Comments to the Lower Colorado River Authority (LCRA) regarding revisions to the 2015 Water Management Plan for the Highland Lakes

Evaluation of RAINFALL/RUNOFF PATTERNS IN THE UPPER COLORADO RIVER BASIN ("Patterns")

This report[1] indicates that surface water regulations and management practices have allowed surface waters in the Colorado River watershed, intended as inflows to the Highland Lakes to be diverted to other uses by permits and by exemptions from permits. The magnitude of these diversions reduced the inflow volumes to the Highland Lakes below those necessary to adequately provide for firm and interruptible water supplies during the most recent period of extreme drought identified in the current planning process as June 2010 through May 2016. Groundwater permitting and other management practices have further exacerbated this situation by decreasing or reversing the hydrological flow from aquifers to the river and its tributaries.

Because the same regulations and practices are used in the lower basin below Longhorn Dam, it can expect similar results. This would make the implementation of the proposed new WMP extremely problematic. As such, these impacts should be reviewed and considered in the current revisions to the WMP.

Land management practices, including brush control, have not substantially increased stream flows because aquifers must recover before the benefits of brush removal can be realized as recovered baseflows. The details of brush control practices[2] are important because the deep roots of prairie grass are a key to getting rainwater back into the soil, thus recharging the aquifers so they can provide outflows to surface waters.

The "Patterns" report reveals gaps in information and deficiencies in regulatory processes used in permitting and regulating water rights that seem to have left inflows to the Highland Lakes inadequately protected. Some of these deficiencies are in the modeling tools (WAM's) used to predict the impact of surface water allocations and groundwater pumping on surface water baseflow, aquifer recharge and recovery, and --ultimately-- on inflows to the Highland Lakes and environmental flows in the lower basin and Matagorda Bay.

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[1] Kennedy Resource Company. August, 2017. EVALUATION OF RAINFALL/RUNOFF PATTERNS IN THE UPPER COLORADO RIVER BASIN, TWDB Contract # 1600012011. https://www.twdb.texas.gov/publications/reports/contracted_reports/doc/1600012011_Kennedy.pdf

[2] Though outside the scope of the referenced study, an evaluation of the effects of "brush control" best practices--including replacement of grasses with native Texas prairie grasses -- might provide insights into adaptation of such practices to help restore ecological and hydrological functions. The groundwater-surface water connection is a hydrologic system that must be maintained in a "primed state" to effectively and efficiently pass water into the soil and thereby into the aquifer for outflow or alluvium for baseflow. Emphasizing this component in a brush control project is essential to restoring the hydrological system.

RELEVANCE TO LCRA WMP

To the extent that the same surface water laws and regulations, along with similar land management practices have been applied in the lower Colorado River basin, operational issues regarding the delivery of water from the Highland Lakes to reaches as far downstream as Wharton are likely less predictable by WAMS and other operational models. As LCRA's Operations Model relies on information available on surface waters (inflows, outflows, rainwater, evaporation, etc.) and not groundwater information, the model will likely be unreliable for predicting the amount of water that needs to be released to deliver the amount needed at the point of diversion. The shift in agriculture practices from dependence on surface water to a reliance on groundwater will make these predictions less accurate, because groundwater pumping amounts and timing are not generally available on a timely basis and the models may not be capable of using[3] such information.

Figure 1 below, taken from the Colorado County Groundwater Conservation District's Management Plan, is an example of the shift from using surface water to groundwater for irrigation in Colorado County just above Wharton. The impact of this shift is likely exacerbated in LCRA's Operations Model due to the extent of the Colorado River Alluvium shown in Figure 2. Groundwater pumping patterns in the Austin-Bastrop-La Grange-Columbus-Wharton reach of the Colorado River have changed significantly over the last decade and are expected to change even more dramatically in the decades to come. Because of the alluvium, there is likely a great deal of groundwater-surface water interaction in this reach of the river and the impacts of groundwater pumping on the river at any time are uncertain.

> ***SECTION 3.2 – Annual Groundwater Use[4]***
>
> *A significant portion of the economy of Colorado County can be attributed to agribusiness, most notably farming. The dominant crop type is rice which is heavily dependent upon irrigation. Colorado County and Wharton and Matagorda counties to the south are leading rice producers in the state and by far account for the most irrigation water use in Region K (Lower Colorado Regional Water Planning Group, 2010).*
>
> *The Lower Colorado River Authority (LCRA) provides the bulk of the irrigation water needed to farmers in Colorado County. Specifically, the water is diverted from the rivers to LCRA owned irrigation districts which consists of hundreds of miles of canals used to deliver the water to individual farmer's fields. In Colorado County, the LCRA owned and operated Garwood Irrigation District provides water to farmers on the west side of the Colorado River and the Lakeside*

[3] The RiverWare software used for the Operations Model is able to calculate mass balances and therefore may be able to make use of such data.

[4] Colorado County Groundwater Conservation District Management Plan, Section 3.2.

Irrigation District provides farmers on the east side. Both these irrigation districts extend southward into Wharton County.

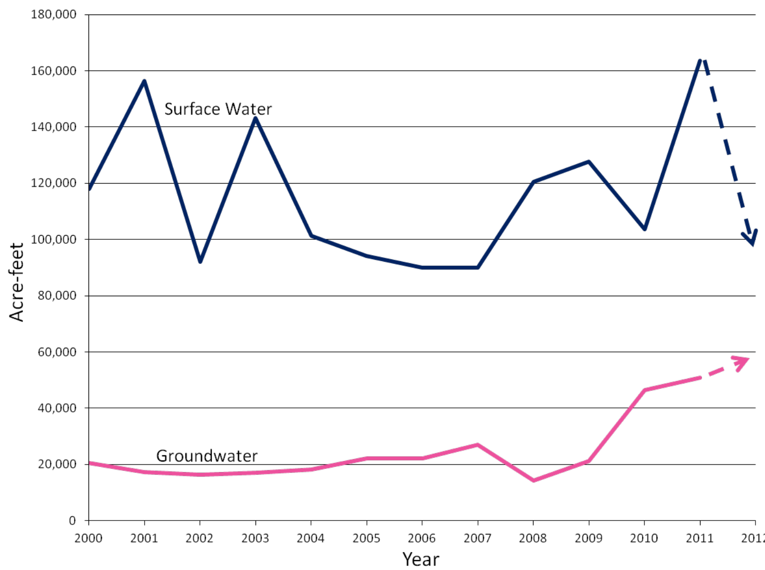

Figure 1. Usage of surface water (top line) and groundwater (bottom line) for irrigation in Colorado County from year 2000 though 2011. Dashed lines indicate projected trends beyond 2011. Modified from data provided in Appendix C1 (Allen, 2014; TWDB 2014).

Since 2000, irrigation usage has in part been a function of precipitation. In wet years such as in 2007, farmers require less water for irrigation whereas drier years, like 2001 and 2003, tend to require more (figure 5). Another related factor is the storage volume in the Highland Lake System located along the Colorado River northwest of Austin. Two of these lakes were built to act as reservoirs and their water levels rise and drop according to need and conditions.

In most dry years, if water was taken from the reservoir lakes, ensuing rains would replenish the lake levels. However, 2008 marked the beginning of a severe and sustained drought that has had a discernible impact on the region. As the drought persisted and inflows into the highland lakes were correspondingly reduced, the lake levels began to fall. Eventually, water storage reached a point where LCRA started restricting irrigation water to farmers downriver. In 2012, for the first time ever, farmers that used water through the irrigation districts were denied water from LCRA.

The restriction has persisted through the 2013 and 2014 seasons. Because of the senior water rights and due to the LCRA purchase contract, water has continued to be supplied to the Garwood Irrigation District during this time period.

As a result of the LCRA restrictions, surface water usage for 2012 though at least 2014 is projected to be substantially lower than in previous years (figure 5), reflecting only what was supplied to the Garwood Irrigation District. These restrictions have had an impact on groundwater usage. From 2000 through 2009, groundwater usage was relatively consistent. As the drought continued and farmers became increasingly aware that surface water was not guaranteed, more water wells were drilled and groundwater usage increased (figure 5) in order to compensate for the lack of surface water. The number of irrigation wells present in the Lakeside Irrigation District area in Colorado County has increased from seven (7) prior to 2012 to 26 as of mid 2014. This dramatic increase in high-rate wells has started to put a strain on the aquifer in the area south and east of Eagle Lake.

The amount of water use from other user groups pales in comparison to irrigation. The next largest user groups are mining and municipal. Water use from mining is due to the prolific gravel operations in the county. Owing to the relatively small population of Colorado County, municipal use is on the same scale. For a complete listing of water user group usage from year 2000 through 2011, see Appendix C1.

COLORADO RIVER ALLUVIUM[5]

The Colorado River of Texas stretches from its headwaters in the Trans-Pecos region to the Gulf of Mexico. After passing through the Edwards Plateau where it has eroded canyons in Cretaceous age limestone, which are now impounded by the Highland Lakes chain, the Colorado River flowed through the Balcones Escarpment near Austin. At this point the ancestral river encountered a gently sloping area with low stream gradients, and the river deposited its sediment load in broad floodplain and terrace deposits. Continuing through the Blackland Prairie, the Colorado River eroded the soft Eocene age sediments as it meandered within a restricted floodplain.

Multiple older terrace deposits were isolated as the river continued to erode. Younger alluvial deposits were laid down in the newer, more narrow floodplain. These deposits consisted of rounded sand, pebbles and cobbles of quartz. chert and other minerals which were more resistant to chemical weathering than the granite and limestone from which they were derived.

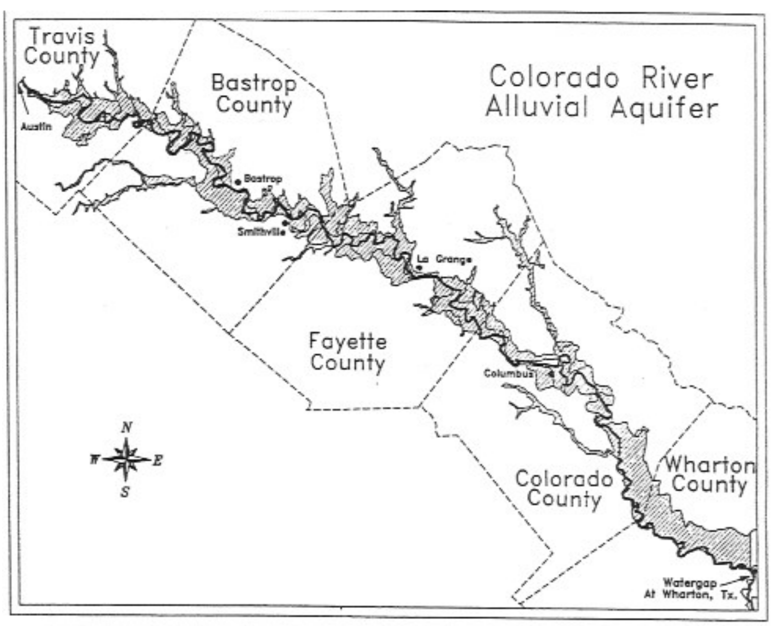

Figure 1. Extent of the Colorado River Alluvium, south-central Texas (after Barnes, 1974).

Figure 2. Extent of the Colorado River Alluvium, south-central Texas (after Barnes, 1974)

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[5] Geoffrey P. Saunders. Lower Colorado River Authority. Qualification of the Colorado River Alluvium as a Minor Aquifer in Texas TRANSACTIONSOF THE GULF COASTASSOCIATIONOF GEOLOGICAL SOCIETIES VOLUMEXLVI, 1996 363.)

The Colorado River Alluvial Aquifer is a laterally continuous, hydraulically interconnected series of alluvial and terrace deposits. These deposits are mapped in Travis. Bastrop, Fayette, Colorado and Wharton counties (Barnes. 1974). At a point near the town of Wharton, the Colorado River passes through a "watergap" where it has eroded a narrow valley through underlying formations, effectively dividing the deposits of the Colorado River from the Gulf Coast Aquifer (Fig. 1).

The total area of mapped alluvial deposits is 14,500 acres (5,870 hectares).The alluvium is variable in width and depth, but it is found at all points along the Colorado River between Austin and Wharton. The alluvium is up to 4 miles in width. mostly depending on the resistance to erosion of underlying formations. Depth of the alluvium is not well defined at all locations, but is described as being between 20 to 40 feet (6 to 12 m) deep (Rodda et al., 1969).The isopach thickness of the alluvium has been mapped in the Austin area; average thickness is about 30 feet (9 m), ranging from less than 10 feet (3 m) to about 60 feet (18 m) (Gamer and Young, 1976).

GROUNDWATER MODEL PREDICTS REVERSAL OF COLORADO RIVER GAIN/LOSS STATUS

The current groundwater availability model (GAM) predicts[6] that groundwater pumping in the Simsboro Aquifer will affect the Colorado River and its tributaries by decreasing the amount of groundwater that currently go into the river (Figure 3). The model predicts that during the fifty-year planning period both baseline and permitted pumping will cause the river segments in the Utley-Bastrop-Smithville reach to reverse from being primarily a "gaining" stream to become a "losing" stream. This reversal will have a significant impact on environmental flows during dry and extraordinary drought periods, especially if LCRA requests emergency exemptions for interruptible water from the Highland Lakes into the lower basin as was the case during the last drought.

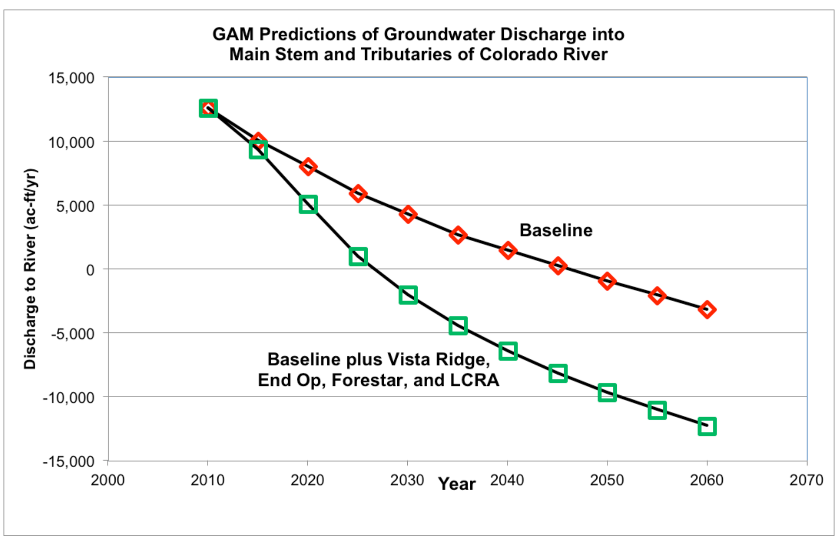

Figure 3. Effects of Vista Ridge, End Op, Forestar, and LCRA Power Plant Pumping on Groundwater and Surface Water in the Lost Pines GCD and Post Oak Savannah GCD

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[6] Rice, George. March 22, 2016. Effects of Vista Ridge Pumping and Additional Pumping by End Op, Forestar, and LCRA on Groundwater and Surface Water in the LPGCD and POSGCD. Report: http://www.environmental-stewardship.org/wp-content/uploads/2016/04/EffectsOfPumping_BaselinePlus_VREndOpForestarLCRA-1.pdf

The improved GMA-12 GAM includes a groundwater-surface water package that permits the model to better predict the impacts of groundwater pumping on surface waters at both a regional and local level. An earlier report[7] to the Colorado-Lavaca BBASC provides additional details regarding the groundwater-surface water package. The model is currently available for reviewed and should be released for use by the groundwater districts in the near future. The "improved" model will provide a better quantitative estimate of the magnitude and timing of the impact of baseline and permitted pumping on the Colorado River and should be used to confirm the predictions of the old model. LCRA should use the new model to inform the WAM in association with these Highland Lakes water management plan revisions.

ES REQUEST 1: Environmental Stewardship requests that the LCRA use the improved GMA-12 GAM to better estimate the impacts of groundwater pumping in the Simsboro Aquifer on the Colorado River and it tributaries in the Austin-Bastrop-Smithville reach to inform the current water management planning process on the potential impacts of such pumping on the overall Highland Lakes system.

EXAMPLE OF HYDROLOGICAL IMPACT OF THE LAST DROUGHT ON THE COLORADO RIVER AT BASTROP GAGE.

Groundwater is a critical component of subsistence and critical flow regimes at the Bastrop gage on the Colorado River. ES' slide presentation[8] to the GMA-12 on June 27, 2014 demonstrates the importance of Carrizo-Wilcox groundwater outflow in the Utley to Bastrop segment of the river. Critical flow is 120 cfs (in old study) and subsistence flows vary by month in the Environmental Flow Standards (EFS) adopted for the river at this gage. Saunders (2006 and 2009) and Deeds et al (2006) place current and historic outflows at between 30 and 50 cfs. Both report indicate that the river may already be losing water to the Simsboro aquifer (Saunders: -9 cfs; Deeds: -4,347 afy) in the Austin-Bastrop segment of the River.

The critical/subsistence environmental flow standard at the Austin gage is 49 cfs and is subject to emergency curtailment. Otherwise, the flow in the river during drought conditions is primarily from City of Austin return flows, and perhaps City of Pflugerville (via Wilbarger Creek) return flows. A significant reduction in groundwater outflows due to pumping could shift this segment of the river from a minor losing segment (estimated at -9 cfs) to a major losing segment if Simsboro pumping were to significantly reduce outflow and/or increase surface water inflows to the aquifer in this segment of the river.

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[7] Young, Steven et al. August 2017. Final Report: Field Studies and Updates to the Central Carrizo-Wilcox, Queen City, and Sparta GAM to Improve the Quantification of Surface Water-Groundwater Interaction in the Colorado River Basin.
Report: http://www.twdb.texas.gov/groundwater/models/gam/czwx_c/Final_BBASC_083117.pdf

[8] Environmental Stewardship. June 27, 2014. GMA-12 DFC GW-SW Considerations Power Point Presentation to GMA-12. http://www.environmental-stewardship.org/wp-content/uploads/2016/04/GMA-12Meeting27June14FINAL.pptx.pdf

Deeds also reports that the Colorado River gains 160,000 ac-ft/yr between Austin and Bay City which agrees with Saunders' (2006) report of 217 cfs total gains (157,100 ac-ft/yr) an essential contribution to Matagorda Bay during drought conditions. Critical Freshwater inflows to Matagorda Bay during drought conditions is set by TCEQ at 14,260 ac-ft/month.

Figure 4 is a hydrograph of the three year drought period from January 2011 through December 2013 when the region experienced some of the most severe drought conditions in decades. The distinguishing feature of this figure is that in-stream flows benefitted from the irrigation releases for down-stream rice farming during the spring, summer, and early fall of 2011. Irrigation water was curtailed during the 2012 and 2013 irrigation seasons. Note, however, that there was very little flow from rainfall during the 2011 period. Lacking irrigation flows, flow in the river for the summer and fall would likely have dropped into the 120 cfs critical environmental flow range during that period.

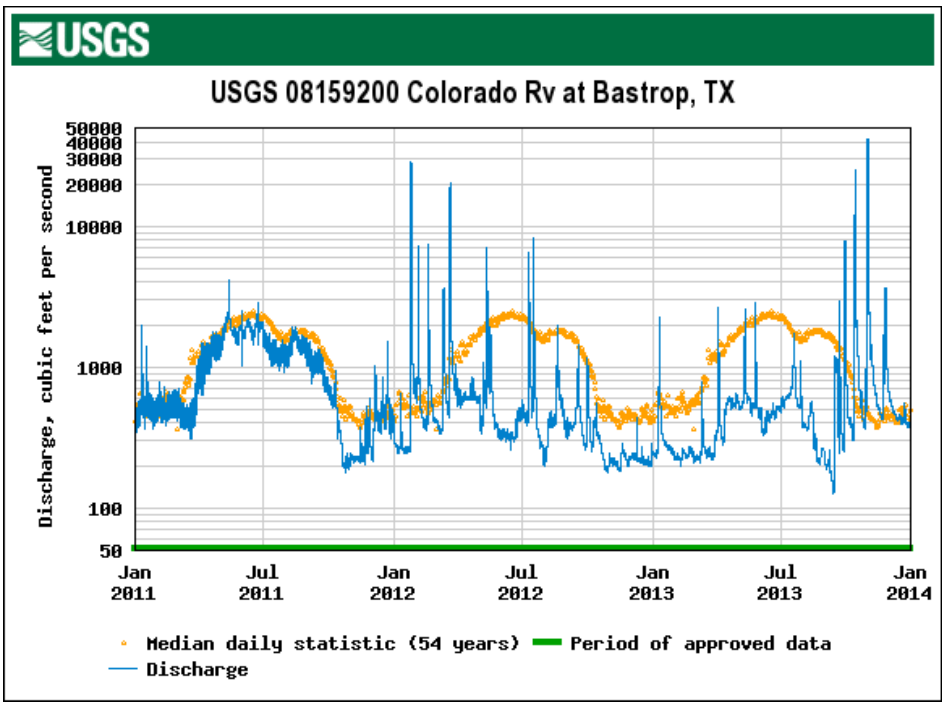


Figure 4. Colorado River at Bastrop gage during drought period Jan.2011 - Dec.2013

Figure 5 is a hydrograph of the month of September, 2013 when the flow was trending toward the critical in-stream flow minimum. Fortunately, the region received significant rainfall starting in mid-September and river flow rebounded.

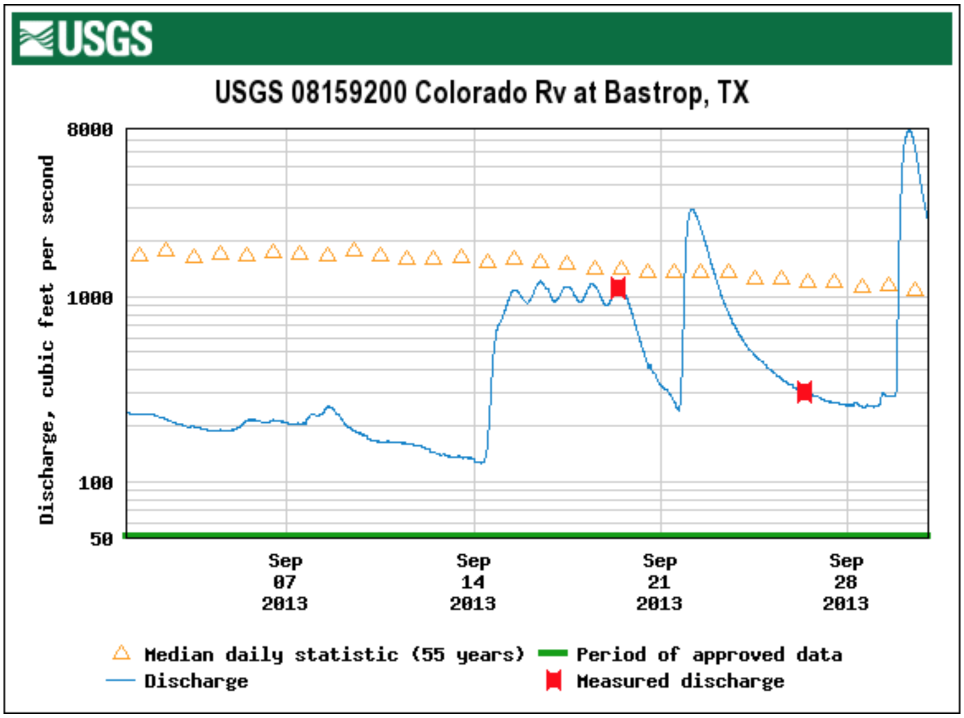


Figure 5. Colorado River at Bastrop gage during drought period Oct. 2012- Sept. 2013

A hydrograph separation on the three year period represented in Figure 4, with irrigation releases removed, would likely reveal a very good estimate of actual groundwater outflows to the river from the Carrizo-Wilcox Aquifer group. During this period the bank storage for the river had likely been exhausted and the river was relying on the minimum flows passing through the Austin gage at Longhorn Dam, City of Austin return flows, and groundwater base flows. Environmental Stewardship attempted to fund a USGS gain-loss study from Utley bridge to Matagorda Bay during that period to provide current period groundwater outflow estimates for purposes of calibrating GAM and WAM models.

ES REQUEST 2: Environmental Stewardship requests that the LCRA prepare the hydrographic separation as described above for the period January 2011 through December 2013 for the Bastrop and Wilbarger gages of the Colorado River to gain insights on the quantity of groundwater that was being contributed to river flow for this extraordinary drought period.

QUESTIONS

In the context of the LCRA WMP, the report raises the following questions that are relevant to revisions to the 2015 plan:

1. To what extent, in the modeling tools (WAM) or other management practices, is LCRA considering and using the information from the rainfall/runoff report to adapt its management practices to better predict and improve inflows to the Highland Lake system? Solving the inflow problem is a critical function to improving management of the river and Highland Lakes system.

2. To what extent is the LCRA using its Operations Model or other tools to measure and predict the quantity of groundwater outflows to surface waters available to satisfy environmental flows (especially subsistent flows during extraordinary drought)? Could the Operations Model (RiverWare) take data from a Surface Water-Ground Water monitoring system that interfaces with the improved GMA-12 GAM? Would this improve the predictive function of the model for delivering water down-river to users and to meet environmental needs?

   Are groundwater outflows in "gaining" stream segments, and surface water losses in "losing" stream segments accounted for and considered in decisions to release stored water from the Highland Lakes or to allow storable water to pass through the system? Are there policy questions/decisions that need to be considered or adapted in making such decisions?

3. In what ways and to what extent is the LCRA taking active measures to manage and protect groundwater inflows from being diminished through groundwater pumping of aquifers that intersect and influence the Colorado River and tributaries?

4. In what ways and to what extent is the LCRA taking active measures to protect historic interactions between groundwater, the Colorado River and its tributaries from unreasonable impacts resulting from groundwater pumping?

APPENDIX A

Specific Draft Final Report Comments and Author's Reply:

ES 2: Section 3.3, page 30: The assumption here seems to be that stream flow in relation to rainfall is a function of runoff and does not consider the hydrologic connection between rainfall, vegetation, aquifers and groundwater outflows to rivers and streams (baseflows). To what extent are stream flow gains and losses to and from groundwater aquifers considered in WAM data and analyses?

Author's Reply: WAM simulated results were not analyzed to assess historical rainfall/runoff relationships in the upper basin because the WAM model simulates a hypothetical condition, as prescribed by the user, not the historical condition. However, streamflow gains and losses are effectively considered in the overall WAM process in two ways. First, the extent that historical streamflow gains and losses actually occurred are captured in the naturalized flows, the hydrologic input to the WAM model, because the naturalized flows are based on observed flows that reflect all historical gains and losses. Second, for most of the upper Colorado Basin, the WAM has channel losses associated with stream reaches between primary control points and these loss factors are applied to changes in flow due to water rights activities that are simulated in the WAM.

ES 14, Section 3.5, page 37: Bringing groundwater management into the overall water management practices in the upper basin might be an important aspect of future adaptive management of these natural systems and associated resources. Groundwater trends seem to vary throughout the study area. Groundwater management practices used by Groundwater Conservation Districts (instilled in their Management Plans) and by Groundwater Management Areas in developing their Desired Future Conditions might be diminishing groundwater outflows to rivers, streams, and springs, thus impacting baseflows.

a) It would be useful to review the GMA, DFCs, and GCD Management Plans to determine which are protective of surface water and spring flow and which are not. Groundwater availability models (GAMs) vary considerably in their ability to model and confidently (quantitatively) predict outflows to surface waters and springs.

Author's Reply: Agree with comment. With regard to recommendation in item (a), review of the ground water districts' desired future condition information is beyond this project's scope of work and budget.

ES 21: Section 4.6, page 48: This scenario demonstrates the importance of the hydrologic connection between rainfall, the importance of woody vegetation returning water to the soil, aquifer recovery, and improved groundwater outflow (baseflow) to surface waters. All of these are components of hydrologic recovery. Was there a native prairie grass recovery component that went along with the woody plants?

Author's Reply: This comment is not clear, but it appears to ask whether the particular document summarized in this section describes a native prairie grass recovery component along with the increase in woody plants in the North Concho watershed

during the period after 1960. Additional review of this document indicates that it does attribute "greater vegetation cover – both woody and herbaceous plants" to the hydrologic recovery but does not describe whether there was a deliberate replanting of native prairie grass or not. The text included in the draft report is considered to be sufficient.

ES 24: Section 5.2.3,page 53: Were these groundwater declines incorporated into WAM data? Would it have raised a flag that surface water availability was being significantly impacted?

Author's Reply: The review of Groundwater Management Area's planning information, including their Desired Future Condition, is beyond this project's scope of work and budget.

ES 25: Section 5.3.1, page 54: The following publications referenced in INTERA's Draft Report on GAM Improvements may provide some insight into the groundwater-surface water interactions in the upper basin and how they may have impacted runoff during some portion of the study period. These studies should be reviewed and included in the report if appropriate. INTERA may be able to provide other references and insights regarding aquifer conditions and outflows to surface waters.

Slade, R.M., Jr., and Buszka, P.M., 1994, Characteristics of streams and aquifers and processes affecting the salinity of water in the upper Colorado River Basin, Texas: USGS, Water Resource Investigations Report 94-4036.
See Section 4.3.1, page 34 in GAM Improvements Draft Report

Slade, R.M., Jr., Bentley, J.T., and Michaud D., 2002. Results of Streamflow Gain-Loss Studies in Texas, With Emphasis on Gains From and Losses to Major and Minor Aquifers, Texas, 2000, U.S. Geological Survey - Open-File Report 02-068.
See Figure 4-2 and 4-3 in GAM Improvements Draft Report

Wolock, D.M., 2003b, Hydrologic landscape regions of the United States raster digital data U.S. Geological Survey Open-File Report 03-145 and digital data set (available at http://water.usgs.gov/lookup/getspatial?hlrus).
See Figure 4-9 in GMA Improvements Draft Report

Wolock, D.M., and others, 2003a, Flow characteristics at the US Geological Survey steamgages in conterminous United States: US Geological Survey Open-File Report 03-146, Data accessed February 2016, Available from: (available at http://water.usgs.gov/lookup/getspatial?qsitesdd).
See Figure 4-7, 4-8 and 4-9 in GMA Improvements Draft Report

Wolock, D.M., and others, 2004, Delineation and Evaluation of Hydrologic-Landscape Regions in the United States Using Geographic Information System Tools and Multivariate Statistical Analysis: Environmental Management, Volume 34, Supplement 1, pp. 71-88.
See Figure 4-9 in GMA Improvements Draft Report

Author's Reply: As a result of this comment, each of the references stated above was reviewed. For various reasons, the text of the report was not changed in response to these documents/data sources.

CENTRALTEXAS WATERCOALITION

COMMENTS OF THE CENTRAL TEXAS WATER COALITION RELATING TO LCRA'S PRESENTATION OF ADDITIONAL INFORMATION ON THE UPDATE OF ITS 2015 WATER MANAGEMENT PLAN

SUBMITTED VIA EMAIL TO LCRAWMP@lcra.org
July 31, 2018

On behalf of the Central Texas Water Coalition (CTWC), thank you for the continuing opportunity to submit comments, questions, and items for discussion with respect to LCRA's ongoing efforts to develop an updated Water Management Plan (WMP) for the operation of the Highland Lakes. These comments are generally intended to respond to matters raised during or after the most recent LCRA-hosted informational meeting on July 12, 2018, although we understand that LCRA welcomes comments on all topics at any time during its work to update the 2015 WMP. In accordance with the requested schedule for submittals of comments, these comments are timely submitted on Tuesday, July 31, 2018. Our first comments were timely submitted on Wednesday, June 20, 2018.

CTWC would like to respectfully suggest that this truncated process does NOT allow time for a thorough review of the materials presented by LCRA. Even though none of us want another process as lengthy as the 2010 process, it did allow a true dialogue and sharing of diverse concepts and ideas. We were all able to hear the comments from all parties. The modelers were available to clarify data and answer concerns. We were encouraged to debate issues and to try and understand the perspective of each stakeholder group. In contrast, it seems that this process does not allow for the interactions and open discussions that could provide important insights into the evolution and development of this Plan.

Please consider the following comments:

1. Incorporation of Watershed Changes and Low Inflows

It is our understanding that the Colorado River watershed has experienced major structural changes in terms of land use and development that are contributing to the reduction in runoff response due to rainfall events. How is LCRA incorporating these changes into the water availability model (WAM) being utilized in the WMP revision process? We believe the reduced rainfall/runoff response is not being considered in the flow naturalization process that is fundamental to WAM modeling, and therefore the modeling presented by LCRA will not be representative of likely hydrologic conditions to be experienced in the Highland Lakes region in the future. As a result, we believe that the WAM modeling undertaken by LCRA during this WMP revision process will overstate the availability of interruptible water and will exacerbate future concerns regarding the water supply for LCRA's firm customers.

The inflow issues on which we base our assertion were investigated by Kennedy Resources Company and reported in the August 2017 Report for the Texas Water Development Board (TWDB) entitled "Evaluation of Rainfall/Runoff Patterns in the Upper Colorado River Basin." (See link below)
https://www.twdb.texas.gov/publications/reports/contracted_reports/doc/1600012011_Kennedy.pdf

The Kennedy Report identified four issues that may be causing the reduction in observed inflows: 1) the proliferation of noxious brush, 2) the construction of small reservoirs, not accounted for in naturalized flows, 3) groundwater use and aquifer water level declines, and 4) changes in average temperatures and drought conditions. A key point in the Report was the fact that these changes are not accounted for in the flow naturalization process.

A major factor in reduced run-off was the change from a sheep/goat economy to a cattle and recreational use economy during the mid 1980's to 1990's. The multiple effects resulting from this shift is detailed in an attached report entitled "Decreased Run-off from a Rancher's Perspective", provided by a long time rancher in Llano County. In summary, a cattle economy brought about re-establishment of native grasses on range- lands, and improved grasses in fields. The elimination of the sheep/goat economy (short grazers), coupled with rotational grazing of cattle, caused less run-off. Also, a shift to recreational ranching facilitated an explosion in brush, which provides deer cover. Another issue that is likely reducing inflows and not reflected in the Naturalized Flows is the large number of alluvial wells that have been drilled by the rivers and lakes.

If major changes have occurred and are continuing to occur in our watershed that are not picked up in the Naturalized Flow Process, it appears that the historical Naturalized Flows that occurred in past years would not be predictive of what inflows would occur, if these changed conditions had existed back then. This seems to create a major issue with the "stationarity" assumption, which is a critical component of water availability modeling. Specifically, the State of Texas uses historically based water availability modeling to assess the likelihood of water availability for specific intended uses. The model results can, for example, suggest that over the historical period of record, sufficient water was available for rice irrigation in X out of Y years. This information can then be used to provide estimates of the likelihood that irrigation water will be available in any given future year. We assert, however, that because the water availability modeling does not account for the changed rainfall/runoff response in the watershed, then the statistical assessments of water availability based on the WAM modeling are overstated, and potentially drastically overstated.

We trust LCRA has properly calculated the naturalized flows used in the WAM model, although we have not verified their accuracy. We assert, however, that the watershed has changed over the period of record, and the effects of these changes have not been properly accounted for in the flow naturalization process. We do not believe that the naturalized flows computed over the 1940-2016 modeled period of record will accurately reflect future basin hydrology, and therefore we cannot accept the idea that these WAM modeling results will provide a reliable indication of future water availability for LCRA's firm and interruptible customers. As such, we believe the WAM modeling presented during this WMP revision process overstates the likelihood of future Interruptible water releases and jeopardizes LCRA's ability to meet its Firm demands (including its commitments to Firm customers). We believe the WMP's proposed revisions do not adequately protect the Firm water supply for the region, and the lakes are likely to drop below the current 600,000 acre-feet combined storage "floor" during a future drought as a result.

To further illustrate our concerns, we present a statistical analysis of the Naturalized Flows (computed at the outlet of Lake Travis) and the inflows reported by LCRA (based on USGS gauges and LCRA reference factors). Dr. Bill McNeese performed this analysis. In his statistical analysis of the historical data, Dr. McNeese concludes that we have very likely shifted downward to a "New Normal" Inflow distribution beginning in 2008, which is much lower than the historical period from 1942-2007. This implies that the inflows observed from the recent 2008-2015 period are likely to be much more predictive of current and future water availability than the old 1942-2007 Period of Record. This change is graphically reflected in the SPC charts of the Naturalized Flows and Actual LCRA reported inflows (attached).

These SPC Charts show the control limits and averages for each flow distribution. The magnitude of the change can be seen by comparisons of the old historical and new distribution averages, as shown below:

Naturalized Flows	1940-2007	2008-2016	% Change
Average, acre-feet/year	1,539,869	876,570	**-43.1%**

Inflows into Highland Lakes from LCRA	1942-2007	2008-2016	% Change
Average, acre-feet/year	1,304,280	577,135	**-55.8%**

SPC charts have long been used to detect process changes in manufacturing and business applications. However, they also are applicable in examination of natural processes and day-to-day activities. Dr. Don Wheeler provided links to several articles on use of SPC to analyze hurricane/flood activities by and to analyze global temperatures by Dr. Bill McNeese.

http://centraltexaswatercoalition.org/wp-content/uploads/Why-We-Keep-Having-100-Year-Floods-Making-Predictions-Using-Historical-Data-Donald-J.-Wheeler-06-04-13.pdf

https://www.spcforexcel.com/knowledge/control-chart-examples/spc-and-global-warming

It appears that the impacts of these factors can already be seen in this year's LCRA Monthly Inflows graphic (attached), which shows 2018 Inflows running far below the historical averages and even well below the recent 2008-2015 new Drought of Record period.

Additional study is obviously required to better quantify and account in WAM modeling for these very adverse changes to inflows into the Highland Lakes, and a new more thorough TWDB study of the watershed will soon begin. However, in the near term, it appears that very conservative approaches and decisions should be taken in the WMP Update process, particularly around parameters associated with water availability to provide sufficient protections for Firm customers.

Recommendations:

A. Take a more conservative approach to Demands, as proposed by Firm customers. More conservative options include:
    - Remain with the dry-year basis only for 2025 Demands
    - Use the 2030 Demand numbers, as recommended by City of Austin
B. If LCRA will not consider the recommendation to extend the Demand Period to 2030, as requested by City of Austin, there should be an automatic adjustment in 2025 to the projected 2030 Demands, if a new WMP is not in place.
C. As recommended by Ken Gorzycki from Horseshoe Bay and supported by Firm customers: Raise the 600,000 acre-feet minimum combined storage requirement to 750,000 acre-feet to provide a more prudent cushion.
D. Increase the mandatory Interruptible customer cut-off point from 900,000 acre-feet to 1,000,000 acre-feet of Combined Storage.
E. Rapid declines in reservoir storage need to be managed in a quicker manner to avoid many issues relating to meeting future needs of water users. This topic should be explored further as a stand-alone discussion. (see item 8)

2. Impacts of Hydroelectric Power Generation on Water Management
LCRA reports minimal releases of water on their Annual Water Use Reports for meeting Emergency Shortages or Ancillary Power. However, from study of their Annual Water Use Reports submitted to TCEQ, LCRA is producing large quantities of hydroelectric power when it makes releases through each dam to meet downstream water demands. Is there a conflict between being stewards of the water and generating hydroelectric power? Although CTWC requestors have obtained a limited amount of information from LCRA about its hydroelectric operations, we understand that some of our questions (including requests for financial information) will not receive responses without a legal process.

When stored water is released to generate power, we believe there are significant financial consequences that impact both the water and electric businesses. Disclosure of relevant financial information will allow the public to understand this critical water/electricity interface.

Interface Related Questions:

A. Why is water used by LCRA in the production of hydroelectric power not included as a Demand?
B. How is the LCRA Water Business compensated for water used to generate hydroelectricity?
C. How much revenue does LCRA make each year from generation of hydroelectric power?
D. How do LCRA decisionmakers handle the apparent conflict of interest between water needs and electricity production?

3. Accounting for Downstream Losses. Please explain how LCRA's water modeling accounts for conveyance and distribution losses for stored water releases to downstream Interruptible irrigation customers. Where and how are downstream losses considered in the modeling? What are the specific assumptions in the WAM modeling for losses in the Colorado River between the storage reservoirs and the downstream diversion points? Based on our review of the recent WAM modeling performed for this LCRA WMP revision, there are no channel losses between Lake Travis and Bay City (as specified on the CP definitions in the WAM input file). Is LCRA accounting for these losses in some other way within the WAM?

4. **Accountability for Lost Water from Stored Releases.** Interruptible stored water allocations should be charged for all Orders from Stored Water versus allowing irrigators to reject the stored water as it passes the Diversion Point. LCRA's stated position that is has always been done this way is not a good business practice as water becomes more precious with reduced inflows being the norm. This would also make the WAM modeling more accurate. At the same time, LCRA may need to increase its oversight over the total volumes of irrigation water that are applied to a customer's fields, to assure that water that is diverted is not wasted and that water conservation efforts are promoted.

5. Water for Emergencies. Wildfires are currently a huge concern for all areas, both urban and rural. Hundreds of acres began burning a few days ago in Burnet County in the Inks Lake State Park area. Public comments made at the July meeting by an Assistant Fire Chief have reminded us that Travis County Emergency Services District 8 relies heavily on the water in Lake Travis in times of emergency, and a fire fighter's ability to access water for firefighting is significantly reduced when Lake Travis falls to 650 feet above mean sea level (msl). Even more frightening, water access for firefighting is primarily limited to only one location on the shores of Lake Travis when lake levels fall to 640 feet above msl (or less). We strongly recommend water management practices that assure that minimum lake elevations are maintained in reservoirs that are potential sources of water for public safety. Please consider methods to address these concerns and to allow water for firefighting to be considered in the modeling results and overall objectives for lake storage. How can the needs for firefighting safety in this basin be factored into water planning in the update of the WMP?

6. **Modeling Results Showing Lake Elevations**. Our review of the recently provided WAM modeling appears to show that Lake Travis would drop to a level of 583 feet above msl (see attached graphic), which would be a detail causing great concern to many, for many reasons, including the devastating impact on the ability of fire fighters to access lake water in cases of emergency. Will you please include the lake levels of both Travis and Buchanan in the outputs and narrative explanations of LCRA's modeling runs, so that this impact can be better understood?

7. **Understanding Irrigation Modeling for Garwood**. At the July informational meeting, LCRA presented water modeling and demand information on some of LCRA's irrigation water customers. Would you please provide the corresponding information on the Garwood irrigation operations? And explain how the Garwood demands and commitments are included in the water modeling for the WMP? Also, we wish to thank LCRA for explaining how the Corpus Christi water right is considered in its water modeling.

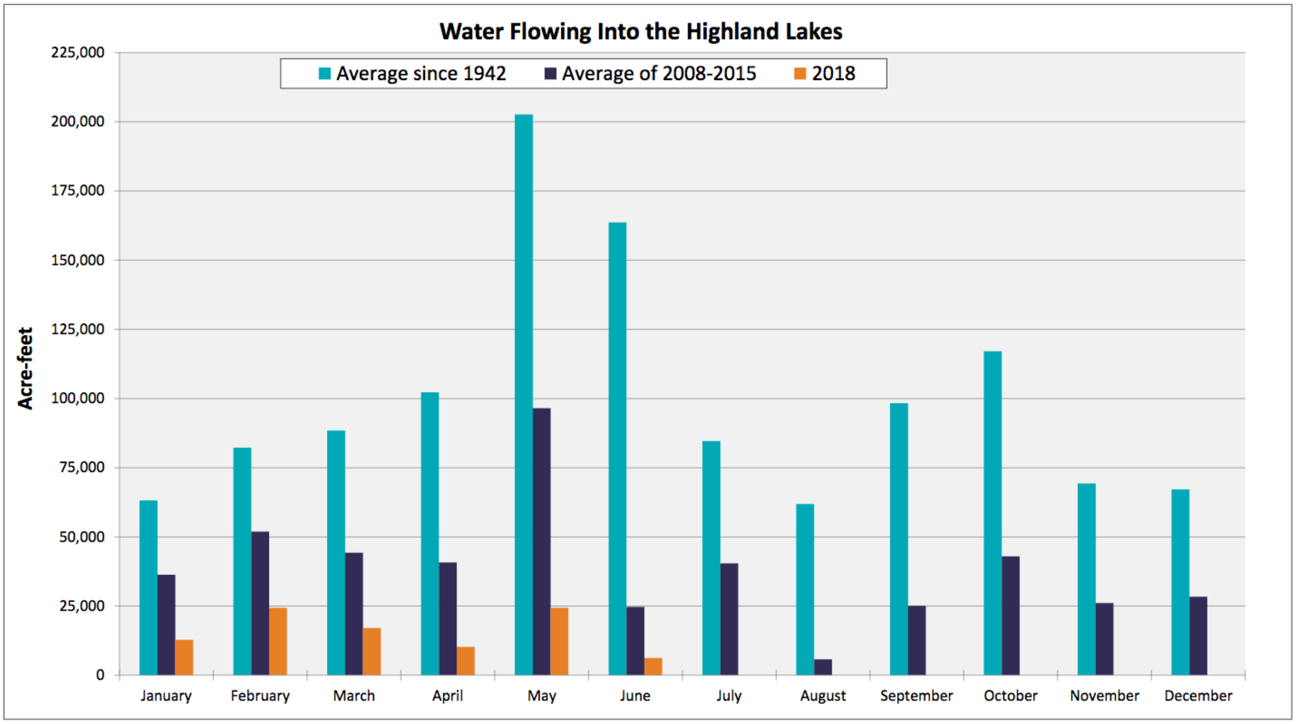
8. **Management of Lake Storage**. We urge LCRA to implement changes to allow a faster, more nimble response to rapid declines in lake storage. As an LCRA manager noted in recent discussions, shortening the time period to trigger a drought designation from 24 months to 18 months would be an option. In addition, in view of the almost non-existent inflows to the lakes in recent weeks, it seems appropriate to add a criterion regarding a minimum quantity of inflows over a period of time, so that periods of extremely low inflows will not continue for months before the WMP reacts to this alarming situation. An LCRA Daily River Operations Report, which stated: "Yesterday's total gauged inflows into the Highland Lakes were 15 acre-feet" should trigger an immediate response under the new WMP.

Please continue to evaluate management tools that avoid precipitous drops in reservoir storage; facilitate LCRA's ability to maintain control over this limited water supply; establish minimum combined storage volumes that adequately protect LCRA's Firm customers in future years; and assure that LCRA can satisfy its Firm water commitments without the need for emergency orders or curtailments that pose threats to public health and safety. We believe these topics deserve priority attention and discussion.

Sincerely,

Jo Karr Tedder

Jo Karr Tedder
CTWC President
JoKarrtedder.ctwc@gmail.com



Period: June (acre-feet)	
Since 1942, June Average:	163,677
2008-2015, June Average:	24,716
June 2018:	6,275

* Inflows: the estimated amount of water flowing into the Highland Lakes from rivers and streams.

Data for 2017 and 2018 is preliminary and subject to change.

Decreased Run-off from a Rancher's Perspective

Stanley Miller and Richard Golladay

July 24, 2018

A 75-year-old rancher named Stanley Miller in Llano County knows exactly what has decreased run-off to the Highland Lakes in recent years. Below are his observations over a lifetime.

The biggest impact on run-off was return of the coyotes (following the ban of 1080 poison), because it ended the sheep and goat business forever in most of the Hill Country during the decade of the 1980's, except on small tracts of 50 acres or less. Coyotes also eliminated the over-population of rabbits. (Sheep, goats, and rabbits are short grass grazers, so they left the land bare and allowed a lot of run-off when it rained.) Ranchers were forced to switch to raising cattle, almost exclusively.

Also, during the predominantly sheep and goat raising economy (before 1980), ranchers planted small grains or hay grazer. Plowing and laying the fields bare between crops created more erosion (and run-off). "We were carrying rocks out of fields as they were uncovered from the erosion."

Following the shift to a cattle economy, two innovations drastically changed ranching: (1) planting and fertilizing improved perennial grasses in the fields, and (2) rotation grazing of cattle. Rotation grazing, in particular, enabled older native perennial grasses to be re-established on the range land not in fields. Both re-established native grasses on range lands, and improved grasses in fields, drastically reduced run-off and erosion, since it means more year-round ground cover. This transition began in the 1990's.

Another factor greatly affects run-off: Invasive species of trash brush, cedar, mesquite, and cactus were formerly somewhat controlled by sheep, goats and rabbits, because these short grass grazers eat these plants when they first sprout. But now these invasive plants have exploded in size and numbers, because cattle predominately eat only grass. These plants lowered the ground water table, even though the grass cover was holding it. All but the biggest springs are dry, and water levels in wells are noticeably deeper. It took a few years for the invading trees and brush to be noticeable, but now ranches are being overrun and they are not being controlled fast enough. Also, almost all land is now being bought for recreational use. Livestock ranching can't pay for land any longer. Brush cover enhances deer numbers and most owners see no need to control invaders. The Texas prairie is disappearing.

Although total rain may be the same, on average, there are fewer 3 and 4 inch rains. Also, many earthen dams were built as far back as the 1950's, which often were full and overflowed during the sheep/goat raising economy. Now, because of less upstream runoff (because of cover of perennial grasses), more and more of these dams are usually dry. If they have water, an inch a day can evaporate on hot summer days. (And summers are hotter). On his ranch there are 1200 acres that drain into two draws - each of which drain into an earthen dam which used to be permanent livestock water sources, but are now usually dry. "I have probably seen my dams overflowing only 10 days in the last two years."

The increase in perennial grasses, rotational grazing, recreational ranching, brush out of control, more dams, a lower water table, and more wells being drilled for people moving to the Hill Country means less run-off, fewer springs, and less in-flow for the lakes. The downward trend will continue.

Mr. Miller sells ranch real-estate in the Hill Country, and the observations he makes about ranches in Llano County applies to ranches all over the Hill Country.

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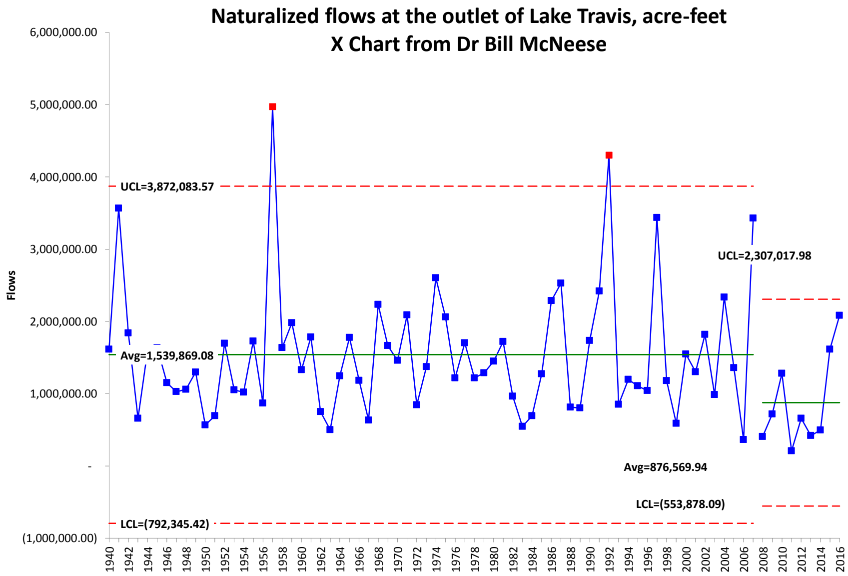
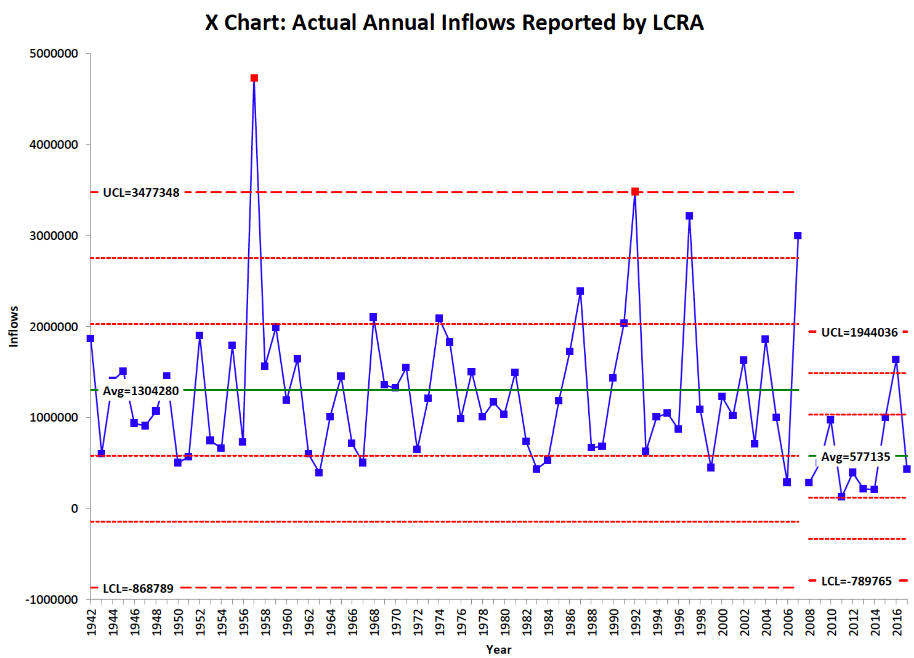
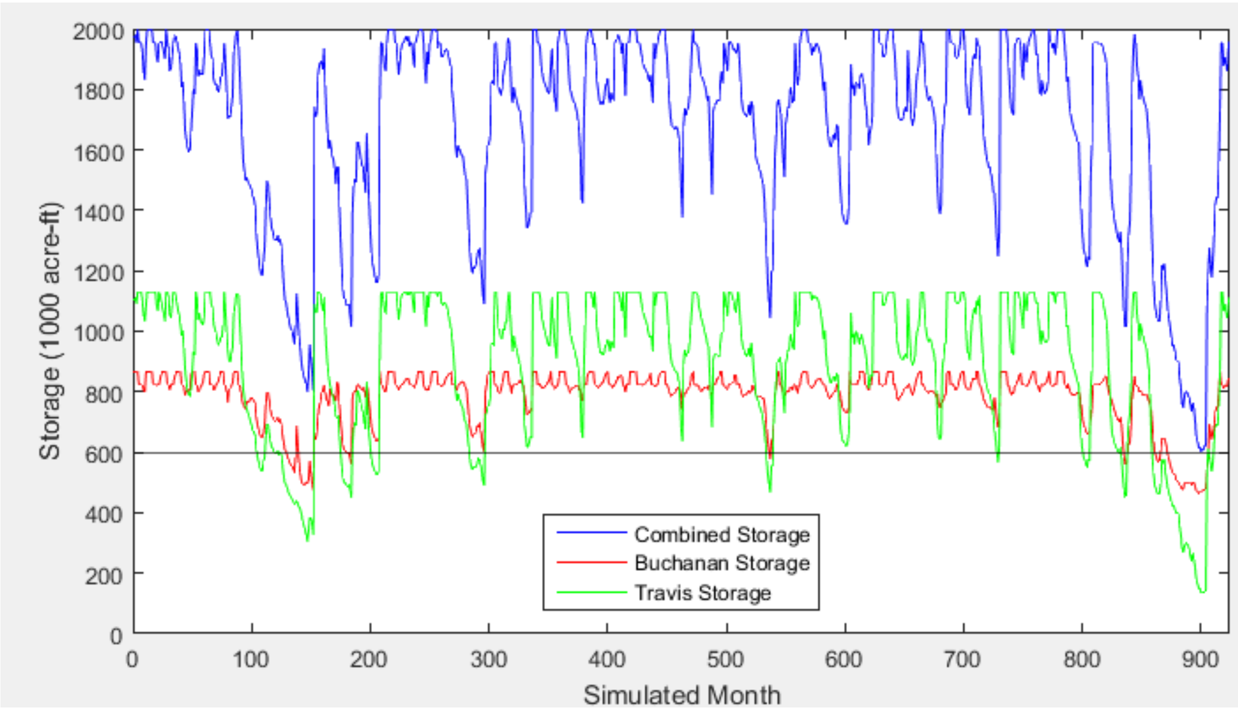
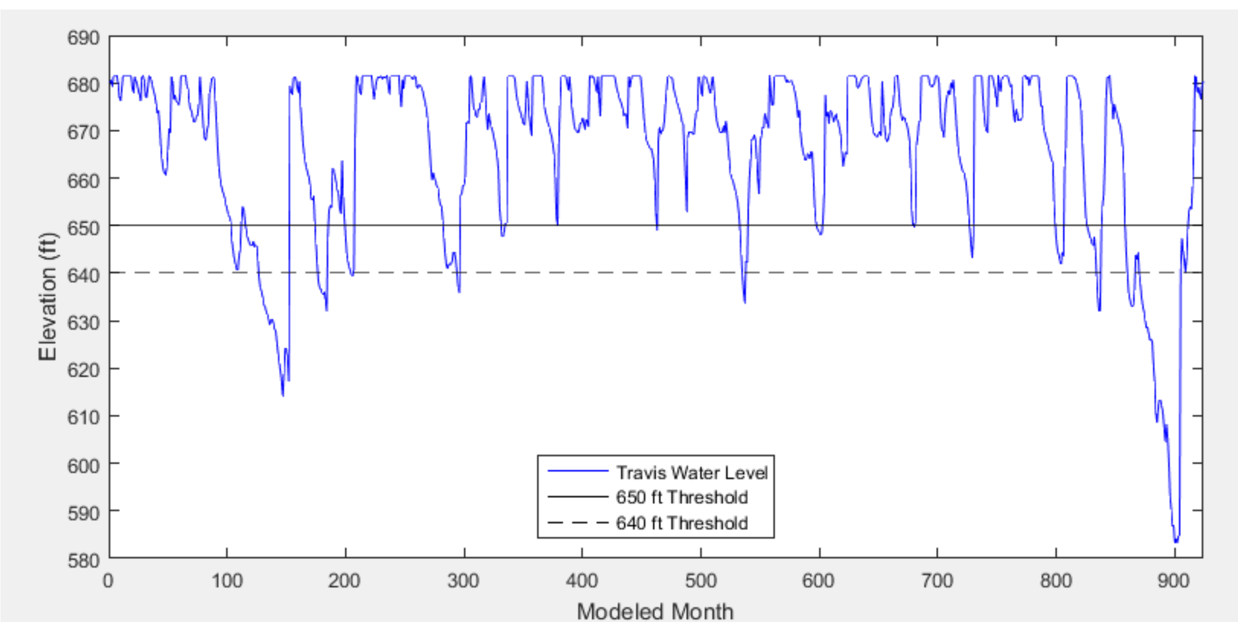
Llano, Tx 78643
stanley miller [stanley4502@gmail.com]
(325)247-6342

Richard Golladay
P.O. Box 1927
Marble Falls, Tx 78654
rgolladay@zeecon.com
(830)265-0538


Naturalized flows at the outlet of Lake Travis, acre-feet
X Chart from Dr Bill McNeese
Flows
UCL=3,872,083.57
Avg=1,539,869.08
LCL=(792,345.42)
UCL=2,307,017.98
Avg=876,569.94
LCL=(553,878.09)


X Chart: Actual Annual Inflows Reported by LCRA
Inflows
Year
UCL=3477348
Avg=1304280
LCL=-868789
UCL=1944036
Avg=577135
LCL=-789765


2000
1800
1600
1400
1200
1000
800
600
400
200
0
Storage (1000 acre-ft)
0
100
200
300
400
500
600
700
800
900
Simulated Month
Combined Storage
Buchanan Storage
Travis Storage


690
680
670
660
650
640
630
620
610
600
590
580
Elevation (ft)
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100
200
300
400
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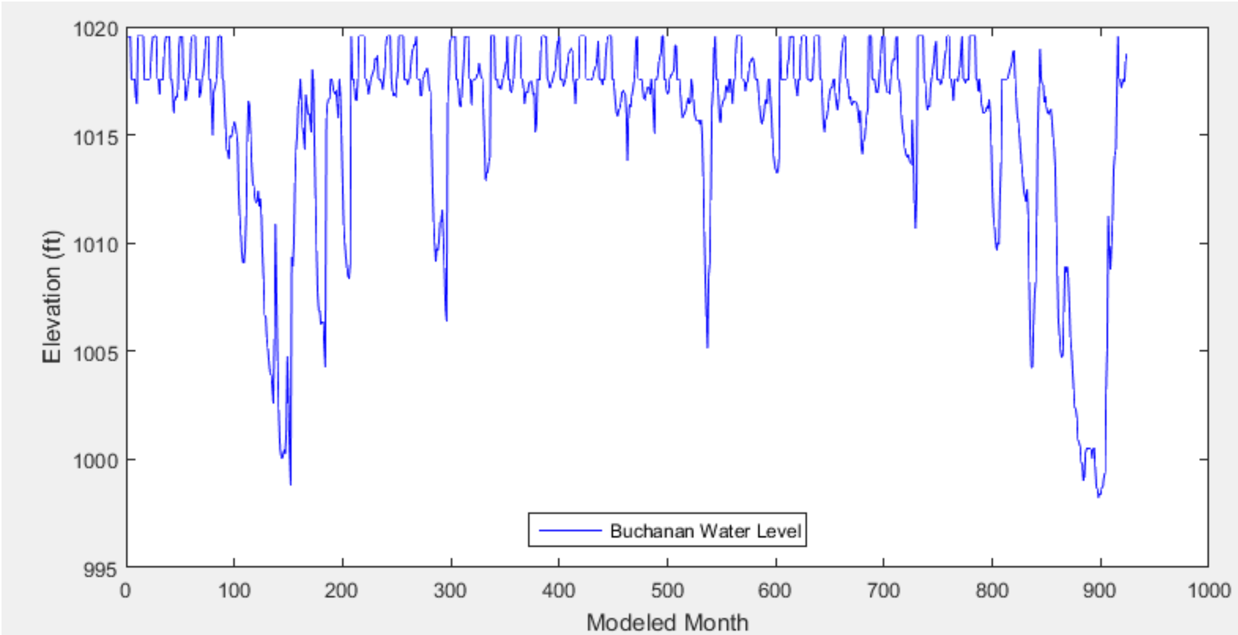
600
700
800
900
Modeled Month
Travis Water Level
650 ft Threshold
640 ft Threshold


1020
1015
1010
1005
1000
995
Elevation (ft)
0
100
200
300
400
500
600
700
800
900
1000
Modeled Month
Buchanan Water Level

Sent: Monday, August 20, 2018 7:57 PM
To: LCRAWMP
Subject: WMP question

Follow Up Flag: Follow up
Flag Status: Flagged

*****From an external source – Think before you click. *****

Hello,

Last WMP meeting you offered changing the drought criteria from 24 month to 18 to help reduce a rapid decline in lake levels.

1, What criteria are you considering a rapid decline in lake levels to be?

2, What would be the outcome of this change? Is there modeling to show the difference?

Thank you,

Tom

CWIC
Colorado Water Issues Committee of the Texas Rice Producers Legislative Group

2511 San Bernard Drive
East Bernard, TX 77435
979-758-4670

Appointed Members:

Lakeside
Ronald Gertson (Chair)
Bryan Wiese

Garwood
Kenneth Danklefs
Billie Heffner

Pierce Ranch
Laurance Armour III
Andrew Armour

Gulf Coast
Paul Sliva (Vice-Chair)
Daniel Berglund

The Purpose of CWIC:

Facilitate the availability of Colorado River water supplies for rice production in the four major irrigation operations on the Colorado River.

Dear LCRA WMP Revision Staff, August 8, 2018

Please consider this letter as formal public comment on the first WMP revision model run and its related policy assumptions.

We appreciate the tremendous effort it has taken to get to this first step in the revision process, and we look forward to working with you to make this revision with its inclusion of the Arbuckle Reservoir (Arbuckle) the best possible product it can be. We recognize that the impending inclusion of Arbuckle into the LCRA water supply system is a benchmark of tremendous accomplishment to be both celebrated and very carefully considered.

Thanks to Arbuckle, for the first time in the thirty-year history of the WMP, we have entered a revision process that should not be centered around how much agriculture and the environment will be further cut to assure the reliability of firm water supplies. Instead, we can improve upon the delivery and reliability of water for these critical lower basin water demands thanks to the foresight and tremendous efforts of LCRA and many throughout the LCRA service area who have recognized the need to balance and provide for the needs of all who have historically depended upon the waters of the Colorado River for sustenance.

This opportunity for a fresh approach to this WMP revision motivates us to provide the following comments:

1. We are in full agreement with staff's decision to weather-vary firm demands in much the same way that interruptible demands have been modeled for some time now. This will move the model one notch closer to the realm of reality. We recognize there may be pushback from some who desire safety factors built upon safety factors in an exercise with such weighty implications, however the Water Management Plan (WMP) and resulting Drought Contingency Plan (DCP) are the appropriate vehicles by which such safety should be achieved, not underlying inflated data and unrealistic modeling.
2. We are surprised that the addition of Arbuckle has shown such slight improvement in the reliability of interruptible water for agriculture. We believe there may be some changes in assumed policies or curtailment criteria that could be beneficial particularly to our ratoon crop without undue impacts to other stakeholders.
3. We are especially interested in looking at ways to improve the reliability of our ratoon rice crop, as it is now more than ever the major source of our net income. The ratoon crop is also the more critical crop to the overwintering waterfowl that have made our rice fields their home for well over a century.
4. In the modelling results summary, it would be helpful to be able to distinguish between water diverted to Arbuckle for storage and later use and water diverted for immediate use in the irrigation system connected to Arbuckle.
5. We assume that the terms "stored water" and "Arbuckle water" do and will continue to refer to different water sources accordingly, however we are still a bit confused going forward how these will be accounted separately and utilized separately or in conjunction with one another. We also recognize that some of these management details may be most appropriately functions of the yet-to-be-considered DCP.

6. We believe that stored water commitments from the Highland Lakes should remain the same as they were in modeling for the WMP now in place, yet with the understanding that Arbuckle water will supplant the need to draw fully upon those stored water commitments. Among other things we are concerned about the potential for confusion in future WMP implementation efforts when irrigators are provided with the accounting of their remaining stored water allocation, how then they may factor in Arbuckle water availability when they are already having to factor in the unknown of run-of-river availability. This initial model run has reduced available stored water from the Highland Lakes in recognition of a dependence of or reliability on Arbuckle water to make up the deficiency. Without some vehicle by which Arbuckle water can be reliably summed with stored water in reporting availability to the end agricultural user, he is left with insufficient information with which to make cropping and irrigation decisions. One solution seems to be to simply keep the stored water available for agriculture at its prior number and utilize Arbuckle to assure that less than that is drawn upon.

We appreciate that the August 10 meeting has been cancelled, as we have not had sufficient time to understand, process and consider reasonable alterations to the initial model run. We did not anticipate being able to offer constructive input or dialogue by that date.

Sincerely,

Ronald Gertson

Chair, Colorado Water Issues Committee of the Texas Rice Producers Legislative Group

City of Austin
Austin Water P.O. Box 1088 Austin, Texas 78767 (52) 972-0101

August 24, 2018

John Hofmann, Executive Vice President of Water
Lower Colorado River Authority (LCRA)
P.O. Box 220
Austin, TX 78767

Re: Second Round of Comments on 2018 LCRA Water Management Plan Update

Dear John:

Attached is the City of Austin, Austin Water's submittal of comments regarding the second stage of the Lower Colorado River Authority's 2018 update to its Water Management Plan (WMP).

We appreciate the opportunity to provide comments. If you have any questions, or need any additional information, I can be reached at 512-972-0191.

Sincerely,

Kevin Critendon, P.E., PMP, Assistant Director
Austin Water

Attachment:
1. City of Austin Second Round of Comments on 2018 LCRA Water Management Plan Update

Attachment 1: City of Austin Second Round of Comments on 2018 LCRA Water Management Plan Update – August 24, 2018

Introduction
Below are several specific comments by the City of Austin in response to LCRA's preliminary WMP model and to LCRA's written reply to participant comments through June 22, 2018. The City also reasserts its comments submitted earlier on June 20, 2018. To provide context to the City's comments, the City highlights a serious concern that, as a basin, with regard to drought, we have returned to a level of low historic inflows that until very recent years had never been experienced.

Last year, 2017, finished as the 8th lowest year for historical inflows to the Highland Lakes. In this year, 2018, the hydrology thus far has worsened. The cumulative historical inflows for the first seven months of 2018 currently rank 2018 as the 3rd lowest in cumulative historical inflows when compared to the first seven months of all other years in the period of record. At this point, 2018 is worse than either 2013 or 2014, which on an annual basis rank as the second (2014) and third (2013) lowest years for historical inflows to the lakes. The past twelve months from August 1, 2017 through July 31, 2018 stand as the third lowest historical inflows for this August through July period. The basin for the past year has been experiencing the same type of extraordinary drought hydrology in terms of inflows that established the new critical period for the basin.

The rapid return to a significant period of extreme low inflows after only a short period of relief suggests that great care should be taken in water planning aimed at assuring the reliability of municipal water supply going forward. Of the planning measures needed to address this circumstance the minimum would be for LCRA to recommend the most conservative planning measures within the framework developed by TCEQ. The City has made some reasonable and well-supported recommendations in this regard, which LCRA indicated in its written response to comments it has chosen not to incorporate. The City remains concerned, as it is critical to assure the reliability of municipal water supply. The City of Austin recommends that LCRA stay on a course more protective of municipal water supply in light of not only a recently established new critical drought period, but a return to the same type of low inflow hydrology that resulted in that new critical period.

1. **The City of Austin reuse supply volume should be corrected to better reflect reality**. The draft WMP WAM released by LCRA used two types of reuse water: offsetting reuse and non-offsetting reuse. From the City's understanding based on discussions with LCRA, the offsetting reuse volume is used in the model to meet the City of Austin's demand and represents growth in direct reuse, while the non-offsetting reuse represents the City's current direct reuse.

The City recommends that LCRA adjust the reuse supply volumes to better reflect current and projected reclaimed water usage by the City of Austin. The City recommends using the following annual non-offsetting reuse supply volumes, based on 2011 actuals. The City also recommends using the following offsetting reuse volumes based on projected increases in direct reuse planned for submission to Region K for inclusion in the state water plan. These volumes do not include reuse water used at Sand Hill Energy Center, which is a significant user of the City's reuse water and is included as a separate demand input in LCRA's model. These volumes also do not include water reuse from the City's small and package plants.

Table 1: Annual City of Austin municipal reuse volumes

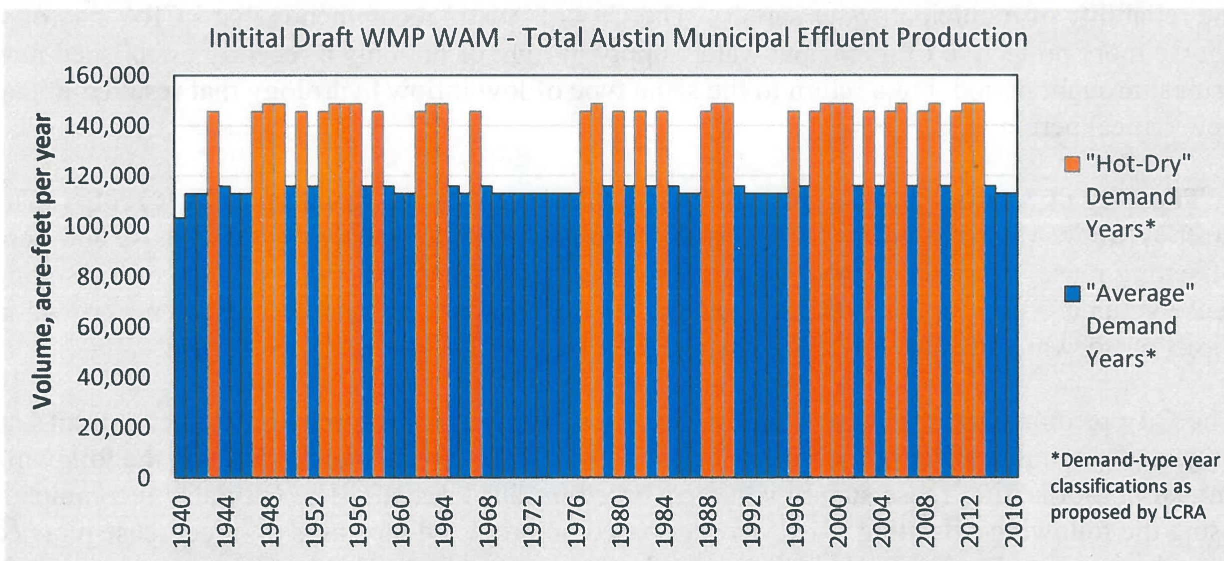
WMP Category	Non-offsetting reuse volume (AFY)	Offsetting reuse volume (AFY)
Annual municipal reuse, City of Austin	2,747	3,375

In addition to changes to the City's municipal reuse assumptions, as discussed above, the City recommends that LCRA change Sand Hill Energy Center reuse assumptions to better reflect the current and expected usage volume, as shown in the following table (based on 2011 usage):

Table 2: Annual Sand Hill Energy Center reuse volume

WMP Category	SHEC reuse volume (AFY)
Annual reuse, Sand Hill Energy Center	1,209

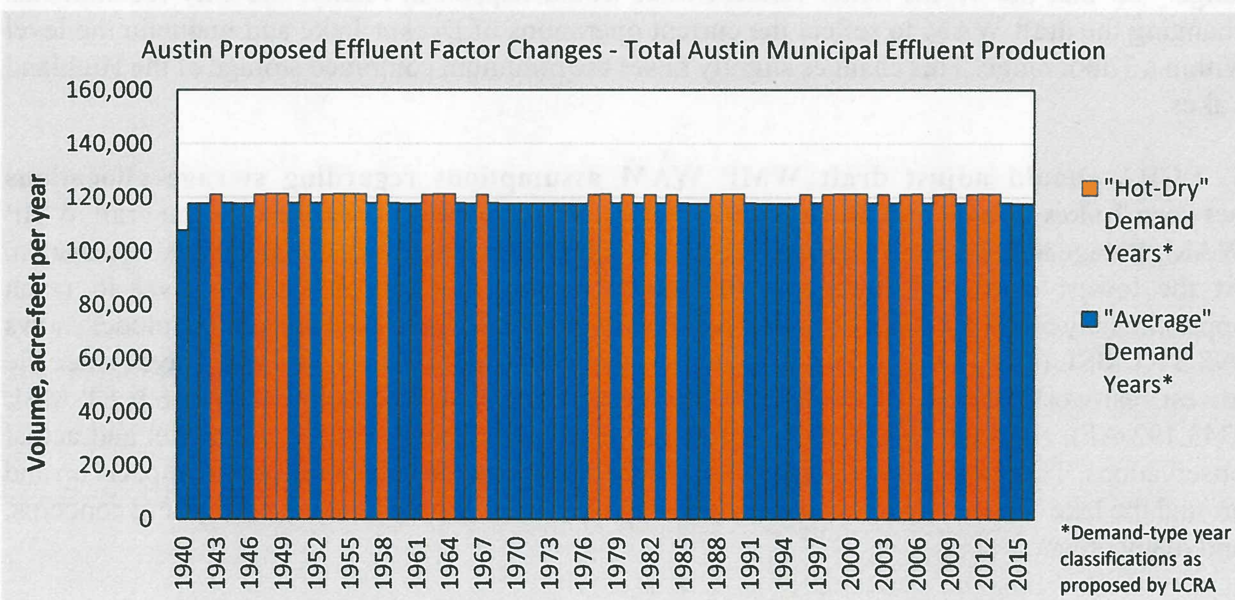
2. **The effluent assumptions in the draft WMP WAM should be adjusted to better reflect actual observed conditions**. In the draft WMP WAM shared with stakeholders, LCRA used a constant effluent production factor for the City for both "hot-dry" and "average" demand years. The constant effluent production factor was based on an average of 2010-2014 actuals. While the City appreciates LCRA's using multiple years to generate an informed effluent production factor, the fact that the effluent production factor is constant creates a situation in the model that is not supported by historical data. Because the draft WMP WAM uses demands fluctuating between "average" and "hot-dry" demands, using a constant effluent production factor results in fluctuating volumes of effluent production in the model, between 112,930 acre-feet per year (AFY) in "average" demand years and 148,630 AFY in "hot-dry" demand years. The graph below shows the total effluent production pattern resulting from LRCA's approach. These large fluctuations are not expected to occur.



Increases in demand during hot-dry conditions tend to be consumptive demands that do not generate effluent, such as cooling and irrigation. Additionally, in "hot-dry" demand years, inflow and infiltration to the collection system is generally lower and further reduces the amount of effluent generated. Since increased demands do not typically generate a correspondingly larger effluent production and inflow and infiltration is lower in hot-dry years, the total effluent production volume would be expected to not fluctuate significantly between "average" or "hot-dry" demands and conditions. Although the LCRA effluent production factor is based on historical data, it produces results in the WMP WAM that likely could not be expected in a repeat of the 2008-2016 drought.

If this effluent production factor discrepancy is not corrected in the WMP WAM, it can produce results that overstate the water available to meet downstream needs. To correct this discrepancy, the City recommends that LCRA use two different effluent production factors dependent on the demand type ("average" or "hot-dry") to reflect the variation in effluent production. The City recommends using a 57% effluent production factor in "hot dry" demand years (based on 2011 actuals), and a 71.8% effluent production factor for "average" demand years (based on 2017 actuals). As discussed above, a constant factor applied to two different types of demand conditions (for "hot-dry" and "average" demand years) is not suggested by the City. Additionally, "hot-dry" demand year and "average" demand year effluent production factors based on averages of data from the critical period are not recommended for use over the 77-year period of record due to drought contingency plan implementation and exceptionally large rain events in many of the years in the recent past. Because of the implementation of Stage 2 demand restrictions by Austin in 2012, 2013, 2014, and 2015, these years do not support the best effluent production factors for use in the WMP. Further, 2015 and 2016 are not good representative years due to the occurrence of large rain events leading to higher inflow and infiltration.

The variable percent factors proposed by the City result in significantly less fluctuation in effluent production volume, as shown in the following figure. An Excel file containing the proposed effluent production factors and monthly pattern information will be emailed along with these comments when they are submitted to LCRA. Using the City's proposed effluent factors addresses the concerns described above.



3. **The City recommends that LCRA consider how conserved water is treated in the WMP process**. In LCRA's written responses to WMP participant comments from the first round, they responded to a comment from the City of Austin regarding the importance of equitably distributing the benefits of conserved water, saying that, "[a]llocating conserved water in a way that does not allow that water to be considered when determining the available supply for interruptible water would be counter to the intent of the WMP." This statement is very concerning to the City of Austin as it appears to disincentivize LCRA firm customers from making exceptional efforts to achieve water conservation. The City questions that this is the intent of the WMP, particularly with the continued and increasing emphasis on water conservation from the state legislature, Texas Commission on Environmental Quality (TCEQ), and Texas Water Development Board (TWDB).

Without protections for conservation in place, the City of Austin does not appropriately realize the benefits particularly of its exceptional conservation. For example, one-day-per-week watering restrictions for automatic irrigation systems and other conservation programs have significantly reduced City-wide water demand over recent years. The way the current draft WAM is structured, the water saved by the City through its exceptional conservation measures with the purpose of increasing the reliability of municipal water supply by drawing less on lake storage, is made available instead to be used downstream to meet interruptible customer demands. Providing protections in the WMP to retain at least some of the benefit of conservation where the entity performing the conservation can appropriately realize those benefits is a crucial factor in the case for conservation for firm customers. There are a variety of mechanisms that can be considered, which the City would like to discuss with LCRA.

4. **LCRA should adjust the draft WMP WAM assumptions to better reflect the actual operating conditions of Decker Lake, rather than modeling it as empty for the majority of the period of record**. In the draft WMP WAM results, Walter E. Long Lake (Decker Lake) is modeled to empty out before 1948 and never gets close to refilling for the rest of the period of record. This does not reflect the actual operation of Decker Lake, which fluctuates within a 3-foot range. So that the WAM better reflects what would happen in reality, the City recommends changing the draft WAM to reflect the current operations of Decker Lake and maintain the level within a 3-foot range. This changes slightly raises the minimum combined storage of the Highland Lakes.

5. **LCRA should adjust draft WMP WAM assumptions regarding storage allocations between Lakes Travis and Buchanan to better reflect actual operations**. In the draft WMP WAM, storage in Lake Travis fluctuates over a much greater range than storage in Lake Buchanan. At the lowest combined storage in the model results, this causes Travis's level to reach approximately 584.8 FT MSL (141,067 AF of storage), while Lake Buchanan in the model shows 998.5 FT MSL (469,154 AF). This is an unprecedentedly low lake level for Lake Travis, since the lowest real-world storage of the lake in the recent drought was approximately 618.6 FT MSL (343,192 AF), resulting in a 33.8 FT difference in lake elevation between the model and actual observations. This extremely low lake level would be anticipated to cause negative impacts on and around the lake. These impacts could include exposed water supply intakes, firefighting concerns, and many others.

The City acknowledges that operating decisions about how lake storage is distributed are not made through the WMP process, and is not suggesting that they should be. However, the lake balancing should be corrected in the model not to inform operational decisions, but to better reflect reality and accurately model how much empty storage is likely to be available to capture rain events. The City recommends that LCRA change the draft WMP WAM assumptions to better reflect LCRA's guidelines, documented in "LCRA Highland Lakes Operating Guidelines: Buchanan-Travis Release Allocation Guidelines" so that fluctuations in storage are more evenly distributed between Lakes Travis and Buchanan, thereby more accurately reflecting what the real-world storage would be in the Highland Lakes and providing more accurate estimates of how much runoff could be captured in storm events.

6. **Additional supplemental documentation of the draft WMP WAM provided in a timely manner would be helpful given the compressed timeline of this WMP process**. The City appreciates supporting documentation provided thus far. The City asks LCRA to continue to provide as much supporting documentation for their draft WMP WAM as early in the process as possible, as there is a short timeline for analysis and comments. Early documentation regarding assumptions made about key items would greatly expedite the process of analyzing the draft WMP WAM in order to provide comments to LCRA in a timely manner.

7. **The City recommends that LCRA clarify its comments regarding changes in stored water available to irrigators**. An initial analysis of the model results provided by LCRA for the current update of the Water Management Plan (WMP) indicates that overall more stored water will be available to agricultural irrigators than under the 2015 WMP. Some key indicators of the proposed WMP's increase in irrigators' water supply are found in model results which currently show under the new plan that the average annual stored water supply to irrigators will increase to about 143,000 acre-feet a year from 118,000 acre-feet a year under the current plan. Over the period of record, this average of approximately 25,000 AF a year more of stored water appears to represent about 2 million acre-feet more water—or about the full volume of Lakes Travis and Buchanan.

More specifically, for sake of comparison, the amount of average annual interruptible stored water diverted for irrigation shown on the period-of-record results issued on November 2014 on page 6 line 27 indicates 118,015 acre-feet. For the current proposed plan, in the August 10, 2018 results the comparable amount of stored water for irrigation customers can be calculated by adding lines 4 and 5 on page 6 of LCRA's period of record results. Line 4 is titled "Average annual interruptible stored water diverted for irrigation" and Line 5 is titled "Average annual Arbuckle Reservoir water diverted for irrigation." Together these two lines represent the total amount of stored water diverted for irrigation customers. The Line 4 amount is 68,270 AF and Line 5 is 75,182 AF. The total of these two categories of stored water diverted for irrigation is 143,452 AF.

A slide from LCRA's presentation for the July 12, 2018 meeting could use clarification as, it can give the impression that irrigators under the proposed plan will have less stored water. Slide 29 from LCRA's presentation states:

- Preliminary Ag Supply Changes
  - Reduce the amount of interruptible stored water available
  - Maximum first season interruptible stored water: about 175,000 acre-feet
  - Maximum second season interruptible stored water: about 60,000 acre-feet

- Corresponding changes to curtailment curves

To avoid potential misimpressions on a key point, the City believes that it is important that this information provide needed context to explain that: due to offsetting supplies to irrigators from the Arbuckle Reservoir, the highest remaining demand from irrigators for interruptible stored water from the Highland Lakes for first season in the model is about 175,000 acre-feet. LCRA's statement "[r]educe the amount of interruptible stored water available" can be phrased "Set the amount of interruptible stored water available from the Highland Lakes at the highest modeled demand from irrigators when Arbuckle operates." This helps to clarify that there is actually not a reduction overall in stored water supply to irrigators.

Specifically on this point, with the effects of the supply from the Arbuckle Reservoir considered in the WMP model, the highest demand for non-Garwood interruptible stored water on the Highland Lakes for first crop season, appearing in the drought year of 2011, is reduced to 177,692 acre-feet. This 177,692 AF amount is the most water that irrigators could be anticipated to use from the Highland Lakes when the Arbuckle Reservoir starts operations as currently planned in the WMP. LCRA's draft curtailment curves for interruptible stored water availability issued August 10, 2018 show the maximum amount available as 178,000 acre-feet. The second highest first crop season demand shown in the model results is 144,580 AF, the third highest is 125,337 AF and most years are well below 100,000 AF. Thus 178,000 AF Highland Lakes interruptible stored water for first season crop in these other years in the model comfortably meets irrigators' demands when Arbuckle Reservoir also supplies stored water to irrigators.

Further, although LCRA's Slide 29 places a maximum of 60,000 AFY on the second crop season amount, the graphs and table issued by LCRA on August 10, 2018 show this amount as 66,000 AFY. This 66,000 AF number exceeds the highest possible second crop season demand in the model by more than 5,000 AFY. In addition, the maximum first and second crop amounts occur during different years in the model. Adding these two numbers creates a maximum annual total that well exceeds interruptible demands in the model in any single year. The highest interruptible stored water demand is 221,391 AFY in 2011. LCRA's August 10, 2018 document, however, provides for a maximum total first and second crop season amount of 244,000 AF. LCRA's proposed plan actually provides a maximum annual amount of interruptible water that is 22,069 AF in excess of any annual modeled demand for Highland Lakes stored water by irrigators.

The total irrigation supply in the model from both run-of-river and stored water increases in the proposed plan. The average total supply for irrigators from the proposed plan is 317,247 AFY, while the average total supply for irrigators from the 2015 WMP was 311,963 AFY. These totals include both run-of-river and stored water supply. The key difference between these numbers is that a higher percentage of the average total supply in the proposed plan is from stored water, increasing the reliability of supply to the irrigators. This overall improvement for irrigators' water supply in the proposed WMP again underscores a need to clarify the information in Slide 29. In sum, the City believes that it is important that LCRA's presentation indicating that the next WMP will reduce the amount of interruptible stored water available be clarified to state that this does not represent a cut in overall stored water supply to irrigators, but instead reflects that some of the stored water will be supplied from another source—the Arbuckle Reservoir, which offsets the demand for interruptible stored water supply from the Highland Lakes.