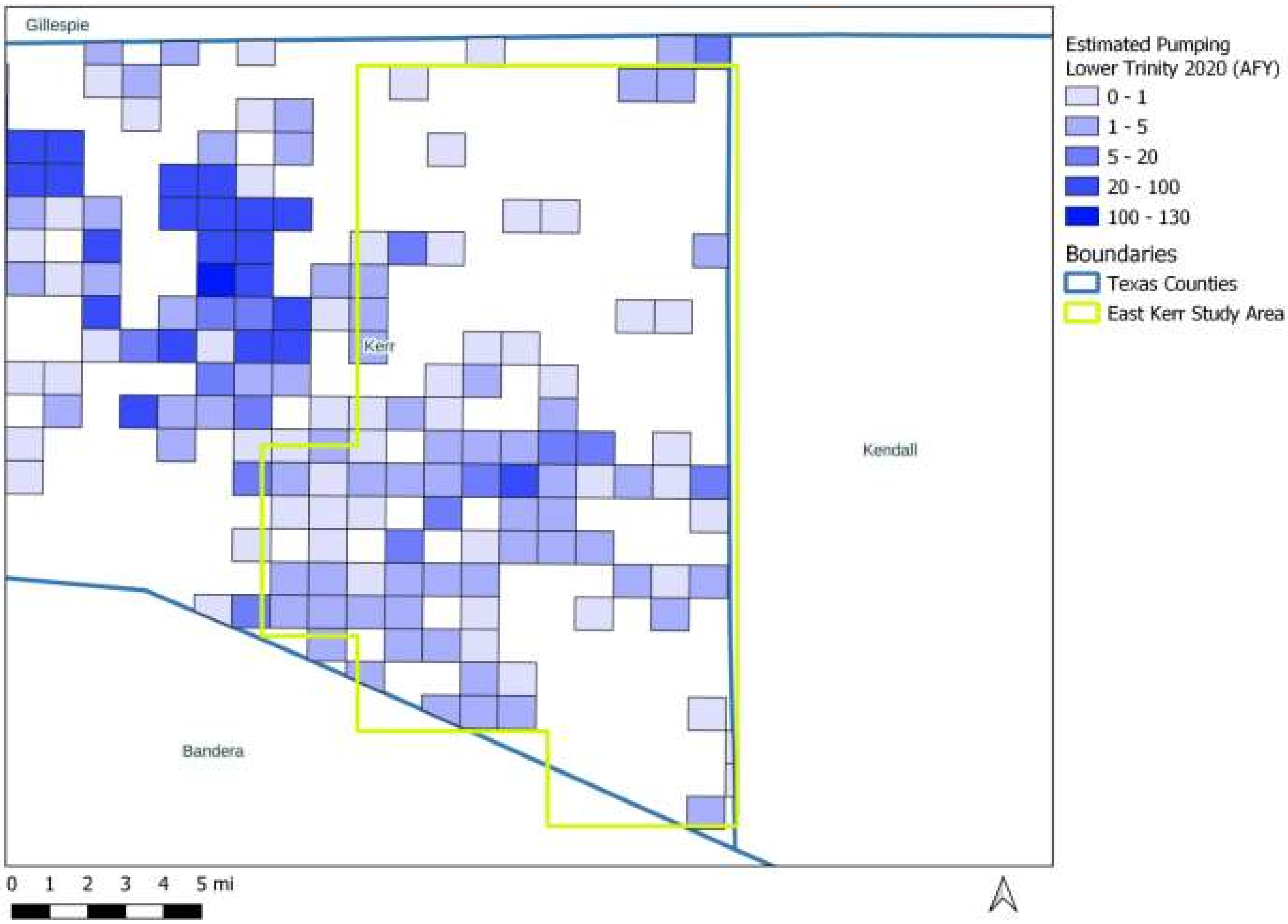


Figure 30. Lower Trinity Aquifer Pumping Distribution for 2020 as Estimated in the Eastern Kerr Study Area

The difference in per-gridblock pumping between the estimated 2020 pumping and the THCGAM MAG pumping is shown in Figure 31. This figure attempts to illustrate where actual estimated pumping is occurring in the Lower Trinity Aquifer by comparing the actual estimated pumping to the THCGAM MAG pumping on a grid-by-grid basis. As before, purple colors in this figure indicate the THCGAM pumping was higher, and the orange colors indicate where actual pumping is higher than the THCGAM.

In addition, there are places where Lower Trinity Aquifer wells and pumping are existent today that were not represented in the MAG pumping in the THCGAM as completed in the 2010 modeling for DFC and MAG analysis. Note that there are several orange gridblocks around the high growth area of Center Point, and several Lower Trinity Aquifer wells that active today that were not included in the MAG pumping distribution, even though the overall MAG pumping was higher than the 2020 estimated pumping in the eastern Kerr County study area.
In addition, there are places where Lower Trinity Aquifer wells and pumping are existent today that were not represented in the MAG pumping in the THCGAM as completed in the 2010 modeling for DFC and MAG analysis (Figure 31). The blue blocks in this figure indicate where Lower Trinity Aquifer production is now occurring that was not represented in the THCGAM MAG pumping distribution. Note in Figure 29 and Figure 31 that there are several orange and blue gridblocks around the high growth area of Center Point, and several Lower Trinity Aquifer wells that active today that were not included in the MAG pumping distribution, even though the overall MAG pumping was higher than the 2020 estimated pumping in the eastern Kerr County study area.

This assessment illustrates that the regional model pumpage estimates and predictions do not always match the real-world conditions based on local data collected by the district.

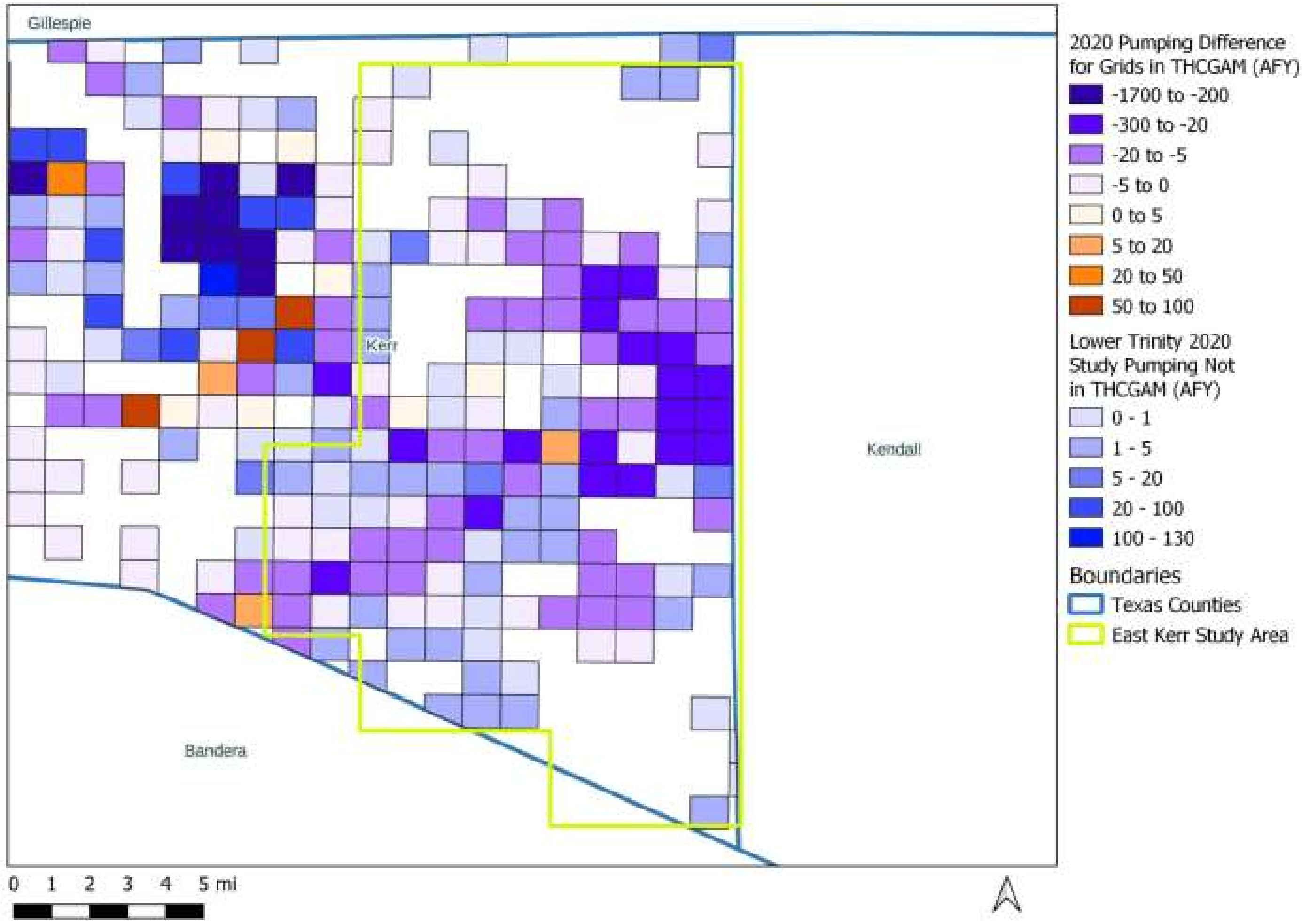


Figure 31. Difference in Lower Trinity Pumping for 2020 Between Actual Pumping and THCGAM estimates. Blue zones are areas where actual pumping exists, but THCGAM pumping does not

3.3 *Aquifer Parameters*

AGS has compiled a summary of aquifer parameters contained in pumping test data and reports submitted to HGCD. The full summary of these reports is tabulated and included as Appendix B.

One of the most important aquifer characteristics in determining groundwater availability and well production is transmissivity. Transmissivity is the general measure of the ability of an aquifer to transmit groundwater. Aquifers exhibiting low transmissivity transmit groundwater slowly and have wells that produce less water. Aquifers exhibiting high transmissivity transmit groundwater relatively faster and have wells that produce more water with less drawdown in the well and aquifer. Groundwater availability studies generally require an aquifer pumping test that measures drawdown as a well is pumped. From this data, the transmissivity of the aquifer can be estimated for the aquifer near the well. When the estimate of transmissivity is divided by the aquifer thickness, an estimate of hydraulic conductivity can be obtained. Aquifer models like the THCGAM contain estimates of hydraulic conductivity to help define the aquifer flow system and productivity of aquifers represented in the model.

Figure 32 shows the histogram of hydraulic conductivity estimates from HGCD water availability studies in the Middle Trinity Aquifer throughout Kerr County. A histogram illustrates the frequency and distribution of hydraulic conductivity values from the pumping tests from lower to higher. Figure 32 shows that most of the hydraulic conductivity estimates in the Middle Trinity wells are below 3 feet/day. The red line on the right side of the histogram indicates the single value of hydraulic conductivity across the study area contained in the THCGAM for the Middle Trinity Aquifer, which is higher than any measured hydraulic conductivity from water availability studies in the eastern Kerr County study area.

This finding indicates that the THCGAM is likely overestimating the hydraulic conductivity and transmissivity of the Middle Trinity Aquifer in eastern Kerr County. The data show that the transmissivity can vary significantly over short distances in the Trinity Aquifer, which is consistent with numerous previous studies of the Trinity Aquifer. The finding is significant because it indicates that combinations of relatively low aquifer transmissivity and relatively higher demands in some areas may create situations where local water level decline can be greater than the typical average declines from the regional THCGAM simulations used to assess the water level decline in GMA 9 and in Kerr County.

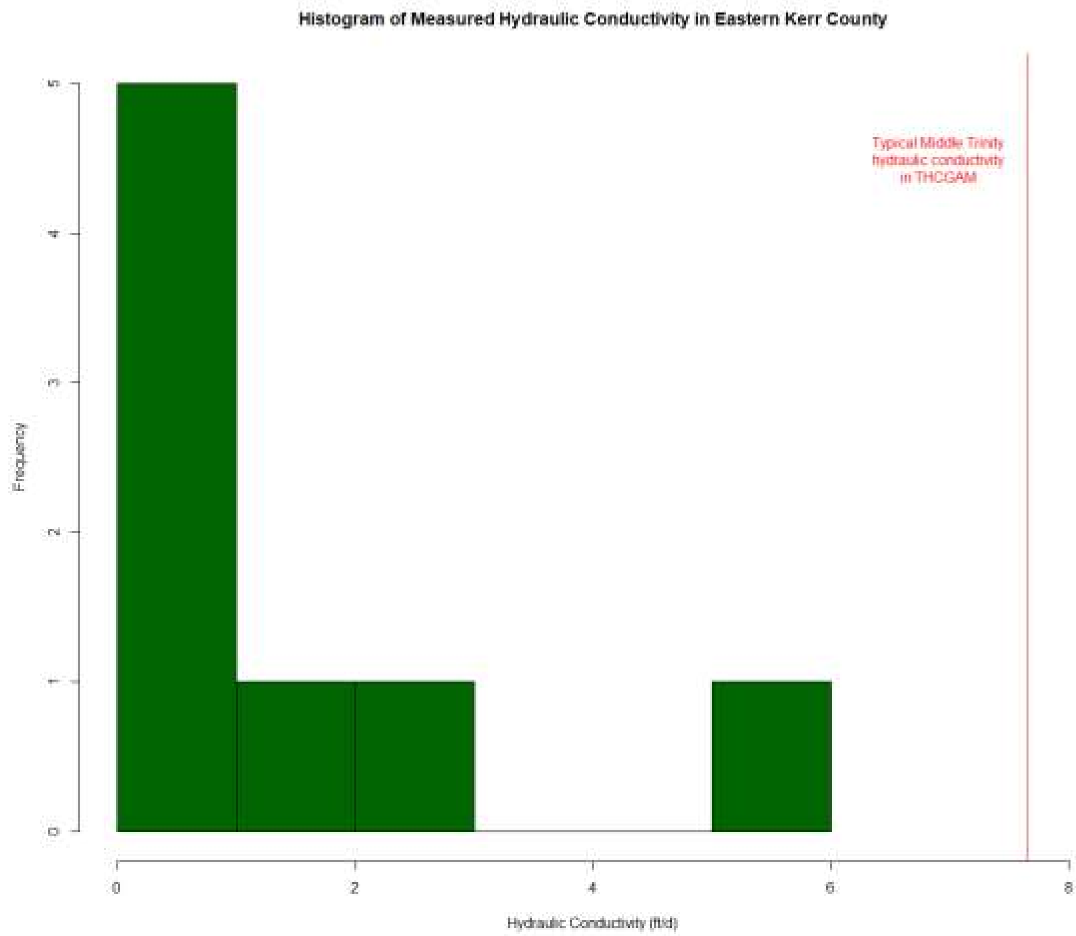


Figure 32. Histogram of Middle Trinity Aquifer Hydraulic Conductivity From Water Availability Studies compared to the THCGAM

Evaluation of the hydraulic conductivity estimates in the summary table in Appendix B shows that the Lower Trinity Aquifer estimates from the pumping tests in Kerr County are typically 10 to 100 times lower than the estimate in the THCGAM. These differences can also cause actual water level declines to occur much faster than predicted by the regional THCGAM for the DFC and MAG analysis. The local groundwater availability studies are valuable in highlighting those areas that are significantly different than the THCGAM and may require a more local approach to groundwater management.

3.4 *DFC/MAG Details for Kerr County*

The Desired Future Conditions (DFCs) for GMA 9 are stated as a drawdown across the entire GMA (Jones, 2017). Specifically, it is stated that for the Trinity Aquifer [Upper, Middle, and Lower undifferentiated] – “Allow for an increase in average drawdown of approximately 30 feet through

2060 (throughout GMA-9) consistent with "Scenario 6" in TWDB GAM Task 10-005 (Hutchison, 2010). The appendices for TWDB GAM Task 10-005 indicate that the average drawdown in all Trinity Aquifer layers after 50 years is 39.2 feet in Kerr County. The reported MAG for Kerr County ranges from 14,918 to 14,223 af/yr from 2020 to 2060, respectively.

An important detail of the model results is shown in Figure 33 and Figure 34. Figure 33 shows the simulated drawdown contours in 2060 in the Middle Trinity in Kerr County. The purple box shows the area where drawdown contours are about 5 feet when all the surrounding contours are 30 to 50 feet. This anomaly is an artifact of the model and indicates the MODFLOW cells have "gone dry" in that area. Figure 34 provide another depiction showing the six purple MODFLOW cells that have "gone dry" in the model during the simulation to ending in 2060. When cells go dry in MODFLOW, the pumping from these cells are eliminated and not accounted for in the drawdown estimates. It is evident that some of the production in a key demand center in Kerr County is not accounted for in the DFC and MAG. It is likely that simulated drawdown would have been greater in the area if all this pumping would have been active in the model.

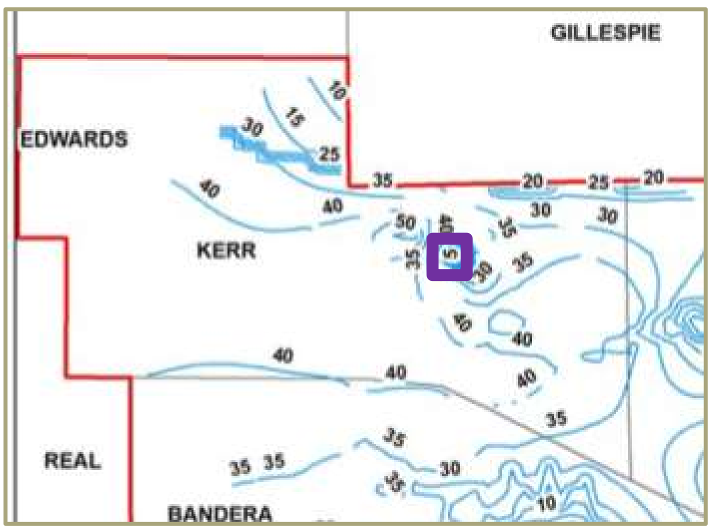


Figure 33. Simulation results from DFC simulation in 2060. Purple box shows area of high pumping around City of Kerrville where MODFLOW cells went dry, and pumping was reduced to zero during simulations.

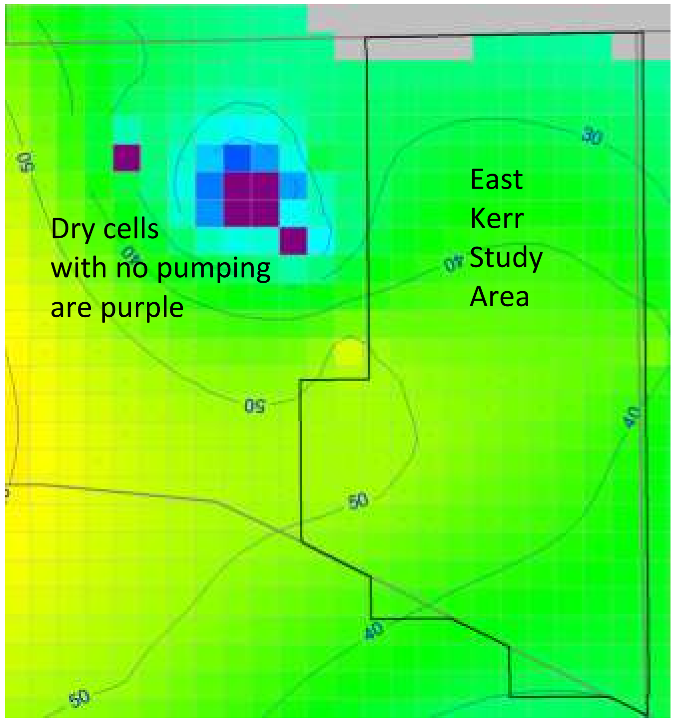


Figure 34. Area of MODFLOW dry cells (purple) around Kerrville just west of the study area that have zero pumping in the DFC simulations.

4.0 Groundwater Availability in Eastern Kerr County

Figure 35 shows the locations where pumping in the Middle Trinity Aquifer is higher than the MAG estimate in the THCGAM as well as the locations of hydraulic conductivity estimates (from pumping tests). It is not unusual for future (i.e. predictive) pumping distributions to be different than actual pumping for many reasons. However, Figure 35 does indicate the pumping around Center Point is already greater than that predicted in the MAG scenario, and it is also the area where water level decline has been the greatest. We recommend close review of pumping tests in that area with careful consideration of potential impacts to existing wells. Water levels should be monitored closely in areas where production continues to increase and in areas where hydraulic conductivity is relatively low.

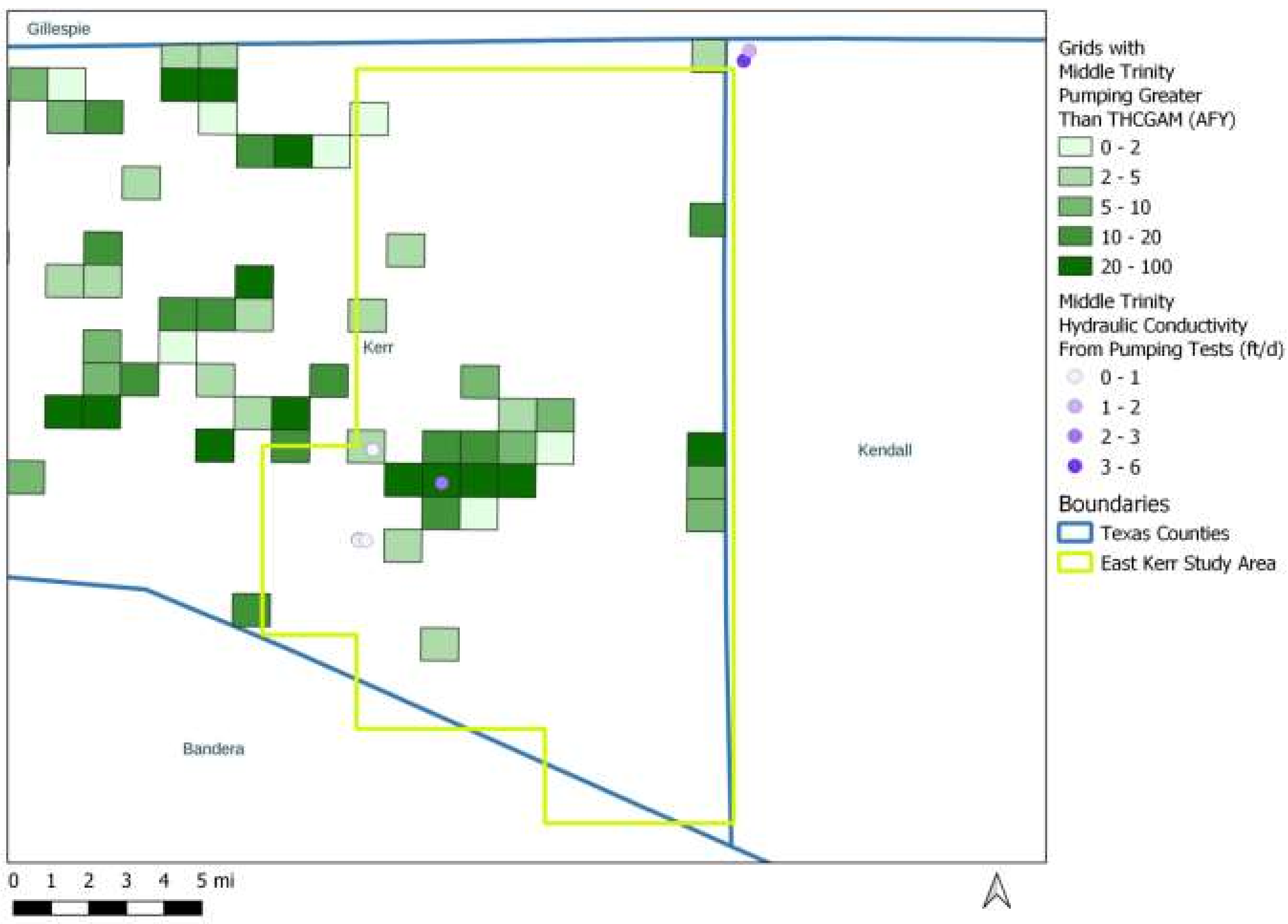


Figure 35. Estimated Pumping Greater Than THCGAM for 2020 and posted Hydraulic Conductivity estimates from Middle Trinity Pumping Tests

To assess impacts in the Middle Trinity, we provide the following example. Assume there is about 150 feet of available drawdown under static conditions, like the Center Point area. Assume a typical transmissivity of about 100 ft^2/day and a storativity of $5x10^{-5}$ based on pumping tests and typical estimates in the area. If a well pumps 25,000 gallons per day (17.36 gpm) for 24 hours, the water level decline very close to well is about 40 feet, and at 500 feet away, the decline is about 8 feet.

If a well pumps 50 gpm for 24 hours, the water level decline very close to well is about 115 feet, and at 500 feet away, the decline is about 22 feet. Under this scenario, there is only about 35 feet of available drawdown near the well. Lower transmissivity or less static available drawdown creates higher water level decline and less remaining available drawdown at 24 hours, and production from the well might decrease. It is clear from the correlation between water level measurements and the precipitation (expressed as SPI) discussed earlier that water level declines can occur under drought conditions, leaving even less available drawdown in wells on a short-term basis or perhaps a long-term basis. Each situation is different, and close review of local conditions is more critical when the aquifer is less productive or if demands are higher. The Lower Trinity has a greater available drawdown, but generally has lower transmissivity, so a similar situation could exist for wells in the Lower Trinity. In addition, it is likely that the recharge to the Lower Trinity is lower than the Middle Trinity in general.

5.0 Conclusions and Recommendations

Significant growth in groundwater demand has occurred since the Trinity Hill Country Groundwater Availability Model (THCGAM) was completed in 2000. While the Texas Water Development Board (TWDB) made a minor change in 2009 by incorporating the Lower Trinity Aquifer into the THCGAM, there were no changes in hydraulic properties or pumping distribution in the model with that modification. The current Desired Future Condition in GMA 9 and HGCD is based on work completed in 2010 during the joint groundwater planning process. Since 2000, many new wells have been drilled and documented in eastern Kerr County, and the HGCD and other districts have collected significant data regarding pumping, pumping distribution, water levels, and hydraulic properties of the Trinity Aquifer. The differences between HGCD data and the THCGAM confirm the limitations of the THCGAM to address local management issues, especially in areas where development and groundwater pumping are increasing significantly and where aquifer hydraulic properties limit well capacity or recharge or both. Consistent with that limitation, the DFC and MAG estimates should generally be seen as regional and long-term guidelines only. Because the THCGAM has limits in application on a local scale, the resulting DFCs and MAG estimates are also limited in application on a local scale.

Hydrographs indicate that the Middle Trinity Aquifer continues to receive recharge in eastern Kerr County but there are areas where water level decline is consistent through time and some areas that are experiencing more significant declines than other areas. Water levels in the Lower Trinity Aquifer also indicate water level decline. This is partially due to the concentration of the Middle and Lower Trinity production in developing areas where pumping in both aquifers has increased. Available drawdown in both the Middle and Lower Trinity should be monitored closely in areas with relatively higher demand or lower transmissivity.

The purpose of this evaluation was to assess recent data to gain insights into groundwater hydrology in eastern Kerr County and to provide a basis for discussion of groundwater resource management in HGCD. As more insight from groundwater availability studies is gained, more localized approaches to groundwater allocation may be considered. The study results provide incentive to HGCD to consider how local management approaches might impact the balance of maximum practicable production and conservation considering recent hydrologic data and development patterns. If the district adopts a policy of greater conservation, the district may consider reducing the maximum production limit per acre. Additionally, management zones within the district may also be considered in areas of low transmissivity and growing demand if water levels are consistently declining and available drawdown is decreasing.

6.0 Bibliography

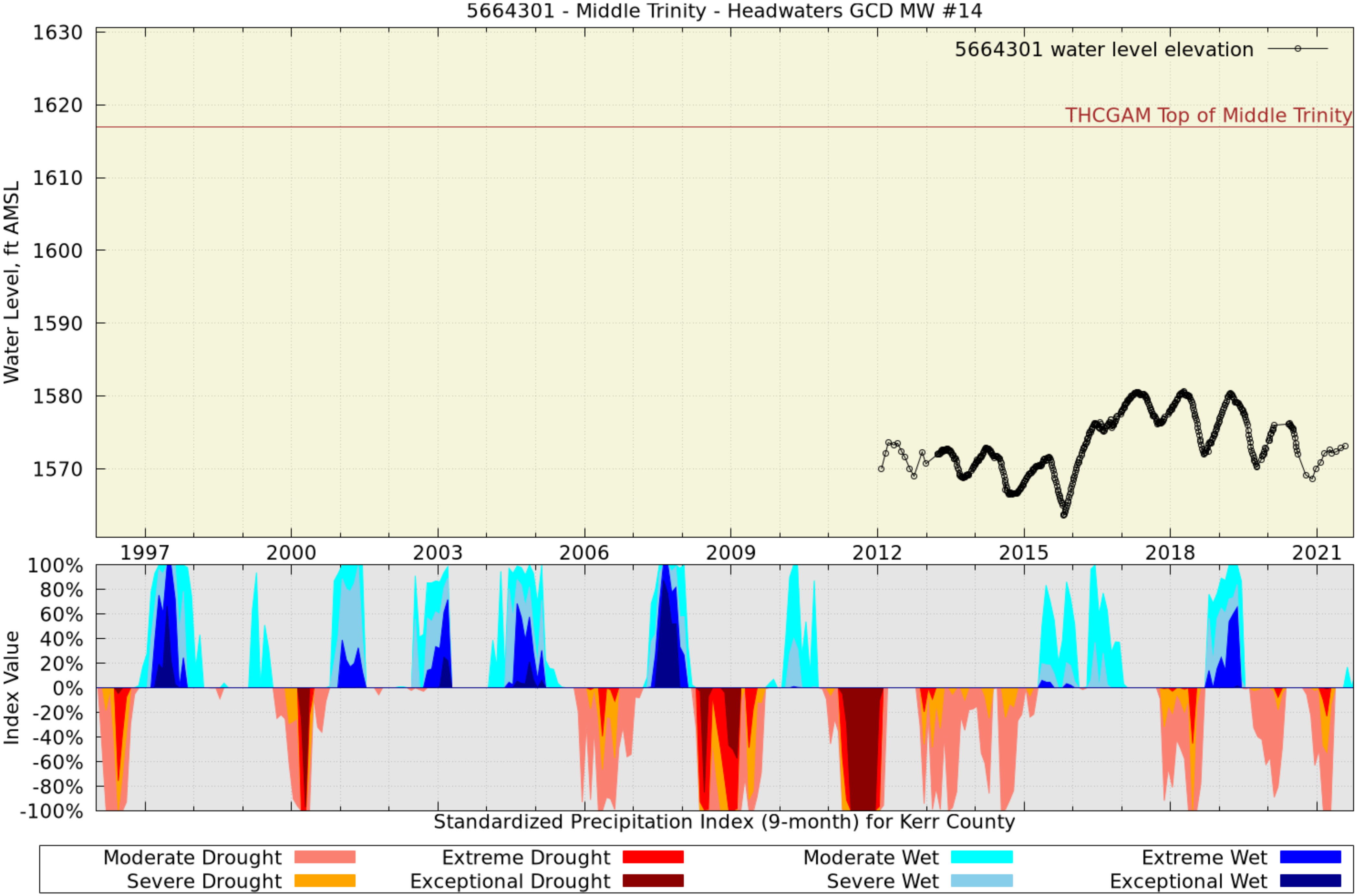
Hutchison, W.R., 2010. GAM Task 10-005. Texas Water Development Board unpublished report.

Jones, I., 2017. GAM Run 16-023 MAG: Modeled Available Groundwater for the Aquifers in Groundwater Management Area 9

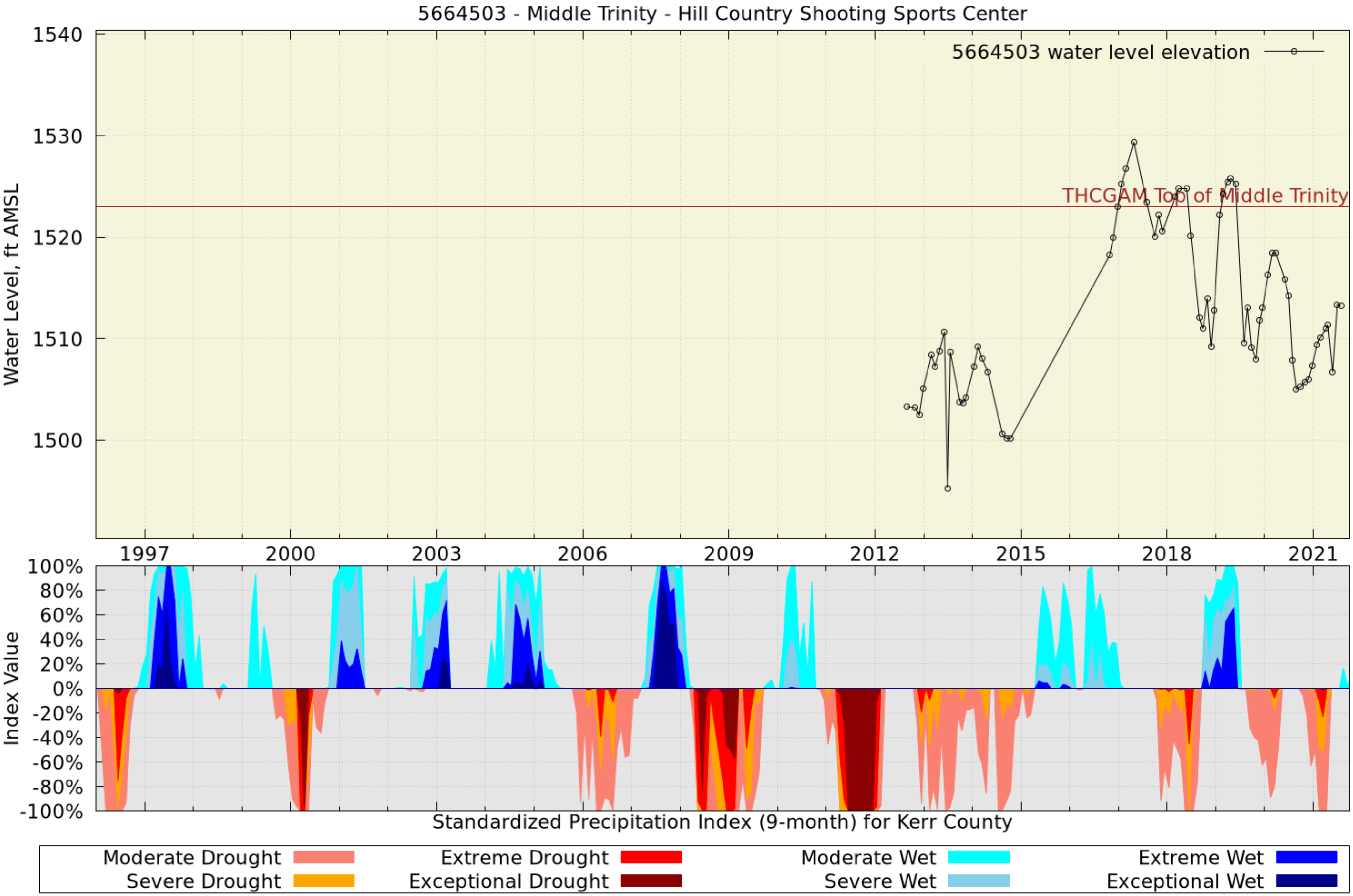
Advanced Groundwater Solutions, LLC

Appendix A

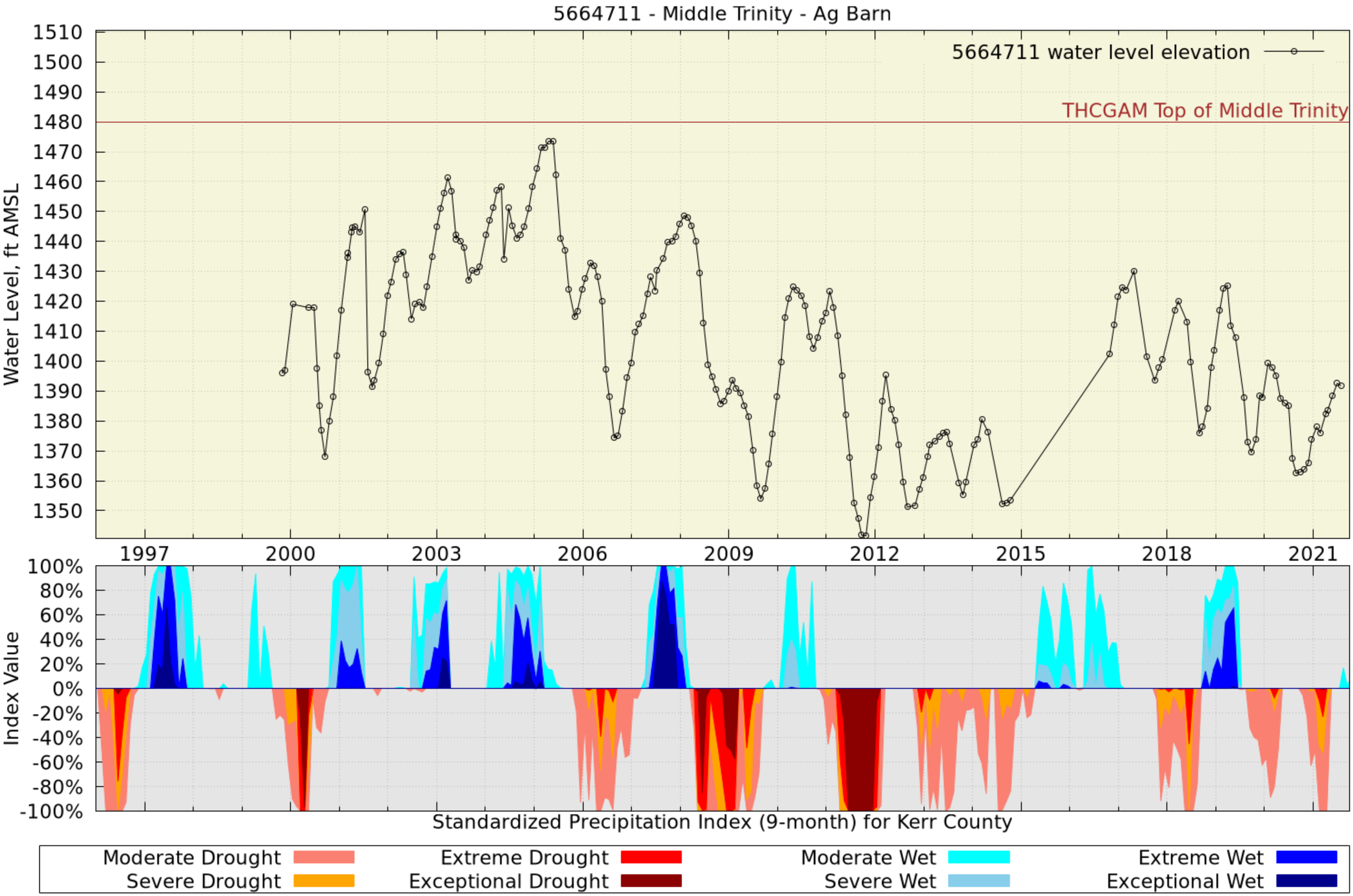
Hydrographs

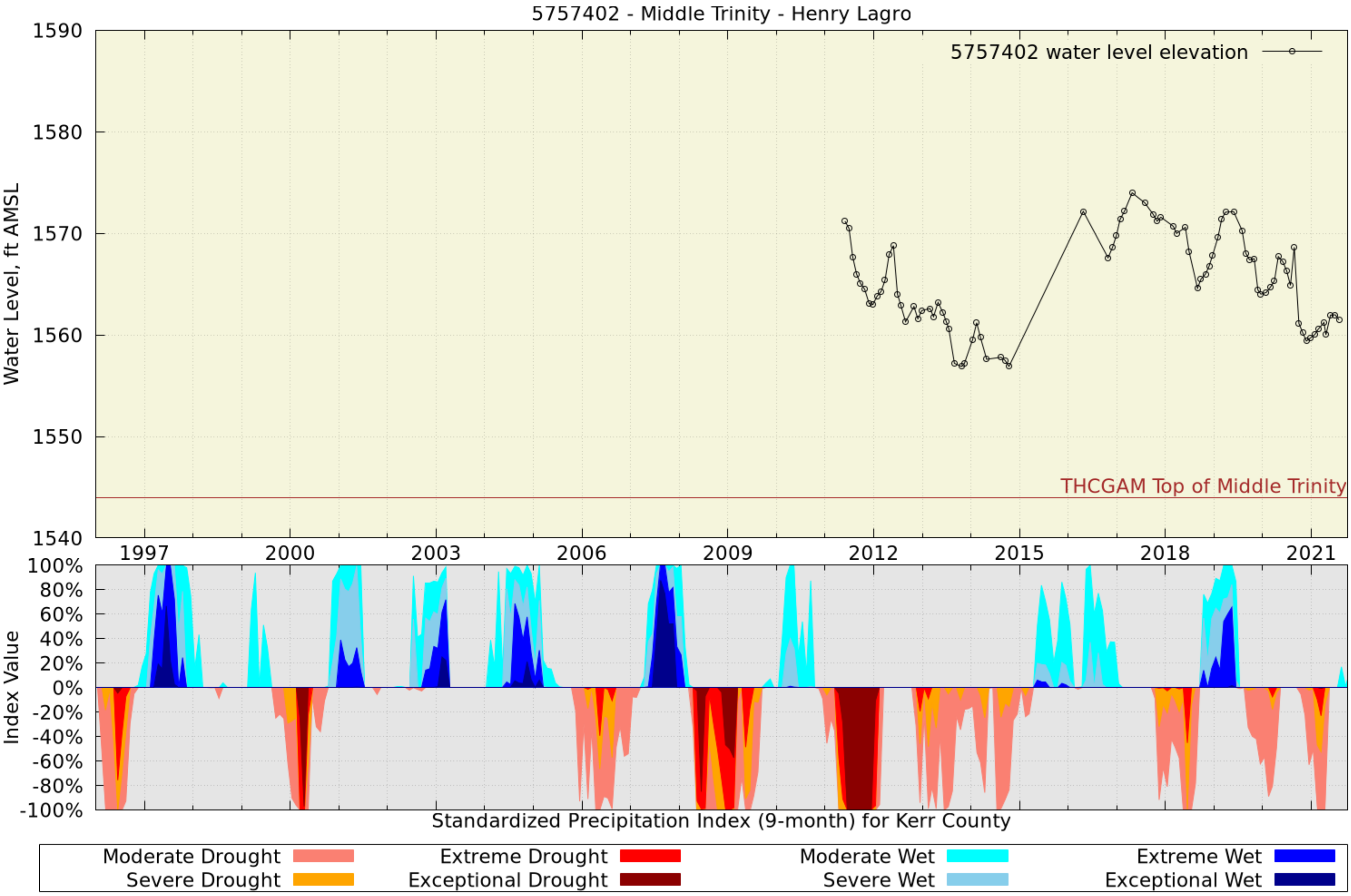


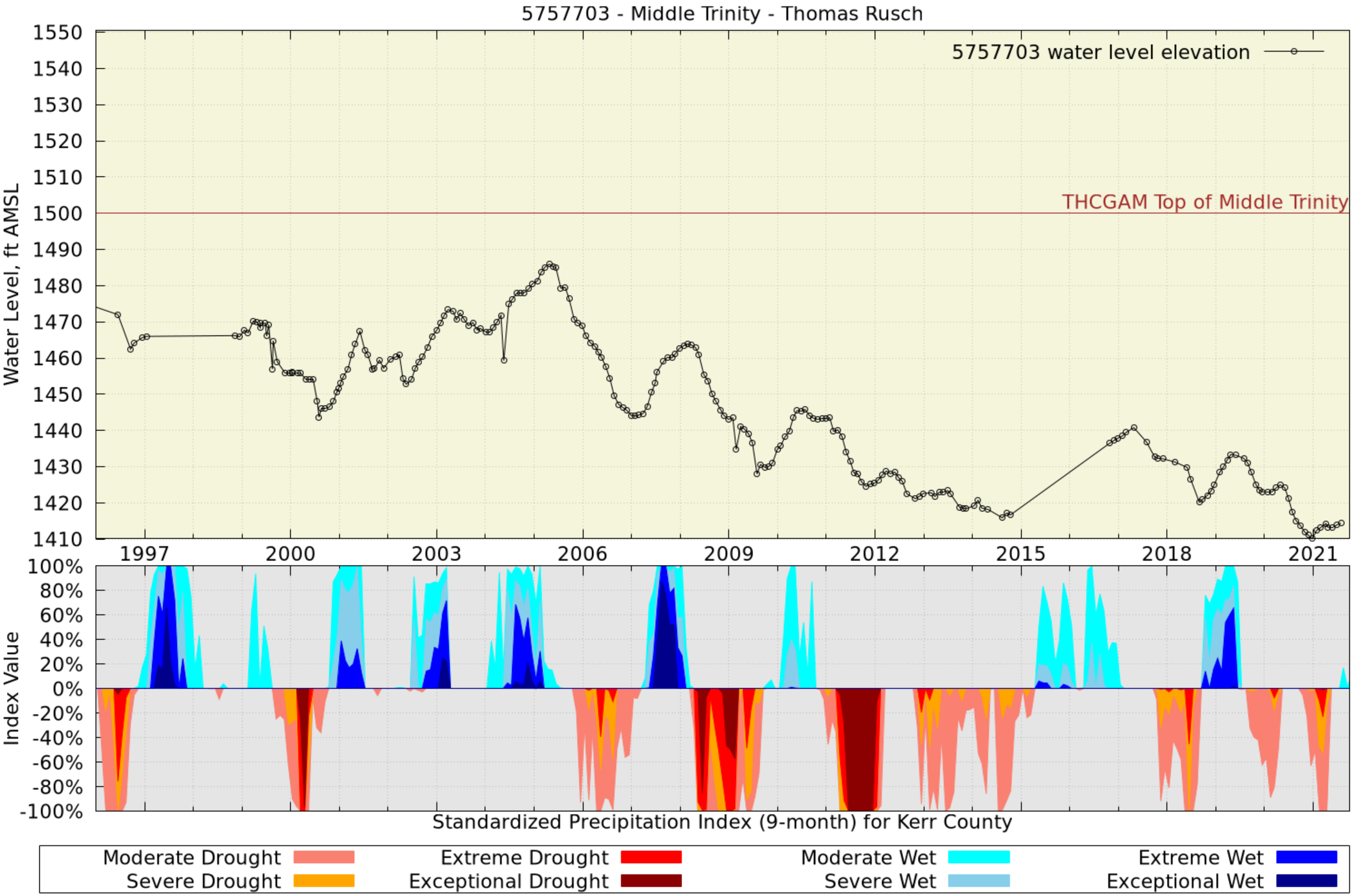
5664301 - Middle Trinity - Headwaters GCD MW #14
Water Level, ft AMSL
5664301 water level elevation
THCGAM Top of Middle Trinity
1630
1620
1610
1600
1590
1580
1570
1997
2000
2003
2006
2009
2012
2015
2018
2021
Index Value
100%
80%
60%
40%
20%
0%
-20%
-40%
-60%
-80%
-100%
Standardized Precipitation Index (9-month) for Kerr County
Moderate Drought
Severe Drought
Extreme Drought
Exceptional Drought
Moderate Wet
Severe Wet
Extreme Wet
Exceptional Wet



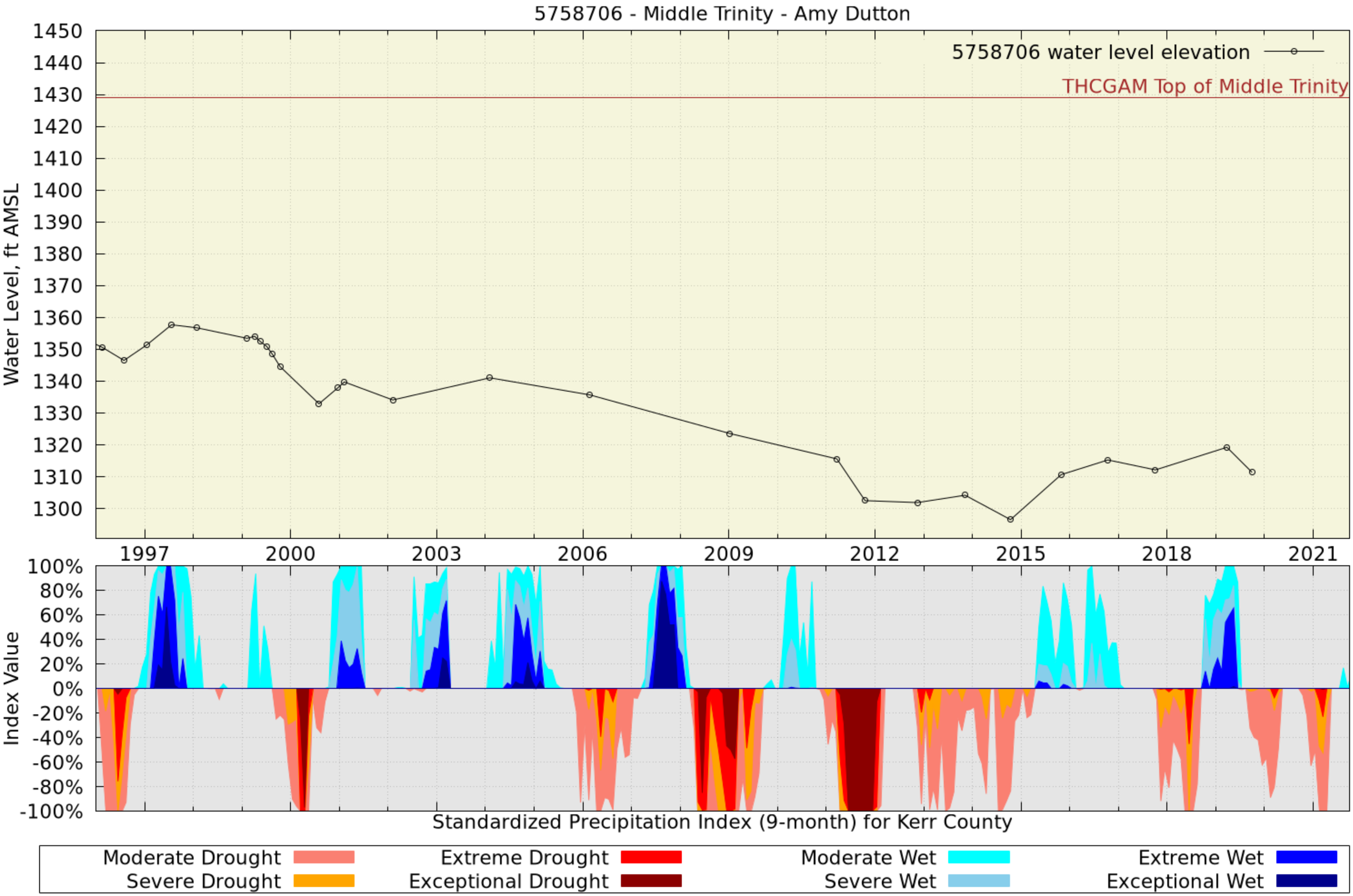
5664503 - Middle Trinity - Hill Country Shooting Sports Center
5664503 water level elevation
THCGAM Top of Middle Trinity
Water Level, ft AMSL
1540
1530
1520
1510
1500
1997
2000
2003
2006
2009
2012
2015
2018
2021
Index Value
100%
80%
60%
40%
20%
0%
-20%
-40%
-60%
-80%
-100%
Standardized Precipitation Index (9-month) for Kerr County
Moderate Drought
Severe Drought
Extreme Drought
Exceptional Drought
Moderate Wet
Severe Wet
Extreme Wet
Exceptional Wet

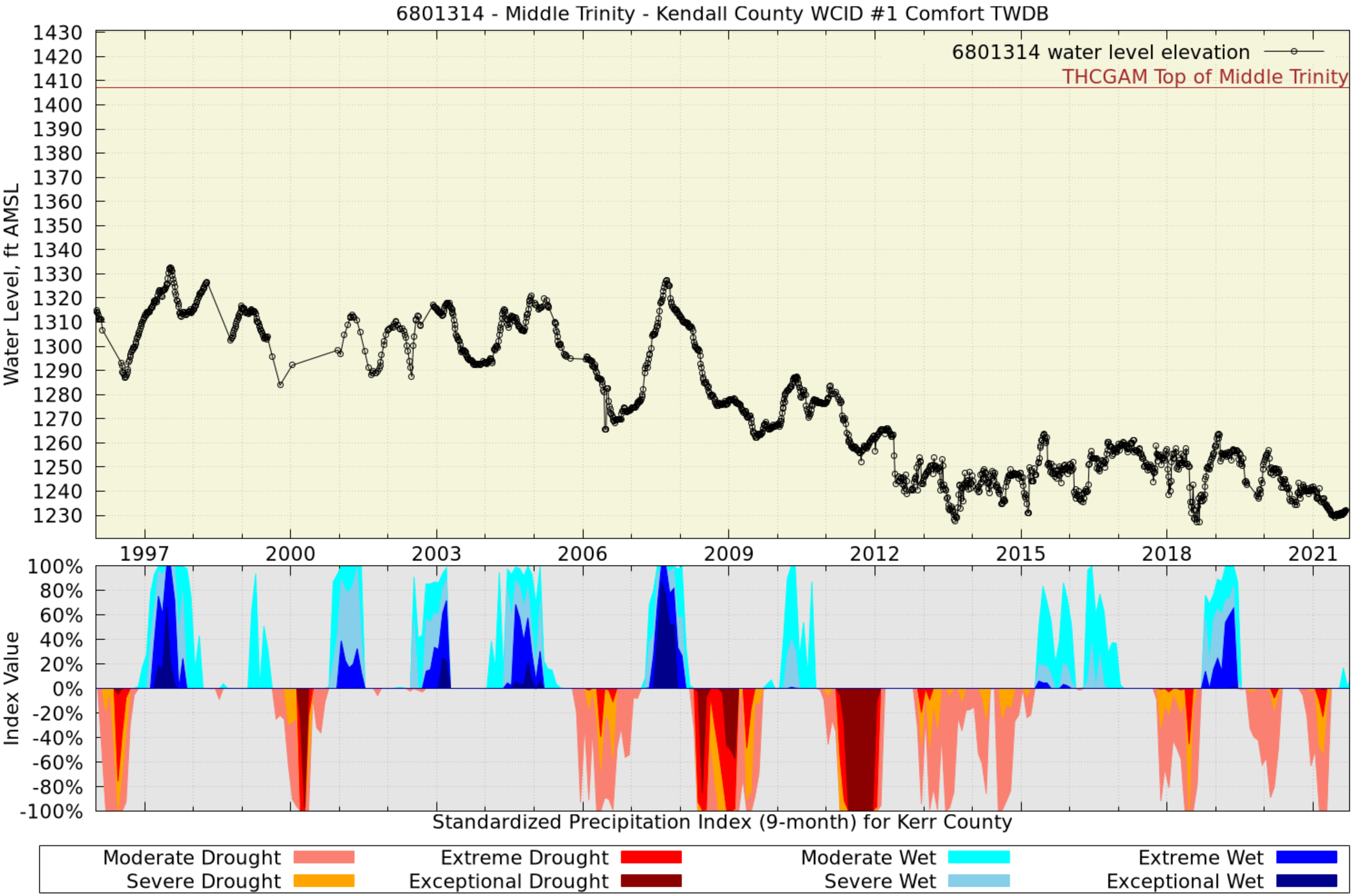

5664711 - Middle Trinity - Ag Barn
5664711 water level elevation
THCGAM Top of Middle Trinity
Water Level, ft AMSL
1510
1500
1490
1480
1470
1460
1450
1440
1430
1420
1410
1400
1390
1380
1370
1360
1350
1997
2000
2003
2006
2009
2012
2015
2018
2021
Index Value
100%
80%
60%
40%
20%
0%
-20%
-40%
-60%
-80%
-100%
Standardized Precipitation Index (9-month) for Kerr County
Moderate Drought
Severe Drought
Extreme Drought
Exceptional Drought
Moderate Wet
Severe Wet
Extreme Wet
Exceptional Wet


5757402 - Middle Trinity - Henry Lagro
5757402 water level elevation
Water Level, ft AMSL
1590
1580
1570
1560
1550
1540
THCGAM Top of Middle Trinity
1997
2000
2003
2006
2009
2012
2015
2018
2021
Index Value
100%
80%
60%
40%
20%
0%
-20%
-40%
-60%
-80%
-100%
Standardized Precipitation Index (9-month) for Kerr County
Moderate Drought
Severe Drought
Extreme Drought
Exceptional Drought
Moderate Wet
Severe Wet
Extreme Wet
Exceptional Wet

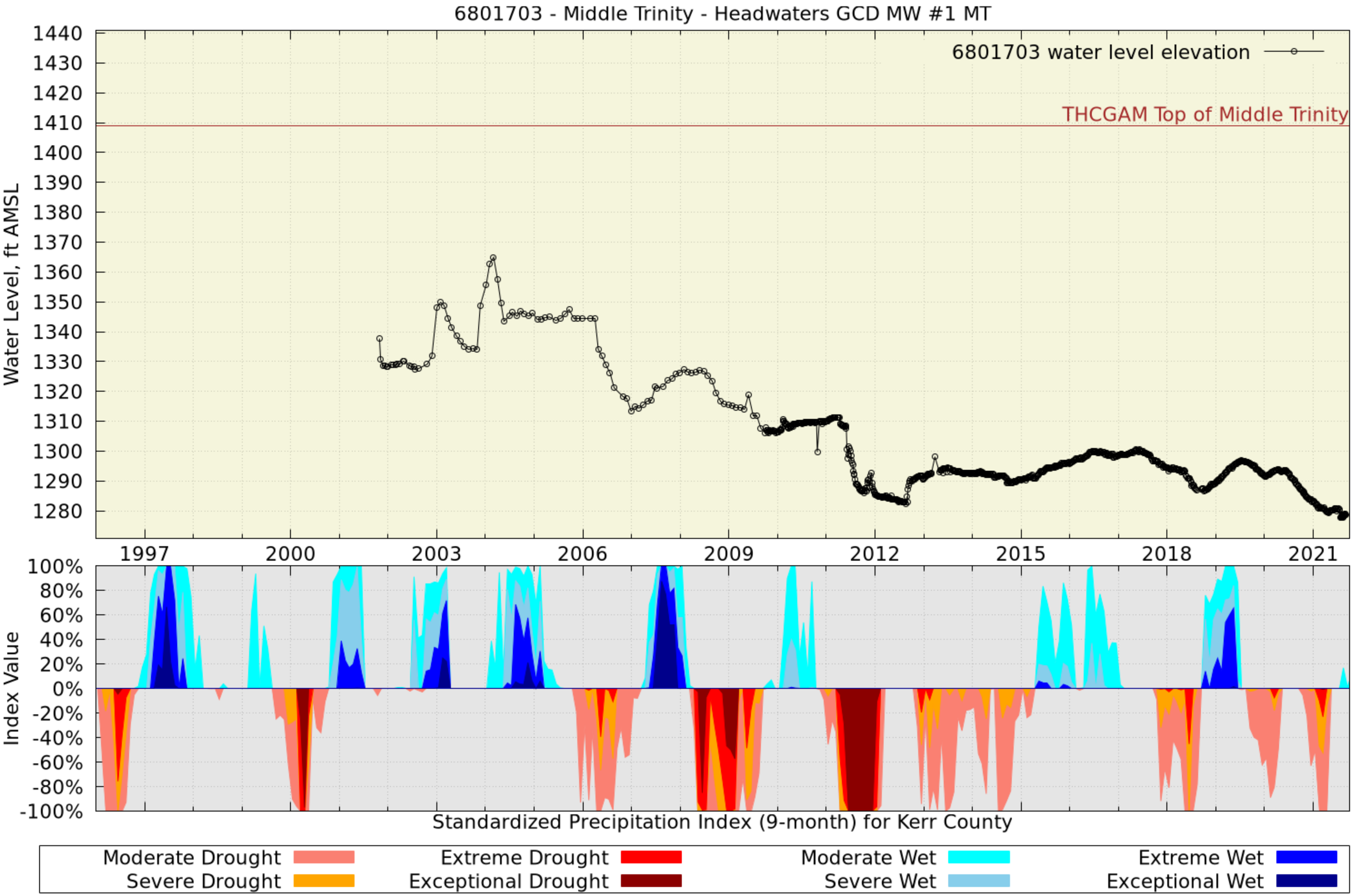


5757703 - Middle Trinity - Thomas Rusch
5757703 water level elevation
THCGAM Top of Middle Trinity
Water Level, ft AMSL
1550
1540
1530
1520
1510
1500
1490
1480
1470
1460
1450
1440
1430
1420
1410
1997
2000
2003
2006
2009
2012
2015
2018
2021
100%
80%
60%
40%
20%
0%
-20%
-40%
-60%
-80%
-100%
Index Value
Standardized Precipitation Index (9-month) for Kerr County
Moderate Drought
Severe Drought
Extreme Drought
Exceptional Drought
Moderate Wet
Severe Wet
Extreme Wet
Exceptional Wet

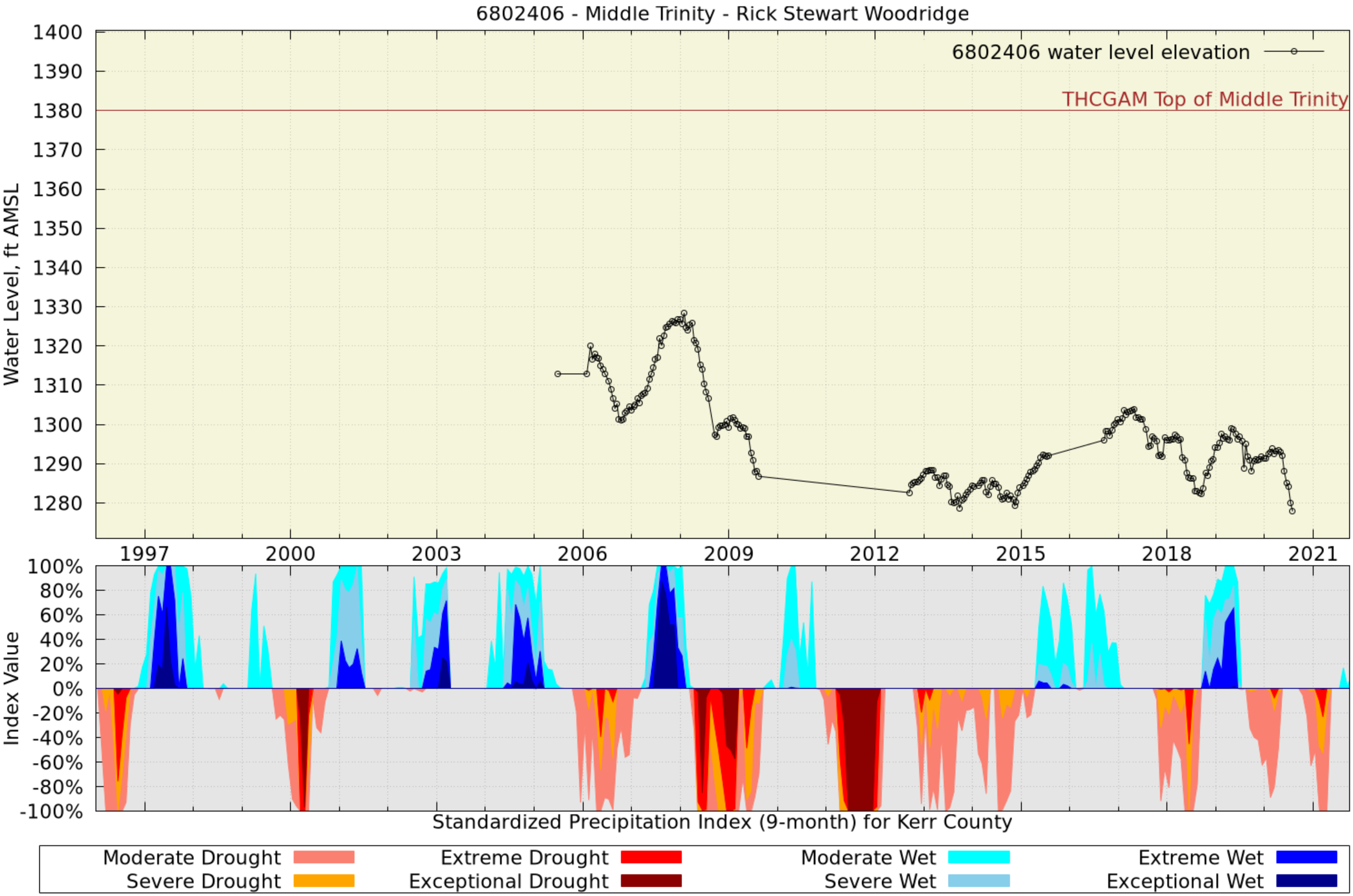

5758706 - Middle Trinity - Amy Dutton
5758706 water level elevation
THCGAM Top of Middle Trinity
Water Level, ft AMSL
1450
1440
1430
1420
1410
1400
1390
1380
1370
1360
1350
1340
1330
1320
1310
1300
1997
2000
2003
2006
2009
2012
2015
2018
2021
Index Value
100%
80%
60%
40%
20%
0%
-20%
-40%
-60%
-80%
-100%
Standardized Precipitation Index (9-month) for Kerr County
Moderate Drought
Severe Drought
Extreme Drought
Exceptional Drought
Moderate Wet
Severe Wet
Extreme Wet
Exceptional Wet



6801314 - Middle Trinity - Kendall County WCID #1 Comfort TWDB
6801314 water level elevation
THCGAM Top of Middle Trinity
Water Level, ft AMSL
1430
1420
1410
1400
1390
1380
1370
1360
1350
1340
1330
1320
1310
1300
1290
1280
1270
1260
1250
1240
1230
1997
2000
2003
2006
2009
2012
2015
2018
2021
Index Value
100%
80%
60%
40%
20%
0%
-20%
-40%
-60%
-80%
-100%
Standardized Precipitation Index (9-month) for Kerr County
Moderate Drought
Severe Drought
Extreme Drought
Exceptional Drought
Moderate Wet
Severe Wet
Extreme Wet
Exceptional Wet



6801703 - Middle Trinity - Headwaters GCD MW #1 MT
6801703 water level elevation
THCGAM Top of Middle Trinity
Water Level, ft AMSL
1440
1430
1420
1410
1400
1390
1380
1370
1360
1350
1340
1330
1320
1310
1300
1290
1280
1997
2000
2003
2006
2009
2012
2015
2018
2021
Index Value
100%
80%
60%
40%
20%
0%
-20%
-40%
-60%
-80%
-100%
Standardized Precipitation Index (9-month) for Kerr County
Moderate Drought
Severe Drought
Extreme Drought
Exceptional Drought
Moderate Wet
Severe Wet
Extreme Wet
Exceptional Wet



6802406 - Middle Trinity - Rick Stewart Woodridge
6802406 water level elevation
THCGAM Top of Middle Trinity
Water Level, ft AMSL
1400
1390
1380
1370
1360
1350
1340
1330
1320
1310
1300
1290
1280
1997
2000
2003
2006
2009
2012
2015
2018
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Index Value
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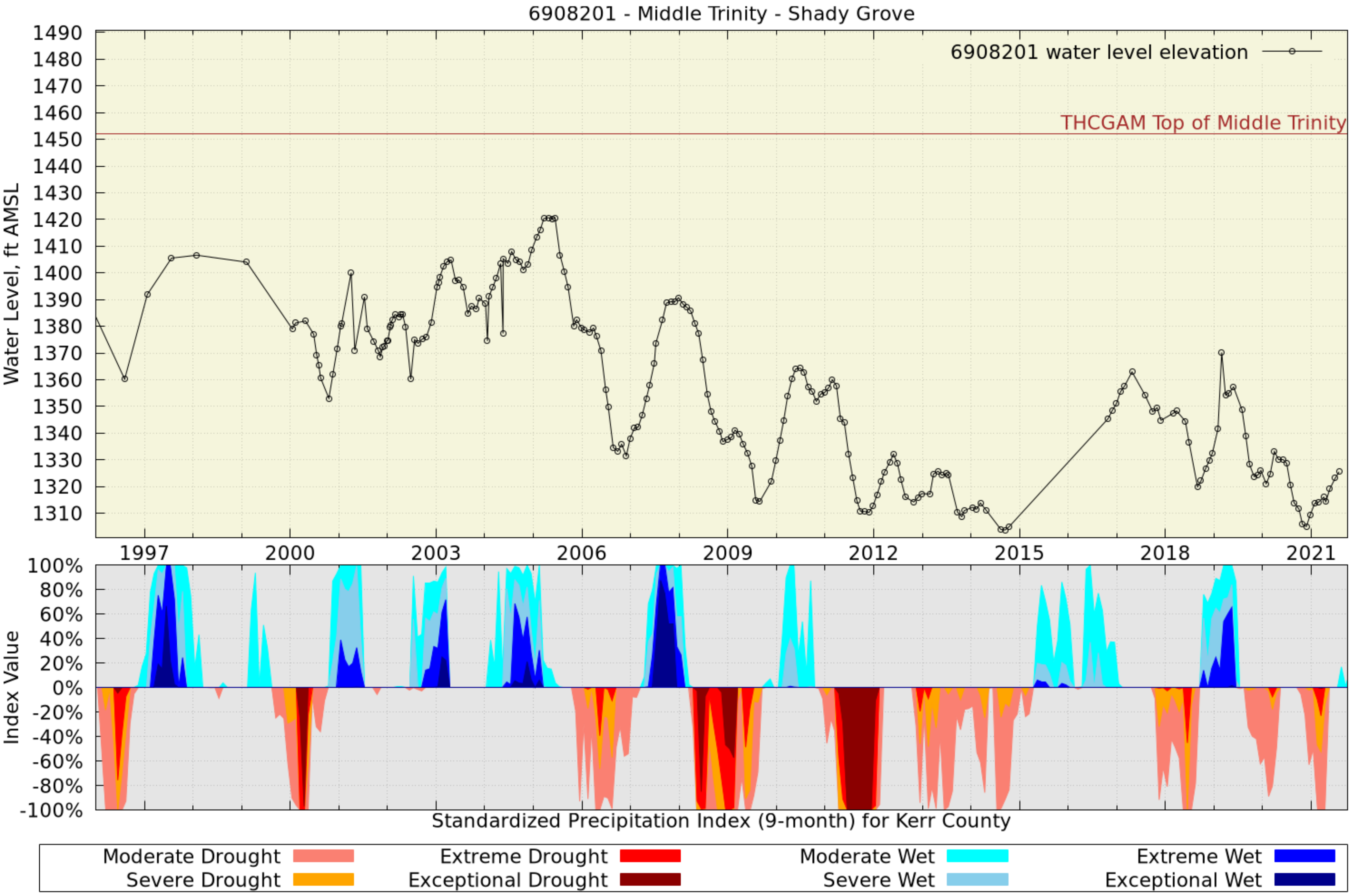
-80%
-100%
Standardized Precipitation Index (9-month) for Kerr County
Moderate Drought
Severe Drought
Extreme Drought
Exceptional Drought
Moderate Wet
Severe Wet
Extreme Wet
Exceptional Wet



6908201 - Middle Trinity - Shady Grove
6908201 water level elevation
THCGAM Top of Middle Trinity
Water Level, ft AMSL
1490
1480
1470
1460
1450
1440
1430
1420
1410
1400
1390
1380
1370
1360
1350
1340
1330
1320
1310
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2000
2003
2006
2009
2012
2015
2018
2021
Index Value
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-100%
Standardized Precipitation Index (9-month) for Kerr County
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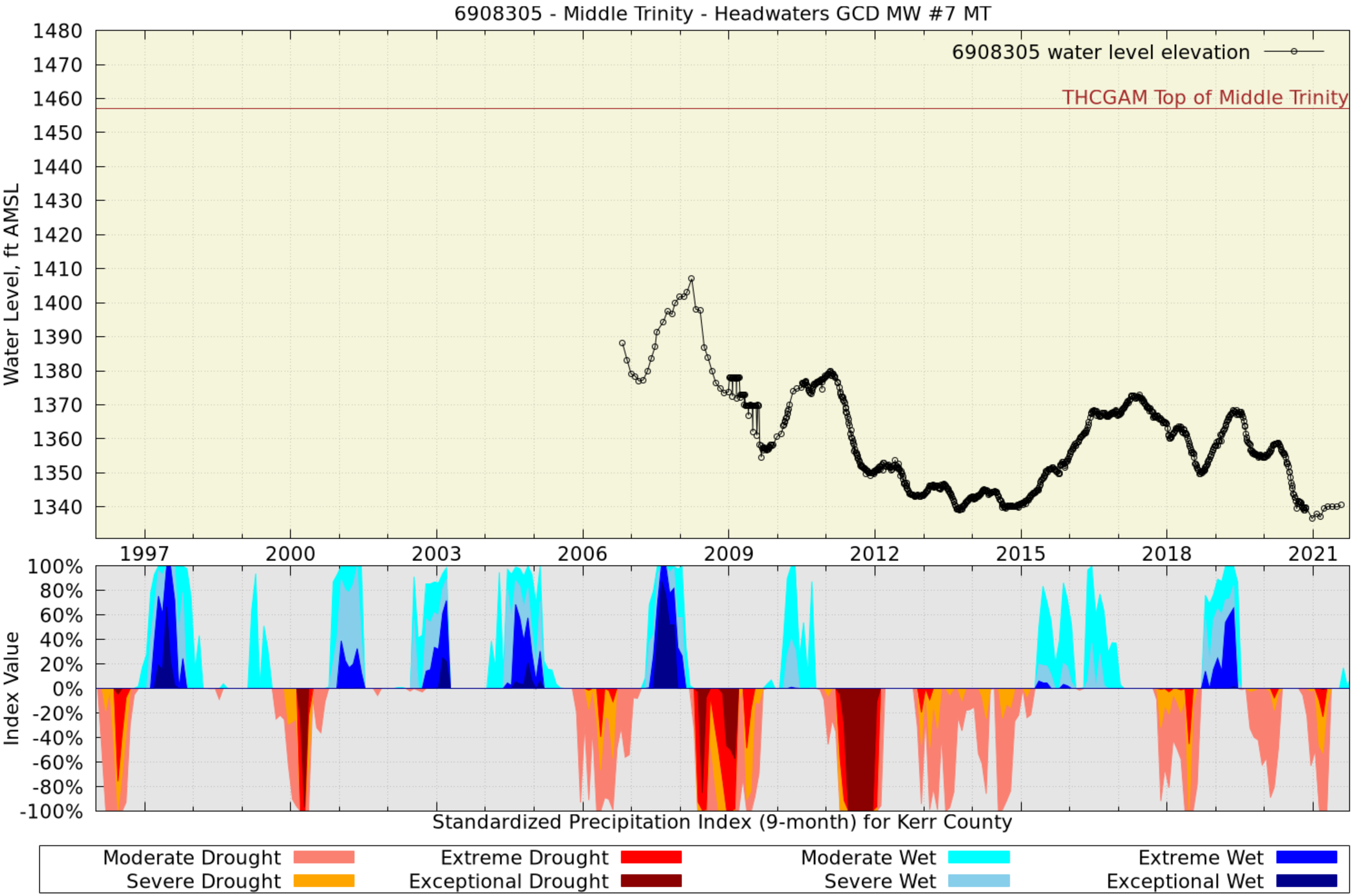
Severe Drought
Extreme Drought
Exceptional Drought
Moderate Wet
Severe Wet
Extreme Wet
Exceptional Wet


6908305 - Middle Trinity - Headwaters GCD MW #7 MT
6908305 water level elevation
THCGAM Top of Middle Trinity
Water Level, ft AMSL
1480
1470
1460
1450
1440
1430
1420
1410
1400
1390
1380
1370
1360
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1340
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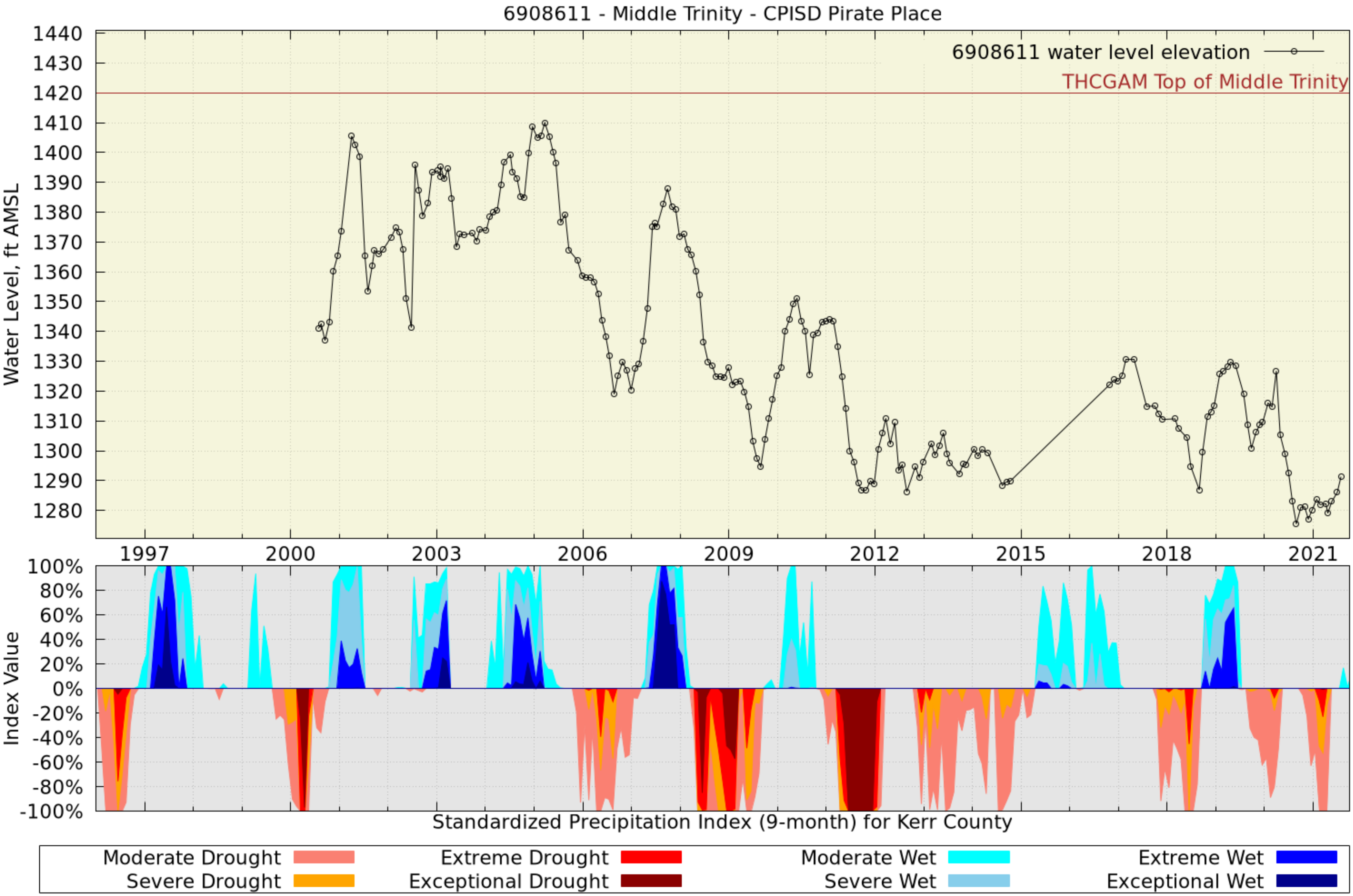
Extreme Wet
Exceptional Wet



6908611 - Middle Trinity - CPISD Pirate Place
6908611 water level elevation
THCGAM Top of Middle Trinity
Water Level, ft AMSL
1440
1430
1420
1410
1400
1390
1380
1370
1360
1350
1340
1330
1320
1310
1300
1290
1280
1997
2000
2003
2006
2009
2012
2015
2018
2021
Index Value
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80%
60%
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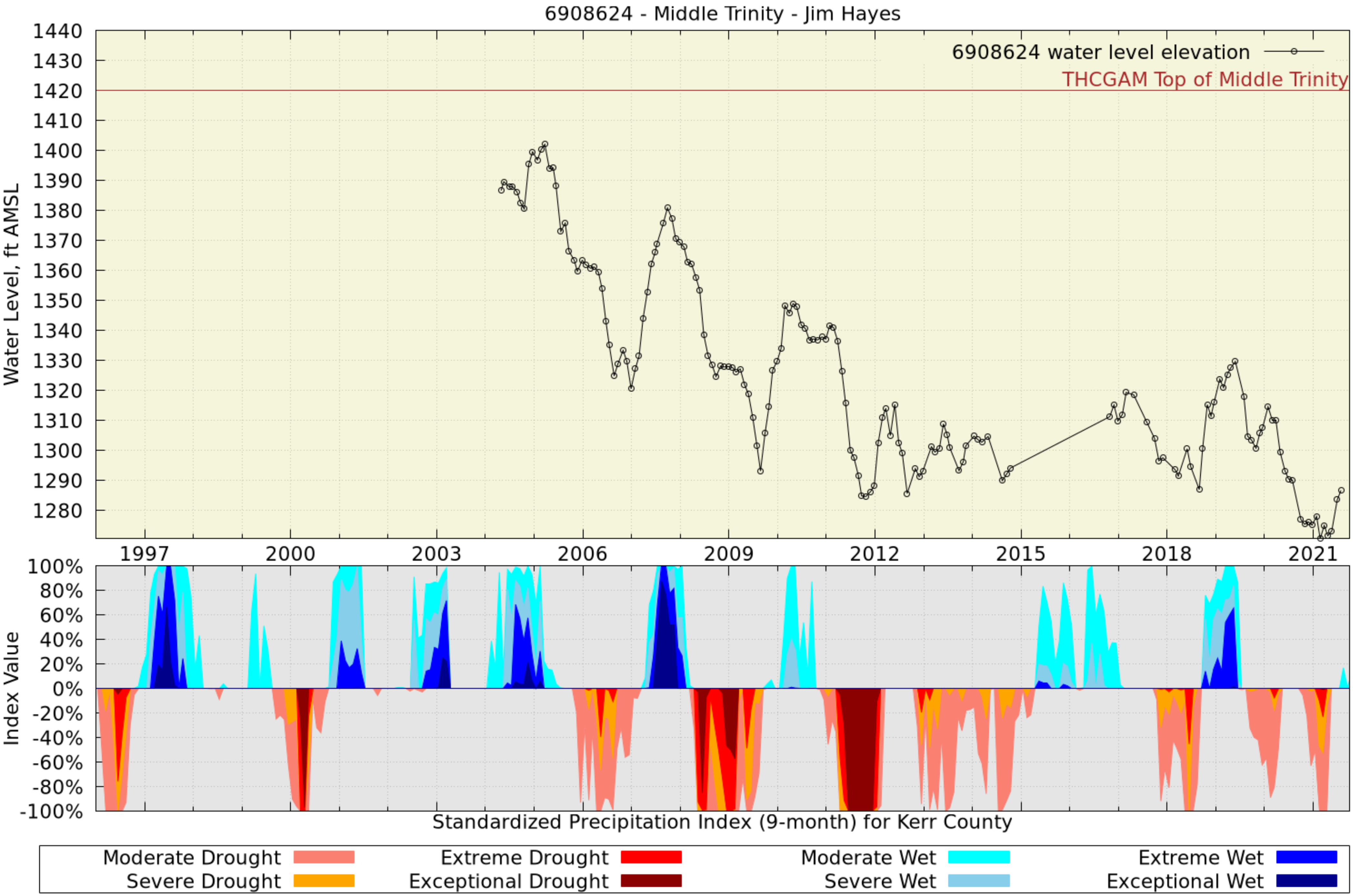
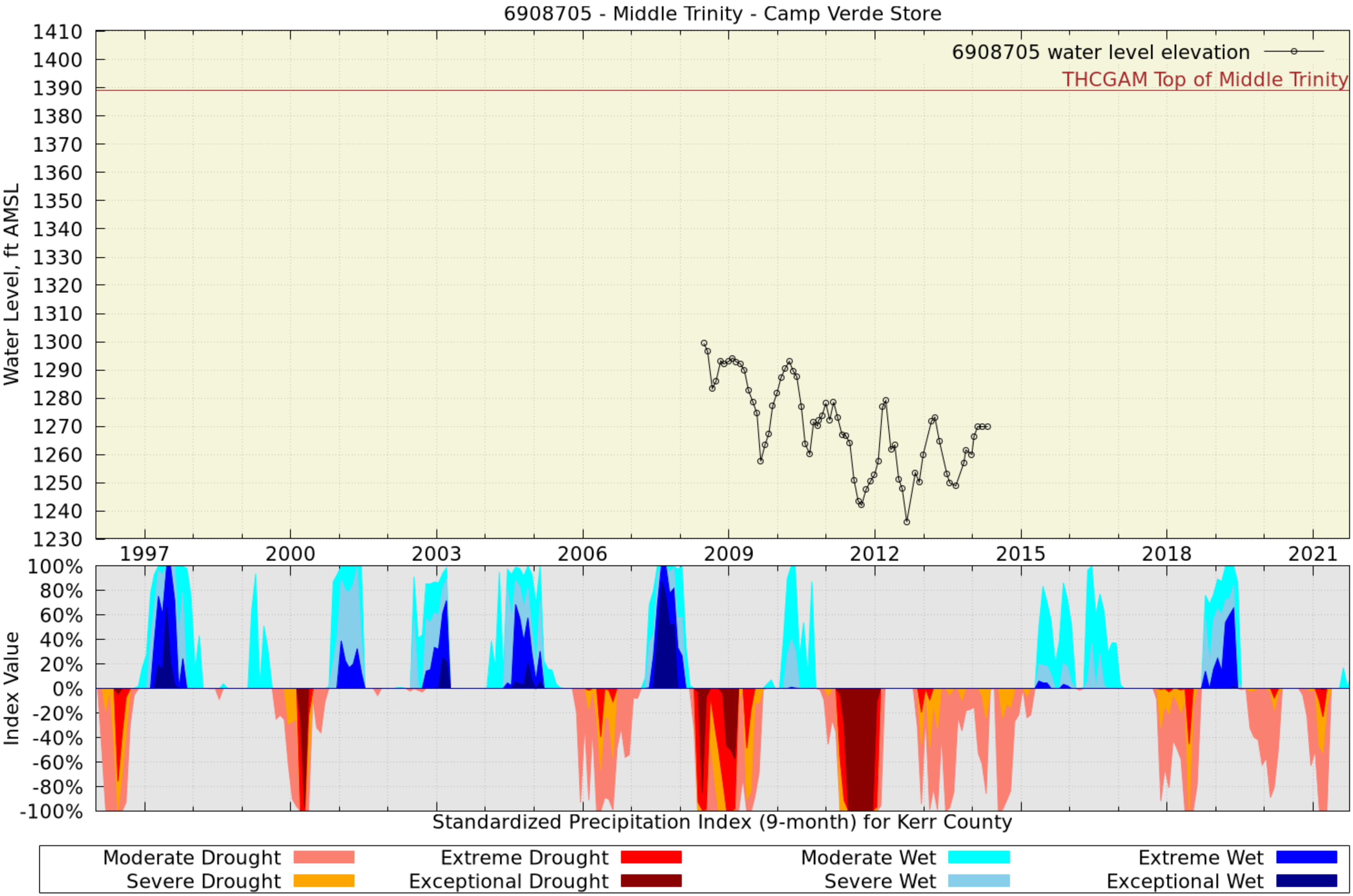
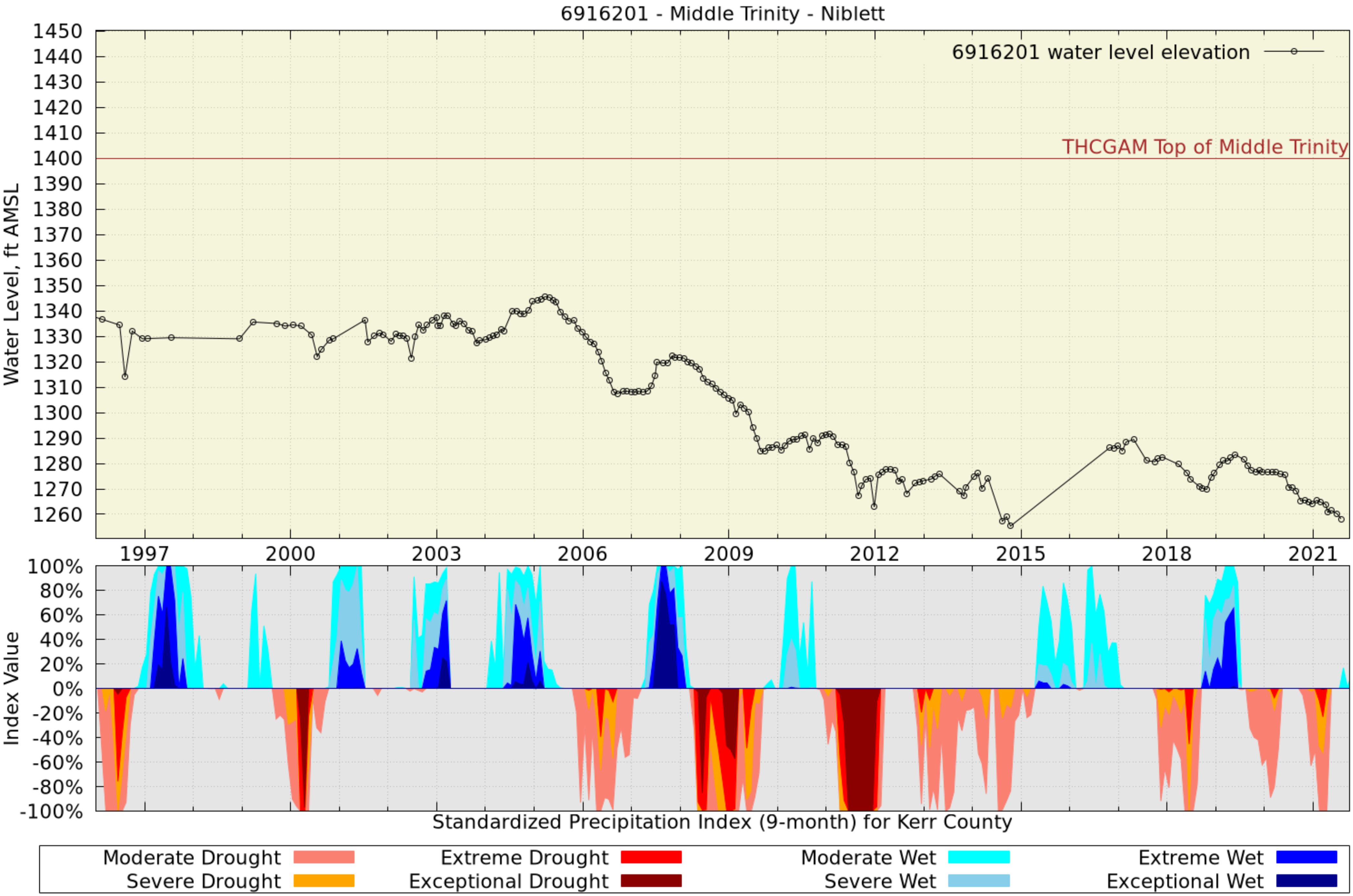
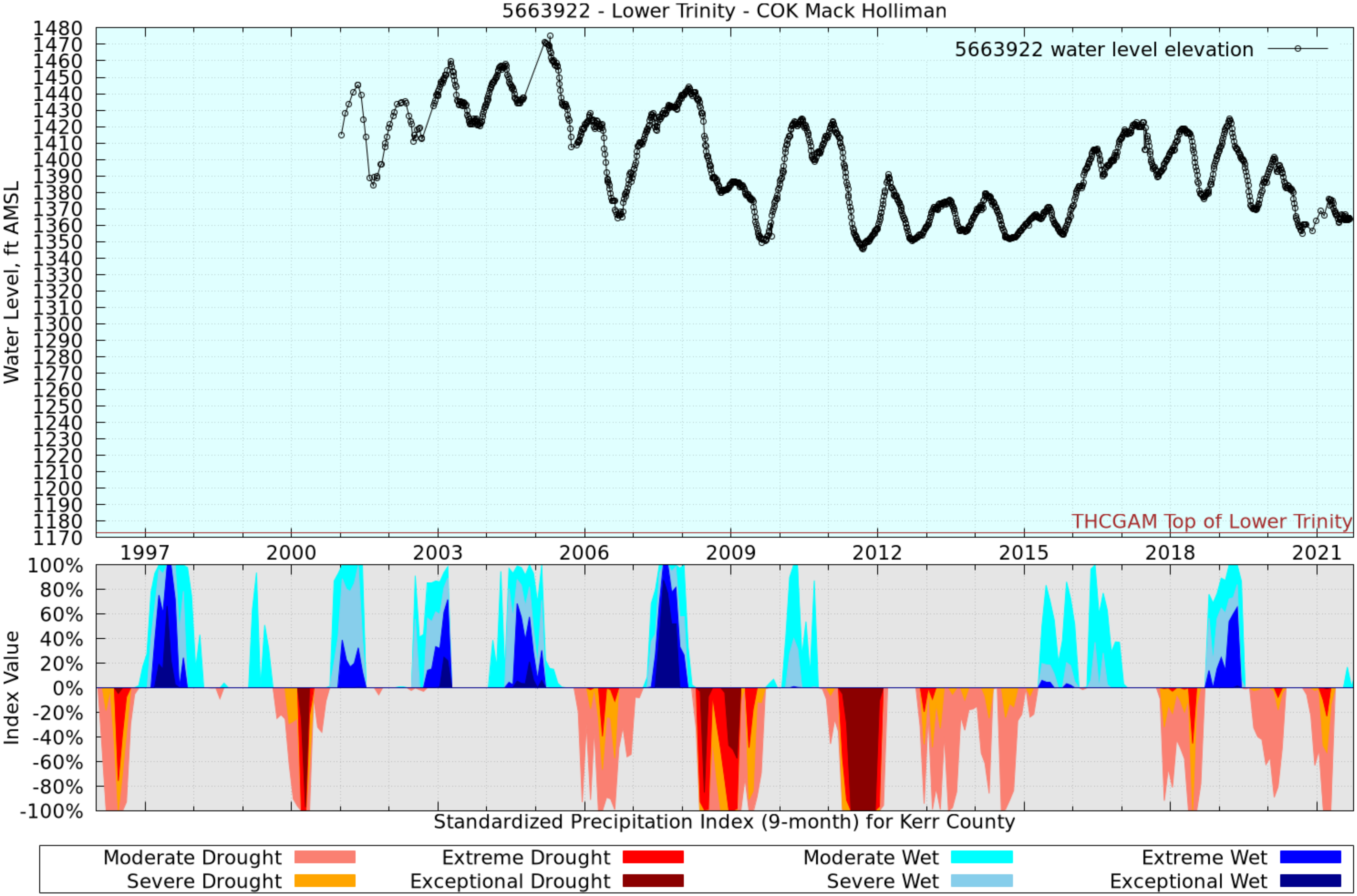
20%
0%
-20%
-40%
-60%
-80%
-100%
Standardized Precipitation Index (9-month) for Kerr County
Moderate Drought
Severe Drought
Extreme Drought
Exceptional Drought
Moderate Wet
Severe Wet
Extreme Wet
Exceptional Wet



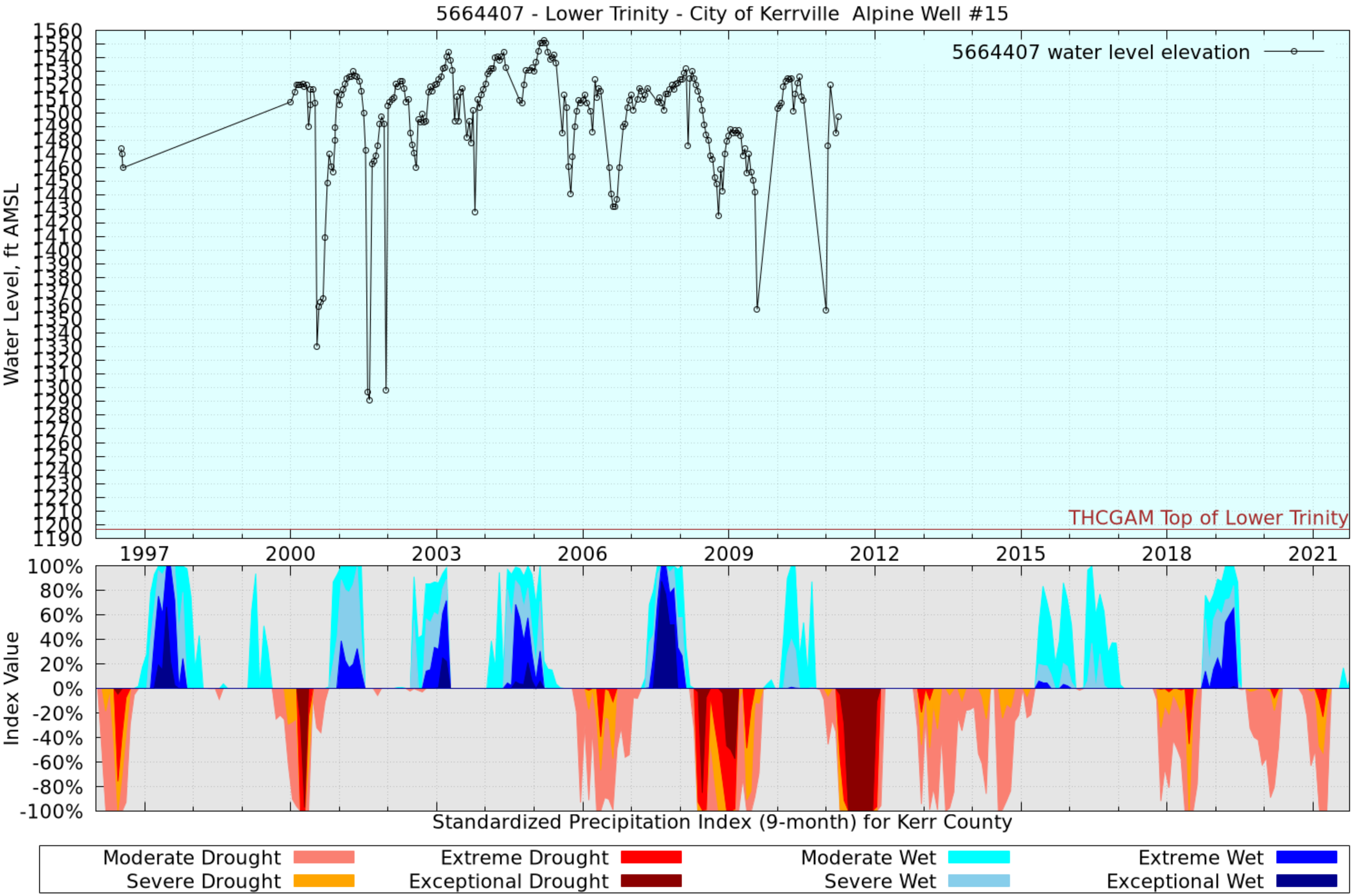
6908624 - Middle Trinity - Jim Hayes
6908624 water level elevation
THCGAM Top of Middle Trinity
Water Level, ft AMSL
1440
1430
1420
1410
1400
1390
1380
1370
1360
1350
1340
1330
1320
1310
1300
1290
1280
1997
2000
2003
2006
2009
2012
2015
2018
2021
Index Value
100%
80%
60%
40%
20%
0%
-20%
-40%
-60%
-80%
-100%
Standardized Precipitation Index (9-month) for Kerr County
Moderate Drought
Severe Drought
Extreme Drought
Exceptional Drought
Moderate Wet
Severe Wet
Extreme Wet
Exceptional Wet

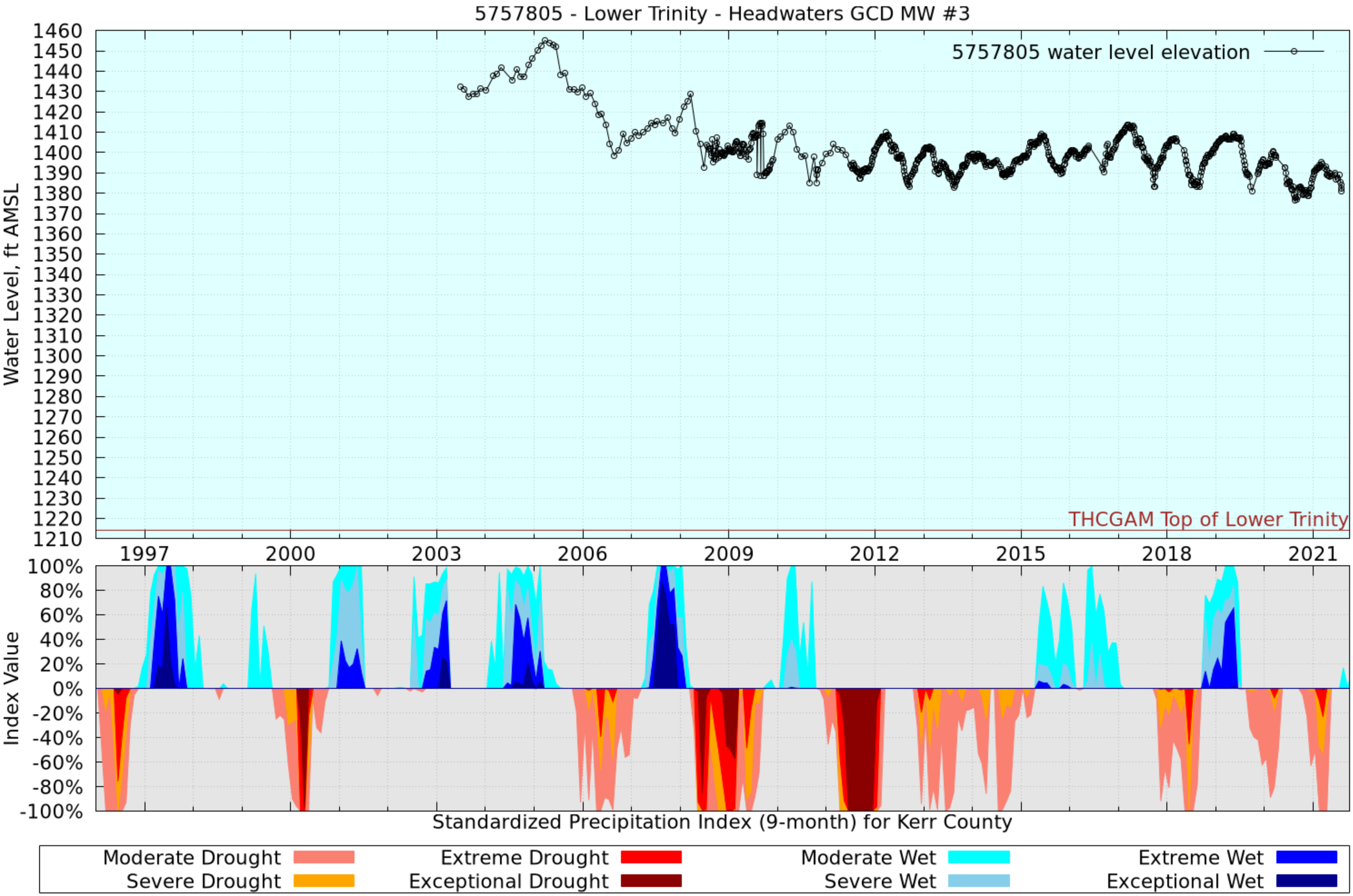

6908705 - Middle Trinity - Camp Verde Store
6908705 water level elevation
THCGAM Top of Middle Trinity
Water Level, ft AMSL
1410
1400
1390
1380
1370
1360
1350
1340
1330
1320
1310
1300
1290
1280
1270
1260
1250
1240
1230
1997
2000
2003
2006
2009
2012
2015
2018
2021
Index Value
100%
80%
60%
40%
20%
0%
-20%
-40%
-60%
-80%
-100%
Standardized Precipitation Index (9-month) for Kerr County
Moderate Drought
Severe Drought
Extreme Drought
Exceptional Drought
Moderate Wet
Severe Wet
Extreme Wet
Exceptional Wet


6916201 - Middle Trinity - Niblett
6916201 water level elevation
THCGAM Top of Middle Trinity
Water Level, ft AMSL
1450
1440
1430
1420
1410
1400
1390
1380
1370
1360
1350
1340
1330
1320
1310
1300
1290
1280
1270
1260
1997
2000
2003
2006
2009
2012
2015
2018
2021
Index Value
100%
80%
60%
40%
20%
0%
-20%
-40%
-60%
-80%
-100%
Standardized Precipitation Index (9-month) for Kerr County
Moderate Drought
Severe Drought
Extreme Drought
Exceptional Drought
Moderate Wet
Severe Wet
Extreme Wet
Exceptional Wet

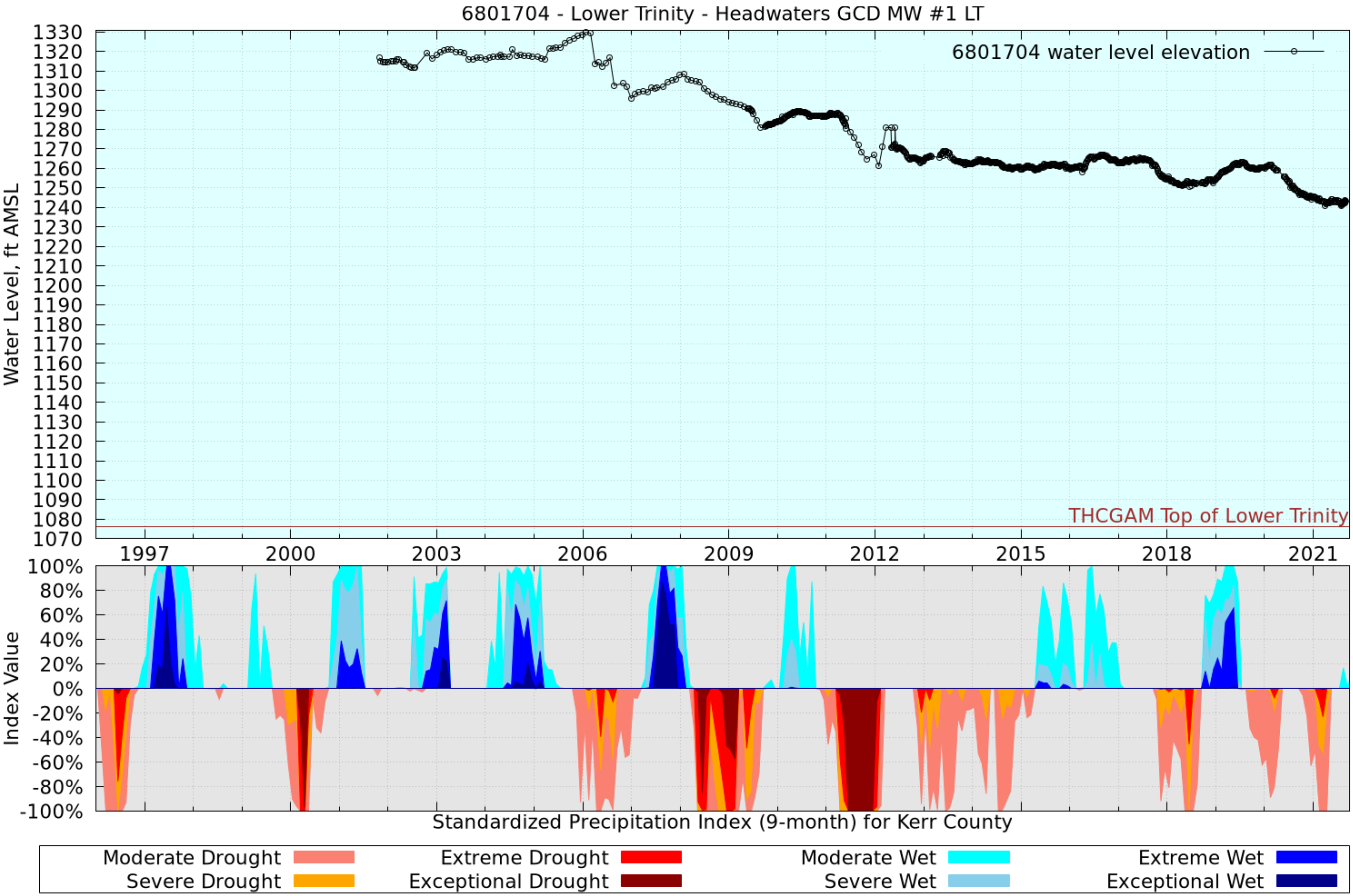


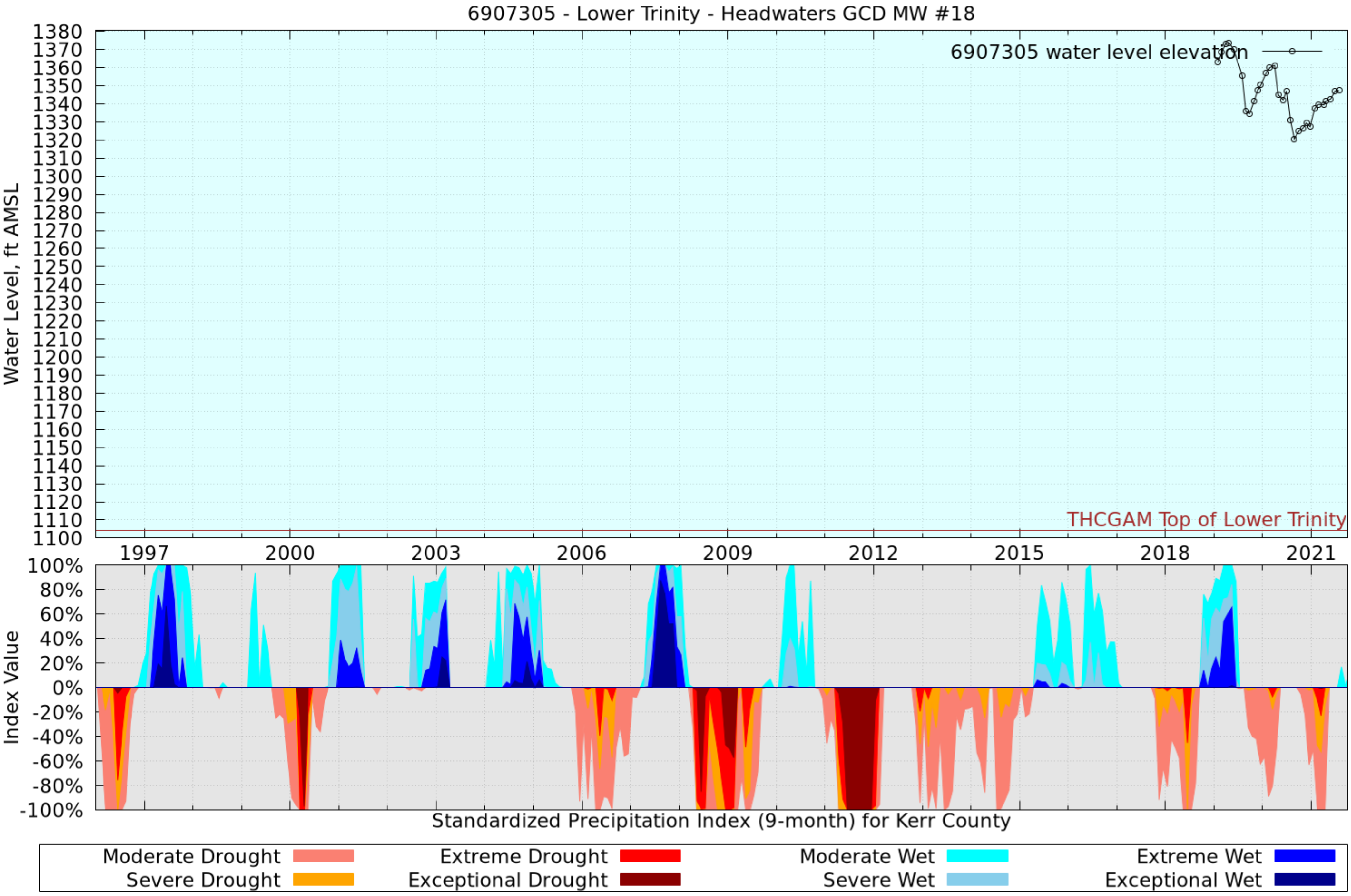
5663922 - Lower Trinity - COK Mack Holliman
5663922 water level elevation
Water Level, ft AMSL
THCGAM Top of Lower Trinity
1997
2000
2003
2006
2009
2012
2015
2018
2021
Index Value
Standardized Precipitation Index (9-month) for Kerr County
Moderate Drought
Severe Drought
Extreme Drought
Exceptional Drought
Moderate Wet
Severe Wet
Extreme Wet
Exceptional Wet

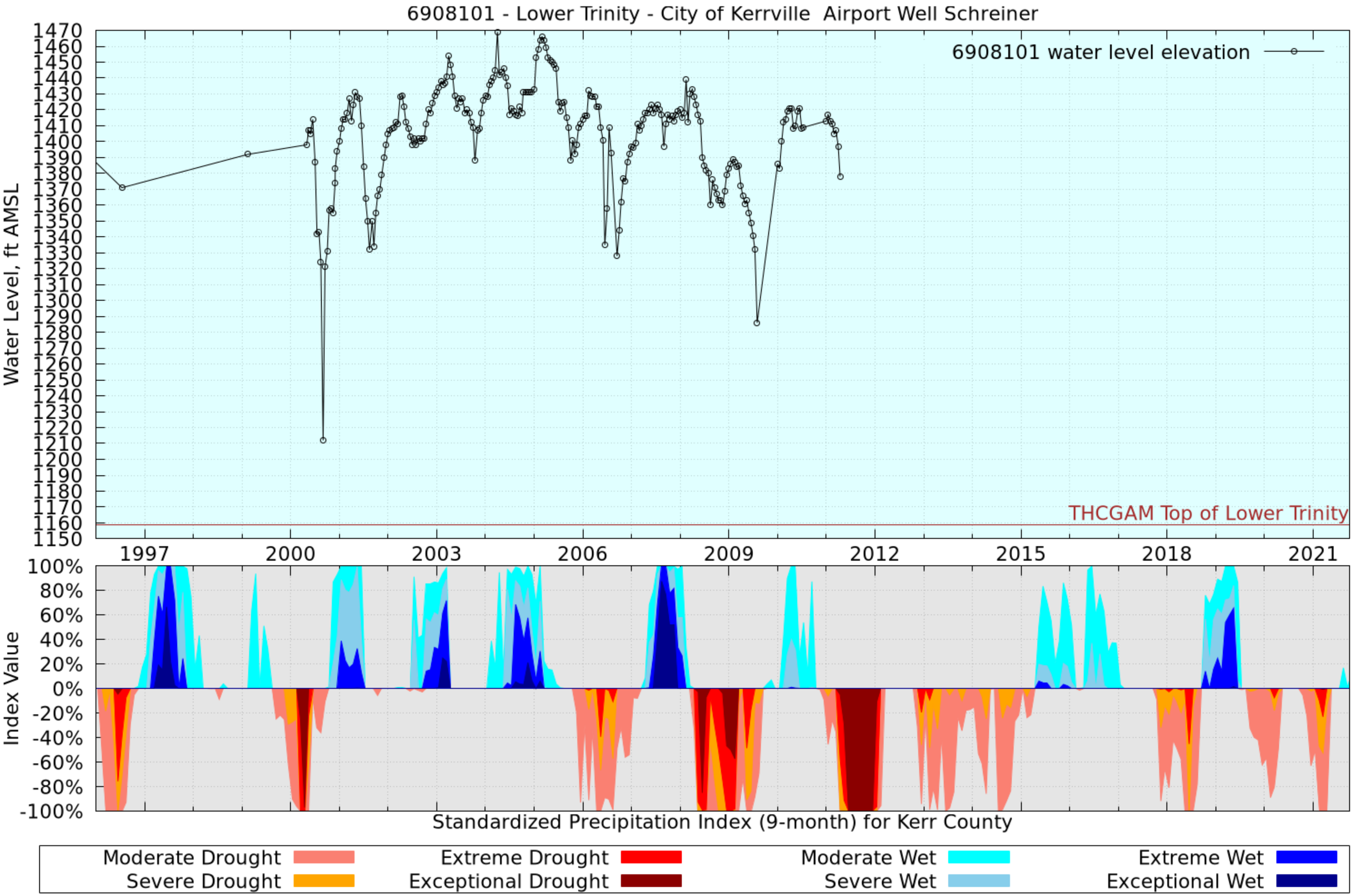

5664407 - Lower Trinity - City of Kerrville Alpine Well #15
5664407 water level elevation
Water Level, ft AMSL
THCGAM Top of Lower Trinity
1997
2000
2003
2006
2009
2012
2015
2018
2021
Index Value
Standardized Precipitation Index (9-month) for Kerr County
Moderate Drought
Severe Drought
Extreme Drought
Exceptional Drought
Moderate Wet
Severe Wet
Extreme Wet
Exceptional Wet



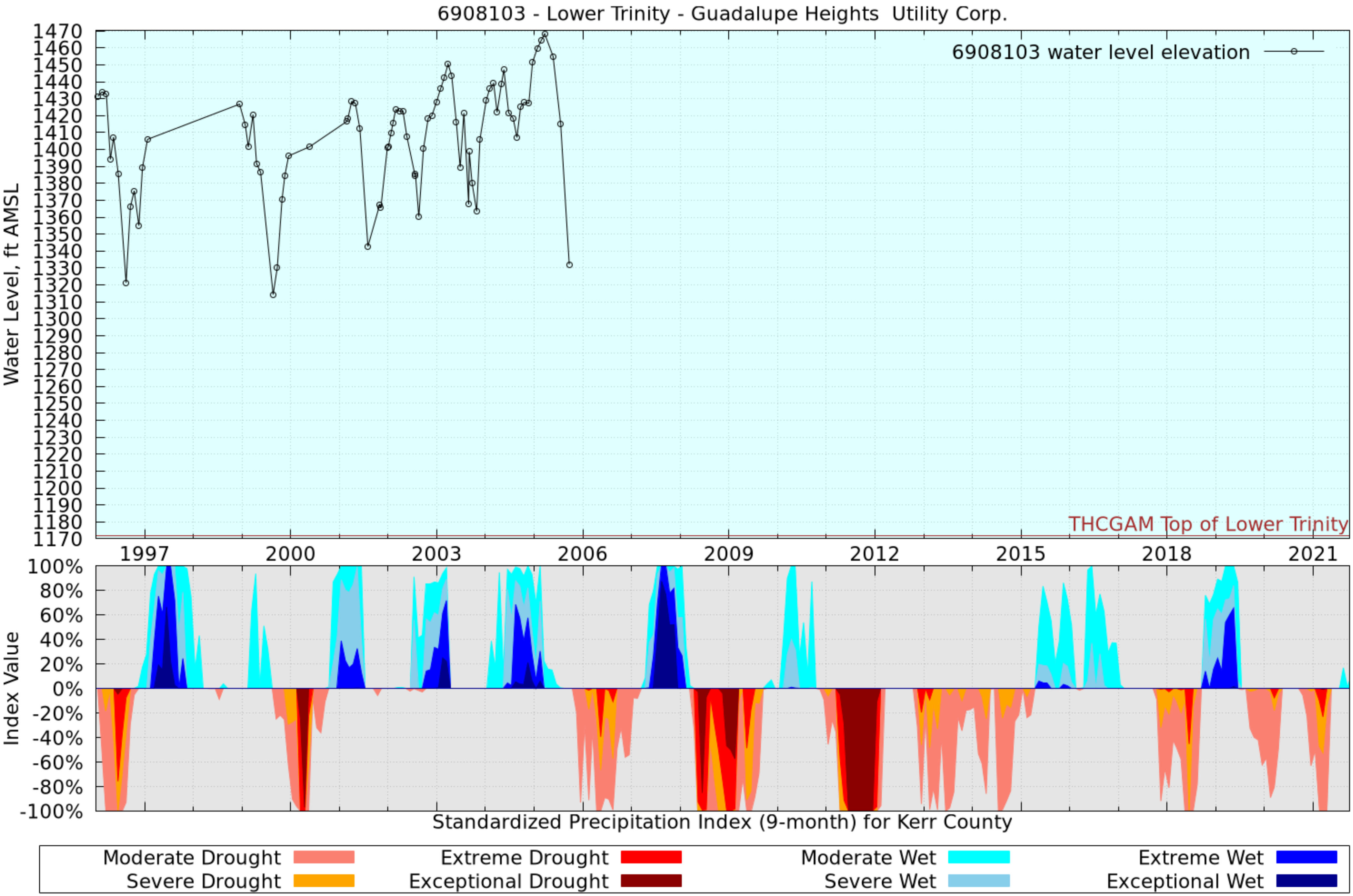
5757805 - Lower Trinity - Headwaters GCD MW #3
5757805 water level elevation
Water Level, ft AMSL
THCGAM Top of Lower Trinity
1460
1450
1440
1430
1420
1410
1400
1390
1380
1370
1360
1350
1340
1330
1320
1310
1300
1290
1280
1270
1260
1250
1240
1230
1220
1210
1997
2000
2003
2006
2009
2012
2015
2018
2021
Index Value
100%
80%
60%
40%
20%
0%
-20%
-40%
-60%
-80%
-100%
Standardized Precipitation Index (9-month) for Kerr County
Moderate Drought
Severe Drought
Extreme Drought
Exceptional Drought
Moderate Wet
Severe Wet
Extreme Wet
Exceptional Wet


6801704 - Lower Trinity - Headwaters GCD MW #1 LT
6801704 water level elevation
Water Level, ft AMSL
1330
1320
1310
1300
1290
1280
1270
1260
1250
1240
1230
1220
1210
1200
1190
1180
1170
1160
1150
1140
1130
1120
1110
1100
1090
1080
1070
THCGAM Top of Lower Trinity
1997
2000
2003
2006
2009
2012
2015
2018
2021
Index Value
100%
80%
60%
40%
20%
0%
-20%
-40%
-60%
-80%
-100%
Standardized Precipitation Index (9-month) for Kerr County
Moderate Drought
Severe Drought
Extreme Drought
Exceptional Drought
Moderate Wet
Severe Wet
Extreme Wet
Exceptional Wet

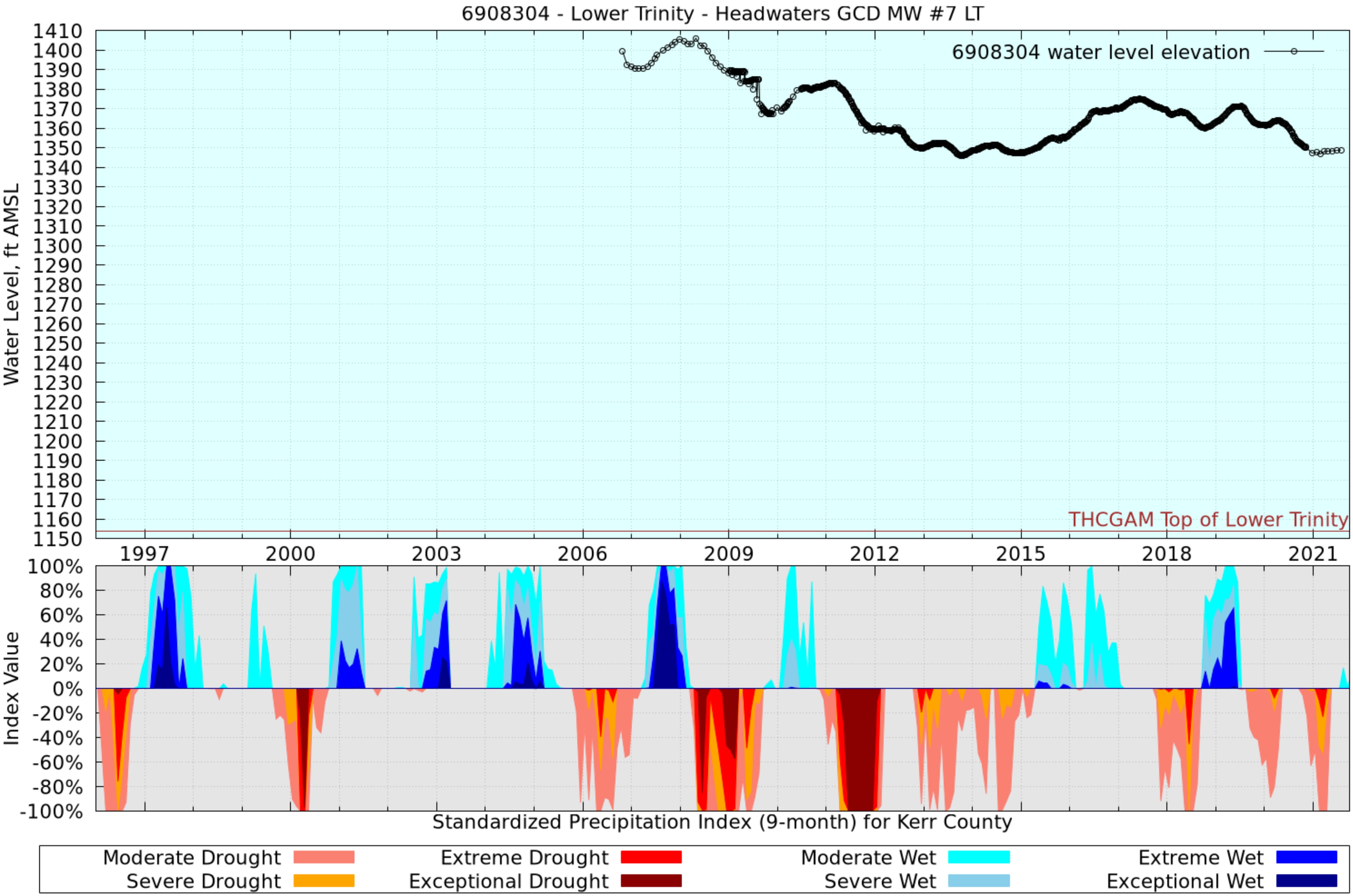

6907305 - Lower Trinity - Headwaters GCD MW #18
6907305 water level elevation
Water Level, ft AMSL
THCGAM Top of Lower Trinity
1997
2000
2003
2006
2009
2012
2015
2018
2021
Index Value
Standardized Precipitation Index (9-month) for Kerr County
Moderate Drought
Severe Drought
Extreme Drought
Exceptional Drought
Moderate Wet
Severe Wet
Extreme Wet
Exceptional Wet

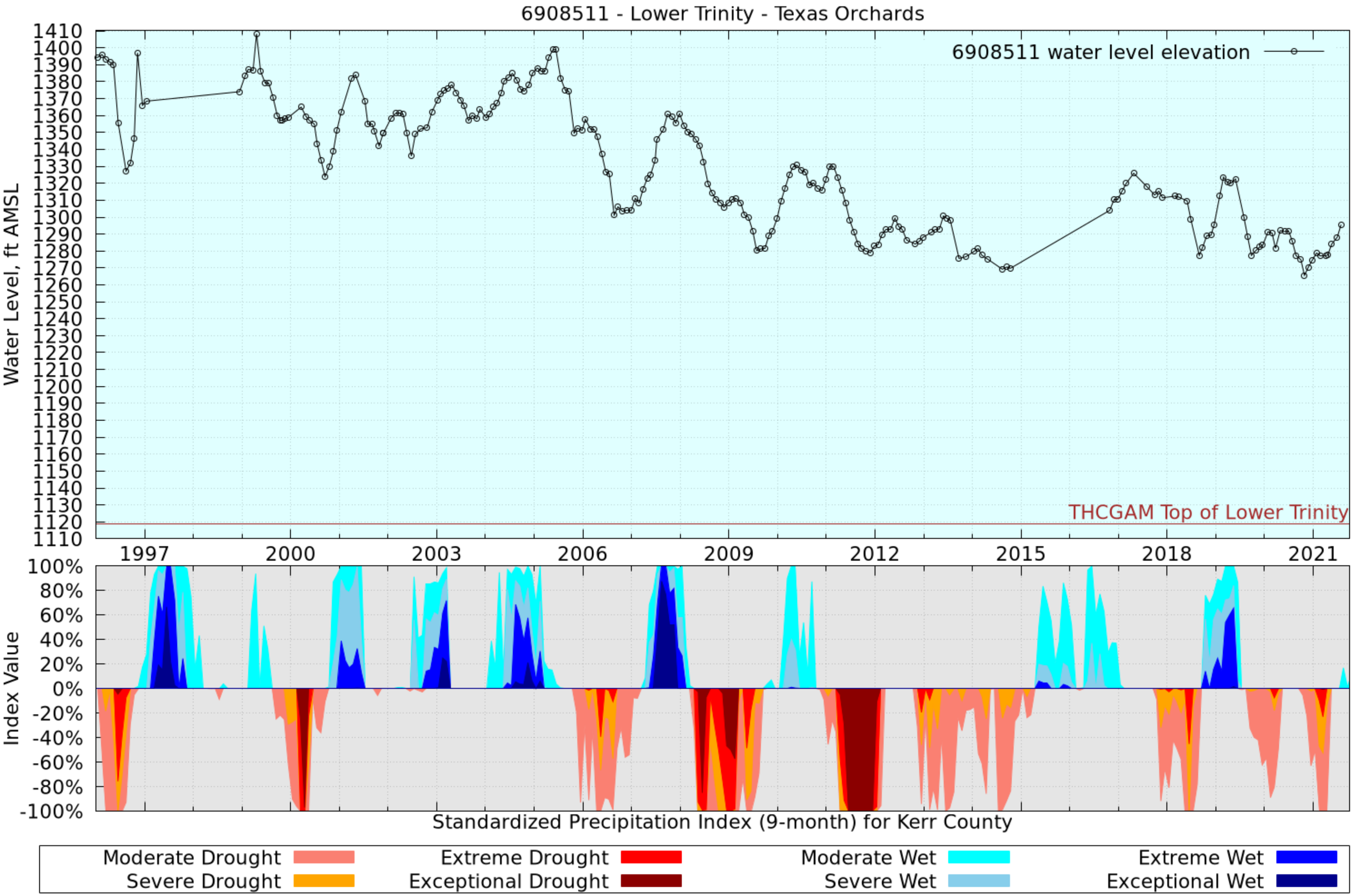


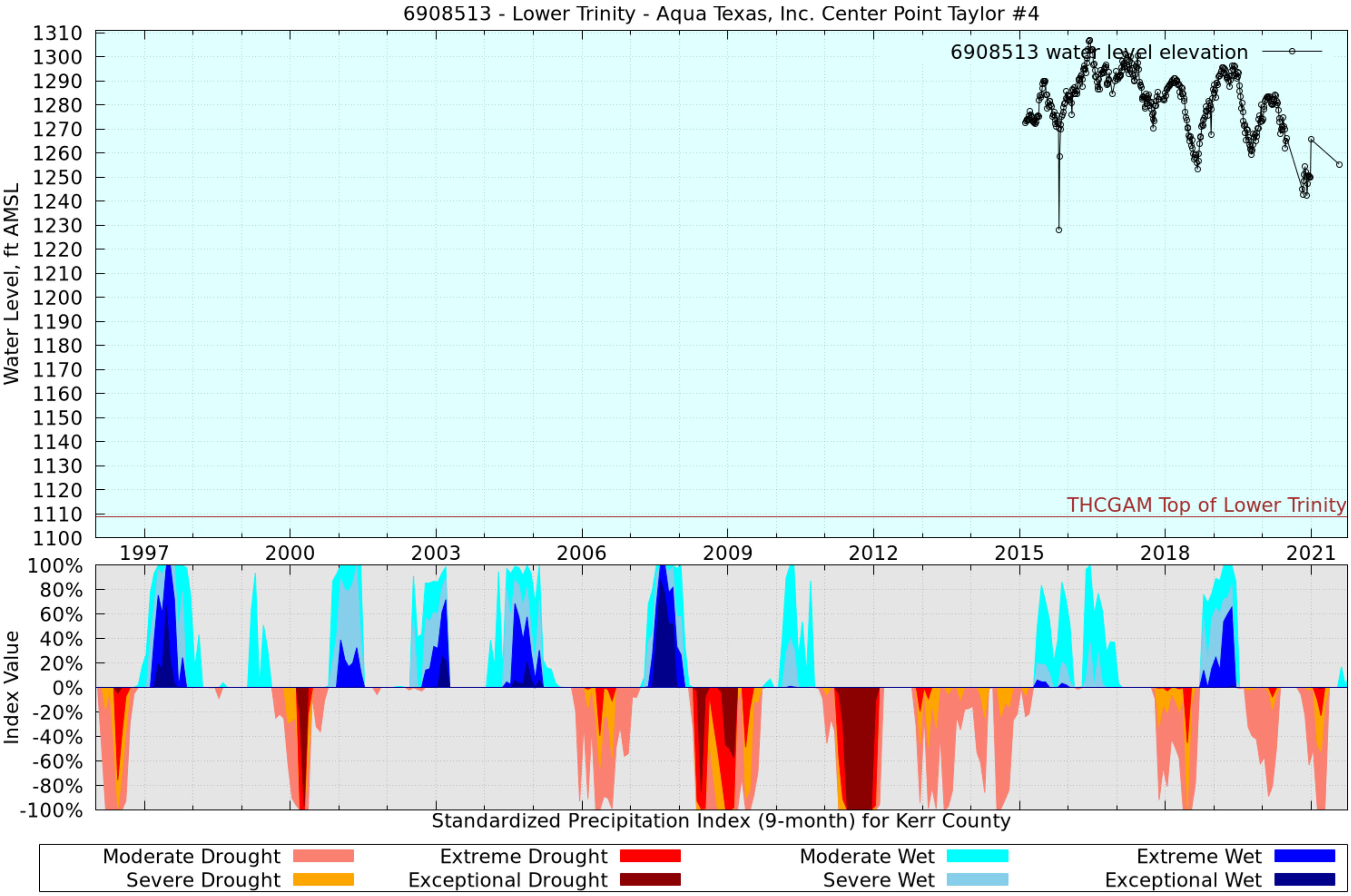
6908101 - Lower Trinity - City of Kerrville Airport Well Schreiner
6908101 water level elevation
Water Level, ft AMSL
THCGAM Top of Lower Trinity
1997
2000
2003
2006
2009
2012
2015
2018
2021
Index Value
Standardized Precipitation Index (9-month) for Kerr County
Moderate Drought
Severe Drought
Extreme Drought
Exceptional Drought
Moderate Wet
Severe Wet
Extreme Wet
Exceptional Wet



6908103 - Lower Trinity - Guadalupe Heights Utility Corp.
6908103 water level elevation
Water Level, ft AMSL
THCGAM Top of Lower Trinity
1997
2000
2003
2006
2009
2012
2015
2018
2021
Index Value
Standardized Precipitation Index (9-month) for Kerr County
Moderate Drought
Severe Drought
Extreme Drought
Exceptional Drought
Moderate Wet
Severe Wet
Extreme Wet
Exceptional Wet


6908304 - Lower Trinity - Headwaters GCD MW #7 LT
6908304 water level elevation
Water Level, ft AMSL
THCGAM Top of Lower Trinity
1410
1400
1390
1380
1370
1360
1350
1340
1330
1320
1310
1300
1290
1280
1270
1260
1250
1240
1230
1220
1210
1200
1190
1180
1170
1160
1150
1997
2000
2003
2006
2009
2012
2015
2018
2021
Index Value
100%
80%
60%
40%
20%
0%
-20%
-40%
-60%
-80%
-100%
Standardized Precipitation Index (9-month) for Kerr County
Moderate Drought
Severe Drought
Extreme Drought
Exceptional Drought
Moderate Wet
Severe Wet
Extreme Wet
Exceptional Wet


6908511 - Lower Trinity - Texas Orchards
6908511 water level elevation
Water Level, ft AMSL
THCGAM Top of Lower Trinity
1997
2000
2003
2006
2009
2012
2015
2018
2021
Index Value
Standardized Precipitation Index (9-month) for Kerr County
Moderate Drought
Severe Drought
Extreme Drought
Exceptional Drought
Moderate Wet
Severe Wet
Extreme Wet
Exceptional Wet


6908513 - Lower Trinity - Aqua Texas, Inc. Center Point Taylor #4
6908513 water level elevation
Water Level, ft AMSL
THCGAM Top of Lower Trinity
1997
2000
2003
2006
2009
2012
2015
2018
2021
Index Value
Standardized Precipitation Index (9-month) for Kerr County
Moderate Drought
Severe Drought
Extreme Drought
Exceptional Drought
Moderate Wet
Severe Wet
Extreme Wet
Exceptional Wet

Appendix B

Summary of Aquifer Parameters from Groundwater Availability Studies

Summary of Aquifer Parameters from HGCD Water Availability Studies

Well	Latitude	Longitude	Aquifer	Transmisssivty (ft2/d)	Aquifer Thickness (ft)	K (ft/d)	Storage Coefficient
Hidden Springs							
C-1	30.128611	-98.912222	Middle Trinity (Hensell)	505	95	5.312	2.2 x10-5
C-2	30.133056	-98.909722	Middle Trinity (Hensell)	365	220	1.659	2.3 x10-5
Camp Verde							
No. 1	29.917111	-99.082611	Middle Trinity (Cow Creek)	32	362	0.088	9.3 x10-5
No.2	29.916611	-99.082389	Middle Trinity (Cow Creek)	78	362	0.216	
No.3	29.916639	-99.079139	Middle Trinity (Cow Creek)	32	362	0.090	2.4 x10-5
Old River Road RV							
No. 1	29.956528	-99.076056	Middle Trinity (Hensell & Cow Creek)	27	262	0.102	--
Nickerson Farms							
Well No. 2	29.950494	-98.974786	Lower Trinity	12	132	0.090	--
Center Point Taylor							
Well 3	29.942089	-98.045561	Middle (Cow Creek)	120	40	3.000	--
Texas Lions Camp							
HGCD Well #2102	30.011222	-99.103306	MT (Hensell) & LT (Hosston)	178	216	0.824	--
Old River Road							
HGCD Wel No. 2475	29.956528	-98.076056	Middle (Hensell & Cow Creek)	27	262	0.102	--
Monitor Well #17	30.131139	-99.923222	Ellenburger	1059	563	1.881	--
Oak Ridge							
Well No. 2	29.981389	-99.031750	Lower Trinity (Hosston)	* no calc,35.1' DD/455 minutes			--