Water Management Plan Update Process
Participant comments received between April 12 and May 21, 2025, and LCRA responses

Comments related to naturalized flows

From CTWC:

Extending Hydrology through 2024 and Annual Updates of Hydrology

CTWC respectfully requests that LCRA develop naturalized inflows for 2024 and include them for use in modeling during this WMP revision process. Doing so should assist in determining whether the 2008-2016 drought period remains the controlling drought period based on the current WAM modeling procedures (including flow naturalization procedures) and assist in determining whether the current water modeling reflects the severity of the ongoing drought. Data for performing the 2024 flow naturalization should be readily available, as LCRA has recently published its 2024 Water Use Summary report, and TCEQ should have other needed data. CTWC would also like to request that LCRA begin updating the hydrology on an annual basis going forward to better monitor this drought as well as future droughts.

Need for Adjustment of Naturalized Flow Data

The productivity of a watershed can be described by the "Capture Rate," defined as the ratio of watershed outflows to rainfall volume over a set period of time. CTWC's analysis of capture rates for the Lakes Buchanan and Travis watershed demonstrate significant declines over time, indicating that the watershed is not producing the same volume of inflows as it had in the past, for the same volumes of rainfall experienced. CTWC requests that LCRA consider this decline in capture rate when developing this new WMP to ensure that the rules and guidelines put in place will be adequately protective of water supplies resulting from diminishing inflows.

Recognizing Meteorological Droughts

CTWC recognizes that much debate could be had regarding any methodology used to adjust naturalized flows based on the capture rate, as presented in the included documents. However, the important "take away" is that the critical period is likely to be the 1950s drought period, if WAM modeling were based on rainfall rather than streamflow. CTWC is gravely concerned that future low-rainfall years like those that occurred repeatedly in the 1950s drought period would result in unprecedented low-inflows to Lakes Buchanan and Travis. To mitigate this concern, the upcoming WMP should be altered to be much more protective of the water supplies to be managed in order to achieve a sustainable future.

LCRA's response to naturalized flow-related comments:

To update the WMP now, LCRA intends to use the naturalized flows through 2023,

as approved by TCEQ. The process for updating naturalized flows is a significant, lengthy endeavor and requires review and approval by TCEQ. The timing of future updates to naturalized flows can be considered at a later date.

As with prior water management plans, the modeling for this update will use historic hydrology. LCRA does not intend to artificially adjust the observed hydrology. Under the TCEQ framework, the WMP will maintain a minimum combined storage of 600,000 acre-feet over a repeat of historic hydrology. The WMP also will continue to include a process for identifying the potential occurrence of a drought worse than the drought of record. The 600,000-acre-foot minimum combined storage will continue to be a mechanism to provide a cushion in the event of future hydrology that may be worse than experienced in the period of record.

Comments related to evaporation

From CTWC:

Need for Use of Latest Science on Evaporative Losses from Large Reservoirs

CTWC wishes to ensure that LCRA is utilizing the best available science when performing modeling in support of the WMP. CTWC also recognizes that LCRA must develop naturalized flows according to accepted methods and using accepted data, and that TCEQ will currently only accept use of standard TWDB-published evaporation data within WAM modeling. CTWC urges LCRA to discuss the new evaporation data with TWDB, and get the data properly incorporated into the WAM modeling process for the State of Texas. We believe the new methods of Zhao and others (2024) are improvements over the TWDB-published data and older methods. We urge LCRA, TWDB, and TCEQ to adopt the data provided through Zhao and others (2024) for all future WAM modeling in Texas.

LCRA's response to evaporation comments:

Naturalized flows throughout the state use Texas Water Development Board evaporation data. It is important to use the same dataset for both naturalized flows and WAM modeling.

An ongoing evaporation study with TWDB, NASA, Army Corps of Engineers Fort Worth Office, U.S. Bureau of Reclamation, Desert Research Institute, Texas A&M University and LCRA is encouraging, but the data has not been fully developed. LCRA will continue working with TWDB to develop Texas-relevant data for the study, including installing equipment on Lake Buchanan to gather additional data. Once more data is obtained, we will work with TWDB to move the effort forward.

Comments related to modeling

From CTWC:

Modeling Runs that Apply More Protective Values for Water in Storage

CTWC acknowledges that the 2020 WMP has been effective in managing water supplies to date. However, the ongoing drought is more severe than ever previously experienced. Accordingly, we believe the revised WMP must have lower interruptible release amounts and higher curtailment triggers to continue to avoid DWDOR declarations and firm customer curtailment.

<u>Modeling Parameters</u>
Please describe the parameters that will be used in the Water Availability Model (WAM) runs.

Would it be appropriate to consider separating the Water Availability modeling work into the Upper and Lower Reaches of the river basin?

<u>Modeling for, and Future Operations of, Arbuckle Reservoir</u>
Please describe how the Arbuckle Reservoir will fit into the next WMP. Is Arbuckle considered another water supply reservoir within LCRA's system? How is it accounted for with respect to the terms of the Adjudication of Water Rights and LCRA's obligation to prepare and obtain approval of a WMP for the operation of Lakes Buchanan and Travis?

How will the existence of be modeled for purposes of this WMP?

How will that differ from the assumptions made for Arbuckle in the 2020 WMP?

What are the operating parameters for Arbuckle?

Will Arbuckle be used to determine the Firm Yield of LCRA's water supply reservoirs?

Will the presence of Arbuckle have an impact on the updated Firm Yield determination?

Would it be appropriate to consider separating the Water Availability modeling work into the Upper and Lower Reaches of the river basin?

<u>Modeling Runs that Include Additional Reservoir Volumes in Reserve</u>
As LCRA prepares to run Firm Yield models for the next WMP, CTWC requests that LCRA also include modeling runs that generate a "safe yield" for its water supply reservoirs. For example, if LCRA leaves a minimum one-year supply in reserve, what is the volume of the "safe yield" that can be used during the critical drought period? Utilizing safe yield in this WMP is justified by the high degree of uncertainty and vulnerability associated with this river basin's dependence on surface water supplies.

LCRA's response to modeling-related comments:
The preliminary approach to update the WMP includes adjustments to interruptible agricultural supply and environmental flows to accommodate increasing firm demands. The model will continue to maintain a minimum combined storage of at least 600,000 acre-feet.

LCRA does not intend to deviate from the standard approach for firm yield models as part of this WMP update.

The parameters used in the WMP are similar to those in the modeling of the 2020 WMP and will be documented in a revision to the technical papers from the 2020 WMP. The technical papers for the 2020 WMP are available at www.lcra.org/watermanagementplan.

LCRA will continue modeling the upper and lower reaches of the river basin as a system. Supplies in the lower reaches will be used first to meet downstream demands to the extent possible, before relying on releases of upstream supplies. Arbuckle Reservoir is part of the system and will be used to help meet firm demands in Matagorda County, some interruptible agricultural demands and Matagorda Bay inflow obligations. For this WMP update, Arbuckle Reservoir will be modeled similar to how it was modeled for the 2020 WMP. Supply from Arbuckle Reservoir is independent of the firm yield of lakes Buchanan and Travis.

May 21, 2025, Revised 6/6/2025

VIA EMAIL TO LCRAWMP@lcra.org

LCRA Staff
Austin, Texas

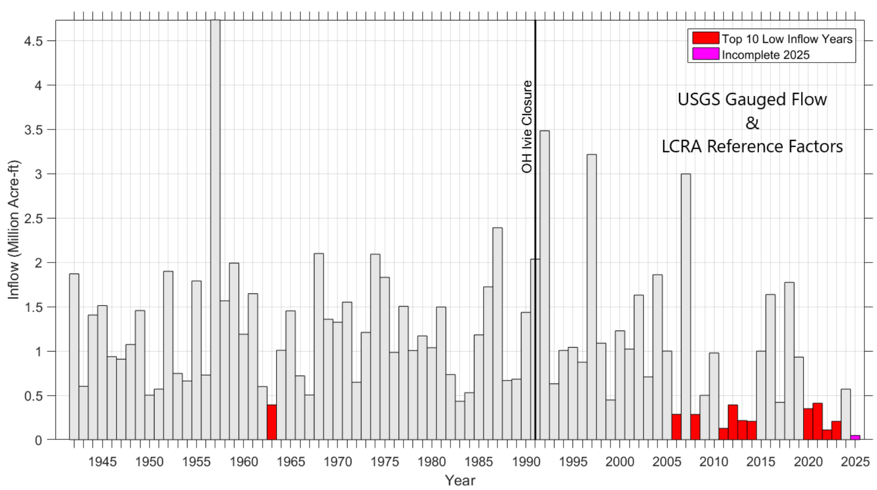
Re: Response to LCRA Water Management Plan Participant Meeting on April 23, 2025; Comments and Questions Relating to Naturalized Flows and Development of Water Management Plan

Dear LCRA Staff,

The Central Texas Water Coalition (CTWC) appreciates the opportunity to submit the following comments and questions for consideration in the development of the next Water Management Plan (WMP). These remarks reflect both the topics discussed at the April 23 meeting, and our additional ongoing concerns about water supply sustainability.

As LCRA begins the process of drafting the next WMP, we respectfully urge you to approach this work with a strong sense of urgency and a commitment to incorporating the best available science. As you are aware, the WMP is not merely a planning document—it governs the real-time management of two vital water supply reservoirs that serve millions of Texans.

Recent years have brought a significant and measurable decline in inflows to Lakes Buchanan and Travis. Notably, 9 of the 10 lowest inflow years have occurred since 2006. This concerning trend has motivated CTWC, in partnership with LRE Water, to conduct extensive studies to better understand and quantify these changes.



To this end, CTWC has compiled average rainfall data across the Lake Buchanan and Lake Travis watershed to evaluate watershed productivity. Our findings indicate that for equivalent rainfall amounts, the watershed's yield—or capture rate—has significantly declined compared to previous decades. A key factor appears to be the exponential increase in the number of small, permit-exempt ponds since the 2001 revision to Texas water law, which allowed ponds for "fish and wildlife purposes."

CTWC has determined the following:

- Rainfall across the Highland Lakes watershed was lowest during the 1950s drought.
- The inflow productivity of the watershed has been significantly reduced during both the 2008–2016 drought and the ongoing drought beginning in 2019.
- As a result, CTWC is deeply concerned that a repeat of 1950s rainfall patterns under current conditions would result in even lower inflows than experienced in the past, due to the diminished capacity of the watershed to generate runoff.

The next WMP must address this critical issue. While rainfall totals and naturalized flows remain important inputs to the Water Availability Models (WAM) used in the WMP, relying on unadjusted historical data is no longer sufficient. CTWC has developed proposed adjustments to account for present-day watershed conditions and recommends their incorporation in all upcoming modeling efforts.

Although the meteorological drought of record remains the 1950s based on rainfall data, our research indicates that the current drought may be hydrologically more severe than any Period between 1940 and 2016. This new WMP must account for the declining yield of the watershed and include more protective measures to reflect the loss of available water and ensure long-term sustainability.

In summary, the attached analysis will show why CTWC strongly believes our watershed has undergone a profound and potentially irreversible transformation. We must now plan for the water we have—not the water we once had. We respectfully request that you review the attached technical analyses and incorporate these findings into the upcoming WAM runs for the new WMP.

We greatly value the opportunity to participate in the ongoing WMP process and appreciate the continued dialogue and partnership with LCRA. We stand ready to assist where appropriate. Thank you for your commitment to safeguarding our region's water future.

Sincerely,

Shannon Hamilton
Shannon Hamilton
Executive Director

Attachments:
List of Comments
Executive Summary and Technical Synopsis

CC: Dave Stauch, President CTWC

CWTC WMP Comments to LCRA May 21, 2025

EXECUTIVE SUMMARY

CTWC has been monitoring inflows, using LCRA reported gauged flows, since 2011. During years when updated naturalized flow data is not available, USGS gauged flows provide a good approximation for naturalized flow data. This early analysis recognized that a pattern of much lower inflows from the watershed into the Highland Lakes began to emerge in 2006. Our statistical analysis of the inflows (USGS gauged) over the 1942-2024 historical period-of-record revealed that a major downward shift in the inflow process to a “new much lower normal”, beginning around 2008, with an average reduction of over 50%.

Previous studies of the causes for the declining inflows point to the proliferation of small ponds, higher temperatures and alluvial wells. LCRA’s analysis reported in 2024 that the count of small ponds in the watershed had grown to over 44,000, and that figure is still growing. A large increase appears to have followed a 2001 amendment of the Texas Water Code, which expanded the universe of permit-exempt small ponds to include private ponds for wildlife and fishing purposes. Previously, permit-exempt ponds were largely restricted to ponds for domestic and livestock. The trend toward increasing ambient temperatures is also likely a contributing factor to the reduced inflows as it increases evaporation in the small ponds and streams. Additional evidence of the shift includes that 9 of the worst 10 annual inflows (USGS gauged flows) have all occurred since 2006.

The shift to lower inflows and the structural changes in the watershed created a need to better understand and quantify the productivity or % capture rate of the watershed to produce the inflows into the Highland Lakes that provide the water supply.

CTWC and LRE Water have developed approaches for determining the total annual weighted average rainfall volume across the watershed using the TWDB Quads Water from the TWDB Quads database and other sources. The combination of the historical annual naturalized flows with the historical weighted average rainfall over the Highland Lakes watershed allows the calculation of a new measure of productivity of the watershed, represented by a % Capture Rate. This <u>is effectively a macro version of a Run-off Ratio of the entire watershed.</u> The calculation is shown below:

$$\boldsymbol{Capture\ Rate = \frac{Watershed\ Outflow\ Volume}{Watershed\ Rainfall\ Volume} \cdot 100\%}$$

Average annual rainfall over the watershed from 1940-2024 was found to be 26.3 inches/year, which equated to 20.67 million acre-feet/years. All years of the annual rainfall from 1940 to 2024 fell within 3 standard deviations, but some significant variation and concerns were noted, particularly the very low sustained rainfall that occurred during the Drought of the 50s. This introduced the question of whether it would be the controlling drought, based on rainfall.

CTWC's study of the rainfall over the 1940-2024 period has also found that the watershed has thus far not experienced a period of extended drought and low inflows for more than 6-7 years, and we are now in year 6 of the current drought.

The analysis of naturalized flows from 1940-2023 historical period-of-record also indicated a major downward shift in the inflow, beginning around 2008, with an average reduction of 41%. The % Capture Rate, with the reflection of a downward shift at 2008, shows a 38.9% decline from the average % Capture Rate of 5.45 % from 1940-2007 to 3.33% from 2008-2023. Further analysis found that the % Capture Rate varied with the annual average rainfall pattern, with lower capture rates occurring with low annual rainfall. As such the % Capture Rates were evaluated for dry/low rainfall, medium/average rainfall and for high/wet rainfall patterns. This analysis identified large reductions in % Capture rate for all rainfall patterns after 2008. It has also been found that the decline in productivity of the watershed is continuing post 2008.

This capture rate analysis has identified a lack of stationarity in the watershed contributing inflows to Lakes Buchanan and Travis. If current rainfall events are generating less inflows than they would have in the past, then it is improper to develop current rules for water management using historical hydrology. CTWC believes that the data shows that historical naturalized flows are no longer representative of the hydrologic patterns to be expected within the watershed for Lakes Buchanan and Travis, and that adjustments to the historical naturalized flows, based on historical rainfall and current % Capture Rates, are needed in order reflect current conditions and to use the WAM to provide reasonable statistics regarding water management plan rules and guidelines.

An analysis of Firm Yield, utilizing the WAM with proposed adjusted annual naturalized flows, has found that the Drought of the 50s is the controlling drought, with dramatic reductions in the Firm Yield down to the 200, 000 acre-feet range with full proposed adjustments. This demonstrates the importance of strong consideration of this new research by CTWC in the development of the Update of the WMP.

CWTC WMP Comments to LCRA May 21, 2025 – Technical Synopsis

The objective of the LCRA Water Management Plan, in the opinion of the CTWC, is to direct LCRA on how to manage the water supplies of the Lower Colorado River system, from the outlet of OH Ivie Reservoir all the way to the Gulf of Mexico. The plan lays out a set of rules dictating water release volumes for environmental flow purposes, and maximum interruptible release quantities for non-firm LCRA customers. Rules are tested against historical hydrology to answer the following questions:

- *If we had the hydrology of the past, how would our proposed management policies work?*
- *Would customers meet their needs most of the time, and would a healthy environment be sustained?"*

A successful plan would be one where stakeholders can accept the expected results and make operational decisions based upon the likelihood of receiving needed water supplies under plan rules and proper lake system operation.

This premise necessarily assumes that the hydrology experienced during the time of the new plan implementation matches the hydrology experienced in the past. Recent observations suggest that the current drought (2019-Present) is more severe than anything previously experienced in the basin at least over the period from 1940-2016. This calls into question the validity of assuming future conditions will have been experienced in the past.

As of 5/18/2025, the current drought has been in place for almost 6 years. This is reflective from the time when Lakes Buchanan and Travis were last each 100% full. By LCRA's definitions in the 2020 WMP, the current drought actually commenced on August 1, 2019, making the drought slightly less than 6 years in duration at least for accounting purposes. Figure 1 presents a plot of the cumulative inflows to the Highland Lakes during the current drought (BLUE) and during the 2008-2016 drought (GREEN). The inflows from the current drought are approximately 75% of those experienced during the 2008-2016 drought of record, suggesting that should this current drought continue, it will become the new drought of record. Through 5/182025, Lakes Buchanan and Travis have received over 585,000 acre-feet less inflow since drought commencement as compared to the same time period during the current drought of record.

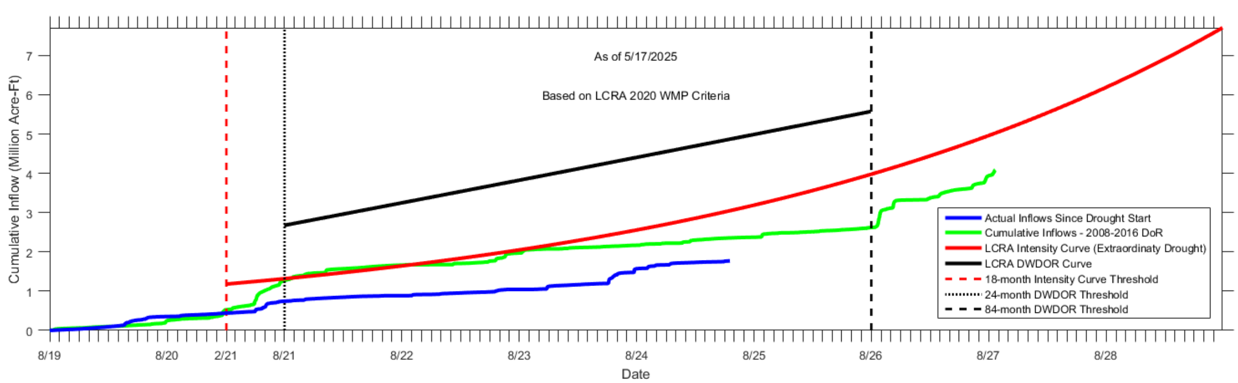


Figure 1 – Cumulative inflows during the current drought (BLUE) and 2008-2016 drought of record (GREEN) compared to the 2020 WMP-defined drought intensity curve (RED). Current inflows are approximately 75% of the inflows that occurred during the official drought of record.

Per the 2020 WMP, LCRA will declare a Drought Worse than the Drought of Record (DWDR) if all three of the following conditions are simultaneously met:

Condition	Date Satisfied
1) Drought Duration ≥ 24 Consecutive Months	Since August 2021
2) Drought intensity is greater than that of the Drought of Record as measured by inflows into Lakes Buchanan and Travis	Since February 2021
3) Combined Storage in Lakes Buchanan and Travis < 600,000 acre-ft	Not Yet

As indicated, the current drought has resulted in the satisfaction of 2 of the 3 criteria for declaration of a drought worse than the drought of record. The remaining unsatisfied criterion is that the current combined storage of the Lakes Buchanan and Travis is above 600,000 acre-feet.

CTWC commissioned a mathematical analysis of the current drought conditions with respect to interruptible water releases. The primary objective was to determine how interruptible releases compared to the maximum allowable releases per the 2020 WMP. If the actual releases were found to be less that allowable releases, then the secondary objective of the analysis was to determine the likely combined storage of Lakes Travis and Buchanan if full allowable interruptible releases had been made. CTWC made its analysis available to LCRA, who reviewed it and suggested improvements to the analysis, including identifying a mathematical error which CTWC has since corrected and LCRA has acknowledged. The results of that analysis, updated through the end of calendar year 2024, are shown in Figure 2.

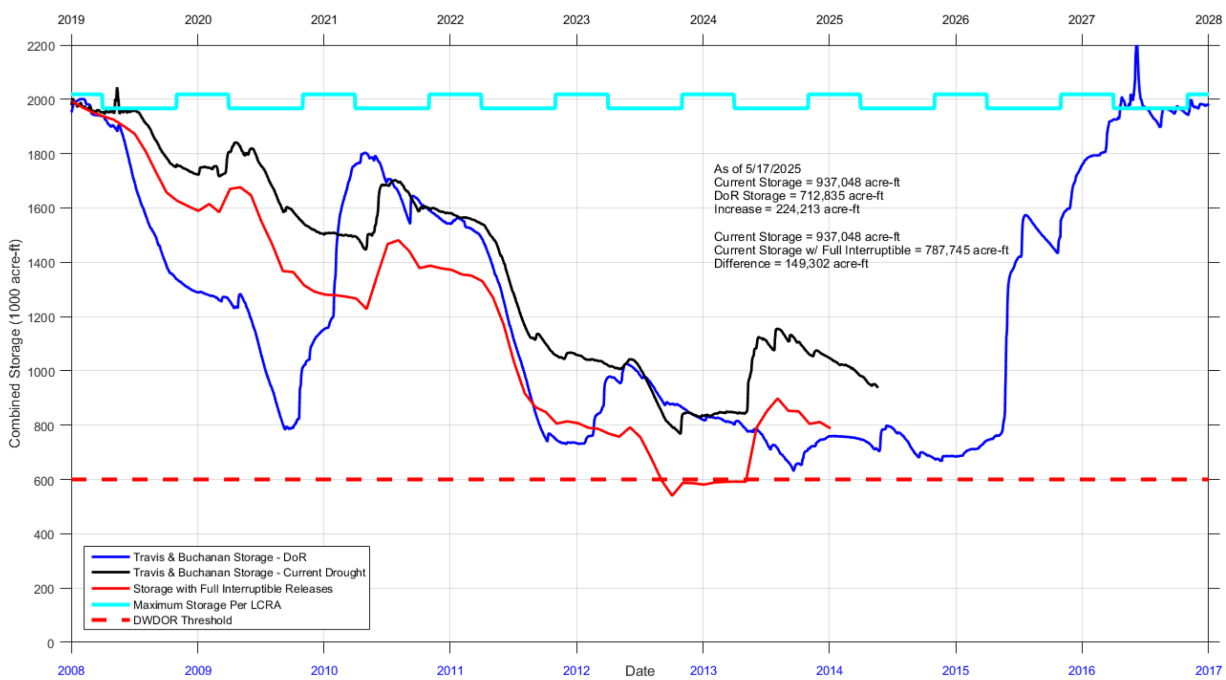


Figure 2 – Combined storage of Lakes Buchanan and Travis in the Drought of Record (DoR) and Current Drought, as well as the modeled current combined storage (Through 1/1/2025) if full authorized 2020 WMP interruptible releases has been met.

As shown in Figure 2, modeled combined storage under full WMP interruptible releases would have slightly dipped below the 600,000 acre-ft threshold in late 2023, thereby satisfying all three LCRA-defined DWDR criteria and likely triggering a DWDR declaration and firm customer curtailment. Such a declaration was not made, and storage levels did not dip below 600,000 acre-feet because interruptible releases were less than the maximum amount allowed under the 2020 WMP.

> **<u>COMMENT #1:</u>** CTWC acknowledges that the 2020 WMP has been effective in managing water supplies to date. However, the ongoing drought is more severe than ever previously experienced. Accordingly, we believe the revised WMP must have lower interruptible release amounts and higher curtailment triggers to continue to avoid DWDOR declarations and firm customer curtailment.

CTWC has also studied the naturalized flows dataset developed by LCRA for use in the WMP revision process. This dataset contains extended hydrology through 2023, and does not contain data for 2024. As such, the extended hydrology does not contain data to allow for full assessment of the current drought within the WMP revision process. CTWC has not reviewed in detail the calculations used by LCRA to create the extended naturalized flows dataset, and understands that TCEQ is in the process of reviewing and approving the data.

CTWC did utilize the extended hydrology to compute the firm yield of Lakes Buchanan and Travis, following the guidelines for so doing as detailed within the 2020 WMP and supporting documents. To perform this calculation, CTWC utilized the 2020 WMP Firm Yield WAM as provided by LCRA during the stakeholder process for developing the 2020 WMP. The only modifications made by CTWC were to allow for the use of the extended hydrology (inflows and evaporation data), and to extend the WAM period of simulation through 2023. Modeled combined storage from this firm yield analysis is shown in Figure 3.

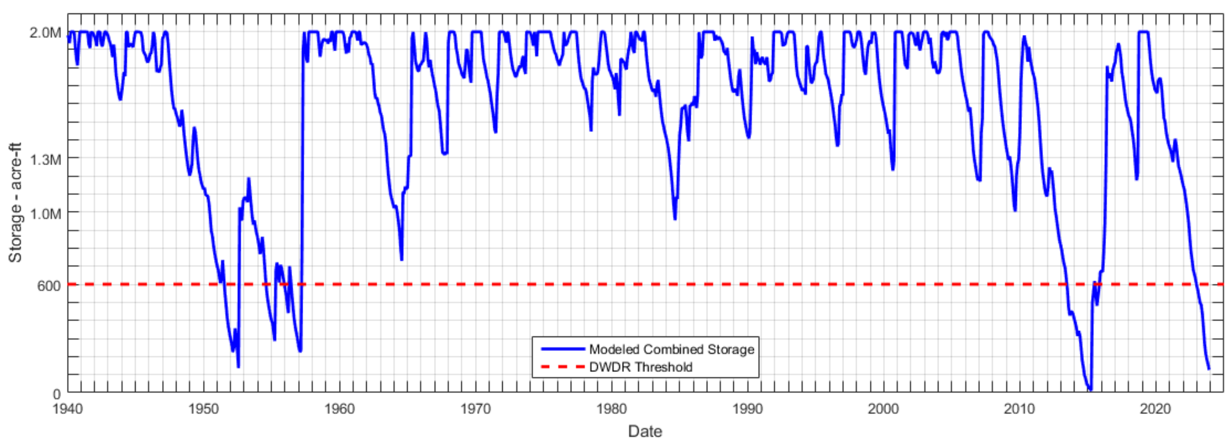


Figure 3 – WAM Modeled Combined Storage of Lakes Buchanan and Travis using the 2020 WMP Firm Yield Model. Firm Yield remains unchanged as a result of extending the hydrology through2023, yet the current drought period is likely to be the controlling drought if the hydrology were extended into the future.

As shown in Figure 3, when using WAM hydrology through 2023, the firm yield of Lakes Buchanan and Travis is still dictated by conditions modeled during the 2008-2016 drought period. This is the period at which modeled lake storage drops to zero, signifying the limited amount of firm water available to customers. From Figure 3, however, it is also evident that the current drought period results in low modeled combined storage values, reaching approximately 125,000 acre-feet by the end of the model simulation period in 2023. This suggests that extending the modeled drought period by another year (to include 2024) may indicate that the current drought period is in-fact the controlling drought period based on the observed inflows and current inflow naturalization process. It is possible, however, that the 500,000+ acre-feet of inflows received in 2024 would cause the modeled combined storage not to reach 0 acre-feet during the simulated 2024 period, thereby not making the current drought the controlling drought for the firm yield. CTWC suspects firm yield modeling inclusive of 2024 would result in a slightly lower firm yield, with the lakes reaching 0 acre-feet storage within April 2024, yet quickly rebounding due to the relatively large inflows which occurred in May 2024.

> **COMMENT #2:** CTWC respectfully requests that LCRA develop naturalized inflows for 2024 and include them for use in modeling during this WMP revision process. Doing so should assist in determining whether the 2008-2016 drought period remains the controlling drought period based on the current WAM modeling procedures (including flow naturalization procedures) and assist in determining whether the current water modeling reflects the severity of the ongoing drought. Data for performing the 2024 flow naturalization should be readily available, as LCRA has recently published its 2024 Water Use Summary report, and TCEQ should have other needed data. CTWC would also like to request that LCRA begin updating the hydrology on an annual basis going forward to better monitor this drought as well as future droughts.

CTWC has also commissioned a study to expand upon prior TWDB studies looking at the reduction in runoff for rain events within the watershed of Lakes Buchanan and Travis. This study is ongoing, and data provided here should be considered preliminary. Never the less, the data has been reviewed extensively by CTWC and has been discussed with Texas State Climatologist John Neilsen Gammon, who has found similar results using his own analysis. CTWC has also shared some of this work with LCRA staff, and looks forward to the next opportunity to discuss the effort with LCRA. As a result of our last discussion with LCRA, we updated our analysis based on LCRA's suggestions to use naturalized flows and TWDB rainfall data.

CTWC's initial analysis of inflows to Lakes Buchanan and Travis involved the use of gauged streamflow from four USGS monitoring stations, with the flows measured at each station multiplied by an LCRA-defined reference factor. This method of computing inflows has been developed by LCRA and is used to assess conditions in the watershed with respect to the various 2020 WMP triggers. CTWC has recognized that a pattern of much lower inflows from the watershed into the Highland Lakes began to emerge in 2006. CTWC's initial analysis statistical analysis of the inflows over the 1981-2024 period showed a downward shift in 2008, as shown below in Figure 4. The downward shift is indicated, per standard SPC analysis (SPC, 2025), when 8-consecutive datapoints are below the average of all datapoints. As shown in Figure 4, this occurred from 2008-2016, indicating the shift commencement in 2008.

Per LCRA's recommendation, CTWC repeated this SPC analysis of inflows using naturalized flows defined at Mansfield Dam. CTWC adjusted these naturalized flows by subtracting naturalized flows computed for the location of the outlet of OH Ivie Reservoir. The resulting naturalized flows therefore represent the inflows to the Highland Lakes originating within the incremental watershed between OH Ivie Reservoir and Mansfield Dam (the outlet for Lake Travis). The SPC analysis of naturalized flows from the 1940-2023 historical period-of-record also indicates that a major downward shift occurred beginning around 2008 (Figure 5). This period from 2008 to present contains inflows with an average 41% reduction as compared to inflows prior to 2008.

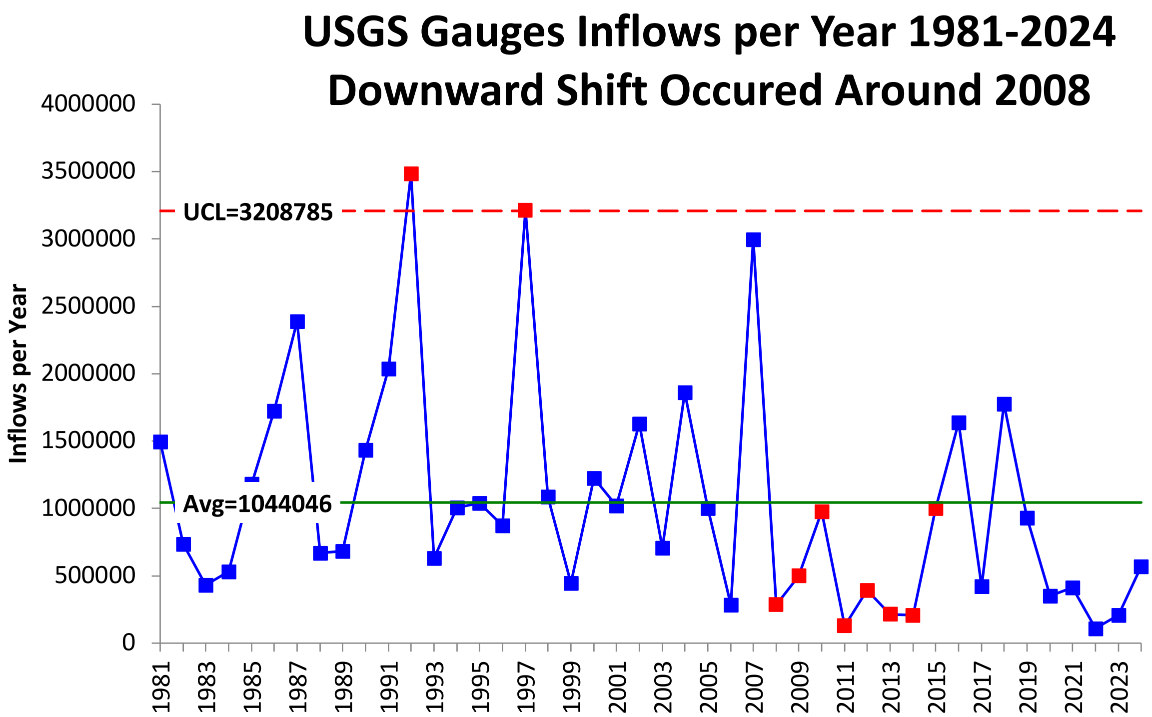


Figure 4 – SPC Analysis of Highland Lakes inflows based on USGS Gauged flows and LCRA Reference Factors, 1981-2024.

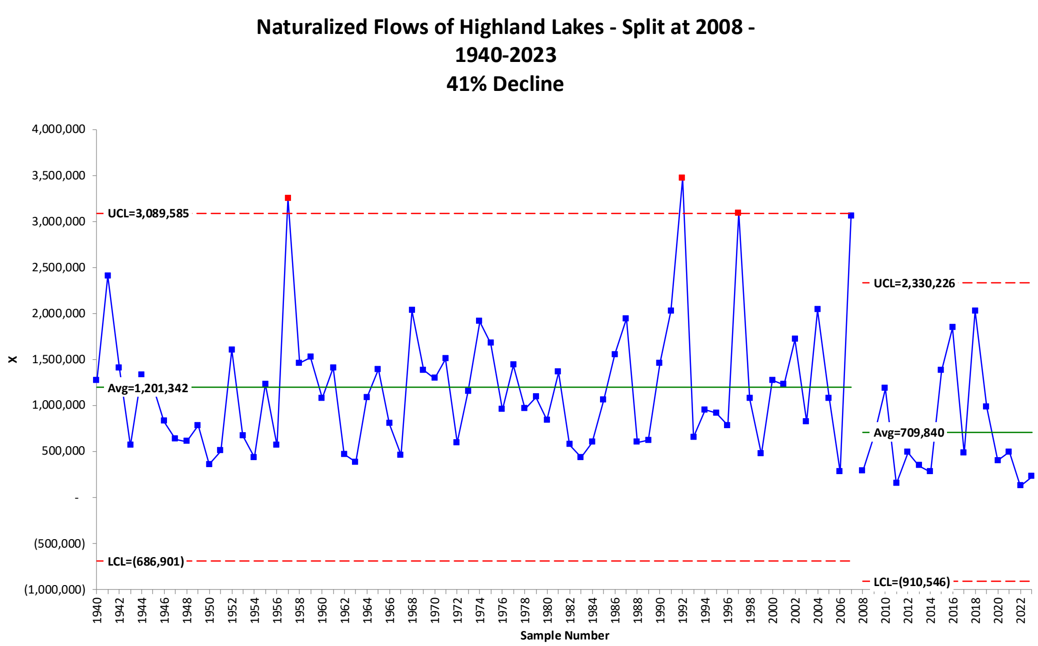


Figure 5 - SPC Analysis of Highland Lakes inflows based on Naturalized Flows, 1940-2024.

Previous studies of the causes for the declining inflows point to the proliferation of small ponds within the watershed of Lakes Buchanan and Travis, generally higher temperatures, and the increase in pumpage from alluvial wells adjacent to streams. **LCRA's analysis reported in 2024 that the count of small ponds in the watershed is over 44,000 and growing rapidly**. **A large increase in the numbers of small ponds appears to have been initiated in 2001 with the passage Texas HB 247 which allowed a pond exemption for wildlife and fishing.** Previously, property owners were only allowed to construct small ponds of under 200 ac-ft for livestock and farming purposes. The trend to increasing ambient temperatures is also likely a contributing factor to the reduced inflows as it increases evaporation from the small ponds, streams, and large waterbodies within the watershed.

Based on the observed shift to lower inflows and the structural changes in the watershed, there is now a need to better understand and quantify the productivity and efficiency of the the watershed. As used herein, the productivity of the watershed is defined as the ability of the watershed to produce runoff and streamflow, and the efficiency of the watershed is the percentage of rainfall on the watershed that is converted to streamflow at the watershed outlet. Watershed efficiency may be assessed as a "Capture Rate," defined mathematically as a percentage:

$$Capture\ Rate = \frac{Watershed\ Outflow\ Volume}{Watershed\ Rainfall\ Volume} \cdot 100\%$$

As applied to the watershed for Lakes Buchanan and Travis, the watershed outflow volume is equivalent to the inflows to the lakes, and the volumes used in the Capture Rate calculations must be over a defined timeframe (in this case calendar years, but other timeframes are also suitable). The annual timeframe for defining a Capture Rate is recommended as it minimizes the impact of travel time for water to move through the watershed. Monthly capture rates are also useful, yet could be more easily affected when rainfall at the end of one month generates streamflow at the watershed outlet in the subsequent month, thereby skewing the significance of the capture rate calculated for both months.

CTWC commissioned LRE Water to analyze the annual total rainfall results along with the annual inflows to calculate annual Capture Rates and assess changes in watershed productivity over time As requested by LCRA, our CTWC / LRE Water analysis has developed approaches for determining the total annual rainfall volume across the watershed using data from both the TWDB (Water for Texas database, 2025) and PRISM database (PRISM, 2025). While results from both sources were highly comparable, our analysis presented herein focuses only on TWDB rainfall data, as usage of this data was requested by LCRA staff.

TWDB precipitation data are available as monthly total depths averaged over 1-degree by 1-degree quadrangles (Quads) for all of Texas. LRE Water computed precipitation totals for the watershed of Lakes Buchanan and Travis as an area-weighted average of precipitation totals for each Quad overlying a portion of the watershed. This area-weighted averaging was performed separately for each month from 1940-2024, and monthly totals were summed to compute annual total precipitation for each calendar year. Average annual rainfall over the watershed from 1940-2024 was found to be 26.26 inches/year (Figure 6) As evident in Figure 6, all annual rainfall totals are within 3 standard deviations about the mean (as indicated by the UCL and LCL red lines on the chart), which suggests rainfall totals have been consistent over the 1940-2024 time period. It is notable, however, that variations in rainfall totals are evident in the data, , particularly in the 1950's drought period (1947-1957).

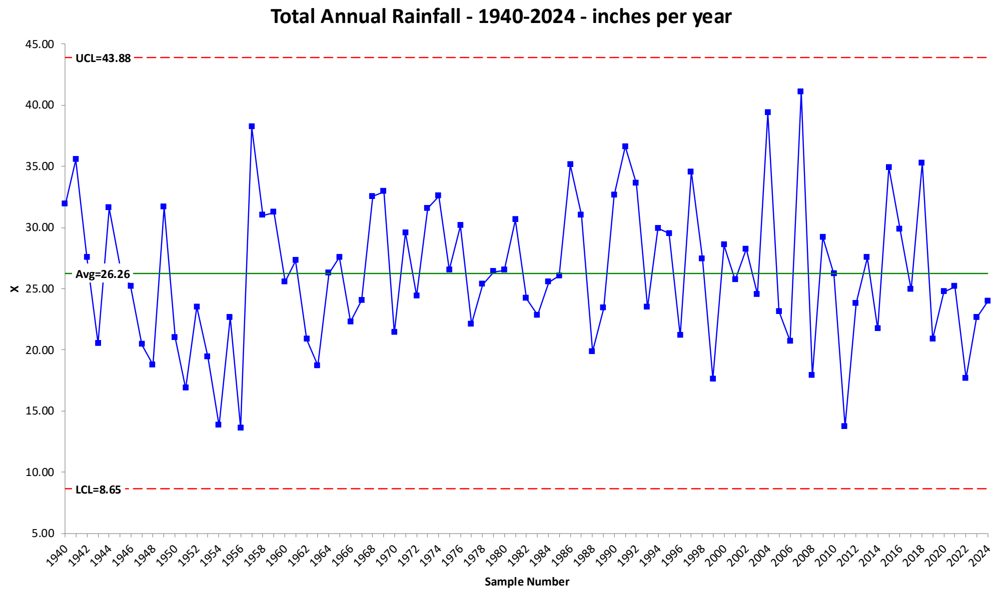


Figure 6 – Annual rainfall depths averaged across the watershed of Lakes Buchanan and Travis, based on TWDB Quadrangle data.

Figure 7 presents annual data related to the ability of the Highland Lakes watershed to produce runoff and inflows. Figure 7A shows the average precipitation depth (in inches) over the entire watershed (1940-2023) , defined at the outlet at Mansfield Dam (on Lake Travis) and limited at the upstream end to the outlet of OH Ivie Reservoir. Figure 7B presents the annual “Capture Rate” for the watershed, detailing the percentage of watershed rainfall which becomes inflows to Lakes Buchanan and Travis. For this analysis, precipitation was calculated from monthly data provided by the TWDB, and inflows were calculated as the difference between naturalized flows at Mansfield Dam and the OH Ivie Reservoir outlet location.

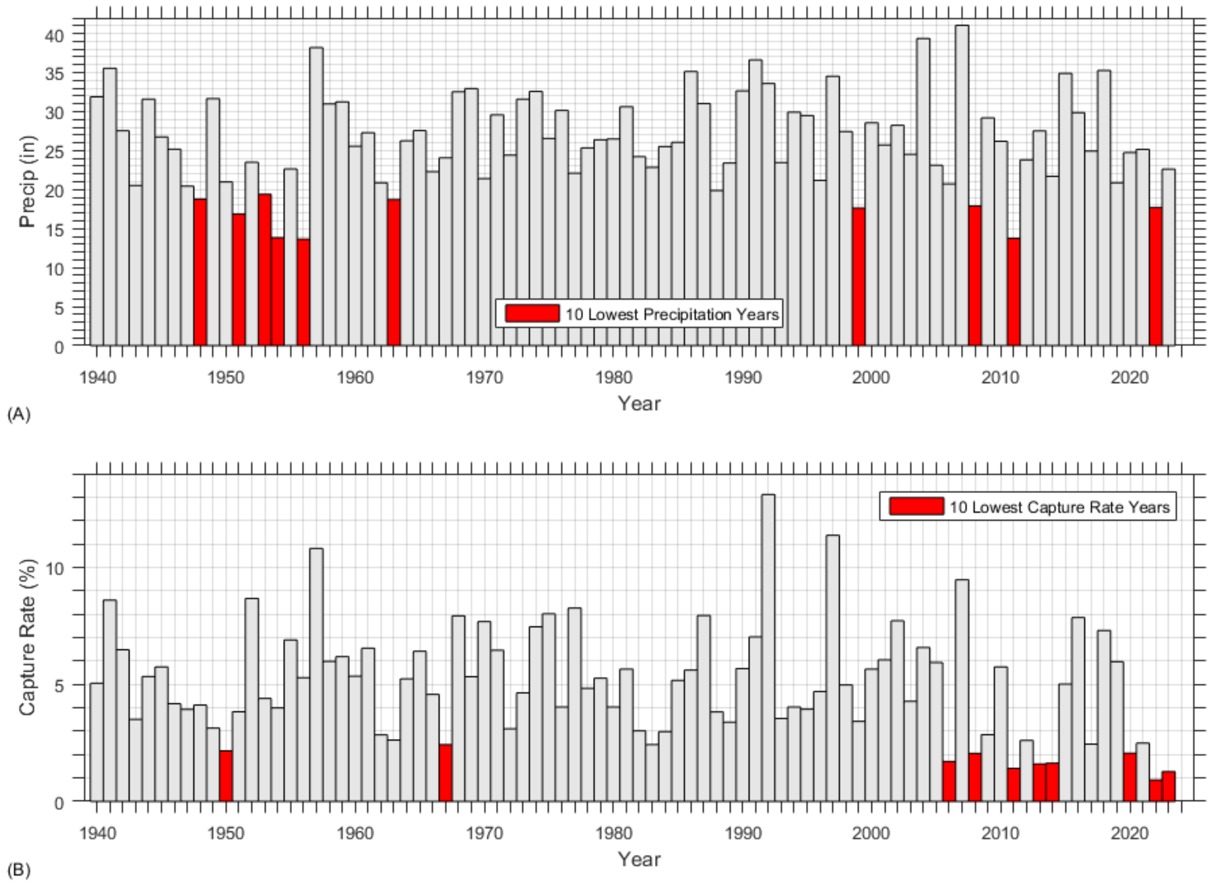


Figure 7 – Precipitation & Inflows Analysis for the Lakes Buchanan and Travis Watershed – A) Annual average precipitation across the watershed, in inches, and B) Annual capture rate relating the volume of inflows to the volume of precipitation. Red bars indicate the 10-lowest value years for each dataset.

Of note in Figure 7A is that 5 of the ten lowest rainfall years occurred during the 1950's drought period. The lowest rainfall totals occurred in 1956, yet 2011 and 1954 had only slightly more precipitation. The 1950's drought period was devastating because the low-rainfall years occurred practically in sequence, with only minor respites in 1952 and 1955. **After the 1950's drought period, there was never a series of low rainfall years that occurred back to back.**

Figure 7B explains why the current drought and the current drought of record have occurred since 2006, even though rainfall over the watershed during this period has not been especially low or consistently low from year to year. **The "Capture Rate" of the watershed has been low during this period, with 8 of the ten lowest capture rates calculated for years after 2005.** As show in the 1950's drought period, capture rates ranged from 2.2-6.9%, with an 8.7% outlier value calculated for 1952. Capture rates from 2006-2023 range from 0.9% (2022) to 9.5% (2007), and have been low in successive years. It is notable that 2022 is the year for which LCRA has reported the lowest inflows to Lakes Buchanan and Travis, and 2022 was not also the year with the lowest precipitation total. In fact, 2022 had roughly equal precipitation totals as measured in 1999 and 2008, yet in those years the capture rates were 3.4% and 2.1%, respectively. Inflows to Lakes Travis and Buchanan in 1999 and 2008 were significantly higher than in 2022.

Factors that could influence the capture rate, listed in no particular order, include:

- Small Ponds within the watershed
- Duration and intensity of rainfall events
- Frequency of rainfall events
- Air temperatures
- Land use changes
- Groundwater level changes

CTWC has not attempted to quantify the individual impacts of all potential changes on the watershed's ability to generate inflows to Lakes Buchanan and Travis. However, **the net effect of all these potential changes within the watershed appears to be that the watershed is producing less inflows than in the past, when considering years with similar rainfall totals.**

> **Comment #3:** The productivity of a watershed can be described by the "Capture Rate," defined as the ratio of watershed outflows to rainfall volume over a set period of time. CTWC's analysis of capture rates for the Lakes Buchanan and Travis watershed demonstrate significant declines over time, indicating that the watershed is not producing the same volume of inflows as it had in the past, for the same volumes of rainfall experienced. CTWC requests that LCRA consider this decline in capture rate when developing this new WMP to ensure that the rules and guidelines put in place will be adequately protective of water supplies resulting from diminishing inflows.

Additional analysis could provide insight into why the watershed is producing less inflows in more recent years when rainfall totals have remained similar. **This is particularly important to better understand the impacts from the ongoing proliferation of small ponds within the watershed**. The proliferation of small ponds appears to be having a continuing impact, even since 2008, requiring adjustments to the naturalized flows beginning in 2008. For example as shown in Appendix A, naturalized inflows in 2022 were 127,621 acre-ft, when the watershed received an average of 17.69" of rain. Yet in 2011, naturalized inflows were 152,233 acre-ft, when the watershed received an average of 13.73" of rain. Therefore in 2022 less inflows were generated with greater rainfall than in 2011. Similarly, in 1954 the watershed received 13.83" of rainfall, which is nearly equivalent to the rainfall received in 2011. Yet inflows in 1954 were 435,192 acre-feet, which is nearly 286% of the inflows generated in 2011. Explanations for these differences in generated inflows need to be developed and incorporated into the water management plan and State of Texas water planning process.

CTWC and LRE Water further evaluated precipitation trends in time by dividing the available period of record into 4 equal 21-year stretches (excluding 2024 data). To consider variations, precipitation trends were also analyzed by dividing the 84-year history into 4 x 21 year stretches (Table 1). As shown, there is some variation in the median precipitation over these four 21-year periods, yet with comparable average rainfall occurring in the 1940-1960 period and the 2003-2023 period.

Table 1 – Median annual precipitation and Capture Rates on the Lakes Buchanan and Travis watershed based on TWDB Quad data, by 21-year period,

Period	Average Annual Precipitation, inches/yr	Capture rate/Yield, %	Reduction, % From Prior Period	Reduction % from 1940-1960 Period
1940-1960	25.17	5.28%	<>	<>
1961-1981	26.50	5.26%	0.4%	0.4%
1982-2002	27.44	4.97%	5.5%	5.9%
2003-2023	24.74	2.61%	47.4%	50.6%

This analysis shows a relatively stable capture rate for the watershed from 1940 to 2003. However, a large 47.4% decline in productivity is found from 2003 to 2023, which roughly corresponds to the change in the Texas Water Code that allows for amenity ponds. The capture rate for the 2003-2023 period represented a reduction of 50.6% of that from the 1940-1960 period, indicating that the watershed has lost over half of its productivity since the 1940-1960 period.

Similar trends can be seen when comparing capture rates from pre- and post-2008 years, and when separately considering capture rates by year with years classified into dry, average, and wet rainfall categories. In every instance, there is a drop in capture rate in more recent years as compared to years within the earlier period of record. Table 2 provides computed capture rates and the reduction occurring after the 2008 shift in inflow patterns (as indicated by SPC analyses). We provide raw data by year in Appendix A, so that LCRA and others may reproduce our calculations or develop alternative pertinent metrics.

Table 2 – Average and Median Annual Capture Rates for Pre- and Post-2008 periods, considering years of Dry, Average, and Wet rainfall categories.

	Average Capture Rates			Median Capture Rates		
Rainfall Category	Pre-2008	Post-2008	% Reduction	Pre-2008	Post-2008	% Reduction
Dry	3.80%	2.15%	43.55%	3. 10%	1.36%	55.96%
Average	4.21%	2.34%	44.43%	3.78%	1.79%	52.60%
Wet	6.02%	4.23%	29.70%	5.24%	4.23%	19.21%

This capture rate analysis and discussion highlights the lack of stationarity in the watershed contributing inflows to Lakes Buchanan and Travis. If current rainfall events are generating less inflows than they would have in the past, then it is improper to develop current rules for water management using historical hydrology. CTWC believes that the data shows that historical naturalized flows are no longer representative of the hydrologic patterns to be expected within the watershed for Lakes Buchanan and Travis. We believe that adjustments to the historical naturalized flows are needed in order to use the WAM to provide reasonable statistics regarding water management plan rules, guidelines, and the likelihood that interruptible and firm customers will receive their expected water in the future. It is strongly believed that without applying appropriate adjustments to the naturalized flows, the revised WMP will result in significant over-estimation of available water. It also appears to be clear that we are now dependent on major rain events or successive years of above average rains to achieve recovery of the reservoir lakes.

Effectively, CTWC believes naturalized flow calculations should be adjusted to focus on rainfall patterns and distributions, rather than on streamflow. This approach would assume that past rainfall patterns are to be expected in the future, but that those patterns will produce differing runoff and streamflow volumes due to changes in the characteristics of the watershed.

To demonstrate the impact of declining inflow production by the Lakes Buchanan and Travis watershed, CTWC adjusted naturalized flows in the WAM according to the capture rate analysis. Specifically, we classified years as having either “High,” “Average,” or “Low” precipitation, and looked at median capture rates for years in these classifications. We then developed “adjustment factors” based on the ratio of current capture rates to historical capture rates. These adjustment factors were multiplied by the naturalized flow values in the “C3.FLO” file for primary control points located within the Highland Lakes watershed. This was performed on a year-by-year basis focusing on adjusting naturalized flows during the 1950’s and 2008-2016 drought periods. The adjustment factors are provided in Appendix A.

As a theoretical example, consider a current low-rainfall year capture rate of 2.0%, compared with a historical low-rainfall year capture rate of 3.5%. The adjustment factor for the historical year would be:

$$Adjustment\ Factor = \frac{2.0\%}{3.5\%} = 0.57$$

Therefore if the original naturalized flows in the historical low rainfall year were 100 acre-feet/month, the adjusted flow would be: 100 acre-feet/month * 0.57 = 57 acre-feet/month.

Adjustments were made only to naturalized flows defined at primary control points within the Lakes Buchanan and Travis watershed. These control points are: D10000, D20000, E10000, E20000, E30000, E40000, F10000, F20000, F30000, G10000, G20000, G30000, G40000, G50000, H10000, H20000, I20000, I30000, and I40000. Naturalized flows adjustments were not carried to primary control points downstream of Mansfield Dam. Four model runs were defined as follows:

- Model 0 = No Reduction in Historical Naturalized Flows
- Model 1 =100% Reduction in Historical Naturalized Flows based on Capture Ratios
- Model 2 = 75% Reduction in Historical Naturalized Flows based on Capture Ratios
- Model 3 = 25% Reduction in Historical Naturalized Flows based on Capture Ratios

Note that the percentage reduction noted in the Model 1, 2 and 3 descriptions refers to the calculation of the adjustment factors for each simulation The adjustment factors applied to each year by model are provided in Table 3. No adjustments were made to naturalized flows simulated in any year not listed in Table 3.

Table 3 – Adjustment Factors by run used to simulate alterations to the historical capture ratio.

	YEAR												
#	1947	1948	1950	1951	1952	1953	1954	1955	1956	1957	2008	2010	2011
0	100	100	100	100	100	100	100	100	100	100	100	100	100
1	37.4	35.7	68.1	38.4	20.2	33.4	36.8	21.3	27.8	64.8	48.7	43.5	65.1
2	53.0	51.8	76.0	53.8	40.1	50.1	52.6	41.0	45.9	73.6	61.5	57.6	73.8
3	68.7	67.8	84.0	69.2	60.1	66.7	68.4	60.7	63.9	82.4	74.4	71.8	82.5

The modified naturalized flow data was incorporated into a modified version of the 2020 WMP Firm Yield WAM. In this modified WAM, all water right diversions authorized to remove water from Lakes Buchanan and Travis were removed, except for the water right “HLFY.” Backup water simulations for the City of Austin and STP were also removed. This allows for a simply running of the Firm Yield (FY) card within the WAM/WRAP system, and for computing firm yields without first defining a critical period and averaging certain diversions.

Firm yield results from each modeling scenario are presented in Table 4. As shown, the un-modified WAM (run #0) resulted in a firm yield of 405,000 acre-feet/yr. This value is lower than the approximately 418,000 acre-feet/yr determined during the 2020 WMP update process. The difference in computed yields lies in the difference in methodologies used to calculate each yield. Yields were significantly lower when historical naturalized flows were adjusted based on the relative capture rate. It is notable, that in each modeled scenario where yields were adjusted, the critical period for defining the yield shifted from the 2008-2016 period to the 1947-1957 period. Plots of the modeled combined storage for Lakes Buchanan and Travis are provided in Figure 8.

Table 4 – WAM Modeling – Firm Yield Results with Modified Naturalized Flows

Run #	Reduction	Firm Yield	Critical Period
0	0%	405,000 acre-ft/yr	2008-2016
1	100%	198,000 acre-ft/yr	1947-1957
2	50%	349,000 acre-ft/yr	1947-1957
3	25%	272,000 acre-ft/yr	1947-1957

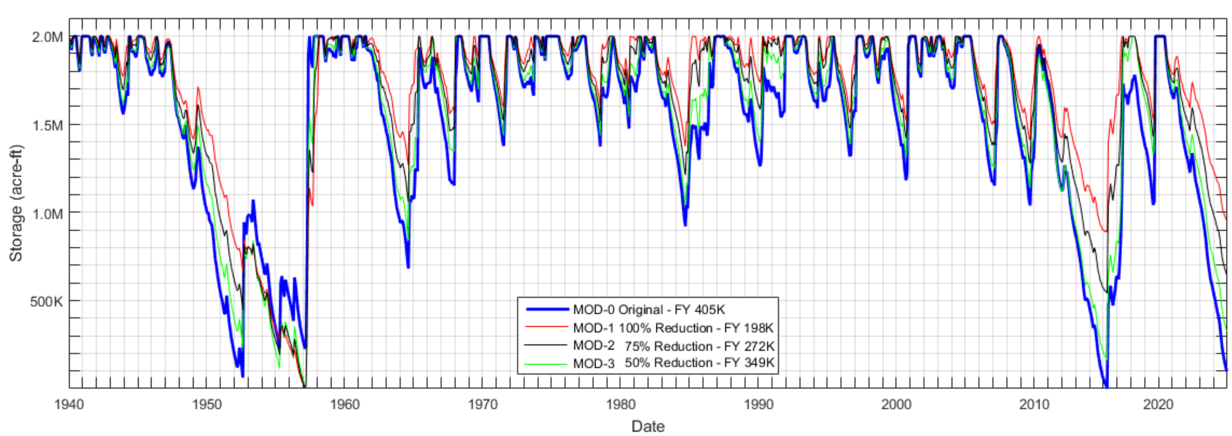


Figure 8 – Modeled Combined Storage from Lakes Buchanan and Travis using the modified 2020 WMP Firm Yield Model.

COMMENT #4: CTWC recognizes that much debate could be had regarding any methodology used to adjust naturalized flows based on the capture rate, as presented in the included documents. However, the important "take away" is that the critical period is likely to be the 1950s drought period, if WAM modeling were based on rainfall rather than streamflow. CTWC is gravely concerned that future low-rainfall years like those that occurred repeatedly in the 1950s drought period would result in unprecedented low-inflows to Lakes Buchanan and Travis. To mitigate this concern, the upcoming WMP should be altered to be much more protective of the water supplies to be managed in order to achieve a sustainable future.

Recently Zhao and others (2024) developed evaporation estimates from waterbodies within Texas. This work was performed as a collaboration between LCRA, the TWDB, Texas A&M, and the Desert Research Institute. This revised evaporation dataset is available at the URL:

https://dri-apps.earthengine.app/view/twdb-reservoir-evaporation

From this website, it is possible to download monthly gross evaporation data for each major reservoir within Texas. CTWC commissioned a study to use these evaporation data within the LCRA Firm Yield WAM and to compare the data with the evaporation rates currently within the WAM as produced by the TWDB. Evaporation data used in the WAM and applied to the Highland Lakes is derived from Quad 709 and Quad 710 from the TWDB database, Water Data For Texas, available at: https://waterdatafortexas.org/lake-evaporation-rainfall

Figure 9 presents computed annual evaporative losses from the Highland Lakes (Buchanan, Inks, LBJ, Marble Falls, Travis, Austin, and Ladybird) using TWDB approved "WAM Data" and using the newly available LCRA Evaporation Data from Zhao and others (2024). As shown in red, the new data is only available from 1980 onwards. There are many years when evaporative losses using the WAM data exceed those calculated when using the new LCRA data. However there are also many years when the use of the new LCRA evaporation data results in increased losses. This is especially true in 2007, when the WAM suggests a net GAIN of 9,000 acre-feet, whereas the new LCRA data suggests a loss of approximately 35,000 acre-feet. Volumetric gains/losses were determined by multiplying the average lake surface area (by month) the evaporation rate, and summing up the monthly values into annual values.

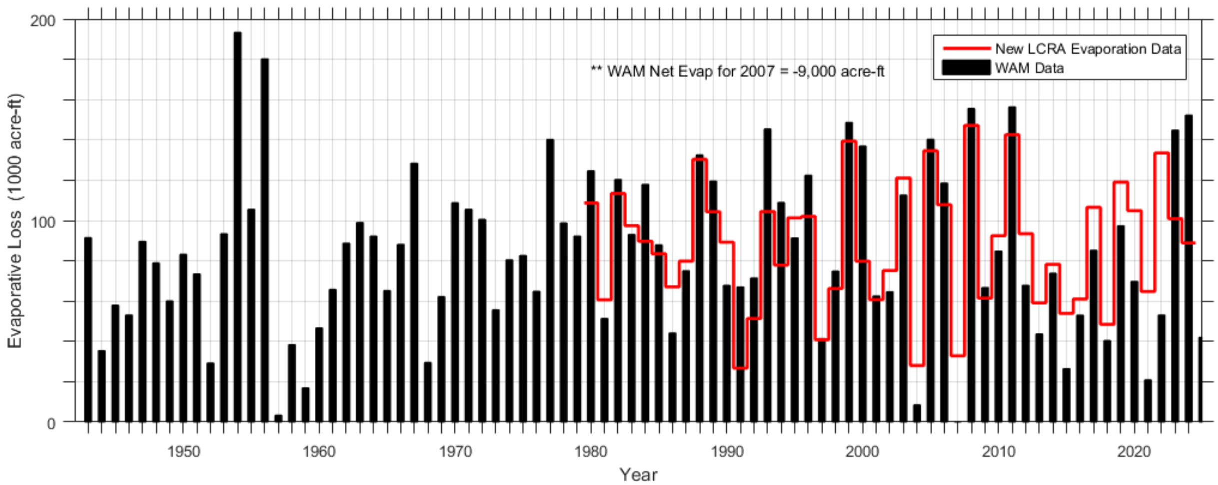


Figure 9 – Computed annual evaporation losses from the Highland Lakes, using 'WAM" Data (approved by TWDB) and using new data published by LCRA and others (Zhao and others, 2024).

Within WAM modeling, the evaporation rate is used in two ways:

- In developing the naturalized flows, and
- In simulating water accounting using the naturalized flows.

It is possible that these two uses would be in opposition, and would effectively "cancel each other out" leading to little alteration of WAM modeled results from changes in the evaporation data. For example, if evaporation were increased in a given. month, then that would result in the naturalized flows for that month being higher. These higher naturalized flows would mean more water would be available for allocation within the WAM simulation, thereby possibly increasing yield values.

To assess the impact of using LCRA's new evaporation data within the 2020 WMP WAM, CTWC commissioned a revision of the naturalized flows to utilize the new evaporation data. This was performed using the naturalized flows workbooks LCRA provided to TCEQ in 2016 as part of the 2020 WMP revision process. Using this workbooks, the gross evaporation depths from TWDB were replaced with gross evaporation depths defined for all lakes processed by Zhao and others (2024). The changes to gross evaporation results in changes throughout the linked Excell workbooks provided by TCEQ, and resulted in modified naturalized flow values throughout the simulated watershed. The modified evaporation data was incorporated into a new "C3.EVA" file suitable for use in the 2020 WMP Firm Yield WAM.

Modeling results from the 2020 WMP Firm Yield WAM indicate that the firm yield of Lakes Buchanan and Travis drops by 1.1% to 414,206 acre-feet/yr from the 418,848 acre-feet/year computed during the 2020 WMP revision process.

> **Comment #5**: CTWC wishes to ensure that LCRA is utilizing the best available science when performing modeling in support of the WMP. CTWC also recognizes that LCRA must develop naturalized flows according to accepted methods and using accepted data, and that TCEQ will currently only accept use of standard TWDB-published evaporation data within WAM modeling. CTWC urges LCRA to discuss the new evaporation data with TWDB, and get the data properly incorporated into the WAM

modeling process for the State of Texas. We believe the new methods of Zhao and others (2024) are improvements over the TWDB-published data and older methods. We urge LCRA, TWDB, and TCEQ to adopt the data provided through Zhao and others (2024) for all future WAM modeling in Texas.

References

Zhao, B., Huntington, J., Pearson, C., Zhao, G., Ott, T., Zhu, J., Weinberg, A., Holman, K. D., Zhang, S., Anderson, R., Strickler, M., Cotter, J., Fernando, N., Nowak, K., & Gao, H. (2024).Developing a general Daily Lake Evaporation Model and demonstrating its application in the state of Texas. Water Resources Research, 60(3), e2023WR036181.

Available at https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2023WR036181

SPC (2025) - https://www.spcforexcel.com/

Water for Texas Database (2025) - https://waterdatafortexas.org/lake-evaporation-rainfall

PRISM (2025) - https://prism.oregonstate.edu/

APPENDIX A – DEVELOPED DATA

	Naturalized Flows (acre-ft)					
	CPI20000	CPD20050		Rainfall (TWDB Quads)		Capture Rate
Year	Mansfield Dam	OH Ivie Outlet	Watershed	ac-ft	inches	%
1940	1,614,700	346,775	1,267,925	25,105,564	31.89	5.05%
1941	3,565,973	1,159,006	2,406,966	27,985,674	35.55	8.60%
1942	1,841,450	435,851	1,405,599	21,677,902	27.54	6.48%
1943	659,076	91,944	567,133	16,157,719	20.53	3.51%
1944	1,605,507	279,390	1,326,117	24,863,284	31.58	5.33%
1945	1,632,951	423,918	1,209,033	21,051,501	26.74	5.74%
1946	1,152,288	324,765	827,523	19,817,987	25.17	4.18%
1947	1,026,573	393,757	632,816	16,094,329	20.44	3.93%
1948	1,059,026	449,578	609,448	14,786,701	18.78	4.12%
1949	1,299,346	518,224	781,122	24,924,142	31.66	3.13%
1950	566,910	210,111	356,799	16,517,154	20.98	2.16%
1951	692,098	183,699	508,398	13,262,370	16.85	3.83%
1952	1,694,065	90,674	1,603,391	18,498,775	23.50	8.67%
1953	1,053,752	382,110	671,642	15,276,317	19.41	4.40%
1954	1,020,516	585,324	435,192	10,885,165	13.83	4.00%
1955	1,726,129	495,593	1,230,537	17,831,066	22.65	6.90%
1956	870,704	303,926	566,778	10,725,121	13.62	5.28%
1957	4,972,358	1,720,746	3,251,612	30,075,656	38.21	10.81%
1958	1,637,498	178,710	1,458,788	24,385,873	30.98	5.98%
1959	1,981,323	460,642	1,520,681	24,594,054	31.24	6.18%
1960	1,331,240	253,921	1,077,319	20,124,230	25.56	5.35%
1961	1,783,773	377,413	1,406,361	21,473,058	27.28	6.55%
1962	749,467	282,129	467,338	16,426,001	20.87	2.85%
1963	499,566	113,505	386,061	14,725,016	18.71	2.62%
1964	1,246,301	164,716	1,081,585	20,667,544	26.25	5.23%
1965	1,775,350	383,241	1,392,109	21,694,127	27.56	6.42%
1966	1,183,698	380,647	803,051	17,554,757	22.30	4.57%
1967	634,838	175,838	459,000	18,939,025	24.06	2.42%
1968	2,232,061	201,116	2,030,945	25,608,607	32.53	7.93%
1969	1,663,666	282,159	1,381,506	25,931,196	32.94	5.33%
1970	1,460,815	166,063	1,294,752	16,855,830	21.41	7.68%
1971	2,088,459	584,937	1,503,522	23,286,651	29.58	6.46%
1972	843,306	246,544	596,762	19,222,699	24.42	3.10%
1973	1,372,947	219,281	1,153,666	24,861,507	31.58	4.64%
1974	2,601,923	688,081	1,913,841	25,648,185	32.58	7.46%
1975	2,062,327	387,246	1,675,081	20,899,330	26.55	8.01%
1976	1,219,130	261,986	957,145	23,717,839	30.13	4.04%
1977	1,701,663	264,590	1,437,072	17,404,622	22.11	8.26%
1978	1,216,601	251,844	964,756	19,951,968	25.35	4.84%
1979	1,287,824	194,796	1,093,028	20,768,507	26.38	5.26%
1980	1,449,083	607,836	841,247	20,859,007	26.50	4.03%
1981	1,720,349	357,790	1,362,559	24,108,006	30.62	5.65%

APPENDIX A – DEVELOPED DATA, Continued

	Naturalized Flows (acre-ft)					
	CPI20000	CPD20050		Rainfall (TWDB Quads)		Capture Rate
Year	Mansfield Dam	OH Ivie Outlet	Watershed	ac-ft	inches	%
1982	965,262	389,885	575,377	19,059,619	24.21	3.02%
1983	546,084	110,245	435,839	17,975,712	22.83	2.42%
1984	692,485	93,495	598,991	20,091,744	25.52	2.98%
1985	1,274,414	214,349	1,060,065	20,514,715	26.06	5.17%
1986	2,286,834	735,115	1,551,719	27,646,241	35.12	5.61%
1987	2,527,704	587,647	1,940,057	24,425,026	31.03	7.94%
1988	814,782	216,248	598,534	15,647,100	19.88	3.83%
1989	804,010	180,707	623,303	18,420,073	23.40	3.38%
1990	1,735,715	277,300	1,458,415	25,690,927	32.64	5.68%
1991	2,418,850	391,885	2,026,965	28,824,121	36.62	7.03%
1992	4,301,203	832,981	3,468,222	26,446,658	33.60	13.11%
1993	852,026	197,502	654,523	18,471,646	23.46	3.54%
1994	1,197,138	247,063	950,075	23,561,784	29.93	4.03%
1995	1,110,010	194,591	915,419	23,223,445	29.50	3.94%
1996	1,042,864	260,085	782,778	16,660,898	21.16	4.70%
1997	3,435,896	345,296	3,090,600	27,183,101	34.53	11.37%
1998	1,177,695	103,314	1,074,381	21,602,891	27.44	4.97%
1999	589,902	115,401	474,501	13,879,852	17.63	3.42%
2000	1,547,430	275,756	1,271,675	22,481,102	28.56	5.66%
2001	1,302,726	78,140	1,224,586	20,245,472	25.72	6.05%
2002	1,819,831	102,505	1,717,325	22,234,881	28.25	7.72%
2003	984,921	159,364	825,557	19,306,259	24.52	4.28%
2004	2,335,599	298,915	2,036,684	30,980,828	39.36	6.57%
2005	1,342,836	263,034	1,079,803	18,203,206	23.12	5.93%
2006	362,395	83,349	279,045	16,316,376	20.73	1.71%
2007	3,427,276	366,648	3,060,628	32,322,389	41.06	9.47%
2008	405,134	116,061	289,073	14,084,022	17.89	2.05%
2009	718,266	62,473	655,793	22,978,101	29.19	2.85%
2010	1,281,322	97,081	1,184,241	20,613,806	26.19	5.74%
2011	210,070	57,836	152,233	10,811,391	13.73	1.41%
2012	659,339	170,272	489,067	18,742,978	23.81	2.61%
2013	419,031	72,488	346,544	21,668,580	27.53	1.60%
2014	501,088	221,379	279,709	17,081,197	21.70	1.64%
2015	1,626,912	250,246	1,376,665	27,472,348	34.90	5.01%
2016	2,084,514	238,419	1,846,096	23,502,900	29.86	7.85%
2017	603,453	123,354	480,099	19,630,521	24.94	2.45%
2018	2,554,000	526,629	2,027,371	27,754,954	35.26	7.30%
2019	1,344,612	363,500	981,112	16,436,855	20.88	5.97%
2020	559,641	159,065	400,576	19,472,905	24.74	2.06%
2021	759,543	265,816	493,727	19,802,178	25.15	2.49%
2022	213,632	86,012	127,621	13,928,837	17.69	0.92%
2023	305,715	78,196	227,519	17,812,280	22.63	1.28%