TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

P.O. Box 13087 MC-160, Austin, Texas 78711-3087
Telephone (512) 239-4691, FAX (512) 239-4770

APPLICATION FOR EMERGENCY MODIFICATION OF PERMIT CONDITIONS AND EMERGENCY AUTHORITY TO MAKE AVAILABLE WATER SET ASIDE FOR ENVIRONMENTAL FLOWS

Notice: This form will not be processed until all delinquent fees and/or penalties owed to the TCEQ or the Office of the Attorney General on behalf of the TCEQ are paid in accordance with the Delinquent Fee and Penalty Protocol.

1. **Data on Applicant and Project:** Social Security or Federal ID No. CN 600253637

   A. Name: Lower Colorado River Authority (LCRA); Attn: David Wheelock, P.E., Manager, Water Supply and Conservation

   B. Mailing Address: P.O. Box 220, L200, Austin, TX 78767

   C. Telephone Number: 512-730-6822 Fax Number: 512-473-3529 E-mail Address: david.wheelock@lcra.org

   D. Applicant owes fees or penalties? ☐ Yes ☑ No

   If yes, provide the amount and the nature of the fee or penalty as well as any identifying number:

   N/A

   E. Describe Use of Water Temporary emergency authorization to allow LCRA to deviate from the 2010 Water Management Plan as it relates to the modification of the instream flow requirement related to the Blue Sucker contained in LCRA's Water Management Plan (WMP) for lakes Buchanan and Travis, as described more fully in LCRA's Attachments provided with this application.

   F. Description of Project (TDH Project No. if applicable) N/A

   G. Highway Designation No. N/A Counties Llano, Burnet, Travis, Bastrop, Fayette, Colorado, Wharton, and Matagorda

2. **Type of Diversion (check one):**

   ☑ From Stream ☑ From Reservoir

3. **Rate of Diversion:**

   A. Maximum _____ gpm
   (capacity of pump)

4. **Amount and Source of Water:**

   See Attachments provided with this application.

   _____ acre-feet of water within a period of _____ (specify term period not to exceed a three year term). The water is to be obtained from _____, tributary of _____, tributary of _____, tributary of _____, _____ Basin.

5. **Location of Diversion Point:** Provide Latitude and Longitude in decimal degrees to at least six decimal places, and indicate the method used to calculate the diversion point location.

   At Latitude _____°N, Longitude _____°W, ((at) or (near) the stream crossing of), (at a reservoir in the vicinity of) _____(R-O-W) (Highway), located in Zip Code _____, located _____ miles in a _____ direction from _____ _____ (County Seat), _____ County, and _____ miles in a _____direction from _____ _____, a nearby town shown on County road map. Note: Distance in straight line miles.

   Enclose a USGS 7.5 minute topographic map with the diversion point and/or the return water discharge points labeled. Owner's written consent is required for water used from any private reservoir, or private access to diversion point.

6. **Access to Diversion Point (check one):**

   ____ Public right-of-way
   ____ Private property
   (A letter of permission from landowner is attached)
   ____ Other (Explain)

7. **Fees Enclosed:**

	10 ac-ft or less	greater than 10 ac-ft
Filing	$ 100.00	$ 250.00
Recording.....	$ 1.25	$ 1.25
Use ($1.00 per ac-ft or fraction thereof)	$ _____	$ 500.00
(Note: 1 ac-ft = 325,851 gals. 1 ac-ft = 7758.35 bbls.) Total	$ _____	$ 751.25

Upon completion of any project for which a temporary water permit is granted, the Permittee is required by law to report the amount of water used. This document must be properly signed and duly notarized before it can be accepted or considered by the Texas Commission on Environmental Quality.

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CHIEF CLERKS OFFICE
TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

CERTIFICATION (30 Tex. Admin. Code §35.24(e)(5))

"I, Phil Wilson, General Manager the Lower Colorado River Authority, certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Phil Wilson

Phil Wilson, General Manager
Lower Colorado River Authority

Date: 3/21/2014

Subscribed and sworn to as being true and correct before me on this the 21st day of March, 2014.

TABETHA JASKE
Notary Public, State of Texas
My Commission Expires
January 11, 2018

Tabetha Jaske

Notary Public of the State of Texas

ATTACHMENT A

LCRA APPLICATION FOR EMERGENCY REDUCTION OF INSTREAM FLOW REQUIREMENTS UNDER ITS WATER MANAGEMENT PLAN FOR LAKES BUCHANAN AND TRAVIS (PERMIT 5838)

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I. SUMMARY OF REQUEST

The extraordinary drought gripping central Texas, which has already caused LCRA to seek emergency relief to cut off nearly all water releases for agricultural irrigation three years in a row, and which has caused record-low inflows to lakes Buchanan and Travis, presents an ever more pressing emergency water supply condition. With the threat of mandatory curtailment of water use by firm customers (mainly municipalities and industries) served from these lakes ever closer to a reality, the Lower Colorado River Authority (LCRA) now brings to TCEQ a request to reduce, but not eliminate, the instream flow requirement related to the Blue Sucker included in LCRA's Water Management Plan (WMP), LCRA's reservoir operations plan for lakes Buchanan and Travis. By seeking this one adjustment, it is important to stress that LCRA is not seeking as part of this request to reduce the overall firm commitment of water for instream flows included in LCRA's 2010 WMP. That commitment, which provides for multiyear caps, would remain in effect and be subject to curtailment like other firm commitments, should LCRA declare a Drought Worse than Drought of Record.

Although LCRA has previously obtained emergency relief from its current 2010 WMP that has resulted in the cutoff of interruptible stored water from lakes Buchanan and Travis to most downstream irrigation customers for 2012, 2013, and 2014 (through May 26 at a minimum), LCRA has not previously obtained relief from any of the environmental flow conditions in the WMP.[1] Water supply conditions, however, are worse than in March 2012 or March 2013, with combined storage as of March 19 of 757,000 acre-feet or 38 percent full. If storage drops below 600,000 acre-feet, the LCRA Board will declare a Drought Worse than Drought of Record. Such a declaration is based on indicator criteria (described in Section IV, below) including drought duration, drought intensity, and combined storage levels that suggest the basin may be experiencing a drought worse than the 1950s. At such time, LCRA will require firm customers to cut back their water use by 20 percent and further curtail its commitment to environmental flows by 20 percent. LCRA currently projects this could happen as early as June 2014. As the Commission has previously recognized, these conditions pose an imminent threat to human health and safety. Accordingly, the Board has now concluded that the unanticipated drought conditions require more extraordinary actions and that it must now seek permission to reduce the potential amount of releases this Spring from lakes Buchanan and Travis for specific instream flow purposes related to the state threatened Blue Sucker so that this water may instead be preserved to ensure LCRA can continue to meet critical needs should this extraordinary drought persist.

As discussed in more detail below, without emergency relief on or before April 15, 2014, LCRA could be required to release about 21,000 acre-feet of previously stored water by the end of May 2014. LCRA requests that this application be processed under Texas Water Code §5.506, 11.139, or 11.148, as the Commission deems appropriate.

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[1] LCRA did file an emergency relief application related to its bay and estuary inflow obligation under the WMP in September 2013 but withdrew the application in November 2013.

II. COPY OF PERMIT AND RESERVOIR OPERATING PROCEDURES (30 Tex. Admin. Code §§ 35.101(c)(1), 35.101(c)(7))

LCRA's 2010 WMP is available on LCRA's website at: http://www.lcra.org/water/water-supply/water-management-plan-for-lower-colorado-river-basin/Documents/lcra_wmp_june2010.pdf. The relevant excerpts related to LCRA's obligations to provide water for environmental flows are included in Attachment B.

III. CONTACT INFORMATION (30 Tex. Admin. Code § 35.24(c)(1))

This application is being submitted by:

Phil Wilson, General Manager
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P.O. Box 220, H107
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Questions regarding this application should be directed to the following person(s):

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IV. DESCRIPTION OF LCRA's WATER MANAGEMENT PLAN & INSTREAM FLOW REQUIREMENTS AND AREA AFFECTED BY REQUESTED ORDER (30 Tex. Admin. Code §§35.24(c)(2), 35.24(c)(4))

LCRA provides raw water to over 60 retail and wholesale potable water suppliers that together serve over one million people throughout the lower Colorado River basin and LCRA's water service area. LCRA's municipal raw water customers include, but are not limited to, Austin, Cedar Park, Leander, Burnet, Marble Falls, Pflugerville, Lakeway, Bee Cave, Horseshoe Bay, other Highland Lakes municipalities; water supply corporations, special districts (including LCRA's own water utility systems); and investor-owned utilities. In addition, LCRA provides water to several electric utilities—LCRA, Bastrop Energy Partners, Austin Energy, Gen-Tex Corporation, and South Texas Project Nuclear Operating Company—from the firm water supply of lakes Buchanan and Travis. These utilities provide power into the electrical grid in Texas operated by the Electric Reliability Council of Texas (ERCOT) to meet the electrical needs of customers in Texas. LCRA also provides firm raw water to several industries located downstream, including Oxea Chemical and Underground Services Markham. *See* Affidavit of

David Wheelock (Attachment C).

To meet its water supply obligations, LCRA relies on several water rights, including the water rights for lakes Buchanan and Travis under Certificates of Adjudication 14-5478 and 14-5482, which are further subject to the conditions and criteria set forth in the 2010 WMP. The original Water Management Plan was required by court order[2] and is incorporated into LCRA's Certificates of Adjudication 14-5478 and 14-5482.[3] The Certificates of Adjudication and the TCEQ-approved WMP govern LCRA's operation of lakes Buchanan and Travis and dictate how LCRA makes water available from these lakes to help meet firm water[4] customer needs, downstream interruptible irrigation demands, and environmental flow needs of the lower Colorado River and Matagorda Bay. The WMP further describes how LCRA will manage and curtail supplies from the lakes during times of drought including through a repeat of the Drought of Record.[5] The WMP also sets forth criteria for declaring a Drought Worse than the Drought of Record (DWDR).[6]

To manage the supply, the 2010 WMP imposes several trigger points keyed to the total combined storage capacity of lakes Buchanan and Travis that are intended to ensure there is sufficient firm water supply to meet firm demands through a repeat of the Drought of Record.[7] LCRA's environmental flow obligations contained in the WMP reflect a balance between the competing needs of water within the basin. Similar to how LCRA provides water for interruptible agricultural uses, LCRA's commitment to provide water for environmental needs under the WMP is generally tied to the amount of water LCRA has in storage on Jan. 1 each year. Thus, LCRA's environmental flow obligations are curtailed to some extent in drier years and are higher in years when storage is higher. For purposes of this application, the most relevant trigger points are set out in Table 1.

The 2010 WMP also includes conditions under which the LCRA Board of Directors will declare a Drought Worse than the Drought of Record (DWDR). To declare a DWDR, the Board must find that the following three conditions are simultaneously met:

1. Duration of drought is more than 24 months, which is determined by counting the number of consecutive months since both lakes Buchanan and Travis were last full;[8]

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[2] *In re The Exceptions of the Lower Colorado River Authority and the City of Austin to the Adjudication of Water Rights in the Lower Colorado River Segment of the Colorado River Basin*, No. 115, 414-A-1 (264th Dist. Ct., Bell County, Tex. April 20, 1988), Lake Buchanan Conclusion of Law 4 and Lake Travis Conclusion of Law 6.

[3] *See* Attachment D, Certificate of Adjudication 14-5478 at p.4 (2.B.(7)); and Certificate of Adjudication 14-5482 at p.4 (2.B.(7)).

[4] Firm water refers to the amount of water that LCRA has determined would be available on a consistent or firm basis through a Drought of Record water availability analysis after honoring all senior water rights.

[5] Drought of Record refers to the worst hydrologic drought that has occurred since detailed records have been kept for the lower Colorado River basin. The WMP identifies the Drought of Record for the Highland Lakes as the period from 1947 to 1957. *See* Attachment B – 2010 WMP at 4-20.

[6] *Id.* at 4-34.

[7] *Id.* at 4-5.

[8] *Id.* at 4-34. For purposes of the WMP, the duration of a drought is the time period since both Lakes Buchanan and Travis were at their maximum allowable water conservation storage levels.

2. Inflows to the lakes are less than inflows during the Drought of Record;[9] and
3. Lakes Buchanan and Travis combined storage has less than 600,000 acre-feet of water.[10]

Table 1. Triggers in 2010 WMP[11]

Combined Storage of lakes Buchanan and Travis	Date on Which Trigger is Decided	Action Taken
1.7 MAF	On Jan. 1	Environmental releases for bay and estuary inflows reduced to meet intermediate needs for the following year.
1.4 MAF	At any time	Request firm customers to implement voluntary drought response measures.
1.4 MAF	On Jan. 1	Environmental releases for instream flows reduced to meet critical needs for ecosystems for following year. Begin gradual curtailment of interruptible supply to four major irrigation operations.
1.1 MAF	On Jan. 1	Environmental releases for bay and estuary inflows reduced to meet critical needs for the following year.
900,000 acre-feet	At any time	Request firm customers to implement mandatory water restrictions; develop firm customer curtailment plan.
600,000 acre-feet	At any time	If criteria indicates a drought worse than the Drought of Record, then cease interruptible supply and begin curtailment of firm supply.

Under the 2010 WMP, once a drought has lasted more than 36 months and a DWDR has been declared, interruptible stored water would be fully and immediately curtailed – making no stored water available for agricultural irrigation or other interruptible uses until lake levels recover or the inflows into the lakes increase substantially.[12] Moreover, LCRA will implement pro rata curtailment of its firm water users once a DWDR is declared and after interruptible stored water (agriculture) uses have been cut off.[13] Under a DWDR declaration, water for instream flows and bay inflows is subject to a pro rata reduction along with other firm users of water.[14]

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[9] The cumulative inflow deficit since the beginning of the drought must exceed the envelope curve for cumulative inflow deficits by at least 5 percent for six consecutive months. *Id.* at 4-34.

[10] *Id.* at 4-34.

[11] Emergency relief from the WMP in 2012, 2013, and 2014 amended criteria for cutoff of interruptible stored water to farmers in the Gulf Coast, Lakeside, and Pierce Ranch irrigation operations.

[12] *Id.* at 4-34.

[13] *Id.*

[14] *Id.* at P-10.

LCRA has reserved 33,400 acre-feet of firm supply to meet its instream flow and bay inflow obligations under the WMP. This year, LCRA has been obligated under the WMP to maintain critical instream flows (i.e. flow in the Colorado River) and to help meet the critical bay inflow needs of Matagorda Bay. *See* Affidavit of Ryan Rowney (Attachment E). These obligations include a requirement to maintain a minimum continuous instream flow of 120 cubic feet per second (cfs) from Bastrop to Eagle Lake[15] at all times and a minimum flow of 500 cfs for a continuous six-week period in between March and May to provide higher flows to support habitat for Blue Sucker spawning. If flows in the river downstream and/or releases LCRA is making to meet other downstream demands are insufficient to meet these instream flow requirements, the 2010 WMP calls for the release of stored[16] water. In 2012 and 2013, the 500 cfs requirement resulted in releases from lakes Buchanan and Travis averaging about 20,000 acre-feet each year over just a six-week period on top of releases LCRA was making for other downstream needs. *See* Affidavit of Ryan Rowney (Attachment E).

In 2012 and 2013, LCRA operated under emergency orders that modified the total amount of water supplied from lakes Buchanan and Travis for irrigated agriculture in the lower basin. Total use of water from lakes Buchanan and Travis in 2012 was about 188,000 acre-feet, of which about 31,385 acre-feet was supplied to help meet environmental flow needs consisting of 28,235 acre-feet for instream flows (of which 22,991 acre-feet was for the 500 cfs requirement) and 3,050 acre-feet for bay inflows. Total use of water from lakes Buchanan and Travis in 2013 was about 173,148 acre-feet, of which about 33,465 acre-feet was supplied to help meet environmental flows needs consisting of 18,779 acre-feet for instream flows (of which 15,678 acre-feet was for the 500 cfs requirement) and 14,686 acre-feet for bay inflows. *See* Affidavit of Ryan Rowney (Attachment E).

V. THE EMERGENCY CONDITIONS JUSTIFY ISSUANCE OF ORDER (30 Tex. Admin. Code §§35.24(c)(3)-(4), 35.101(a), (c)(2), (k), (o) & 295.91(1))

A. Inflows into lakes Buchanan and Travis are at record lows.

By almost every measure, the inflows to the Highland Lakes are at record lows. At times, the deficit has been as much as 90% more than the inflow deficit for a similar period of inflows experienced during the historic Drought of Record for the lower Colorado River basin, which occurred from 1947 to 1957. *See* Affidavit of Ron Anderson (Attachment F, Tab 2).

Annual inflows into lakes Buchanan and Travis in five of the last six years are among the ten lowest years of inflow on record. *See* Table 3. By contrast, only one year during the historic 1950s Drought of Record makes the list of ten lowest annual inflows. Inflows in 2011 were the lowest on record; inflows in 2012 were the fifth lowest on record; and inflows in 2013 were the second lowest on record. Monthly inflows for January and February of 2014 were each lower

[15] Eagle Lake is just downstream of the USGS gauge at Columbus.

[16] LCRA's obligation to provide critical instream flows is met using storable inflows into lakes Buchanan and Travis as well as previously stored water. LCRA's obligation for the higher target flows, and for bay and estuary inflows is limited to storable inflows—the actual daily inflows to the reservoirs minus the daily pass throughs to meet downstream senior water rights. *See* Attachment B – 2010 WMP at P-12, 4-12, 4-14.

than in any of the recent drought years of 2011 to 2013 and were the lowest since the 1950s. *See* Affidavit of Ryan Rowney (Attachment E).

Inflows into lakes Buchanan and Travis in the current drought include the lowest inflows over a various time period ranging from 12 months to 72 months, lower than for any similar time periods in the historic record, including the 1950s. In fact, the past 72 months of inflows are about half of the lowest inflows in any 72-month period in the historic Drought of Record. *See* Table 4; Affidavit of Ryan Rowney (Attachment E).

Table 3. Lowest Annual Inflows into the Highland Lakes (acre-feet)

Year	Amount
2011	127,802
2013	215,138
2008	284,462
2006	285,229
1963	392,589
2012	393,163
1983	433,312
1999	448,162
2009	499,732
1950	501,926
Average (1942-2013)	1.23 million

Table 4. Comparison of inflows in current drought to Drought of Record

	Lowest inflows for time period in ongoing drought		**Lowest inflows for time period in 1950s Drought of Record**	
Time Period	Period ending	Inflows (acre-feet)	Period ending	Inflows (acre-feet)
12 months	Sept. 2011	120,160	Apr. 1951	408,784
24 months	Mar. 2013	503,989	Mar. 1952	1,006,681
36 months	Sept. 2013	695,099	Aug. 1952	1,636,088
48 months	Feb. 2014	1,351,593	Aug. 1952	3,035,846
60 months	Aug. 2013	2,147,157	Aug. 1952	4,128,806
72 months	Feb. 2014	2,443,346	Apr. 1955	5,193,016

When inflows are adjusted to account for the fact that O.H. Ivie Reservoir was not in place in the

1950s, the comparison of the current drought to the Drought of Record still shows the recent inflows are dramatically lower than the 1950s Drought of Record, with inflows since 2008 at about half of the inflows for the first six years of the Drought of Record. *See* Affidavit of Ron Anderson (Attachment F, Tab 3).

Rain events in 2013 did not provide significant inflows to lakes Buchanan and Travis. An event on Sept. 19 and 20, 2013 included rain totals averaging two to three inches in the watershed upstream of lakes Buchanan and Travis, with some rain gages reporting as much as seven inches. *See* Affidavit of Bob Rose (Attachment G). Although the rainfall amounts were significant, the resulting inflows to lakes Buchanan and Travis were very limited, totaling only about 25,000 acre-feet. The limited amount of inflows are indicative of the severity of the ongoing drought and the extremely dry soil conditions that have yet to be overcome. By comparison, an event in March 2007 with about 40 percent less rainfall produced almost 100,000 acre-feet of inflows to lakes Buchanan and Travis. *See* Affidavit of Ryan Rowney (Attachment E). Rain events in October 2014, including the flood of October 30-31 fell in the watersheds downstream of lakes Buchanan and Travis. Those events contributed significant flows in the lower Colorado river past Bay City and into Matagorda Bay, but did little to help the water supply condition (October and November 2013 gauged flows past Bay City totaled about 355,000 acre-feet while gauged inflows to lakes Buchanan and Travis were only 69,000 acre-feet). *See* Affidavit of Ryan Rowney (Attachment E).

The inflow conditions experienced in the last several years present an extreme drought situation that was not contemplated when the special conditions related to freshwater inflows were incorporated into the 2010 WMP. [17] Although the 2010 WMP already contains provisions for the staged reduction in instream flows, these extraordinary conditions represent new and changed conditions that support further and different relief consistent with this request for emergency relief. (*See* 30 Tex. Admin. Code § 35.101(o).) The 2010 WMP was developed using simulations of a repetition of the hydrologic period from 1940 to 1965.[18] While that period includes the 1950s Drought of Record, the recent severe low inflows of 2011 and 2013 are less than half of the lowest annual inflow in the 1950s and the multi-year inflows are also worse than any that were simulated during the development of the WMP. *See* Tables 3 and 4.

B. The forecast does not offer much hope for improvement.

Extraordinary drought conditions have gripped much of Texas, including the lower Colorado River basin for over three years, dating back to October 2010. The Texas State Climatologist, Dr. John Nielsen-Gammon, has recognized the period from October 2010 to September 2011 as the worst one-year statewide drought on record dating back to 1895. *See* Affidavit of Bob Rose (Attachment G). Although 2012 and 2013 included some periods with near-normal or normal rainfall totals, rainfall has been very sporadic, often with several weeks of dry weather between significant rainfall events such that the soils have not remained saturated enough to allow runoff

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[17] *See* Attachment H, TEX. COMM'N ENVTL. QUAL., Docket No. 2014-0124-WR, Order affirming in part and modifying in part the Executive Director's emergency order authorizing the Lower Colorado River Authority to amend its Water Management Plan, Permit No. 5838, pursuant to section 11.139 of the Texas Water Code (Feb. 27, 2014) (herein "February 2014 Emergency Order") Finding of Fact 30.

[18] *See* Attachment B – 2010 WMP at 4-37.

to occur in any substantial amount. The rain event in September 2013 discussed above is the most recent example of this pattern. *See* Affidavit of Bob Rose (Attachment G); Affidavit of Ryan Rowney (Attachment E).

High temperatures have also been unprecedented. For Texas, the summer of 2011 was the hottest summer ever recorded in Texas and the hottest summer on record for Austin. Statewide, calendar year 2011 was the third hottest year ever recorded and the hottest year on record for Austin. The summer of 2012 was the 10th hottest summer on record statewide and the 11th hottest summer on record for Austin. Statewide, 2012 tied with 1921 as the hottest year on record. Summer temperatures for Austin in 2013 were the 5th hottest on record. *See* Affidavit of Bob Rose (Attachment G).

These conditions have created a circumstance where the lakes have been unable to recover in any significant manner, even with an emergency cutoff of nearly all water supply for downstream irrigation in 2012 and 2013. Recent weather forecasts do not include any clear signs of relief. *See* Affidavit of Bob Rose (Attachment G). The National Weather Service's 3-month outlook calls for the drought to persist across the Hill Country through June 2014. Longer-term indicators suggest a fifty percent or greater chance of El Niño developing in late summer. However, should El Niño develop, it is not expected to have a significant impact on Central Texas weather until late summer or fall. Furthermore, El Niño is far from certain as was experienced in fall 2012. And, as observed during this drought, even if near-normal to normal rainfall occurs, significant drought relief in the form of inflows into lakes Buchanan and Travis cannot be expected. *See* Affidavit of Bob Rose (Attachment G); Affidavit of Ryan Rowney (Attachment E). As noted above, by many measures, the recent low inflows are already as bad as or worse than the 1950s.

C. Combined storage in lakes Buchanan and Travis is approaching record low levels and LCRA may declare a Drought Worse than Drought of Record as early as June 2014.

Criteria prompting LCRA to make a Drought Worse than Drought of Record declaration[19] could be met in as soon as June. *See* Affidavit of Ron Anderson (Attachment F). Two of the three criteria for such a declaration have already been met. The drought has lasted more than 24 months. *See* Affidavit of Ryan Rowney (Attachment E). The cumulative inflow deficit criterion has been met. *See* Affidavit of Ron Anderson (Attachment F). Only the combined storage criterion, with a 600,000 acre-foot trigger, remains to be met. The combined storage as of March 19 was about 757,000 acre-feet. *See* Affidavit of Ryan Rowney (Attachment E). Combined storage could reach the 600,000 acre-foot level as early as June, triggering a declaration of Drought Worse than Drought of Record by the LCRA Board of Directors.

D. Depending on conditions in the lower river, the 2010 WMP could require LCRA to release significant quantities of stored water for the Blue Sucker

As noted above, the requirement of 2010 WMP that stored water be released to maintain

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[19] Attachment B – 2010 WMP at 4-32.

minimum flows of 500 cubic feet per second (cfs) from Bastrop to Eagle Lake for a continuous six-week period between March and May resulted in the release of about 20,000 acre-feet of water from lakes Buchanan and Travis in a six week period in both 2012 and 2013. The released water was in addition to water that LCRA was already releasing from storage or passing though the Highland Lakes to meet downstream customers' demands, such as those at the Garwood Irrigation Division.

The proposed emergency relief would reduce the release requirement from 500 cfs to 300 cfs. This could save about 17,000 acre-feet from being released from lakes Buchanan and Travis while not having a substantial effect on the Blue Sucker habitat or water quality as discussed further below. *See* Affidavit of Ryan Rowney (Attachment E).

E. The emergency conditions present an imminent threat to the public health and safety.

The current conditions and outlook are similar or worse to those in place when the Commission issued emergency orders related to LCRA's Water Management Plan, including the order issued on February 27, 2014. The facts once again support the conclusion that there is an imminent threat to firm customers served by LCRA.[20] This has occurred notwithstanding the actions of LCRA and its customers over the past two years in implementing drought contingency plans to reduce demands. In addition, LCRA has preserved supply in lakes Buchanan and Travis by obtaining emergency relief from its Water Management Plan and by obtaining authorizations for the temporary use of its downstream water rights to meet firm customer demands. Those actions have delayed the timeframe for reaching a DWDR declaration.

This request, which is expected to have little to no adverse effect on the Blue Sucker, would help meet the clearly identified water needs of the LCRA's firm water customers and thus constitutes an undeniable benefit to the public welfare. Despite LCRA's efforts to reduce large demands on the lakes through these measures, the drought has persisted and lake levels have continued to fall. As discussed above, there is a chance that LCRA will declare a DWDR as soon as June, thus prompting a call on firm customers to implement significant curtailments in their water use. In fact, a substantial release this spring for the Blue Sucker contributes to the chance of triggering DWDR in June. In that case, LCRA and its customers may need to acquire or develop large quantities of alternative water supplies to meet essential needs of their respective potable water systems. However, it takes many years to develop significant new water supplies. As the

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[20] *See* Attachment H, February 2014 Emergency Order, Findings of Fact # 18-25, 28, 30, 31, 33-36, 45, 60, 61. *See* also TEX. COMM'N ENVTL. QUAL., Docket No. 2011-2096-WR, Order Affirming an Emergency Order Granted by the Executive Director to the Lower Colorado River Authority (Dec. 12, 2011) (herein "2011 Emergency Order") Findings of Fact # 22, 25, 26; TEX. COMM'N ENVTL. QUAL., Docket No. 2013-0225-WR, Order Affirming, with Modification, an Emergency Order Granted by the Executive Director to the Lower Colorado River Authority (Feb. 19, 2013) (herein "2013 Emergency Order") FOFs # 22, 27, 31; TEX. COMM'N ENVTL. QUAL., Docket No. 2013-0225-WR, Order Affirming, with Modification, an Emergency Order Granted by the Executive Director to the Lower Colorado River Authority (June 10, 2013) (herein "2013 Emergency Order Extension") FOFs # 16, 17; TEX. COMM'N ENVTL. QUAL., Docket No. 2013-0225-WR, Order granting an emergency authorization to the Lower Colorado River Authority to amend its Water Management Plan, Permit No. 5838, pursuant to section 11.139 of the Texas Water Code (July 26, 2013) (herein "2013 Second Emergency Order") FOFs # 21-25, 28.

Commission has recognized in its emergency orders, the sheer length of time that it takes to develop or conserve significant quantities of water supply mean that a water supply emergency arises well before a reservoir goes dry.[21] For the most part, although LCRA's firm customers are working on plans to implement curtailment and secure alternative supplies, most have not secured any readily available alternative sources of water supply that could substitute for their reliance on the Colorado River. *See* Affidavit of Ryan Rowney (Attachment E); Affidavit of David Wheelock (Attachment C).

Moreover, as the lake levels drop, it becomes more difficult and expensive for the retail water suppliers to pump water from lakes Buchanan and Travis. Currently, LCRA owns four systems that take water from lakes Buchanan and Travis. LCRA has 15 customers that actively take water for municipal purposes from Lake Travis that are not a part of LCRA's utility facilities. The lowest pumping elevations of the intakes range from 555 feet mean sea level (msl) to 650 feet msl on Lake Travis. If the levels in Lake Travis or Lake Buchanan drop below the current lowest pumping elevations, LCRA and its wholesale raw water customers must take action to either lower their pumping elevation or find alternative supplies. For smaller systems such as Paradise Point, Smithwick Mills, or Ridge Harbor, the alternative is likely hauling water from a water utility with a viable source. For larger systems, temporary measures must be implemented to extend the intake capabilities to reach lower water levels. LCRA's raw water customers that have their own intake facilities would likely require similar measures. Firm customers have indicated that they are spending or planning to spend funds to allow their intakes to operate at lower elevations, or making plans to haul water. *See* Affidavit of Ryan Rowney (Attachment E). Overall, well over 40 public water systems that rely on the Highland Lakes or that draw from the tributaries that typically contribute significant inflow to the Highland Lakes are already in some form of drought restriction and are at risk of water supply shortages.[22] If the lake levels drop more quickly than arrangements for alternative intakes or supplies can be implemented, the current drought presents an imminent threat to public health and safety for the LCRA water systems and for its customers' water systems. Any emergency relief that helps LCRA retain supply in lakes Buchanan and Travis mitigates some of the impacts described above. Finally, much of the lower Colorado River watershed is included in the Governor's drought proclamation, which recognizes that "exceptional drought conditions pose(d) a threat of imminent disaster."[23]

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[21] *See* Attachment H, February 2014 Emergency Order, Findings of Fact # 34, 60, 61.
See also 2011 Emergency Order, Findings of Fact # 30, 31; 2013 Emergency Order, FOFs 32, 33; 2013 Emergency Order Extension, FOFs 15, 16; 2013 Second Emergency Order, FOF 28.

[22] *See* Tex. Comm'n Envtl. Qual., *List of Texas PWSs Limiting Water Use to Avoid Shortages* at: http://www.tceq.texas.gov/drinkingwater/trot/droughtw.html (last updated on March 13, 2014) (last visited March 18, 2014).

[23] Attachment I, *available at*: http://www.tceq.texas.gov/assets/public/response/drought/proclamation.pdf (last visited March 18, 2014). Counties included in the Governor's declaration that contribute flows into the Highland Lakes or the lower Colorado River watershed include: Blanco, Brown, Burnet, Coleman, Colorado, Concho, Edwards, Gillespie, Kendall, Kerr, Kimble, Lampasas, Llano, Mason, McCulloch, Menard, Mills, Real, San Saba, Schleicher, Sutton, and Travis.

F. The emergency condition overrides the necessity to comply with the established procedures.

As documented above, the emergency condition presents an imminent threat to public health and safety. Because LCRA's WMP is required by, and incorporated into, LCRA's Certificates of Adjudication 14-5478 and 14-5482, the WMP may only be amended in the same manner and following the same procedures as one would amend any state-issued water right, which procedures for this type of amendment would require basin-wide 30-day public notice and significant staff review. Releases for the Blue Sucker in 2014 would start, at the latest, in mid-April. The decision-making window regarding those releases is not compatible with the WMP amendment process.[24] Thus, an emergency authorization is the only means by which LCRA can obtain timely approval of the requested relief and preserve water in storage.

VI. WATER QUALITY AND BLUE SUCKER SPAWNING HABITAT ARE NOT SUBSTANTIALLY AFFECTED BY THE REQUESTED RELIEF (30 Tex. Admin. Code §§ 35.101(a)(1)(B), (m))

A. With the requested relief, water quality will be maintained.

The Colorado River between Bastrop and Eagle Lake includes three stream segments. The state has previously identified water quality standards for these segments. LCRA monitoring when flow levels have been near or below 300 cfs demonstrates that the water quality standards are consistently met with few exceptions. *See* Affidavit of Bryan Cook (Attachment J). . Although the emergency conditions override the need to maintain a balance between protecting environmental flow needs and other public interests,[25] as demonstrated in this and the following subsections, environmental flow needs would nonetheless continue to be protected under the requested relief.

B. With the requested relief, the Blue Sucker will be protected, and impacts to its spawning habitat will be minimal.

The Blue Sucker (Cycleptus elongatus) is a state-listed threatened species in Texas which is uniquely adapted to life in swift current. Blue Suckers are known to undertake long spawning migrations, often covering hundreds of miles. When spawning, adults utilize high velocity flow areas over hard substrate such as bedrock outcrop, boulders, and cobble riffles. These habitat types are abundant between Bastrop and Eagle Lake. *See* Affidavit of Bryan Cook (Attachment J).

TCEQ rules provide when considering an application for emergency relief, flows necessary to protect a species of high interest may be required.[26] The proposed emergency relief will provide flows that protect the Blue Sucker and the relief is expected to have very little impact on Blue Sucker spawning habitat. At 500 cfs, the flow provides for 93 to 100 percent of the maximum available spawning habitat; while at the proposed 300 cfs, at least 86 percent of the habitat would

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[24] *See* 2011 Emergency Order, Finding of Fact 32.
[25] 30 Tex. Admin. Code § 35.101(a)(1)(B).
[26] 30 Tex. Admin. Code § 35.101(m).

still be supported. *See* Affidavit of Bryan Cook (Attachment J).

Furthermore, without any dedicated releases so far in 2014, streamflows in February and March of 2014 are already providing significant spawning habitat. The Blue Sucker can begin spawning as early as February. *See* Affidavit of Bryan Cook (Attachment J). For the period from February 1 through March 18, flow at the Bastrop gage has averaged 335 cfs with a minimum daily flow of 281 cfs; while flow at the Columbus gage has averaged 458 cfs with a minimum daily flow of 297 cfs. *See* Affidavit of Ryan Rowney (Attachment E). With the onset of releases for the Garwood Irrigation Division forthcoming, similar or higher flows are expected through the end of May. The flow conditions that have been in place this year and conditions with the proposed reduction in the obligation from 500 cfs to 300 cfs are supportive of significant Blue Sucker spawning habitat. *See* Affidavit of Bryan Cook (Affidavit J). The release of additional stored water from lakes Buchanan and Travis to maintain 500 cfs, if anything, would only provide a small incremental benefit to the Blue Sucker spawning habitat. In this exceptional drought with no clear end in sight, that additional water should remain in storage to help meet the critical needs of LCRA's firm water customers should this drought persist.

VII. THERE ARE NO FEASIBLE AND PRACTICABLE ALTERNATIVES TO THE REQUESTED RELIEF (30 Tex. Admin. Code §§35.24(c)(4), 35.101(c)(3)-(4), 295.91(3))

There are no immediate feasible or practicable alternatives to the emergency authorization sought herein. Water released from the lakes cannot be recaptured. LCRA is currently evaluating a number of short and long-term alternatives to address the emergency conditions, but they will take time to implement. *See* Affidavit of David Wheelock (Attachment C). As noted above, LCRA has already taken many steps to preserve its water supply in this drought, including: 1) the implementation of its drought contingency plan resulting in firm customers implementing mandatory watering restrictions; 2) emergency relief from the 2010 WMP in 2012, 2013, and 2014, resulting in the cutoff of interruptible stored water to most irrigation customers; and 3) obtaining temporary authorization to use its downstream water rights at additional diversion points where its firm customers currently divert water. While those actions have preserved significant amounts of water supply, there is no readily available option that would immediately offset the irreversible impact of releasing additional stored water to maintain a 500 cfs flow condition in the lower Colorado River, as currently required by the WMP.

VIII. REQUESTED RELIEF, TRIGGERS, AND DATES (30 Tex. Admin. Code §§ 35.24(c)(2), 35.24(c)(5)-(6), 35.101(c)(5), 35.101(c)(8), 295.91(2))

LCRA requests that it be allowed to reduce the instream flow requirement in effect for a continuous six-week period from March to May associated with the Blue Sucker under the 2010 WMP[27] from 500 cfs to 300 cfs with such relief to be effective for a period through May 31,

[27] LCRA acknowledges that its WMP already provides for some reductions in the amount of water provided for environmental flow needs, see 30 Tex. Admin. Code § 35.101(n) & (o); however, it is evident that the emergency conditions presented by this unprecedented drought were not fully appreciated when these special requirements were incorporated into the WMP. Specifically, the inflow conditions in 2011 and in 2013 represent conditions that are worse than conditions in the Drought of Record.

2014, or the end of the six week period, whichever is earlier. As noted above, significant spawning habitat has already been supported in 2014 and will continue to be supported at a 300 cfs flow level. Reducing the releases for the Blue Sucker results in an overall reduction in the chance of triggering DWDR this year. *See* Affidavit of Ron Anderson (Attachment F). Moreover, LCRA estimates that it would to preserve up to about 17,000 acre-feet in the lakes for later use during this extreme drought. *See* Affidavit of Ryan Rowney (Attachment E).

Based on the low inflows and resulting low storage levels in lakes Buchanan and Travis, significant amounts of water are necessary to alleviate the emergency conditions. Just to get within five percent of the inflows in the Drought of Record would require 252,000 acre-feet of water. *See* Affidavit of Ron Anderson (Attachment F, Tab 2). True recovery from the drought would require much more. (With combined storage currently at about 757,000 acre-feet, it would take over one million acre-feet to refill lakes Buchanan and Travis.) If storage drops below 600,000 acre-feet, firm customers will be forced into mandatory curtailment with cuts of 20 percent or more. The water which would be preserved as a result of the emergency relief sought by this application could avoid reaching that trigger level, and more importantly will be preserved to meet critical needs should the drought persist.

IX. WATER CONSERVATION PLAN AND DROUGHT CONTINGENCY PLAN IMPLEMENTATION (30 Tex. Admin. Code §§ 35.101(c)(6), 295.91(3))

The 2009 LCRA Raw Water Conservation Plan and relevant appendices include elements for LCRA as a wholesale water provider.[28] The LCRA Drought Contingency Plan included within chapter 4 of the 2010 WMP applies to all LCRA raw water customers.[29] The LCRA 2009 Water Utilities Conservation and Drought Contingency Plan applies to LCRA's retail surface water systems.

LCRA has been diligently implementing its Water Conservation and Drought Contingency Plans in an ongoing effort to reduce unnecessary water use. *See* Affidavit of Nora Mullarkey Miller (Attachment K). In 2011 when combined storage in lakes Buchanan and Travis fell below 900,000 acre-feet, LCRA called on its firm water customers implement the mandatory restrictions in their drought contingency plans to reduce water use by 10 to 20 percent. As lake conditions continued to deteriorate, LCRA's firm customers stepped up their efforts to extend the water supply. Since that time, most of LCRA's municipal customers have stayed in or moved into some form of mandatory water restrictions, significantly limiting landscape irrigation. LCRA industrial customers, who consist of power plants and a few large industries along the Gulf Coast, have also worked to reduce non-essential water uses. *See* Affidavit of Nora Mullarkey Miller (Attachment K, Tab 2).

In response to the ongoing drought conditions, the LCRA Board amended the firm customer drought contingency plan to require that, if combined storage on March 1, 2014 was below 1.1 million acre-feet and interruptible stored water to the Gulf Coast, Lakeside and Pierce Ranch

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[28] LCRA's Raw Water Conservation Plan is on file with TCEQ and available at: http://www.lcra.org/water/save-water/Documents/2009_LCRA_Water_Conservation.pdf.

[29] See Attachment B – 2010 WMP, Chapter 4.

irrigation operations was cut off, LCRA's firm customers would be required to implement a landscape irrigation watering schedule of no more than once per week.[30] The criteria for this restriction to take effect have been met and the restriction will be in effect until storage increases to above 1.1 million acre-feet or the supply of interruptible stored water to the Gulf Coast, Lakeside and Pierce Ranch irrigation operations resumes. LCRA has also adopted measures that would take effect in the event that combined storage falls below 600,000 acre-feet and is also preparing for possible further declines in storage. *See* Affidavit of Nora Mullarkey Miller (Attachment K).

X. CONSISTENCY WITH THE REGIONAL WATER PLAN

The Region K Water Plans identifies lakes Buchanan and Travis as the source of supply for numerous water users in the lower Colorado River basin. The existing Water Management Plan for lakes Buchanan and Travis calls for a release from those reservoirs for environmental purposes in the lower Colorado River, thus removing such water from the supply available to meet firm customers' demands. Preserving this water to meet the needs of LCRA's firm water customers is consistent with meeting an identified demand in the regional plan.

XI. APPLICATION FEES (30 Tex. Admin. Code §§35.24(c)(8), 35.30)

Enclosed please find a check in the amount of $751.25 to cover filing and recording fees.

[30] *See* Attachment L, LCRA Board Resolution, November 2013.

LIST OF EXHIBITS

Attachment A –Supplemental Information Supporting LCRA's Application for Emergency Relief
Attachment B – Excerpts from 2010 Water Management Plan
Attachment C –Affidavit of David Wheelock
Attachment D – Certificates of Adjudication 14-5478, as amended, and 14-5482, as amended
Attachment E – Affidavit of Ryan Rowney
Attachment F –Affidavit of Ron Anderson
Attachment G – Affidavit of Bob Rose
Attachment H – TEX. COMM'N ENVTL. QUAL., Docket No. 2014-0124-WR, Order affirming in part and modifying in part the Executive Director's emergency order authorizing the Lower Colorado River Authority to amend its Water Management Plan, Permit No. 5838, pursuant to section 11.139 of the Texas Water Code (Feb. 27, 2014)
Attachment I – Governor's Drought Proclamation (dated March 14, 2014)
Attachment J – Affidavit of Bryan Cook
Attachment K – Affidavit of Nora Mullarkey Miller
Attachment L – Resolution of the LCRA Board of Directors, November 2013
Attachment M – Certification of LCRA Board Agenda Item 17: Authorization for LCRA Staff to Seek Emergency Relief (dated March 19, 2014)
Attachment N – LCRA Policies Re: Signature Authority

WATER MANAGEMENT PLAN

FOR THE

LOWER COLORADO RIVER BASIN

EFFECTIVE SEPTEMBER 20, 1989

INCLUDING

AMENDMENTS APPROVED BY
TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
THROUGH JANUARY 27, 2010

AND

DROUGHT CONTINGENCY PLAN CHANGES
APPROVED BY THE LCRA BOARD OF DIRECTORS
THROUGH JUNE 16, 2010

Attachment B
Excerpts from 2010 WMP

DEDICATION

This revision of LCRA's Water Management Plan
is dedicated to Dr. Quentin W. Martin (1946-2003).

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VOLUME 1

WATER MANAGEMENT PLAN FOR THE LOWER COLORADO RIVER BASIN

PREFACE

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A. Background

The "business" of water resources management in Texas, and throughout the nation, is in the midst of transition and transformation. The transition is largely the result of ever increasing demands and competition for renewable but limited water supplies and a growing awareness of the limits of "traditional" water supply management strategies. Additionally, the spectra of long-range shifts in global climatic patterns have injected a new element of uncertainty in water resources planning and management. Clearly, the past may no longer be a valid guide to the future.

In response to new challenges and uncertainties, it is imperative that water management institutions, at all levels, adopt a balanced, flexible, and feasible approach that gives due weight to all the conflicting demands on the water, including the heavy economic dependence of the farmers on historic uses of irrigation water, rapidly emerging public interest in recreation, and environmental values. The challenge is to recognize both the historic uses and the forces of change, transform emerging problems into new opportunities, and guide the institutions of water resources management toward a new era where clean water in Central Texas is recognized as a scarce commodity.

On April 20, 1988 Judge J. F. Clawson of the 264th Judicial District of Bell County, Texas, signed the Final Judgment and Decree relating to LCRA's and the City of Austin's respective water rights. (See Appendix 1A, Volume II).[1] This settlement was the product of a long series of negotiations among LCRA, the City of Austin, and the Texas Water Commission (TWC), predecessor agency of the Texas Commission on Environmental Quality (TCEQ).

[1] The Appendices for Volume II of the Water Management Plan are also being updated at this time.

Under the Final Judgment and Decree, LCRA was granted the right to use 1,500,000 acre-feet annually from Lakes Buchanan and Travis. As part of this settlement LCRA was required to determine the Combined Firm Yield of both Lakes Buchanan and Travis. An interim level of Combined Firm Yield of 500,000 acre-feet was established by the Texas Water Commission (TWC) (predecessor to TCEQ) with an understanding that LCRA would establish the basis for the Combined Firm Yield calculation and submit it to the TWC. The amount of water available for use in excess of the Combined Firm Yield is considered interruptible water and may be sold only on an interruptible basis subject to annual availability and certain rules and conditions required by the TWC.

The purpose of this document, Water Management Plan for the Lower Colorado River Basin (WMP), is to define LCRA's water management programs and policies in accordance with these requirements.

The WMP is not a static document. As LCRA's blueprint for its operation of the Lakes Buchanan and Travis, the WMP is periodically revised to reflect changes in water demands. The last revision was completed by LCRA in February 1997 and approved by the Texas Natural Resources Conservation Commission (TNRCC) (predecessor to TCEQ) in 1999 (herein referred to as the 1999 WMP). The present revision was submitted to TCEQ in May 2003 and approved by TCEQ on January 27, 2010. The most notable changed condition over the last five years has been a significant increase in projected municipal and industrial (firm) water demands. With this large projected increase in firm water demand, the WMP must be adjusted to give a compensating reduction in the interruptible stored water supplies available since firm water demands take priority. This reduction will be achieved by revising the annual interruptible stored water supply curtailment policy adopted in this WMP. Revisions to the WMP require approval by LCRA's Board of Directors, followed by approval by the TCEQ. Such revisions become amendments to LCRA's water rights for Lakes Buchanan and Travis.

The allocation of water to various types of use in the WMP is also reviewed on an annual basis by LCRA. LCRA will continue to provide to the TCEQ an Annual Report on or before March 1.

B. Executive Summary

1. Legal Authority

The legal authority underlying the development of the WMP is derived from four principal sources:

(1) The Final Order of Adjudication of the water rights of the Lower Colorado River Authority;
(2) The Enabling Act of the Lower Colorado River Authority;
(3) General law of the State of Texas, particularly the Texas Water Code; and
(4) The water policies of the Lower Colorado River Authority Board of Directors.

In combination, the authorities establish and define LCRA's responsibility to develop and implement a WMP. In particular, the final adjudication of LCRA's water rights includes provisions relating to

the manner in which LCRA will manage the Highland Lakes and the Colorado River above and below the Highland Lakes and directed LCRA to prepare and submit a proposed WMP to the Texas Water Commission, predecessor agency to the TCEQ. This document was initially developed and is periodically revised by LCRA pursuant to that directive.

2. Summary of Water Management Plan

a. Key Elements of the Water Management Plan

The key elements of the WMP include the following:

(1) Lakes Buchanan and Travis and the Colorado River will be managed together as a single system for water supply purposes.

(2) LCRA will manage the system to maximize the beneficial use of water derived from inflows below the Highland Lakes.

(3) LCRA will manage the system to stretch and conserve the waters stored in Lakes Buchanan and Travis.

(4) All demands for water from the Colorado River downstream of Lakes Buchanan and Travis should be satisfied to the extent possible by run-of-river flows of the Colorado River.

(5) Inflows should be passed through Lakes Buchanan and Travis to honor downstream senior water rights only when those rights cannot be satisfied by the flow in the river below the Highland Lakes.

(6) The firm, uninterruptible commitments of water from Lakes Buchanan and Travis should not exceed the Combined Firm Yield.

(7) The water from Lakes Buchanan and Travis will be available on an interruptible basis as long as LCRA's ability to meet the demand for firm water is not impaired.

(8) Water shall not be released through any dam solely for hydroelectric generation, except during emergency shortages of electricity, and during other times that such releases will be needed for another beneficial purpose.

(9) Competing demands on the system include water quality matters, flood control, water supply, recreation and tourism, hydroelectric power, instream flows and bays and estuaries.

(10) The Combined Firm Yield of Lakes Buchanan and Travis is determined to be 535, 812 acre-feet, including that portion allocated to O.H. Ivie Reservoir, which is owned and operated by the Colorado River Municipal Water District.

(11) To supply existing firm water commitments, including commitments to the environment as proposed herein and the allocation of firm water to O. H. Ivie Reservoir, during a repetition of the critical drought would require an average of 442,350 acre-feet per year to be released, diverted, or otherwise committed from storage in Lakes Buchanan and Travis.

(12) LCRA's Board of Directions has reserved 50,000 acre-feet of the remaining Combined Firm Yield of Lakes Buchanan and Travis for the future needs within LCRA's 35-county water service area, particularly those areas now using ground water supplies that are becoming depleted or are of poor water quality.

(13) The four downstream irrigation operations (Gulf Coast, Lakeside, Garwood and Pierce Ranch) will have first priority for all the interruptible stored water in the annual allocation process to the extent of their Conservation Base acreage or Priority Allocation acreage, whichever applies.

(14) In recognition of the importance of recreation and tourism demands, additional sales of interruptible stored water, other than for the four irrigation operations pursuant to a semiannual allocation, will be limited based on the volume of water in Lakes Buchanan and Travis. The supply of interruptible stored water available for the January through June period will be based on the January 1 storage levels in Lakes Buchanan and Travis taken separately. The supply for the July through December period will be based on the minimum of the maximum storage levels in April, May and June in Lakes Buchanan and Travis taken separately. No sales will occur if either lake is less than 94% of its maximum conservation capacity. If both lakes are at their maximum conservation capacity as calculated above for either six-month period then such interruptible stored water sales will be limited to a total of 30,000 acre-feet for that year. For projected lake volumes between 94% and 100% of conservation capacity, such interruptible stored water sales will be limited proportionately, based on the storage reservoir with the lowest percentage of capacity on January 1 as calculated above.

(15) Instream flow needs will be met by the release of stored water from Lakes Buchanan and Travis to maintain the daily river flows at no less than the critical instream flow needs in all years. Daily river flows will be maintained at the target instream flow needs in those years when the four major irrigation operations are not curtailed, to the extent of inflows each day to the Highland Lakes as measured at the upstream streamgages. Releases of stored water will be a combination of firm and interruptible water supplies. Firm stored water will be supplied in years when the four major

irrigation operations' interruptible stored water supplies are curtailed. Interruptible stored water will be supplied in all other years. Total commitments of the Combined Firm Yield from Lakes Buchanan and Travis for instream flow maintenance will be an average of 27,380 acre-feet per year, with a maximum of:

(a) 51,100 acre-feet in any one year;
(b) 85,700 acre-feet in any two consecutive years;
(c) 114,200 acre-feet in any three consecutive years;
(d) 147,700 acre-feet in any four consecutive years;
(e) 184,500 acre-feet in any five consecutive years;
(f) 212,200 acre-feet in any six consecutive years;
(g) 246,500 acre-feet in any seven consecutive years; and
(h) 273,800 acre-feet in any eight to ten consecutive years.

(16) Bays and estuary needs will be met by releasing monthly stored water from Lakes Buchanan and Travis to meet target inflow needs of 1.03 million acre-feet per year if January 1 storage level in Lakes Buchanan and Travis combined is greater than 1.7 million acre-feet. Critical inflow needs of 171,120 acre-feet per year will be met in all years with releases of stored water from Lakes Buchanan and Travis. In years when the January 1 combined storage in Lakes Buchanan and Travis is less than 1.7 million acre-feet but greater than 1.1 million acre-feet (*i.e.* 86% and 55% full, respectively), one hundred and fifty percent (150%) of critical inflow needs (256,680 acre-feet per year) will be met, subject to the available monthly storable inflows into Lakes Buchanan and Travis. Releases of stored water will be a combination of firm and interruptible water supplies. Firm stored water will be supplied in years when the four major irrigation operations' interruptible stored water supplies are curtailed. Interruptible stored water will be supplied in all other years. Total commitments of the Combined Firm Yield from Lakes Buchanan and Travis for bays and estuaries (estuarine inflows) will be an average of 6,060 acre-feet per year, with a maximum of:

(a) 20,660 acre-feet in any one year;
(b) 23,570 acre-feet in any two consecutive years;
(c) 23,680 acre-feet in any three consecutive years;
(d) 32,220 acre-feet in any four consecutive years;
(e) 40,800 acre-feet in any five consecutive years;
(f) 41,400 acre-feet in any six consecutive years;
(g) 47,800 acre-feet in any seven consecutive years; and
(h) 60,600 acre-feet in any eight to ten consecutive years.

(17) The total firm stored water commitment for both environmental purposes will be an average of 33,440 acre-feet per year. Estimated interruptible stored water supplied

during the critical drought for both purposes will be an additional 23,030 acre-feet per year.

b. Key Elements of the Drought Management and Drought Contingency Plans

The key elements of the Drought Management and Drought Contingency Plans (DMP/DCP) include the following:

(1) A 10-year time period from 2000-2010 is the time frame for the DMP/DCP.

(2) The DMP/DCP establishes criteria for the curtailment of stored water that is committed through contract or by LCRA Board resolution.

(3) Establishes a criteria for interruptible stored water supply curtailments that protects firm demands, establishes a Reserve Storage Pool, and provides for gradual curtailment in order to protect the full demand of first crop rice in all years of the critical drought.

(a) Open Supply - If the total January 1 storage in Lakes Travis and Buchanan combined is equal to or greater than 1,400,000 acre-feet, then LCRA will supply all interruptible stored water demands. This assumes 273,000 acre-feet of interruptible storage water is sufficient to irrigate a total of 83,700 acres within the four irrigation operations, with seventy percent (70%) of that acreage being irrigated for a ratoon, or second, crop of rice.

(b) Curtailment occurs in stages when the combined storage in Lakes Buchanan and Travis on January 1 is less than 1.4 million acre-feet and greater than 325,000 acre-feet. If combined storage on January 1 is between 1.4 million acre-feet and 1.15 million acre-feet, the interruptible stored water supply available will vary beginning at 273,000 acre-feet available at 1.4 million acre-feet of storage and decreasing at a rate of approximately 31,200 acre-feet for each 100,000 acre-foot decrease in combined storage until a value of 195,000 acre-feet available at a combined storage of 1.15 million acre-feet. When the combined storage in Lakes Buchanan and Travis on January 1 is less than 1,150,000 acre-feet, the interruptible stored water supply available will vary beginning at 195,000 acre-feet available at 1.15 million acre-feet of storage and decreasing at a rate of approximately 4,250 acre-feet for each 100,000 acre-foot decrease in combined storage until a value of 160,000 acre-feet available at a combined storage of 325,000 acre-feet.

(c) Cutoff of interruptible supply for the coming year occurs when combined storage in Lakes Buchanan and Travis on January 1 is less than or equal to 325,000 acre-feet.

(d) Review and cancel the curtailment of interruptible stored water for the irrigation operations at any time during the year prior to July 31, if the combined storage in Lakes Buchanan and Travis is projected to be equal to or greater than 1.4 million acre-feet anytime in July.

(e) Reserve Storage Pool - Cutoff of all interruptible supplies when combined storage in Lakes Buchanan and Travis is less than or equal to 200,000 acre-feet.

(f) Allow each irrigation operation the option of a fixed maximum amount of interruptible stored water or all the water necessary to cultivate a maximum acreage agreed upon by the operation and LCRA.

(g) LCRA encourages its firm water customers to implement long-term water conservation measures year-round to meet the goals included in their water conservation plans. LCRA will implement a public awareness campaign on water use and conservation.

(h) Whenever total storage in Lakes Buchanan and Travis is at or below 1.4 million acre-feet, LCRA requests its firm water customers implement the voluntary water use reduction measures contained in their drought contingency plans, with a target reduction goal of five percent.

(i) Whenever the total storage in Lakes Buchanan and Travis is at or below 900,000 acre-feet, LCRA will ask all its firm water customers to implement mandatory water use reduction measures in their drought contingency plans, with a target reduction goal of 10 - 20 percent. LCRA will also begin discussions with firm water customers to develop a specific stored water curtailment plan, to be approved by the LCRA Board and TCEQ.

(j) During a drought more severe than the Drought of Record, LCRA will implement a mandatory pro rata curtailment of a minimum of twenty percent among all of its firm water supply customers according to the amount of firm water to which they are legally entitled under the terms of their contract and consistent with the curtailment plan approved by the LCRA Board and TCEQ. If lake levels continue to drop below 600,000 acre-feet, the mandatory pro rata curtailment percentage may be increased as determined by the LCRA Board. All uses of interruptible stored water will be totally cutoff prior to and during any mandatory curtailment of firm stored water customers.

(k) Require legally enforceable local drought contingency plans for LCRA firm water customers and the four major irrigation operations.

TABLE P-1, below, summarizes these plan elements.

TABLE P-1. DROUGHT CONTINGENCY PLAN SUMMARY TABLE

	A	B	C	D	E	F	G	H
	Drought Response Levels and Stages	**Water Use Reduction Goals**	**Water in Storage (acre-feet)**	**Status (Date)**	**Actions Affecting Interruptible Supplies**	**Actions Affecting Firm Supplies**	**Actions Affecting Instream Flows**	**Actions Affecting Matagorda Bay Freshwater Inflows**
1			**Full**	January 1	Full Supply	Full Supply **Voluntary Conservation; Public Awareness Campaign**	1. Full Supply for Critical Needs 2. Supply for Target Needs Limited to Storable Inflows	Supply for Critical and Target Needs Limited to Storable Inflows
2			**N/A**	January 1 or July 1 – Other customers (either Lake Travis or Buchanan less than 94% full)	1. Interruptible Supplies Cease for All Customers Except Four Major Irrigation Operations 2. Full Supply for Four Major Irrigation Operations			
3			**Less than 1,700,000**	January 1				1. Supply 150% of Critical Needs Limited to Storable Inflows 2. Cease Meeting Target Needs
5	**Firm Stage 1: Voluntary Conservation** **Interruptible Level 1: Initial Curtailment**	**5% of firm demand** ***0-30% of interruptible demand**	**Less than 1,400,000**	January 1 At Any Time – Conservation	Begin Curtailment for Four Major Irrigation Operations with interruptible stored water ranging from 273,000 acre-feet available at storage of 1.4 million acre-feet to 195,000 acre-feet at storage of 1.15 million acre-feet	Full Supply Begin Voluntary Drought Measures	1. Full Supply for Critical Needs Only 2. Cease Meeting Target Needs	
6	**Interruptible Level 2: Steeper Curtailment**	***30-40% of interruptible demand**	**Less than 1,150,000**	January 1	Continued Curtailment for Four Major Irrigation Operations with interruptible stored water ranging from 195,000 acre-feet at storage of 1.15 million acre-feet available to 160,000 acre-feet at storage of 325,000 acre-feet			
7	*NOTE: Interruptible water use reductions are built-in to the interruptible stored water curtailment schedule.							

TABLE P-1. DROUGHT CONTINGENCY PLAN SUMMARY TABLE

	A	B	C	D	E	F	G	H
	Drought Response Levels and Stages	**Water Use Reduction Goals**	**Water in Storage (acre-feet)**	**Status (Date)**	**Actions Affecting Interruptible Supplies**	**Actions Affecting Firm Supplies**	**Actions Affecting Instream Flows**	**Actions Affecting Matagorda Bay Freshwater Inflows**
8			**Less than 1,100,000**	January 1 - Environmental Flows At Any Time - Conservation				Supply Only for Critical Needs Limited to Storable Inflows
9	**Firm Stage 2: Requested Mandatory Conservation**	**10-20% of firm demand**	**Less than 900,000**	At Any Time During Year		Full Supply Request Mandatory Drought Restrictions Meet with Firm Customers to Develop Curtailment Plan TCEQ and LCRA Board Approve Curtailment Plan		
10	**Firm Stage 3: Pro-Rata Curtailment**	**20% or more of firm demand**	**Less than 600,000** If Drought Worse Than Drought of Record*	At Any Time During Year	Interruptible Supplies Cease, Unless Drought Less than 36 Months in Duration, then Interruptible Supplies Cease No Earlier than Following July 31 or Jan. 1, which ever comes first	Curtail Firm Customers on Prorata Basis with Other Firm Users According to Approved Plan	Curtail on Prorata Basis with Other Firm Users	Curtail on Prorata Basis with Other Firm Users
11	**Interruptible Level 3: Cutoff Supplies**	**100% of interruptible demand**	**Less than 325,000**	January 1	Interruptible Supplies Cease			
12	**Interruptible Level 4: Cutoff Supplies**	**100% of interruptible demand**	**Less than 200,000**	At Any Time During Year				
13	*NOTE: Drought Worse than Drought of Record defined by all of the following conditions occurring simultaneously at any time: 1. Combined Storage in Lakes Travis and Buchanan being less than 600,000 acre-feet. 2. Drought duration of at least 24 months. 3. The cumulative inflow deficit of the current drought exceeding that of the drought of record by at least 5% for a minimum of six consecutive months. 4. Declaration of the LCRA Board based on all three of the above conditions occurring simultaneously.							

C. Definitions

To understand the WMP, it is important to know the definitions of the key legal and hydrologic terms used in this plan. The major terms are defined below and should be considered specific to LCRA.

adjudication - a court proceeding to determine all rights to the use of water on a particular stream system.

beneficial use of water - use of the amount of water that is economically necessary for a purpose authorized by law, when reasonable intelligence and reasonable diligence are used in applying the water to that purpose. Such uses include domestic use, municipal uses, industrial use, agricultural use, hydroelectric power, navigation, fish and wildlife, etc. The benefit may vary from one location to another and by custom. Beneficial uses are defined by statute in the Texas Water Code.

combined firm yield - a specific amount or quantity of water stated in acre-feet that represents the maximum average annual demand that can be met from a reservoir system during a simulation of a repetition of the system's Drought of Record, while honoring the full extent of upstream and downstream senior water rights.

conservation base acreage - the historical 10-year average acres irrigated at a total of 5.25 acre-feet of water per acre irrigated.

curtail - to reduce the supply of water being provided through a diversion by reducing the amount of water served under the contract for a specific period of time. Curtailment may occur during drought or other emergency conditions.

critical drought period - the period of time during which the reservoir system was last full and refilled, and the storage content was at its minimum value.

cutoff(water) - to discontinue, or to terminate completely, the supply of water provided under contracts for diversion for a certain period of time. Cutoff may occur during drought or other emergency conditions.

diversion demand - the water pumped from a water body for beneficial use.

domestic water use –use of water by an individual or a household to support domestic activity. Such use may include water for drinking, washing, or culinary purposes; for irrigation of lawns, or of a family garden and/or orchard; for watering of domestic animals; and for water recreation including aquatic and wildlife enjoyment, but does not include water used to support activities for which consideration is given or received or for which the product of the activity is sold.

drawdown - the lowering of the water level in a water body by diversion, pumping, or release.

drought - a prolonged period of dryness or lack of rainfall that has a significant effect on water or water-related uses.

drought of record - the drought that occurred during the critical drought period.

firm water - a supply of stored water that is drawn from the combined firm yield of the reservoir system. Such supplies are diverted or otherwise committed under a contract or resolution issued by the LCRA Board.

firm yield - the maximum average annual supply of water that can be supplied from a water source without shortages during a repetition of the critical drought period.

gaging station - particular site on a stream, canal, or lake where systematic observations of hydrological data are obtained.

instream flow - the specific amount of water needed to flow in a stream or river to support aquatic life, minimize pollution, or for recreational use, usually stated as a daily mean discharge values in cubic feet per second.

interruptible stored water - stored water supplied pursuant to contract or resolution, where the contract, resolution or special conditions defining the commitment specifically provides that such commitment is "subject to interruption or curtailment."

irrigation - The use of water for the irrigation of crops, trees, and pasture land, including, but not limited to, golf courses and parks, which do not receive water through a municipal distribution system.

reserve storage pool - a storage level that, when reached at any time during the year, would require the total cutoff of all water for interruptible use.

run-of-river flows - the natural flow in the river that is available under law at a given point on the river at a given instant in time to honor a right with a given priority date. This flow is determined by hydrologic studies that assume that all reservoirs and diversions under upstream junior rights do not exist. Rights to use run-of-river flows for beneficial uses, rights to store inflows in reservoirs, and pass-through of inflows and releases from reservoirs, are regulated by the TCEQ.

storable inflows - the actual daily inflows to the reservoir system minus the daily pass throughs from the reservoir system required to meet downstream senior water rights.

storage capacity - the quantity of water that can be contained in a reservoir.

streamflow - rate of flow of water that occurs in a natural channel.

water conservation - those practices, techniques, and technologies that will: (1) reduce the consumption, loss or waste of water, (2) improve the efficiency in the use of water, or (3) increase the recycling and reuse of water, so that a water supply is made available for future or alternative uses.

water right - a legally protected right, granted by law, to impound, divert, convey, or store state water and put it to one or more beneficial uses.

CHAPTER 1
INTRODUCTION TO THE WATER MANAGEMENT PLAN

A. Goals of the Water Management Plan 1-1
B. LCRA Act 1-2
C. LCRA Water Resources Management – History and Guiding Principles 1-4
D. LCRA's Comprehensive Water Policy Review and Public Stakeholder Process 1-5
E. Organization of the WMP 1-6

A. Goals of the Water Management Plan

The 1988 Final Judgment and Decree adjudicating LCRA's Highland Lakes water rights required LCRA to submit a reservoir operations plan describing how LCRA would determine the amount of firm and interruptible stored waters and how LCRA would manage the waters in Lakes Buchanan and Travis and the Colorado River. The Water Management Plan for the Lower Colorado River Basin (WMP) was developed using the following goals and guidelines as provided in the Final Judgment and Decree:

1. Lakes Buchanan and Travis and the Colorado River will be managed together as a single system for water supply purposes.

2. LCRA will manage the system to maximize the beneficial use of water derived from inflows below the Highland Lakes.

3. LCRA will manage the system to stretch and conserve the waters stored in Lakes Buchanan and Travis.

To achieve the goals stated above, LCRA will manage the system according to the following guidelines:

1. All demands for water from the Colorado River downstream of Lakes Buchanan and Travis should be satisfied to the extent possible by run-of-river flows of the Colorado River;

2. Inflows should be passed through Lakes Buchanan and Travis to honor downstream senior water rights only when those rights cannot be satisfied by the flow in the Colorado River below the Highland Lakes;

3. The firm, uninterruptible commitments of water from Lakes Buchanan and Travis should not exceed the Combined Firm Yield;

4. The water from Lakes Buchanan and Travis will be available on an interruptible basis as long as LCRA's ability to meet the demand of its firm water customers is not impaired;

5. Water shall not be released through any dam solely for hydroelectric generation, except during emergency shortages of electricity and during other times that such releases will be needed for another beneficial purpose.

B. LCRA Act

Through the passage of the LCRA Act by the Texas Legislature in 1934, LCRA was established as a "conservation and reclamation district" consisting of ten counties that comprise the watershed of the lower Colorado River. Those ten counties are Blanco, Burnet, Fayette, Colorado, Llano, Travis, Bastrop, Wharton, San Saba, and Matagorda. The LCRA Act was amended in 1993 to expand LCRA's water service area to include all or part of an additional twenty-four counties. In 1999, the LCRA Act was amended to include Williamson County in LCRA's water service area and was again amended in 2001 to allow LCRA to enter into an agreement with the San Antonio Water System (SAWS) to provide water. LCRA's current water service area is depicted in Figure 1-1. The 1999 amendment contains specific restrictions on LCRA water sales to Williamson County. Similarly, the 2001 amendment contains very lengthy and detailed restrictions and study requirements prior to any transfer of water to SAWS. The Highland Lakes system is comprised of two water storage reservoirs, Lakes Buchanan and Travis, and three intermediate pass-through reservoirs, Lakes Inks, LBJ and Marble Falls. Lake Austin, the last of the lakes in the chain, is owned by the City of Austin but operated by LCRA under agreement and may be referred to as part of the system from time to time. Technical data on each of the dams and lakes is included in Appendix 2A of Volume II.

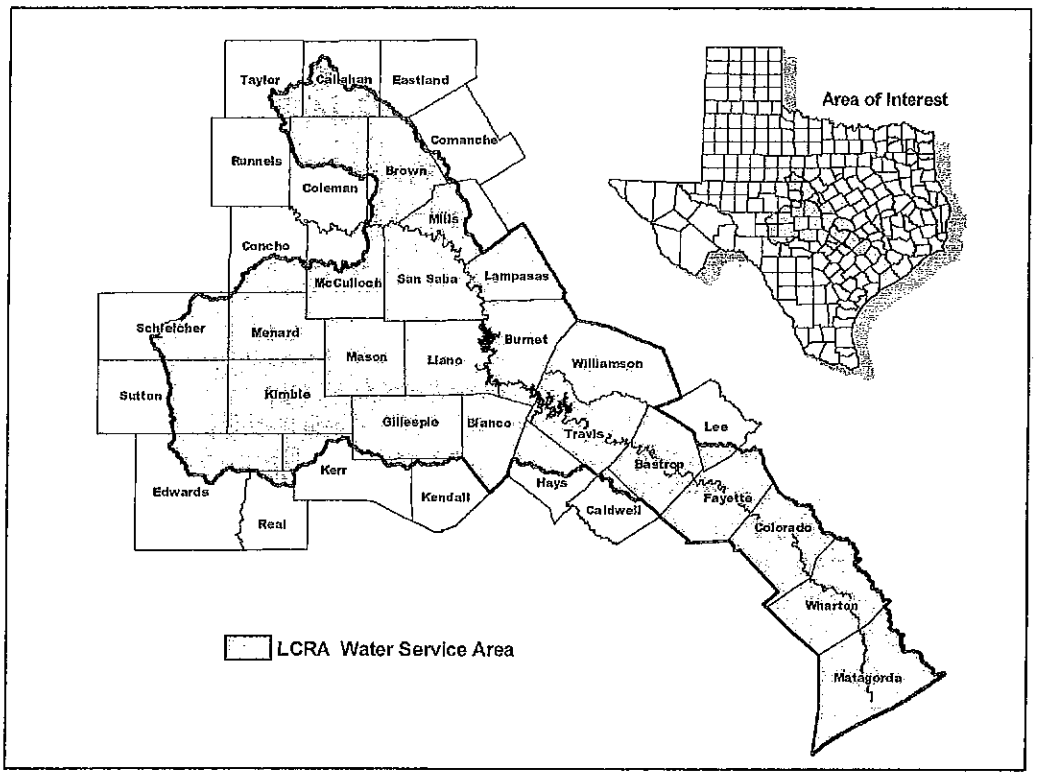

Figure 1-1. LCRA Water Service Area as of January 1, 2003.

LCRA has been delegated the responsibility of harnessing the Colorado River and its tributaries and making them productive for the people within LCRA's water service area.

The Act establishes LCRA's mission in four areas--water, electric energy, conservation and lands. In water, LCRA is empowered to control floods and control, store, sell, preserve and distribute the waters of the Colorado River and its tributaries. The waters are to be used for beneficial purposes including irrigation, generation of electric energy, reclamation of arid lands and the creation of lakes for water storage. LCRA is required to prevent flood damage to people and property by the Colorado River and to control the uses of the surface of the lakes it created.

Consistent with the control of the waters, LCRA is empowered to develop, distribute, and sell the energy created through hydroelectric generation both inside and outside the 10-county district. Later legislation allowed LCRA to expand its electric generation capabilities beyond hydropower through developing fossil fuel generation facilities.

As a conservation and reclamation district, LCRA is to conserve and develop the lands, forests and water of the district and to study and correct both artificial and natural sources of pollution that may affect the ground and surface waters within the district. LCRA is also empowered to provide water and wastewater treatment services within the district.

During the construction of the dams and development of the Highland Lakes system LCRA acquired large tracts of land that surround the reservoir system. The Act authorizes LCRA to develop, manage, and promote the use of these lands for parks, recreational facilities and natural science laboratories and to promote the preservation of fish and wildlife. LCRA must also provide public access to, and use of, its lakes and lands for recreation.

Each of the many purposes, functions, and uses of the elements of the river—the lakes, the lands, the ground and surface waters, the bays and estuaries—must be considered as parts of an integrated system.

The WMP describes the issues and conflicts that LCRA must recognize and, where possible, resolve.

C. LCRA Water Resources Management – History and Guiding Principles

It is important to consider the historical context in which this WMP has evolved. In the early years of LCRA's existence, the predominant priorities in water resources management were to moderate and control the floods and droughts in the Lower Colorado River Basin. This was accomplished through the construction of dams in the Hill Country west of Austin, which created the Highland Lakes.

The results have been impressive. The ravages of floodwaters have largely been controlled. These same dams have also provided a dependable source of water supply for municipal, industrial, agricultural, and mining uses. Additionally, the Highland Lakes provided the source of inexpensive, renewable electrical energy, and recreational opportunities for the citizens and communities of Central Texas. In sum, the work of LCRA in its early years provided the foundation on which much of the present day population and economy of Central Texas depend.

Notwithstanding the successes of the past, in developing a WMP for the river, LCRA today faces an array of water management issues and opportunities that were scarcely envisioned a half-century ago. Recreation has emerged as a major use, both on the lakes and the river. Maintaining the aquatic habitat in the river channel and in the bays and estuaries is a major use, as is water quality and the use of the river to sustain a growing population and economy. This intensified competition among the various users of the water resource is placing increasing stress on the ecological and environmental resources supported by the Colorado River. LCRA, in partnership with the State of Texas, local governments, and private interests, must confront these challenges as we develop a meaningful WMP.

LCRA's WMP is grounded in these key principles:

(1) LCRA recognizes the supremacy of the State of Texas, acting through the TCEQ, as the ultimate authority for water resources management and as the arbiter of disputes involving the allocation of water from the Colorado River and its tributaries. LCRA, within the intent and meaning of its legal authority, is the steward of the water rights granted to it by the State of Texas. Further, LCRA recognizes the responsibilities and prerogatives conferred upon local political subdivisions of the State and the rights of private citizens and corporations.

(2) Many water management issues and opportunities are regional in scope and effect. Solutions and strategies must be built upon regional consensus and action. LCRA considers its role as one of consensus-building among competing users of Colorado River water and among the public and private interests concerned with the management of the Colorado River.

(3) LCRA, in exercising its responsibilities as a steward of the water resources of the Colorado River and its tributaries, will strive to maximize the beneficial use of Colorado River water and achieve a sustainable balance among the competing demands on the system. In pursuing this objective, LCRA will implement management procedures and programs addressing:

(A) The efficient management of available water supplies as an integrated system;
(B) Water demand management measures including long-term conservation measures and short-term drought contingency measures;
(C) Protection and, where possible, enhancement of water-related environmental values; and
(D) Future water supply development and augmentation.

D. LCRA's Comprehensive Water Policy Review and Public Stakeholder Process

LCRA has approached the development of the WMP as much more than a set of complex engineering tools to serve as guidelines for operating the structures on the Colorado River system. The development of the WMP stimulated a comprehensive review of how LCRA has developed and operated the Highland Lakes and the lower Colorado River system for the past 60 years to meet the needs of the area it serves.

As a foundation for the prior versions of the WMP, LCRA conducted a comprehensive review of the policies and programs that guide and shape the way LCRA manages the river system. This review was conducted as a series of meetings held as joint public meetings of the LCRA Board's Planning and Public Policy and Natural Resources Committees. The meetings were designed to use staff expertise and information from outside experts to analyze the environmental, social, economic and legal factors that shape the issues that LCRA faces in managing the Colorado River system.

An important part of these public meetings was the involvement of the State agencies, environmental groups, business, industry and agricultural interests, wholesale electric customers and other constituencies whose interests are affected by LCRA policies. The process was designed to assure that participation was effective in informing LCRA of public views and also so that these constituencies would be better informed about the issues involved in the policy decisions. An issues inventory was developed and briefing papers were prepared for each of the meetings. Summaries of the meetings elements were developed and distributed to the LCRA Board and members of the public.

As a result of the Board and the public review, LCRA adopted a set of water and flood control policies to address many of the issues in water quality and water supply that face LCRA today and

will continue to face the agency well into the future. These policies undergo periodic review and revision by the LCRA Board. (See Appendix A, Volume I for the most current versions of these policies).[1] These policies, read in conjunction with LCRA's Certificates of Adjudication for the Highland Lakes, have formed the foundation of LCRA's WMP.

In developing the initial WMP and all of its subsequent revisions, LCRA has sought broad public participation through the work of an Advisory Committee and a series of public information and input meetings in the LCRA district. The Advisory Committee included over two dozen representatives from varied interests in the river basin. Taking part in the process were State and local officials, rice farmers, representatives of tourism and recreation interests, coastal sports and commercial fishing interests, business and industry and economic development representatives and environmental interest group leaders. The other major water right holders on the Lower Colorado River were also active participants on the Advisory Committee.

The purpose of the Advisory Committee has been to provide information to LCRA on the attitudes and interests of the major organizations and groups concerned with the allocation and management of LCRA's water resources. LCRA management and staff appreciate the commitment of time and energy made by the Advisory Committee. The Advisory Committee has actively participated in the development of the technical studies and the analysis of the policy options during every revision of the WMP. In addition, they aided LCRA by providing information on the WMP to the public and the local news media. Many of the policy concepts and alternatives found in the WMP are the direct result of suggestions made by the Advisory Committee. However, neither the report as a whole, nor any portion thereof, necessarily reflects the views of the Advisory Committee or any member of the Advisory Committee.

E. Organization of the WMP

Volume I of the WMP is organized as follows:

(1) Chapters 1-3 of the WMP describe the issues and conflicts in the demands on the Colorado River system and lays out the policies and management actions LCRA will use to accommodate the variety of demands on the system.

(2) Chapter 4 of the WMP describes the issues and conflicts in the demands on the Colorado River system during drought periods and sets forth the policies and

[1] Since the WMP's last approval in 1999, the LCRA Board of Directors has amended or consolidated several of its policies related to water. Board Policy 502 "Interbasin Transfers" and Board Policy 504 "Water Resources Management" were repealed by the LCRA Board on June 21, 2000 and combined, with amendments, into Board Policy 501 "Water Resources Management," initially adopted on Aug. 18, 1999 and subsequently amended June 21, 2000, Sept. 18, 2002, and November 16, 2005. Board Policy 503 "Lowering of LCRA Operated Lakes" was amended on Oct. 20, 1999, Sept. 18, 2002, and October 20, 2004. Board Policy 507 "Water Quality Leadership" was amended on December 13, 2000. Board Policy 509 "Water Conservation" was last amended on June 21, 2000. Board Policy 508 "Water Pricing Policy" is included, but has not been amended since December 16, 1988, but a reformatted version of the policy is contained in this submission.

management actions LCRA will use to address the competing demands for water in times of shortage based on 2010 projected demands for water.

(3) Chapters 5-6 of the WMP describe the engineering and hydrological models and data sources and the process for the determination of the Combined Firm Yield of Lakes Buchanan and Travis.

Volume II of the WMP is a compilation of several technical appendices used to develop the WMP.

- 40,800 acre-feet in any five consecutive years;
- 41,400 acre-feet in any six consecutive years;
- 47,800 acre-feet in any seven consecutive years; and
- 60,600 acre-feet in any eight to ten consecutive years.

The total firm stored water commitment for both purposes will be an average of 33,440 acre-feet per year. Estimated interruptible stored water supplied during the critical drought for both purposes will be an additional 23,030 acre-feet per year.

8. Summary

To supply the demands of the preceding commitments for firm water existing during a repetition of the critical drought would require an average of 442,350 acre-feet per year to be released or diverted from storage in Lakes Buchanan and Travis, assuming the proposed changes to firm commitments to instream flows and freshwater inflows to the bays and estuaries are accepted. This commitment is summarized below in Table 3-1.

Table 3-1. Existing Firm Water Commitments as of April 2003

O.H. Ivie Reservoir	90,546
City of Austin	122,084
Contracts from Lakes Buchanan and Travis	119,838
LCRA Water Utilities and Facilities	6,911
LCRA Power Plants	63,851
South Texas Project	5,680
Instream Flows/	27,380 (annual average)
Bays and Estuaries	6,060 (annual average)
TOTAL	442,350 acre-feet/year

Out of concern for the future needs of the many areas in LCRA's 35-county water service area, including areas now using ground water supplies that are becoming depleted or are of poor water quality, the LCRA Board committed to reserving 50,000 acre-feet of the remaining Combined Firm Yield.

This leaves an uncommitted balance of the Combined Firm Yield of 60,952 acre-feet per year with the commitments of firm supply to instream flows and freshwater inflows to the bays and estuaries as adopted by the TCEQ in 1999. Or, as indicated in Table 3-1, if the proposed changes to these commitments are accepted, the uncommitted balance of the Combined Firm Yield will drop to 43,462 acre-feet per year.

C. Annual Allocation of Firm and Interruptible Stored Water

Each year, LCRA will determine the amount of water that is available for interruptible commitments to supply the uses authorized under LCRA's Certificates of Adjudication.

No interruptible stored water will be supplied to cities or other industries that should be served on a firm basis. Interruptible stored water will be limited to irrigation or other similar uses where the value of water is well below firm water rates and the purchase is for one year only. New contracts for firm and interruptible stored water are subject to the Water Contract Rules as specified in Appendix 3 of Volume II.

In November of each year, LCRA determines the amount of water that is available in the following year to meet firm and interruptible demands in the system. LCRA manages the conservation storage of the reservoirs by using the interruptible stored waters to increase the average yield of the system.

Should an emergency occur that causes a demand for additional allocations of water to either firm or interruptible stored water contract holders, any interested party may petition the LCRA Board for such additional purchases.

1. Allocation of Firm Water

The amount of water required to meet the firm demand within the system for the preceding year will be calculated in early October. This amount will be compared to the projections for that year, and any variations will be noted and documented. LCRA will solicit information and projections of use from all of its firm supply contract holders and other firm uses provided for by resolution of the LCRA Board. This information will be used to develop a projection of firm demands for the coming year.

LCRA will assess the contents of Lakes Buchanan and Travis as of November 1 to project the storage levels for January 1 of the next year. Inflows into Lakes Buchanan and Travis from the upstream tributaries will be added to this preliminary storage level based on the minimum annual inflow from the period of drought.

This process will allow LCRA to reserve sufficient water in the system to meet all firm demands for one year beyond the year being considered for allocation.

Estimates for firm demand commitments for the next year will be subtracted from the total water supply available. The amount of water remaining will then be available for interruptible allocation for that year.

2. Allocation of Interruptible Stored Water

As part of the overall allocation process, every November LCRA will determine the amount of water that is available in the following year for interruptible contracts. LCRA may make commitments for interruptible stored water for terms in excess of one year. However, the allocation of interruptible stored water to be supplied under such commitments will be determined on an annual basis. All interruptible commitments are subject to full or partial curtailment.

3. Priority Uses in the Allocation of Interruptible Stored Water

In the allocation process, priority will be given to the irrigation operations (Lakeside, Gulf Coast, Garwood, and Pierce Ranch) to firm-up run-of-river water rights associated with individual irrigation operations. The LCRA Board will establish, by resolution, a Conservation Base number of acres determined by the historical (10-year) average acres that have been irrigated by Lakeside and Gulf Coast irrigation operations. The amount of surface water to be used for irrigation under this Conservation Base is based upon a limit of 5.25 acre-feet of water per acre irrigated (see Table 3-2). The priority allocation for Garwood irrigation operation is based on a contract that defines LCRA's commitment to supply interruptible stored water to the Garwood irrigation operation to the extent necessary to firm up the 133,000 acre-foot-per-year run-of-river water right associated with the Garwood irrigation operation. The priority allocation for Pierce Ranch is based on a contract that defines LCRA's commitment to supply interruptible stored water to Pierce Ranch. These contractual commitments to Garwood and Pierce Ranch are not based on a "Conservation Base acreage" calculation, but the 5.25 acre-foot-per-acre duty will apply to the acreage irrigated.

The Conservation Base acreage for the Lakeside and Gulf Coast irrigation operations will be served without charge for the amount of water designated under each operation's run-of-river rights. In years when the amount of run-of-river water is projected to be insufficient to serve the Conservation Base and the priority allocations for Garwood and Pierce Ranch, the annual allocation of interruptible stored water will provide back-up for those rights. The charge for the allocation of interruptible stored water shall be at the prevailing interruptible stored water rate set by the LCRA Board or, in the case of Garwood and Pierce Ranch, in accordance with their respective contracts with LCRA.

TABLE 3-2
CONSERVATION BASE ACREAGE OR OTHER PRIORITY ALLOCATION OF INTERRUPTIBLE STORED WATER

	LAKESIDE	GULF COAST	GARWOOD[1]	PIERCE[3]
Acres x Duty[2]=Ac. Ft.	26,000 x 5.25 = 136,500 acre-feet	24,300 x 5.25 = 127,575 acre-feet	32,000 with 100,000 acre-feet.	25,000 with 20,000 ac. ft. (Max. 30,000 ac. ft.)
Conservation Base[6] Or other Priority Allocation	see above	see above	see above	see above
% R-O-R Rts.[4]	44.6%	58.6%[7]	93.1%	0%[8]
% Stored Int.[5]	55.4%	41.4%[7]	6.9%	100%[8]

[1] Garwood Irrigation Company and LCRA entered into a contract dated December 10, 1987, which defines LCRA's commitment to supply interruptible stored water to Garwood and the terms for curtailment during periods of shortages. This contractual commitment to Garwood is not based on a "Conservation Base Acreage" calculation, but the 5.25 acre-foot-per-acre duty will apply to the acreage irrigated. In 1998, LCRA purchased the assets of Garwood Irrigation Company, including its water rights. Under the terms of the 1998 agreement, LCRA has committed to supply up to 100,000 acre-feet annually consisting of run-of-river under the LCRA-owned Garwood water rights and LCRA interruptible stored water.

[2] Duty set by TCEQ (5.25 Ac.Ft./Ac.) for rice irrigation.

[3] LCRA has entered into a contract with Pierce Ranch regarding LCRA's commitment to supply interruptible stored water to Pierce Ranch and the terms for curtailment during periods of shortage. This contractual commitment to Pierce Ranch of 20,000 acre-feet annually based on a rolling five-year average with a 30,000 acre-feet maximum in any calendar year is not based on a "Conservation Base Average" calculation, but the 5.25 acre-foot-per-acre duty will apply to the acreage irrigated. The Pierce Ranch operation needs may also still be met through exercise of Certificate of Adjudication No. 14-5477D.

[4] % of Conservation Base or other Priority Allocation likely to be supplied by run-of-river rights (*i.e.* estimated reliability of the water right)

[5] % of Conservation Base or other Priority Allocation expected to be supplied by Interruptible Stored Water based on reliability of run-of-river rights.

[6] LCRA purchased 55,000 acre-feet of water rights from Pierce Ranch and transferred these water rights for diversion and use within the Lakeside service area, which is currently 28,300 acres

[7] % based on water used for 37,000 acres (194,250 acre-feet)

[8] % based on water use for 7,200 acres (37,800 acre-feet)

4. Use of Interruptible Stored Water for Recreation

Interest groups around the Highland Lakes, such as marina owners and other tourist and recreation industry members represented by the Highland Lakes Tourist Association expressed the need for recreation to be given some priority in the allocation of interruptible stored water.

In developing the annual interruptible allocation process, LCRA has considered the needs of the recreation industry around the lakes and proposes establishing some use of the interruptible stored waters to maintain lake levels in Lakes Buchanan and Travis. These levels would be above the possible minimal drawdowns of the lakes under the operating rule curve and would be established in recognition of LCRA's public interest responsibilities.

The conflict between supplies of interruptible stored water being held in the lakes for recreation or being released and sent downstream for agricultural irrigation and public recreation is one of the most difficult issues for LCRA to balance. The rice farmers have a historic claim to a "first call" on the water used for rice farming as shown in Table 3-2. However, LCRA believes that the needs and interests of the recreation industry that has developed around the Highland Lakes must be heard and given due consideration.

Once the first priority allocation of interruptible stored water has been made to supply the Conservation Base of the Lakeside and Gulf Coast irrigation operations and LCRA's contractual commitments to the Garwood and Pierce Ranch irrigation operations, LCRA staff will make recommendations to the LCRA Board for the remainder of the interruptible stored water available for supplying other authorized uses under LCRA's water rights. In recognition of the economic benefits to the recreation industry in the Highland Lakes region, the WMP establishes a process to consider the levels of Lakes Buchanan and Travis.

LCRA will limit additional sales of interruptible stored water, other than for the four irrigation operations' Conservation Base or Priority Allocation acreages, based on the combined volume of water in Lakes Buchanan and Travis at certain times of the year. To provide for more flexibility to supply interruptible stored water in normal and wet years, the supply allocation formula is based on a semi-annual allocation process using the following policies:

1. Interruptible stored water supply available (other than to the four major irrigation operations) for January through June in any year is based on the minimum of the separate storage levels, as percent of maximum water conservation capacity) in Lakes Buchanan and Travis on January 1 of that year according to the schedule provided in Table 3-3.

2. Interruptible stored water supply available (other than to the four major irrigation operations) for July through December in any year would be based on the minimum for Lakes Buchanan and Travis of their separate maximum storage levels (as percentage of capacity) in April, May and June of that year. That is, the maximum percent full for each lake over April through June would be compared and the lower

of the two percentages selected. The water supply allocation for July through December is also given in Table 3-3.

3. Maximum supply available in any year is 30,000 acre-feet, with the semi-annual allocation based on a typical municipal monthly demand distribution.

TABLE 3-3. MAXIMUM INTERRUPTIBLE STORED WATER AVAILABLE FOR SALE, EXCLUSIVE OF SALES FOR THE CONSERVATION BASE OR PRIORITY ALLOCATION ACREAGE OF THE FOUR IRRIGATION OPERATIONS

Minimum of the Maximum Reservoir Storage for Either Lakes Travis or Buchanan Either on January 1 or over the months of April, May and June (As Percentage of Full Water Conservation Capacity)	Maximum Additional Interruptible Stored Water Available for Sale in January Through June (Acre-feet)	Maximum Additional Interruptible Stored Water Available for Sale in July Through December (Acre-feet)
≤94	0	0
95	2,170	2,830
96	4,330	5,670
97	6,500	8,500
98	8,670	11,330
99	10,830	14,170
100	13,000	17,000

No maintenance, except for emergencies that would require the lowering of Lakes LBJ, Marble Falls, and Inks, will be permitted if the refilling of those lakes would result in substantial loss of hydropower generation benefits or other costs. Periodic lowering and refilling of Lake Austin will be done when requested by the City of Austin and consistent with LCRA Board Policy 503-Lowering LCRA-Operated Lakes.

5. Publication of Allocation of Firm and Interruptible Stored Water

LCRA will publish the results of the allocation process and notify the LCRA Board, the firm supply contract holders, and any existing or potential interruptible contract holders of the results.

6. Monthly and Quarterly Operations

The operational rule curve will be applied to the system on a monthly basis to determine how the system is responding to current conditions as compared to historical operations. This will allow LCRA to optimize reservoir operations on a real time basis and to determine if adjustments to the amount of interruptible stored water should be considered. The monthly allocation model serves to continually evaluate inflows into the system, to evaluate risks, and to assess system reliability. The monthly analysis would detect early signs of drought and allow LCRA to develop and implement contingency measures in a timely fashion.

At minimum, a quarterly system operations report showing inflows to the system, monthly releases for firm and interruptible commitments, and important operating characteristics will be provided to the LCRA Board.

D. Summary of LCRA's Water Conservation Plan and Programs

Although LCRA has had extensive water conservation programs since the late 1980s, it did not formally adopt a water conservation plan until 1998. This plan was updated to reflect water conservation and drought contingency planning requirements under Senate Bill 1 and approved by the LCRA Board of Directors in April 2000. In March 2009, the LCRA Board of Directors approved water conservation goals and strategies that will be phased in over several years to reduce overall water use in the basin. The 2009 LCRA Raw Water Conservation Plan meets the requirements of Chapter 288 of the TCEQ rules as a wholesale water supplier for municipal, irrigation and industrial customers, as a retail supplier of water to irrigation operations, and as an industrial user of water at LCRA power plants. The Plan discusses separate water conservation strategies for municipal wholesale water customers, LCRA irrigation divisions, LCRA power plants, and other nonagricultural and agricultural irrigation, recreation and industrial uses. The following provides a summary of LCRA's plan.

1. Wholesale Municipal, Industrial and Other Firm Water Supply Strategies

Water conservation and reuse are viewed as important strategies for mitigating the effects of urban growth on the region's water resources, particularly in the Austin and surrounding areas. In addition to reducing future municipal water demands, municipal water conservation and reuse can make important contributions toward satisfying the water and wastewater service requirements of growing urban populations and economics.

LCRA's municipal water conservation programs are predicated on the fact that the implementation of conservation measures must occur in partnership with customers and stakeholders. Many water utilities have limited or no programs for water conservation, while the City of Austin (accounting for more than 70 percent of all municipal water use in LCRA's water service area) has one of the most aggressive conservation programs in Texas. As such, the focus of LCRA's programs is to increase water-use efficiency to reduce the waste of water throughout the water service area Strategies are listed below.

a. Water Measurement and Accounting

The LCRA Water Contract Rules impose requirements on LCRA's water customers to properly measure water diversions. One of the provisions specifically requires all meters to be accurate within +/- 5 percent of the indicated flow over the possible flow range. LCRA personnel read these meters on a monthly basis. Each customer is required to provide third-party verification of meter testing and calibration to LCRA staff each year. LCRA-owned and-operated water utilities must also follow these rules.

b. Monitoring and Records Management

LCRA maintains records of water distribution and sales through several monitoring and billing systems. A Windows-based system provides a central location for water billing information and an automated way to compile and present that information.

c. Conservation-Oriented Rates

LCRA's wholesale raw water rates were designed to encourage water conservation. The water rate is 42 cents per 1,000 gallons or $138 per acre-foot. However, any water used above the contracted amount increases to $262.20 per acre-foot. Customers also are allotted a reservation charge of $69 per acre-foot for water reserved but not used.

LCRA has also developed increasing block rates for all retail water utilities.

d. Contractual Requirements

According to LCRA Board Policy 509 - Water Conservation, all future water sales contracts and water utility agreements shall contain "appropriate conditions requiring conservation measures that are economically feasible." LCRA's Rules for Water Conservation are updated periodically to meet the requirements of Chapter 288 of TCEQ's rules for water conservation and drought contingency plans.

All plans must be reviewed and approved by LCRA staff before contracts are signed. Each customer agrees that, in the event that it furnishes water or water services to a third party that in turn will furnish the water or services to the ultimate consumer, the water conservation requirements shall be met through contractual agreements between it and the third party.

In April 2007, the LCRA Water Contract Rules were amended to clarify that LCRA will determine the reasonableness of the quantity of any raw water contract request. The reasonableness of the quantity requested is evaluated based on many factors, including the applicant's water conservation plan, delivery or system losses, and other factors. Agency and industry standards are used in LCRA's assessment, including but not limited to the TWDB Water Conservation Task Force Best Management Practices Guidebook. To the extent the applicant requests a water supply based on standards other than those commonly used, the applicant must submit a written justification describing the reasons these standards were not

employed and how the water supply needs were calculated.

e. Technical Assistance

LCRA has worked with communities and cities in its water service area for the past two decades to demonstrate the effectiveness of water conservation in reducing water consumption and wastewater flows. This effort ranges from providing sample water conservation programs, to developing conservation and drought contingency plans and landscape ordinances, to providing planning and equipment for plumbing retrofit programs.

f. Public Education and Outreach

LCRA began implementing the Water IQ program in Central Texas in 2006. The program uses a diverse set of tools to reach the public with water-saving tips and information, including television, radio, and print ads; billboards; electronic advertising; and community outreach with key audiences. In 2008, the City of Austin, LCRA, and the City of Cedar Park collaborated on the Water IQ: Know your Water campaign. Recognizing that water conservation outreach programs can be costly and consumers may become confused hearing mixed messages from water suppliers, LCRA and two cities pooled their resources on a shared outdoor water efficiency campaign. By reaching a consensus on a few key outdoor watering recommendations, the three entities were able to transmit a valuable regional message that reached a broad range of customers throughout the 10-county area.

Additional LCRA outreach and education efforts include the promotion of the Texas Hill Country Landscape Option to promote landscape best management practices, continued involvement in the Major Rivers education program, natural science education programs at LCRA nature parks, and the use of video tutorials and other water efficiency tips on the LCRA Web site. In 2008, TWDB and LCRA jointly updated the Major Rivers curriculum to correlate with the latest education standards and to add additional "hands-on" activities such as a new outdoor water use and conservation activity.

g. Future Conservation Strategies

In January 2009 LCRA staff proposed a comprehensive strategic plan for municipal, industrial and non-agricultural irrigation water conservation — based on results of the research and considering input from stakeholders and customers — to the LCRA Board. This comprehensive program will include a variety of strategies to save water, including incentive programs through which LCRA will partner with its customers to offer water-saving fixtures such as high-efficiency toilets; requirements that new construction meet standards for soil depth and irrigation systems; and expansion of LCRA's education outreach efforts to provide useful information to consumers. Elements of the program will be phased in over the next several years.

2. Irrigated Agriculture Conservation Strategies

As the largest user of water from the lower Colorado River system, irrigated agriculture provides the best opportunity for reducing the overall demand through conservation programs. Beginning in 1986, LCRA initiated a major program to increase irrigation water use efficiency in rice irrigation systems. Rice cultivation accounts for more than 90 percent of all irrigation in LCRA's water service area.

LCRA's efforts in irrigation water conservation have been and continue to be focused on promoting water conservation at its irrigation operations: Lakeside, Gulf Coast and Garwood. These systems, along with one other privately owned major irrigation company, account for approximately 65 percent of the surface water irrigation in Colorado, Wharton, and Matagorda counties. The LCRA irrigation operations do not provide water for other wholesale customers or public water suppliers.

Substantial water savings resulted from irrigation conservation programs implemented in the Lakeside and Gulf Coast Irrigation Operations. Combined between the two operations, LCRA saved about 41,500 acre-feet annually from 1989 to 1996. This savings is approximately 13 percent of the projected water use that would have occurred without conservation practices in place. Conservation strategies implemented in the operations include the following:

a. Water Measurement

From 1989 to 1997, LCRA invested about $1.3 million for improvements in the water delivery system, structure standardization, purchase of electronic measurement devices for daily measurements, and customer education. Starting in 1993, LCRA began selling irrigation water in the Lakeside and Gulf Coast systems at a price based on a mix of acreage and water use. Formerly, LCRA provided water to individual customers of the irrigation operations only on the basis of acreage irrigated. In 2009, the LCRA Board approved a project to complete similar improvements to the Garwood system to enable on-farm water measurement which include the purchase of in-canal check structures to improve water distribution as well as structure standardization. Initial funding of $250,000 was approved recently from HB1437 funds. This project began in the fall of 2009 and is anticipated to be complete by 2012. This strategy is anticipated to save at least 3,400 acre-feet per year and possibly as much as 10,000 acre-feet per year.

b. Canal Maintenance (Water Loss) Program

In 1987, LCRA initiated an irrigation canal rehabilitation project for improving canal conveyance efficiency, reducing power consumption, and improving canal system management. In this project, from 1987 to 1996, LCRA invested about $1.5 million for regrading and selectively removing high water-consuming trees and vegetation from about 210 miles of canal; replacing about 300 water control structures, and modifying pump utilization schedules. The large majority of effort was in the Gulf Coast system. Prior to the implementation of this project, canal water loss in the Gulf Coast system was about 55 percent and in the Lakeside system was

about 25 percent. Following the implementation, based on recent analysis, this loss has come down to about 30 percent in the Gulf Coast system and about 20 percent in the Lakeside system.

With the completion of the canal rehabilitation project, LCRA has implemented a routine preventive maintenance program. This effort is expected to maintain existing canal operation efficiencies within the Lakeside and Gulf Coast systems. The Garwood canal system is in relatively good shape, with losses running at about 20 percent, similar to that found in the Lakeside system.

c. Customer Outreach

To facilitate communication with irrigation customers, LCRA created the Lakeside and Gulf Coast Farmer Advisory Committees in 1984. Garwood Irrigation Operation customers formed a farmer advisory committee in 1999, shortly after LCRA acquired the system. These committees represent the interests of customers of the irrigation systems. They also provide forums for LCRA to inform the farming community on LCRA's water conservation programs and to stimulate discussion on potential farming practices that can reduce water use. The HB1437 program also has an advisory committee, as required by the legislation. This committee was reappointed in 2009 and is actively involved in reviewing HB1437 activities.

LCRA initiated agricultural water conservation efforts in the mid 1980s through funding $90,000 to the Texas A&M University Agricultural Research and Experiment Station for developing the "Less Water, More Rice" program. The emphasis of this program was to deliver water conservation messages to rice irrigators. Based on the preliminary results of "Less Water, More Rice," improved cultivation and management practices (e.g., precision land leveling, multiple inlet systems, etc.) can reduce on-farm water use by 25 to 30 percent.

d. House Bill 1437

In May 1999, the Texas Legislature passed House Bill 1437, which allows LCRA to sell up to 25,000 acre-feet of water from the Colorado River to public water suppliers in Williamson County. The HB 1437 legislation requires "no net loss" of water in the Colorado River watershed and authorizes an additional charge to be added to the base water rate to fund strategies to ensure that an equal amount of water is conserved, replaced or offset. Funds collected from the additional charges are to be used for the development of water resources or other water use strategies to replace or offset the amount of surface water transferred. In 2000, LCRA entered into a water supply contract with the Brazos River Authority to provide water to Williamson County communities. A 25 percent surcharge is applied to the standard water rate to provide income to the Agricultural Water Conservation (Ag) Fund. In 2004, the LCRA Board authorized an engineering study and public meetings to develop a plan for implementing the HB 1437 program. The results of this study lead to the revised LCRA Board Policy 501, which defined the term "no net loss," and the development of a short-term plan to implement conservation projects that would allow the water transfer to occur under the provisions of the HB 1437 legislation. This short-term implementation plan has been updated recently and was finalized in October 2009.

The HB 1437 Agricultural Water Conservation Program was developed in 2005 in order to provide grants from the fund to eligible producers to construct on-farm water conservation projects. From 2006-2009, this program has provided grant funding to precision level a little over 19,000 acres, saving an estimated 4,750 acre-feet of water each year, mostly in the Lakeside and Garwood Irrigation Divisions. An annual report is prepared yearly showing details of current demand projects, current planning efforts, program results (including volume conserved and available for transfer), financial details about the Ag Fund, and a program outlook for the next year. To date, approximately $1.875 million has been spent on this program. Recently, the LCRA Board authorized an additional $200,000 to fund precision land leveling cost-share projects in 2010 and $250,000 to begin the Garwood measurement project. In 2009, LCRA contracted with a PhD student at the University of Texas' LBJ School to complete a statistical model to verify water savings from the precision land leveling grant program. This work is expected to be completed in 2010.

3. Industrial Water Conservation Strategies

a. Fayette Power Project

The Fayette Power Project (FPP) has an extensive conservation and reuse program. The power plant conserves and reduces the amount of water diverted from the river. This helps maintain the integrity of the cooling reservoir dam by properly controlling the water level. FPP developed a plant water balance that indicates water usage. It was found that unique opportunities existed at FPP that do not exist at other plants, mainly because of its size and the reuse design from the no-discharge ponds. Highlights of reused water and wastewater include:

- Water reuse from the reclaim pond in the Unit 3 Flue Gas Desulfurization (FGD).
- Reverse osmosis reject water reused in the FGD or returned to the lake.
- Reuse of ash pond water for Units 1 & 2 bottom ash and economizer fly ash removal.
- Reuse of wastewater treatment plant effluent in the ash pond or reclaim pond.
- Reuse of the fly ash runoff pond water in the reclaim pond.
- Reuse of the coal runoff water in the ash pond in times of drought.

Additional conservation measures for FPP include converting the bottom ash system on Units 1 and 2 to a dry system, using reclaimed pond water in place of raw water for dust suppression, recycling stormwater from the coal pile runoff pond back to the reservoir, recycling stormwater from the reclaimed water pond to the reservoir, distributing information and training about water conservation and leak detection to employees, and revising the irrigation system to use wastewater or alternative water sources.

b. Lost Pines Power Park (includes Sim Gideon and Lost Pines 1 Power Plants)

The largest water conservation and cost reduction measure at the facility is the implementation of a Lake Bastrop elevation level management policy, whereby the lake level is managed to an elevation that is eight to 14 inches below the spillway for multiple reasons. By maintaining an

average 12-inch drop in elevation, there is a reduction in the surface area of Lake Bastrop from 915 surface acres to 875 acres. This is a 4.4 percent reduction in the natural evaporation loss rate. Another benefit is the opportunity this level provides to capture rainfall runoff and never incur any loss by overflowing the spillway. Additionally, all the water used at Sim Gideon in the production of high purity boiler water, such as blowdown, backwash, and reverse osmosis reject waters, are returned to Lake Bastrop for reuse, which reduces the power plant's water consumption from Lake Bastrop. Additional conservation strategies include seasonally managing the lake level to optimize rainfall capture and further minimize natural evaporation rates, converting old plumbing fixtures to high efficiency models, distributing of information and training about water conservation and leak detection to staff, and revising the irrigation system to use wastewater or an alternative water source such as rainfall.

c. Thomas C. Ferguson Power Plant

The Thomas C. Ferguson Power Plant currently reuses approximately 450,000 gallons of water from its demineralization process. The water is reused by mixing it with Lake LBJ water and using it as clarifier makeup. Reusing this water has eliminated a discharge outfall to the Colorado River. Additional conservation strategies include converting old plumbing fixtures to high efficiency models, distributing information and training about water conservation and leak detection to staff, and revising the irrigation system to use wastewater or an alternative water source such as rainfall.

CHAPTER 4
DROUGHT MANAGEMENT PLAN AND DROUGHT CONTINGENCY PLAN

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A. Introduction

1. Background

On September 20, 1989, the Texas Water Commission, the predecessor agency to the TCEQ, issued its Order approving LCRA's Water Management Plan (see Appendix C, Volume I) for the Highland Lakes and the lower Colorado River. The Commission's Order included a requirement for LCRA to submit, within one year, a Drought Management Plan (DMP) with the Commission for its review and approval. On December 23, 1991, the Texas Water Commission issued its Order approving the DMP. (See Appendix D, Volume I). TCEQ subsequently adopted specific rules requiring water suppliers, such as LCRA, to develop a Drought Contingency Plan (DCP). LCRA's initial DCP was modeled after the most recent DMP approved by the Commission in 1999. As part of this WMP revision, LCRA proposes to fully incorporate into the WMP the LCRA's DCP, with modifications.

Chapter 4 describes the Lower Colorado River Authority's DMP, as required by the water rights granted to LCRA, as well as LCRA's DCP, as required by Commission rules (collectively DMP/DCP). Although the water resources available in the lower Colorado River are considered

as a system, only waters used under LCRA's water rights are addressed by this DMP/DCP.

LCRA recognizes that its responsibility and authority under this DMP/DCP is subject to and shall not conflict with the authority of any Watermaster operation the TCEQ may establish on the Colorado River. Moreover, LCRA recognizes that the Commission has jurisdiction to resolve any and all disputes regarding the allocation of stored water from Lakes Buchanan and Travis, not withstanding the procedures and guidelines set forth in this DMP/DCP.

2. The Lower Colorado River System

The lower Colorado River is considered to be the lower portion of the drainage basin of Colorado River beginning in San Saba County and continuing to Matagorda County on the Texas Gulf Coast (see Figure 1-1). The river flows through nine of the ten counties that make up LCRA's statutory water district.

The upper portion of LCRA's district is part of the Texas Hill Country. In the Hill Country, the river is largely controlled by a series of five dams and their reservoirs--Buchanan, Inks, Wirtz, Starcke, and Mansfield. Marked by steep slopes and shallow rocky soils with outcroppings of granite and limestone, the Hill Country ends abruptly in the Balcones Fault region near the edges of Austin. At Austin is the Tom Miller Dam that creates Lake Austin. From the eastern edges of Austin the river broadens out, snaking through the dark rich Blackland Prairie soils and then rolls gently downstream through the sand and shale of the coastal plains.

Water from the Colorado River and its tributaries is used for a variety of purposes to support the citizens and economy in the LCRA district. These uses include public water supply, manufacturing, cooling water for electric generating plants, irrigation, agriculture and mining. The water to supply these uses comes largely from the natural runoff into the Colorado River. However, the Colorado River Basin is subject to recurrent, severe droughts and devastating floods resulting in wide ranges of river flows. To provide an assured water supply and to relieve flooding, the LCRA, with the help of the Federal government, constructed the Highland Lakes reservoir system.

The development of LCRA's dams and reservoirs on the Colorado River, accomplished in the years from 1939 through 1951, changed Central Texas in many ways. Beginning by controlling the devastating floods on the river, using the river's power to generate electricity, and creating a secure and reliable water supply, LCRA has helped to stimulate the growth and development of the region. The lower Colorado River's water resources satisfy a wide variety of uses, many of which have changed and will continue to change in concert with the changes in the environment and the growth and development of the region.

3. Major Water Rights Holders

The largest water right holders in LCRA's water district also use the majority of the water (Table 4-1). LCRA holds the largest rights, with rights to use up to 1.5 million acre-feet per year from

Lakes Buchanan and Travis. Some of the other large water right holders downstream of Lakes Buchanan and Travis have priority dates earlier than that of LCRA's Highland Lakes permits. These rights belong to the City of Austin, Corpus Christi (portion of Garwood), LCRA for Pierce Ranch, and the LCRA's Garwood, Lakeside and Gulf Coast Irrigation Operations. These rights are considered as senior in time and superior to LCRA's right to store water in the Highland Lakes. Hence, any inflows to the Highland Lakes that need to be diverted for use under these rights must be passed through the Lakes for use downstream. There are also some large water rights downstream of Lakes Buchanan and Travis that have junior priority dates.

TABLE 4-1 MAJOR WATER RIGHTS AND AUTHORIZED RIGHTS IN THE LOWER COLORADO RIVER BASIN, LISTED IN ORDER OF PRIORITY (Acre-Feet/Year)

LCRA (GARWOOD)	133,000
CORPUS CHRISTI (GARWOOD)	35,000
CITY OF AUSTIN (LAKE AUSTIN)	250,150
LCRA (GULF COAST)	228,570
LCRA (LAKESIDE)	107,500
LCRA (PIERCE RANCH)	55,000
CITY OF AUSTIN (Remainder of Certificate of Adjudication No. 5471)	46,403
LCRA (Lakes Buchanan and Travis)	1,500,000
CITY OF AUSTIN (Certificate of Adjudication No. 5489)	35,456
STP NUCLEAR OPERATING COMPANY and LCRA	102,000
LCRA (Gulf Coast junior portion)	33,930
LCRA (Lakeside junior portion)	78,750
TOTAL	2,606,759

4. Historic Operation of the Highland Lakes

Lakes Buchanan and Travis serve as the water supply and flood control reservoirs in the Highland Lakes system. Since their construction in the late 1930s and early 1940s, the water storage in these lakes has fluctuated dramatically in response to extreme floods and droughts. The lakes were at their lowest levels in 1952 when Lake Buchanan was at 983 feet mean sea level (msl) and Lake Travis was at 614 feet msl. The highest water surface elevations were in 1991 for Lake Travis (710.4 feet msl) and in 1991 for Buchanan (1021.37 feet msl).

Operational management of the lakes has also changed over time. A major use of the dams in the 1940s and 1950s was for hydroelectric power generation. That use became secondary to water supply purposes when LCRA developed its fossil fuel electric generation stations. As a result of the Final Judgment and Decree for LCRA's water rights, the use of water for hydroelectric generation was formally subordinated to higher uses except during emergency shortages of electricity, and during other times to the extent that such releases will not impair

LCRA's ability to satisfy all existing and projected demands for water from Lakes Buchanan and Travis pursuant to all firm commitments and all non-firm, interruptible stored water commitments.

5. Purpose and Legal Considerations

The purpose of the DMP/DCP is to specify how LCRA will contract and supply firm and interruptible stored water supplies during a repetition of the critical Drought of Record. In managing the stored water from Lakes Buchanan and Travis, LCRA must

- Define the conditions under which water shortages exist, and
- Specify the actions to be taken by LCRA to mitigate the adverse effects of such shortages.

The overall goals of the DMP/DCP are to:

- Extend available water supplies.
- Preserve essential uses of water and protect public health and safety during extreme shortages of supplies.
- Equitably distribute among LCRA's water customers any adverse economic, social and environmental impacts associated with drought-induced water shortages.

The scope of the DMP/DCP must adhere to the findings of the State District Court's Final Judgment and Decree, adjudicating LCRA's water rights, as well as the 1989 Water Commission's Order approving the WMP and TCEQ rules concerning drought contingency plans. The scope of the DMP is limited to the curtailment of LCRA's interruptible stored water supplies to insure that there is sufficient firm water available to meet projected demands for such water through a repetition of the Drought of Record and also addresses how LCRA will provide water for environmental flow needs. Firm water is subject to curtailment only if it is determined that the drought in effect is worse than the Drought of Record. The DCP also addresses water use reduction goals required by TCEQ's Chapter 288 rules and establishes more detailed procedures for pro rata allocation of interruptible stored water during periods of curtailment.

In times of shortage of supply caused by drought or emergency, LCRA, in accordance with Section 11.039 of the Texas Water Code, will first curtail and distribute the available supply of interruptible stored water among all of its interruptible stored water supply customers on a pro rata basis, so that preference is given to no one and all interruptible stored water supply customers suffer alike. Although projected firm demands for stored water for the next ten years are significantly greater than demands included in the last revision to WMP, these projected needs are still significantly less than the total firm water supplies available.

If the shortage of supply caused by the drought is worse than the Drought of Record, then LCRA must curtail and distribute the available supply of firm water among all of its firm water supply customers on a pro rata basis, so that preference is given to no one and all firm water supply

customers suffer alike.

In the annual allocation of interruptible stored water supplies, LCRA follows the priority order of water use as specified in Section 11.024 of the Texas Water Code and the WMP.

Similarly, in making additional commitments of firm water supplies, LCRA must also follow the priority order of uses given in Section 11.024 of the Texas Water Code.

As noted above, a goal of the DMP/DCP is to determine how to allocate available water supplies when there is not sufficient supplies to meet projected water demands even after reasonable, cost-effective water conservation efforts have reduced the water demands. Therefore, the DMP/DCP does not emphasize water conservation practices that should occur all the time, not just in drought conditions. LCRA has major programs to encourage conservation in water use. These programs are summarized in Chapter 3 of this WMP.

As discussed previously, the WMP, and the DMP/DCP, require periodic revision to reflect changes in water demands. The last revision was completed by LCRA in February 1997 and approved by TCEQ in March 1999. Significant changes in demand, as discussed below, have necessitated the present revision.

The most noticeable changed condition over the last five years has been a significant increased projection of municipal and industrial (firm) water demands. The WMP approved in 1999 projected the ten-year future firm demands within LCRA's service area at about 280,000 acre-feet annually for 2005. Based on the analyses for Regional Plans pursuant to the Senate Bill 1, the ten-year projected demands are now projected to be about 360,100 acre-feet per year for 2010 (see Table 4-2). The primary reason for this increase is additional water needs to meet population and economic growth in the Austin area, including domestic water use around the Highland Lakes.

With this large projected increase in firm water demand, the WMP must be adjusted to give a compensating reduction in the interruptible stored water supplies available since firm needs take priority. This reduction can be achieved by revising the annual interruptible stored water supply curtailment policy adopted in the WMP.

B. Water Users and Interest Groups

1. LCRA Firm Water Customers

LCRA manages the Highland Lakes for the benefit of all users. LCRA supplies water under its water rights for the Highland Lakes to numerous municipal water supply systems, manufacturers, and power generating plants. As of May 2003, LCRA had over 110 contracts for firm water supplies. The total contractual commitments and reservations of firm water from Lakes Travis and Buchanan at the time was about 318,364 acre-feet per year. This number does not include any commitment to instream flows or freshwater inflows to the bays and estuaries or the amount

allocated to O. H. Ivie Reservoir. Annual use of firm stored water was about 35-36 percent of the 318,364 acre-foot amount.

The major concern of firm water customers is that sufficient supplies be allocated to insure that their demands for water are fully satisfied even during severe drought conditions. An additional concern for those customers pumping water directly from Lakes Buchanan and Travis is that the lake levels remain sufficiently high for them to continue to use their existing water intake structures. Extending intake facilities further into the lake to follow retreating shorelines can be very expensive. Most of the intakes can accommodate water levels at the historical low lake levels of 614 feet msl on Lake Travis and 983 feet msl on Lake Buchanan.

2. Agricultural Interests

a. Historic Claims to the Waters of the Colorado River

The waters of the Colorado River have served the rice farming industry of the Texas Gulf Coast counties of Colorado, Wharton and Matagorda counties since 1885 when the first rice crops were planted near Eagle Lake, Texas. When legislation creating LCRA was first proposed in the Texas Legislature in 1933, promises were given to the rice producers and other farmers that the waters stored behind the dams proposed for the LCRA system would be available to serve their needs when the natural flow of the river diminishes in dry years.

Rice is the major crop irrigated in the most downstream three counties in the LCRA water district. While some rice producers in the region irrigate their crops with pumped groundwater, the major source of water for irrigation is from the waters of the Colorado River, either under run-of-river water rights, or from releases of interruptible stored water from Lakes Buchanan and Travis. Approximately 40% of the water used to irrigate in the three counties comes from groundwater. The majority, 60%, is supplied from surface water. Approximately 379,300 acre-feet, which is about 56% of the annual water use of the Colorado River and the Highland Lakes, is used for rice farming. During an average year, about 30% of the total surface water used for irrigation comes from the interruptible stored water in Lakes Buchanan and Travis.

When LCRA has purchased irrigation operations (Gulf Coast in 1959, Lakeside in 1983, and Garwood in 1998) and their associated senior water rights from private firms, LCRA made certain commitments to the farmers to provide water from Lakes Buchanan and Travis as back-up to the run-of-river rights.

b. Concerns of the Agricultural Interests

The primary concern of the agricultural interests is how LCRA will curtail the interruptible stored water during times of shortage. The producers understand the interruptible concept because, in essence, the waters were always interruptible. The WMP formalizes the understanding of how the water supply--both run-of-river and stored water--is managed.

3. Recreation and Tourism Interests

The waters of the Colorado River and the Highland Lakes serve a variety of recreational and tourism interests in Central Texas. In the WMP, LCRA recognizes the economic interests of the tourism and recreation industry around the Highland Lakes through a commitment to limit its sales or commitments of interruptible stored water, other than to satisfy the four irrigation operations' Conservation Base acreage or Priority Allocation acreage, based on the volume of water in Lakes Buchanan and Travis, as described later in this Chapter.

While the WMP sets minimum projected reservoir storage levels for Lake Travis and for Lake Buchanan, the lakes will most likely have fallen below these levels during even a brief drought period. Economic hardship on the owners of the many marinas, small recreation businesses (bait stores, fishing camps, restaurants, campgrounds), and larger businesses, such as motels, could last much longer than the drought conditions. Many of the marinas on Lake Travis have the ability to move boat docks further out into deeper water and are willing to bear the added operational costs of such moves to stay in business. On Lake Buchanan, the shallow nature of the shoreline allows little flexibility in moving docks and other facilities. Some residents and other lake users have expressed concerns about the lack of access to the lakes during low elevations. Most of LCRA's boat ramp facilities and private boat ramps and launches become unusable when Lake Travis falls below 640 feet msl and Lake Buchanan falls below 1000 feet msl. Additionally, water hazards such as tree stumps and rock areas increase as reservoir levels recede, restricting more of the lake surface available for sail and power boating.

Lake area Chambers of Commerce, residents, and representatives of the tourism industry are also concerned about the elevation of the lakes area during low water periods even when a true drought is not in effect. There is a concern that first time visitors will not return to the area having once experienced low water levels in the reservoirs, thus dampening potential future economic growth.

River recreation interests downstream of the Highland Lakes are also concerned that drought conditions will leave stretches of almost dry riverbed and that water quality will deteriorate severely during drought periods.

4. Concerns for Instream Flows and Freshwater Inflows for the Bays and Estuaries

The Colorado River is the largest single source of freshwater flowing into the Lavaca-Tres Palacios estuary through channels in the Colorado River Delta. The Lavaca-Tres Palacios estuary is one of the largest of the seven major and three minor estuaries along the 370 miles of Texas Gulf shoreline. The bays and estuaries of this system provide a rich environment for wildlife, commercial seafood harvest, recreation, and aesthetic opportunities.

Average inflow to the bay has been 2.9 million acre-feet per year. Of that inflow, about 34 percent came from the Coastal Basins, 22 percent from the Lavaca River Basin, and 44 percent from the Colorado River. Freshwater inflows influence estuarine biological productivity by

lowering salinity, increasing nutrients, and providing sediments. In 1991, the U.S. Corps of Engineers re-routed the Colorado River into West Matagorda Bay to increase biological productivity by increasing the amount of freshwater entering the estuary. However, a storm blocked the new route until its channel could be dredged in 1992, when it became fully functional.

The Colorado River contributes freshwater to the estuary directly from the river and indirectly through return flows from rice fields irrigated from the river. Prior to the 1991 change, an average of 1.3 million acre-feet annually from the Colorado River entered the estuary at the mouth of the river, with about 150,000 acre-feet contributed through irrigation return flows. With the change in the Colorado River delta in 1991, the full average of 1.8 million acre-feet of annual flow of the Colorado River now enters Matagorda Bay.

Estuaries and their associated wetlands are a transition zone between the fresh water and marine environments and serve as the nurseries for over 97% of the fishery species in the Gulf of Mexico. Thus, the levels of salinity, nutrients, and sediments determined by freshwater inflows is critical for high estuarine production. Fluctuation of estuarine conditions from severe droughts, floods, and hurricanes results in a shift of the biological elements of the system and can directly affect the production and survival of many plant and animal species.

During the rice irrigation season, even under drought conditions, the instream flow needs should be satisfied as a result of natural inflows and return flows downstream of the Highland Lakes, pass-throughs of inflows to the Highland Lakes required to honor downstream senior water rights, and releases of interruptible stored water flowing downstream to the irrigation operations. Under current water demand conditions, it is in the winter months, when the portions of inflows required to be passed through the reservoirs to honor downstream senior rights are low and when downstream demands for stored water are also low, that it is most likely that instream flows will need to be supplemented with firm stored water releases. However, should interruptible stored water for irrigation be curtailed or cut off, the periods of low flow in the river would be extended and additional water would be demanded to serve these needs for periods of time.

While it is difficult to estimate the full effect of inadequate instream flows or inadequate inflow to the bays and estuaries, it is clear that many plant and animal species in the food chains would be severely stressed and that productivity would be lessened if the condition persisted for an extended period of time.

C. Projected 2010 Surface Water Demands During Droughts

1. Introduction

To properly allocate available water supplies in the DMP/DCP, LCRA must project the future water demand on those supplies. The DMP/DCP is based on conditions that may occur in the next decade. This ten year planning period was chosen because the critical drought period used to determine the Combined Firm Yield of Lakes Buchanan and Travis lasted approximately a

decade. Further, the estimates of future water demands are most accurate in the near future. If the critical drought were to repeat itself beginning now, the maximum demands during the drought period would be those in year 2010. Thus, a ten year planning period was used for the development of the DMP/DCP.

Total estimated surface water use in LCRA's 35 county water service area (Figure 1-1) in 2000 was approximately 675,800 acre-feet annually, including water released to maintain instream flows in the lower Colorado River. About 56% of water diverted was used for rice irrigation in the four major irrigation operations located in Colorado, Wharton and Matagorda Counties. The next largest demand for surface water is the City of Austin, with approximately 134,000 acre-feet yearly averaged over the last ten years for municipal use and steam-electric power generation. In general, City of Austin's use has been increasing steadily, with a use of 163,800 acre-feet for the year 2000.

LCRA supplies water to two general categories of water demands: firm and interruptible. Firm demands presently include the water for municipal, domestic, industrial, steam-electric power generation, some irrigation, and instream flow maintenance purposes. Currently, interruptible stored water is used almost entirely for agricultural irrigation, specifically rice irrigation, and for environmental needs. As noted earlier, the most noticeable changed condition over the last five years has been a significant increased projection of municipal and industrial water (firm) demands. With the large projected increase in firm water demand, the DMP/DCP must be adjusted to give a compensating reduction in the interruptible stored water supplies available since firm needs take priority.

Surface water demands in LCRA's water district over the next decade have been projected by LCRA staff based on drought-condition weather, population growth, water use patterns, and economic development, as outlined in the Senate Bill 1 regional water plan for Region K. The assumptions used in projecting 2010 demands are described in the following sections.

2. Projected Firm Water Demands

a. Municipal, Manufacturing, Steam-Electric, and Domestic Water Demand Projections

LCRA staff allocated Senate Bill 1 2010 projected demands using a 1996 water use distribution. Actual water use in 2000 and projected water demands for 2010 are shown in Table 4-2.

The water demand for STP and the Austin power plants may be met by using unregulated run-of-river flows under separate water rights associated with those facilities, supplemented as necessary with stored water. The arrangements for satisfying these demands at STP and at LCRA power plants are described in more detail in Finding 58 of the September 7, 1989 Order of the Texas Water Commission approving LCRA's WMP. The 2010 demands included in this WMP for these facilities reflect those provided to the Senate Bill 1 Regional Planning Group (Region K) by the City of Austin and the South Texas Project Nuclear Operating Company.

Today, LCRA has only a handful of firm water contracts for domestic water use. Unfortunately, most of this water is taken from the Highland Lakes by landowners that do not have contracts with LCRA. Absent a contract, most if not all of these diverters have no legal claim to the water they are diverting. At some point, LCRA may choose to pursue enforcement of its water rights to curtail these unauthorized diversions. Total domestic water use is projected to increase to 6,273 acre-feet by 2010. As water supplies become more and more scarce, many landowners are likely to realize the benefit of a firm water contract that better protects their water supply during drought conditions. Thus, for purposes of this WMP, LCRA has estimated that approximately 5,000 acre-feet of domestic water use will come under contract with LCRA over the next ten years.

TABLE 4-2. REPORTED 2000 AND PROJECTED 2010 ANNUAL FIRM SURFACE WATER DEMANDS UNDER DROUGHT CONDITIONS

Water Demand Category	2000 Reported Water Use (Acre-Feet)	Projected 2010 Water Demand (Acre-Feet)
Highland Lakes Municipal	23,100	37,200
Manufacturing (Excluding Austin)	8,500	11,500
City of Austin Municipal and Manufacturing	153,300	187,931
City of Austin Power Plants*	10,400	13,500
LCRA Power Plants	22,000	29,500
South Texas Project (STP)*	64,800	47,000
Instream Flow Maintenance & Estuarine Inflows	14,500	**33,440
Total	296,600	**360,071

*Firm water demands for STP and the City of Austin may be met from run-of-river flows, if they are available, under their existing water rights.

**Based on the 2003 revision resulting from the effect of the new trigger for curtailment of interruptible stored water supplies from Lakes Buchanan and Travis and freshwater inflow needs of the Matagorda Bay, as described in this Chapter.

b.Instream Flow Demands

LCRA completed the initial instream flow needs study in 1992. The study identified two sets of instream flow needs: critical flows and target flows. The recommended instream flows for the Colorado River downstream of Austin are in Table 2-1.

LCRA will continue with the reservoir operation procedure to release stored water from Lakes Buchanan and Travis to maintain daily river flows as follows:

1. LCRA will release stored water and pass storable inflows to maintain no less than the critical instream flow needs in all years as set forth in Table 2-1, including maintaining, on an instantaneous basis, instream flows of 46 cfs and 500 cfs critical flows as set forth in Table 2-1 during the times those respective flow values are in effect, and

2. In those years when the four major irrigation operations are not curtailed, LCRA will schedule the passage of inflows to lakes Buchanan and Travis that are legally available for storage, as measured at the upstream stream gages, to maintain the target flows as set forth in Table 2-1 as a daily average. Furthermore, during those times when target instream flow requirements are in effect and when such inflows are sufficient to allow LCRA to satisfy the daily target flow requirement at the Bastrop gage, LCRA will also schedule the passage of these inflows to maintain the following minimum flows, as measured at any time at the Bastrop gage:

Month	**Minimum Flow (cfs) 100% of the time**	**Minimum Flow (cfs) 95% of the time**
January	266	
February	269	
March	233	
April	244	287
May	492	579
June	355	418
July	295	347
August	165	
September	201	
October	208	

November	241	
December	264	

In rare instances, LCRA's ability to meet the instream flow requirements set forth in this WMP may be impaired by certain unavoidable constraints such as the capacity of its hydro-generation units and hydro-generation scheduling mandates as well as unforeseen diversions, unforeseen changes in flow conditions downstream, and adjustments to the ratings of the applicable gages.

This recommendation fully meets the most important instream flow needs at all times and meets the target flows during periods of normal or above normal streamflow conditions.

To fully honor this commitment, LCRA will use both firm water and interruptible stored water. Firm water is only supplied in years when the interruptible stored water supply is curtailed for the four major irrigation operations. The actual annual releases of stored water will vary from year to year depending on hydrologic conditions.

For the 2003 update, it is estimated that an annual average of about 27,380 acre-feet of firm water is needed to meet these instream flow commitments, with the remainder coming from interruptible stored water supplies. Therefore, the present annual commitment for instream flows of 12,860 acre-feet of firm water is recommended to be increased to 27,380 acre-feet per year. In addition to firm water, interruptible stored water will be provided to meet instream flow needs. The estimated interruptible stored water to be supplied during the critical drought will be an additional 8,590 acre-feet/year. Demands for both firm and interruptible stored water for instream flow needs were estimated from the simulated results of the water supply alternative that was recommended for the 2003 update of the WMP. The recommended water supply alternative represents a careful balance of environmental and irrigation impacts based on results from various scenarios that were considered.

The releases for instream flows generally, but not always, contribute to meeting the Critical or Target freshwater inflow needs of Matagorda Bay. However, the timing for these instream flow releases is independent of the monthly freshwater inflow needs for the bay.

c.Freshwater Inflow Demands

The water demands for maintaining the ecological balance of coastal bays and estuaries have been determined in 1997 by LCRA, in cooperation with TPWD, TWDB and TNRCC (predecessor to TCEQ). As indicated in Table 2-4, estimates of freshwater inflow needs (FIN) from the Colorado River at Bay City are 1.03 million acre-feet annually for the target needs and 171,000 acre-feet yearly to meet critical needs. Historically, an average of approximately 1,800,000 acre-feet flows annually in the Colorado River at Bay City.

For the 2003 WMP update, LCRA has recommended a change in the reservoir operation procedure for releasing stored water from Lakes Buchanan and Travis for estuarine needs after a careful balance of environmental and irrigation impacts from the results of various scenarios that

were considered. LCRA will release stored water from Lakes Buchanan and Travis to maintain monthly estuarine inflows at:

1. the target inflow needs in those years when the combined storage in Lakes Buchanan and Travis on January 1 is greater than or equal to 1.7 million acre-feet, to the extent of storable inflows each month to Lakes Buchanan and Travis, as measured at the upstream stream gages;

2. one hundred and fifty percent of the critical inflow needs in all years when the combined storage in Lakes Buchanan and Travis on January 1 is less than 1.7 million acre-feet and greater than 1.1 million acre-feet, to the extent of storable inflows each month to Lakes Buchanan and Travis, as measured at the upstream stream gages; and

3. the critical inflow needs in all years when the combined storage in Lakes Buchanan and Travis on January 1 is less than 1.1 million acre-feet, to the extent of storable inflows each month to the Highland Lakes, as measured at the upstream stream gages.

With the recommended intermediate estuarine inflow reservoir operation procedure of increasing the release of stored water from Lakes Buchanan and Travis in years when the combined storage is between 1.1 and 1.7 million acre-feet, the estuarine ecosystem will receive more freshwater inflows during moderate droughts than it would have under the WMP as approved in 1999. For any given month, LCRA will compensate for any deficit in releasing stored water to meet freshwater inflow needs during the following month by releasing additional stored water from the Lakes Buchanan and Travis. LCRA will not account for the inflow in the following month in making such release to make up for the previous month's deficits.

The reservoir operation procedure of releasing stored water for the freshwater inflow needs are based on the following:

- both Target and Critical FIN are provided with stored water;
- Target FIN are used as the estuarine inflow demands during years of plentiful water;
- water supply needs for the four major irrigation operations from the interruptible stored water supply were balanced carefully with the environmental needs while assessing the impacts from the results of various scenarios that were considered;
- the frequency and duration of high salinity conditions in Matagorda Bay are kept relatively low; and
- the Critical FIN are met about 80 percent of the months during the critical drought.

This recommendation will require an estimated 205,060 acre-feet of stored water during the ten-year critical drought for estuarine inflows. However, not all of this is from the Combined Firm

Yield of Lakes Buchanan and Travis. Similar to the instream flow demands, both firm water and interruptible stored water are used to meet the freshwater inflow needs. Firm water is only supplied in years when the interruptible stored water supply is curtailed for the four major irrigation operations. An annual average of about 6,060 acre-feet of firm water should be allocated, with the remainder coming from interruptible stored water supplies to meet freshwater inflow needs. The estimated annual interruptible stored water supplied during the critical drought will be an additional 14,450 acre-feet/year. The recommended changes are based on the alternative that was selected for the 2003 update based on a careful balance of environmental and irrigation impacts from the results of various scenarios that were considered.

For purposes of estimating required releases of water from Lakes Buchanan and Travis to meet the instream flow or freshwater inflow requirements of this WMP, LCRA will rely on stage data obtained from the gaging system jointly maintained and operated by the U.S. Geological Survey and LCRA for determining these requirements. If the ratings used to convert stage to flow published by LCRA and the USGS are not identical at the time required releases are estimated, LCRA will exercise its discretion to rely on the latest updated rating of the gage.

3. Projected Interruptible Stored Water Demands

a. Interruptible Stored Water Customers

LCRA presently supplies interruptible stored water to four major irrigation operations. These operations are: Pierce Ranch Irrigation Company, and LCRA's Garwood, Lakeside and Gulf Coast Irrigation Operations. These operations have associated with them very early run-of-river rights to divert surface water from the Colorado River, to the extent it is available, to satisfy customer needs up to their permitted amounts. These run-of-river rights are all senior to LCRA's water rights in the Highland Lakes. Thus, LCRA may impound only that portion of the inflows to the Highland Lakes remaining after passing through inflows to the extent needed to honor these and any other downstream senior water rights.

These four operations are primarily concerned with the growing of rice although there are some turf and row-crops grown within these operations. Virtually all irrigation water is pumped from the Colorado River. Only the Lakeside Irrigation Division has the use of a small amount of groundwater for irrigation purposes.

b. Projected Rice Irrigation Water Demands

The projected average annual irrigation water demand for 2010 is about 438,200 acre-feet annually (Table 4-3). Water to supply that need will come from both interruptible stored water and run-of-river sources. Statistical analysis by LCRA staff indicates that agricultural water diversions at these operations are influenced by the number of acres planted, rainfall, and evaporation. Planted acreage is the strongest statistical predictor of agricultural water use, but is also the most difficult to forecast since annual acreage varies greatly. Rice acreage is largely governed by the federal farm support program, which is currently undergoing changes. It is

premature to forecast the ultimate impact of these changes on the rice industry in LCRA's water district.

Because of the many variables that impact total water diversions at the irrigation operations, a conservative projection was made of future rice irrigation water acreage. First crop acreage for each operation was projected to be equal to the largest acreage cultivated over the last ten years. The projected first crop acreage, as well as 2000 actual first crop acreage, is given in Table 4-3. The Lakeside Irrigation Division has cultivated more acreage in the last ten years, but has used groundwater to meet the excess water needs.

The projections of second crop acreage are based on a fraction of the first crop acreage. The fraction used is the ratio of the second crop to first crop acreage in the year of greatest first crop acreage over the past ten years. These fractions are 0.44, 0.83, and 0.96, respectively, for Gulf Coast, Lakeside and Garwood. Second crop acreage for Pierce Ranch is taken as 6% of the total second crop acreage for Gulf Coast, Lakeside and Garwood.

The actual use of water for irrigation is highly variable, with relatively large differences from year to year. Water diversions projected for each irrigation operation, except Pierce Ranch, are calculated from predictive equations that consider rainfall and evaporation conditions, as well as acreage, during each irrigation season (Martin, 1990). These projected demands are based on rainfall and evaporation conditions expected during the duration of a repetition of the critical drought period experience from 1947 through 1956. The projected demands from Pierce Ranch are taken as 9% of the total projected demands of the other three major irrigation systems. This percentage reflects Pierce Ranch's historical proportion of total diversions over the past ten years adjusted for the major water reductions through water conservation.

TABLE 4-3. REPORTED YEAR 2000 AND PROJECTED ACREAGE AND SURFACE WATER DEMANDS FOR IRRIGATION				
Irrigation System	**Reported 2000 First Crop Acreage (Acres)**	**Reported 2000 Water Use (Acre-Feet)**	**Projected Year 2010 First Crop Acreage (Acres)**	**Projected Year 2010 Water Use (Acre-Feet)**
Gulf Coast	18,800	152,200	30,300	155,600
Lakeside	23,500*	117,800	27,500	135,600
Garwood	15,000**	83,200	21,200	109,000
Pierce Ranch	4,500**	26,100	4,740	36,000
Other Senior Rights	0	0	1,000	2,000
Total	61,800	379,300	84,740	438,200
* Includes acreage supplied from groundwater.				
** Estimated				

Adjustments are also made to the water demand estimates developed from the equations to reflect ongoing water use efficiency improvement programs. Aggressive water conservation efforts are projected to reduce the water diversions at the Gulf Coast Division by over 25% by 2010, from historical 1968-1986 period usage levels. The water demands for the other three major irrigation operations are expected to decline as well due to water conservation efforts, with 5% total cumulative reductions by 2010, from patterns of historical usage.

To estimate the demand for interruptible stored water supply for irrigation needs, a table of acreage was developed for the irrigation operations that included the likely allocation of various amounts of interruptible stored water between first and second rice crop. Such table was developed based on several assumptions.

Allocation of interruptible stored water supply to the individual irrigation operations was according to the following formula:

> Interruptible Stored Water Supply = 0.5*Average annual interruptible stored water usage over past 10 years + 0.5*Highest year of interruptible stored water usage within past 10 years.

Using the last ten years of interruptible stored water usage, it was found that each irrigation operation is entitled to the following percentages of interruptible stored water supplies available:

Gulf Coast	.425
Lakeside	.425
Garwood	.063
Pierce Ranch	.088

Pierce Ranch was not included in the acreage table since there is not a reasonably accurate predictive equation for water use at Pierce Ranch. To represent Pierce Ranch's needs, water use and acreage were assumed at 9 % and 6 %, respectively, of the combined water use and acreage, respectively, of the other three operations.

In developing the table of acreage, it was assumed that the hydrologic and meteorological conditions reflected a 1 in 5 dry year, or stated differently, the dry conditions that would be expected only 20% of the time.

The maximum annual demand for the interruptible stored water acreage projected for 2010, under a 1 in 5 dry year condition, was 273,000 acre-feet. Using that as the greatest interruptible stored water demand, a set of smaller interruptible stored water supplies were assumed to generate a set of first and second crop acreages expected to be cultivated by the three major operations. These acreages were assumed to be the maximum planting acreage that could be supported by the limited water supplies, both run-of-river and interruptible stored water. The allocation of the available interruptible stored water supplies for irrigation was based on the assumption that the demand for projected first crop acreage for rice (83,700 acres) will be fully met, with any acreage curtailments occurring in second crop.

The acreage level was set for each level of interruptible stored water supply using the following process:

1. The total interruptible stored water supply available was allocated to each of the three major operations according to the percentages given above.

2. The available interruptible stored water for each irrigation operation was used first to meet the needs of first crop rice.

3. The remaining interruptible stored water supply, after first crop, was used for second crop needs. If there was insufficient interruptible stored water supplies, then the maximum allowed second crop acreage was reduced in the same proportion as the ratio of the available to the maximum needed interruptible stored water supplies. For example, if there is only 50% of the interruptible stored water needed to meet the needs of the maximum second crop acreage allowed, the second crop acreage is set to 50% of the maximum second crop.

The table of acreage thus developed for the irrigation operations was used in simulations conducted with the RESPONSE model for this WMP update to define the planning decisions of allocating available interruptible stored water when curtailments were instituted. As noted

before, Pierce Ranch acreage and water demand were treated in the RESPONSE model as percentages of the combined acreage and water demand of the three other irrigation operations.

In addition to the senior water right holders and major irrigation operations, there are additional demands for surface water along the Colorado River. These demands, and their water rights, are junior in time to December 1, 1900 but senior to November 1, 1987. Consistent with LCRA's water rights for Lakes Buchanan and Travis, the WMP provides that LCRA will treat any of these rights junior to the water rights for Lakes Buchanan and Travis in the same manner as the users of interruptible stored water. The maximum amount of interruptible stored water to meet the demand of such junior water rights is about 4,700 acre-feet annually, however these demands are not likely to take place each and every year.

c. Instream Flow and Estuarine Freshwater Inflow Water Demands

As noted in the section on firm water demands, interruptible stored water is used to meet part of the environmental water demands for instream flow and estuarine freshwater inflows. During the critical drought, the average annual demand on interruptible stored water is estimated to be 23,030 acre-feet per year, with 8,600 acre-feet per year of that amount provided for instream flow maintenance.

4. Summary

Projected surface water demands in LCRA's ten-county water district during severe droughts total about 798,300 acre-feet annually in 2010. Firm water demands are projected to be approximately 360,100 acre-feet annually in 2010 (See Table 4-2). Surface water demands for irrigated agriculture under drought conditions are estimated to be 438,200 acre-feet annually. The projected irrigation demands, as well as reported use in 2000, are indicated in Table 4-3.

REFERENCES

Tex. Water Dev. Bd., WATER FOR TEXAS – 2002 VOLUME III (2002) (Region K Plan) (available online at http://www.twdb.state.tx.us/rwp/k/PDFs/).

Martin, Q. W. (1990). "Economic Evaluation of Alternative Rice Cropping Decisions," Open File Report, Water and Wastewater Utilities Program, Lower Colorado River Authority, Austin, TX.

D. Projected Water Supplies

1. Water Supply Management Procedure

a. Systems Operation Concept

A fundamental concept of the WMP is that Lakes Buchanan and Travis and the lower Colorado River are operated as a combined water supply system. Unregulated inflows entering the

Colorado River from drainage areas downstream of the Highland Lakes must be used to the maximum extent possible before inflows to the Lakes Buchanan and Travis are passed through or stored and subsequently released to satisfy downstream water needs.

Such a system concept requires a careful and extensive analysis of the interconnection of hydrologic conditions, water demands, and priority of water rights and uses. The WMP uses the following general guidelines for the storage and use of water in the Highland Lakes and the lower Colorado River.

b.Critical Drought Period Concept

A basic assumption in assessing water availability for the DMP/DCP is that all operational procedures must be evaluated as if the worst drought ever recorded for the lower Colorado River were to reoccur. This Drought of Record for the Highland Lakes was the 1947-1957 period, a period that was identified as the most severe occurring during the 105 years since data collection started in February 1898.

c.Procedures For Evaluating Water Availability

LCRA staff developed a computer program for evaluating water availability under a variety of management policies. This program is called "RESPONSE - Lower Colorado River Authority Reservoir System Simulation Computer Program." The evaluation of water availability proceeds on an annual basis. For each year, a three-stage process is executed:

1. water demands are estimated for each user or usage category for the coming year;

2. the daily flows are allocated among users based on legal priority or seniority; and

3. the operation of Lakes Buchanan and Travis is simulated on a monthly basis to reflect the storage of unused inflows, evaporation, and potential spills.

The demands for water in the next year are specified as either fixed annual amounts or demands that vary depending on water in storage. The firm demands are all held constant in each year of simulated hydrologic conditions. The irrigation demands change from year to year depending on: (1) the acres cultivated in each irrigation operation for first and second crop rice; (2) weather conditions (rainfall and evaporation) in that year; and (3) water held in storage in Lakes Buchanan and Travis at the beginning of the year. The water demand for first crop rice occurs only in the months of March through July, while second crop demands are in August through October. All annual water demands are distributed on a daily basis using historical water usage information.

The simulated allocation of inflows into Lakes Buchanan and Travis in the DMP/DCP among downstream senior water rights holders follows the same procedure used in developing the Combined Firm Yield of Lakes Buchanan and Travis for the WMP. It is important to note, however, that these simulated monthly operations do not necessarily reflect the actual day-to-day

operations of the reservoir system, which often requires the exercise of best professional judgment.

2. Supplies for Firm Demands

The annual dependable water supply that can be supplied from Lakes Buchanan and Travis during a repetition of the Drought of Record is referred to as the Combined Firm Yield. Based on the studies available to LCRA, the Combined Firm Yield has been calculated by LCRA to be 445,266 acre-feet per year, exclusive of the amount allocated to O.H. Ivie Reservoir. In addition to this Combined Firm Yield, water supplies are also available from the natural flow of the river downstream of the Highland Lakes to meet a major part of the City of Austin's and the South Texas Project's firm water demands.

Adding the other firm water demands to those of the City of Austin gives a projected drought-condition demand in the year 2010 of approximately 360,100 acre-feet annually, as described in Table 4-2. Portions of the demands of the City of Austin and of STP can be supplied from run-of-river flows under separate water rights, reducing the projected drought-condition demand for stored water in year 2010 to about 184,000 acre-feet annually. The estimate of drought-condition firm demand for stored water in 2005 is about 134,000 acre-feet annually. The firm demands for stored water over the next ten years are low relative to the firm supplies from the Combined Firm Yield. Thus, curtailment of firm demands is not likely in the next decade, even under a recurrence of extreme drought conditions. A large surplus in firm stored water supplies is therefore available to meet interruptible stored water needs without placing at risk the stored water needed for firm water users in the next decade.

3. Supplies for Interruptible Stored Water Demands

As specified by the WMP, the amount of interruptible stored water available for the next irrigation season is projected by LCRA staff in November of each year. The projected supply depends upon the amount expected to be in the combined storage in Lakes Buchanan and Travis on January 1, anticipated inflows for the subsequent months through the irrigation season, and the current demands for firm water.

Several procedures were evaluated to predict the likely supplies available, during a repetition of the Drought of Record, in the next year for interruptible stored water demand. Historical records of streamflow were examined, but were found to be highly variable and hence not accurate in estimating water availability for the next year. The most accurate indicator of water availability is the combined storage in Lakes Buchanan and Travis at the beginning of the year. Thus, for the DMP/DCP, the allocation of stored water supplies to meet interruptible stored water demands is based solely on the combined reservoir storage in Lakes Buchanan and Travis at the beginning of each year, and decisions to curtail interruptible stored water supplies in annual contracts are keyed to particular total January 1 storage levels.

At relatively full storage levels on January 1, the supply of interruptible stored water is sufficient

to meet all projected firm and interruptible stored water demands. However, at or below some storage levels, there are not sufficient supplies and the annual contracts for interruptible stored water must be reduced. At lower and lower January 1 storage levels, less and less interruptible stored water is available for allocation through the annual contracts. At some relatively low storage, there will be a total cutoff of water for interruptible stored water use in the coming year. Provisions will be made to revise the water supply estimates during the year to respond to significant changes in projected streamflow and storage due to rainfall in the basin.

The evaluation of expected hydrologic and water demand conditions during a repetition of the Drought of Record can only be simulated based on projected information. This projected information is subject to some uncertainty. LCRA has determined it prudent to designate some minimum storage level serving as a safety factor to insure that all firm demands are fully met during the critical drought. Under this conceptual operating plan, there would be a storage level which, when reached at any time during the year, would require the total cutoff of all water for interruptible stored water use. That storage level defines a Reserve Storage Pool for the system.

With the increase in projected firm water needs of about 50,000 acre-feet annually from Lakes Buchanan and Travis for 2010, there is less water for interruptible stored water supply from Lakes Buchanan and Travis since firm water needs take priority over interruptible stored water uses. To avoid shortages to firm water users, it is recommended that interruptible stored water supplies from Lakes Buchanan and Travis be reduced during the critical drought years from what is available under the WMP approved in 1999 by revising the annual interruptible stored water supply curtailment policy, as discussed below. This reduction in supplies impacts irrigation primarily since irrigation has the highest priority for use of interruptible stored water.

E. Water Curtailment Policies

1. Triggering Conditions

The DMP/DCP contains distinct triggering levels, as well as several associated cancellation measures, that are associated with the amount of water available in Lakes Buchanan and Travis. These responses range from voluntary conservation by firm water customers to total cutoff of interruptible stored water customers. This DMP/DCP fully meets the critical instream flow needs at all times and meets the target flows during periods of normal or above normal stream flow conditions.

2. Curtailment of Interruptible Stored Water Demands within Irrigation Operations and for Instream and Bay and Estuary Freshwater Inflows

Given the large demand for interruptible stored water for rice production, there will likely be a shortage of interruptible stored water at some time during the next decade. The curtailment policies considered in the DMP/DCP focus primarily on the reduction in interruptible stored water supplies through the annual contracting process. The impact of reducing supplies in the annual contracts is far less than forcing a curtailment or total cutoff during the year after the rice

farmers have made economic commitments based on the assumed availability of the water.

a. Recommendation for Interruptible Stored Water Demand Curtailment for Irrigation and Environmental Needs

To examine possible alternative policies for the 2003 update, LCRA staff reviewed with the Water Management Plan Revision Advisory Committee over thirty options for allocating water supply between irrigation and environmental needs.

In determining available interruptible stored water supplies, it is essential that firm water demands be fully protected during a repetition of the Drought of Record (DOR). This drought is the worst ever recorded on the lower Colorado River and occurred from 1947 through 1956. As noted earlier, projected firm water demands from Lakes Buchanan and Travis over the next ten years (to 2010) are estimated to increase by 50,000 acre-feet annually (24 percent) from the ten-year projections used in the 1999 version of the WMP (to 2005). Meeting those increased demands may only be achieved by decreasing the interruptible stored water supplies presently provided from Lakes Buchanan and Travis. This reduction in supplies impacts irrigation primarily since irrigation has the highest priority for use of interruptible stored water. The second factor affecting interruptible stored water supplies available for irrigation is the allocation of interruptible stored water supplies between irrigation and environmental protection. This allocation is always a delicate balancing between benefits and adverse impacts.

After examining the alternatives, LCRA recommends that interruptible stored water supplies be reduced from present levels and that additional water be provided for estuarine freshwater inflows. As more specifically described below, LCRA recommends that interruptible stored water supplies be reduced from the current levels with the initial storage curtailment threshold raised from the current value of 1.1 to 1.4 million acre-feet. The annual interruptible stored water supplies are determined based on beginning-of-year storage. As storage declines, there is a decline in annual interruptible stored water supplies available. For storage levels less than 1.4 million acre-feet, there would be progressive reductions in annual interruptible stored water supplies.

Further, LCRA recommends that an intermediate release schedule be provided for estuarine freshwater inflows that allows a slightly more gradual reduction of inflows to Matagorda Bay during low flow years. The recommended changes are deemed by LCRA as a balance between a modest incremental decrease in irrigation water supplies during drought conditions and modest increased inflow to Matagorda Bay during non-drought years to help maintain the ecological health of the Bay. Based on a balance of environmental and irrigation impacts, the recommended WMP changes include an increase of stored water released for estuarine freshwater inflow. This increase would be provided in years when the January 1 storage level in Lakes Buchanan and Travis is between 1.1 to 1.7 million acre-feet (55 and 86 percent full).

The recommendations for the current update are as follows:

1) Open Supply - If the total January 1 storage in Lakes Travis and Buchanan combined is equal to or greater than 1,400,000 acre-feet, then LCRA will supply all interruptible stored water demands. This assumes 273,000 acre-feet of interruptible storage water is sufficient to irrigate a total of 83,700 acres within the four irrigation operations, with seventy percent (70%) of that acreage being irrigated for a ratoon, or second, crop of rice.

2) Curtailment will begin if the total January 1 storage is less than 1,400,000 acre-feet and greater than 325,000 acre-feet. The available interruptible stored water supply when combined storage on January 1 is less than 1,400,000 acre-feet is shown in Figure 4-1. If combined storage on January 1 is between 1.4 million acre-feet and 1.15 million acre-feet, the interruptible stored water supply available will vary beginning at 273,000 acre-feet available at 1.4 million acre-feet of storage and decreasing at a rate of approximately 31,200 acre-feet for each 100,000 acre-foot decrease in combined storage until a value of 195,000 acre-feet available at a combined storage of 1.15 million acre-feet. When the combined storage in Lakes Buchanan and Travis on January 1 is less than 1,150,000 acre-feet, the interruptible stored water supply available will vary beginning at 195,000 acre-feet available at 1.15 million acre-feet of storage and decreasing at a rate of approximately 4,250 acre-feet for each 100,000 acre-foot decrease in combined storage until a value of 160,000 acre-feet available at a combined storage of 325,000 acre-feet.

3) Cutoff of the interruptible stored water supply for the coming year will occur when the combined storage in Lakes Buchanan and Travis on January 1 is less than or equal to 325,000 acre-feet.

4) Reserve Storage Pool - If at any time during the year the total storage in Lakes Buchanan and Travis, combined, is less than or equal to 200,000 acre-feet then all use of interruptible stored water will be stopped.

5) During periods of curtailment or cutoff instituted on January 1, LCRA will cancel the curtailment of interruptible stored water for the irrigation operations at any time during the year prior to July 31, if the combined storage in Lakes Buchanan and Travis is projected to be equal to or greater than 1.4 million acre-feet anytime in July. Further, the remaining available interruptible stored water supplies for the year may be reallocated, at this time, between irrigation operations if such allocations do not adversely affect any irrigation operation.

6) During periods of curtailments, LCRA will allow each irrigation operation the option of either: (1) using up to a maximum authorized volume of interruptible stored water allocated to that operation, or (2) using sufficient water to cultivate a level of acreage agreed upon among the customers within each particular irrigation operation and LCRA.

Since the curtailment begins at a storage level more than one half full, curtailment of irrigation water supplies may occur during some relatively mild droughts, however such curtailment would be limited in scope and duration. Further, it is likely that the rice producers will only be

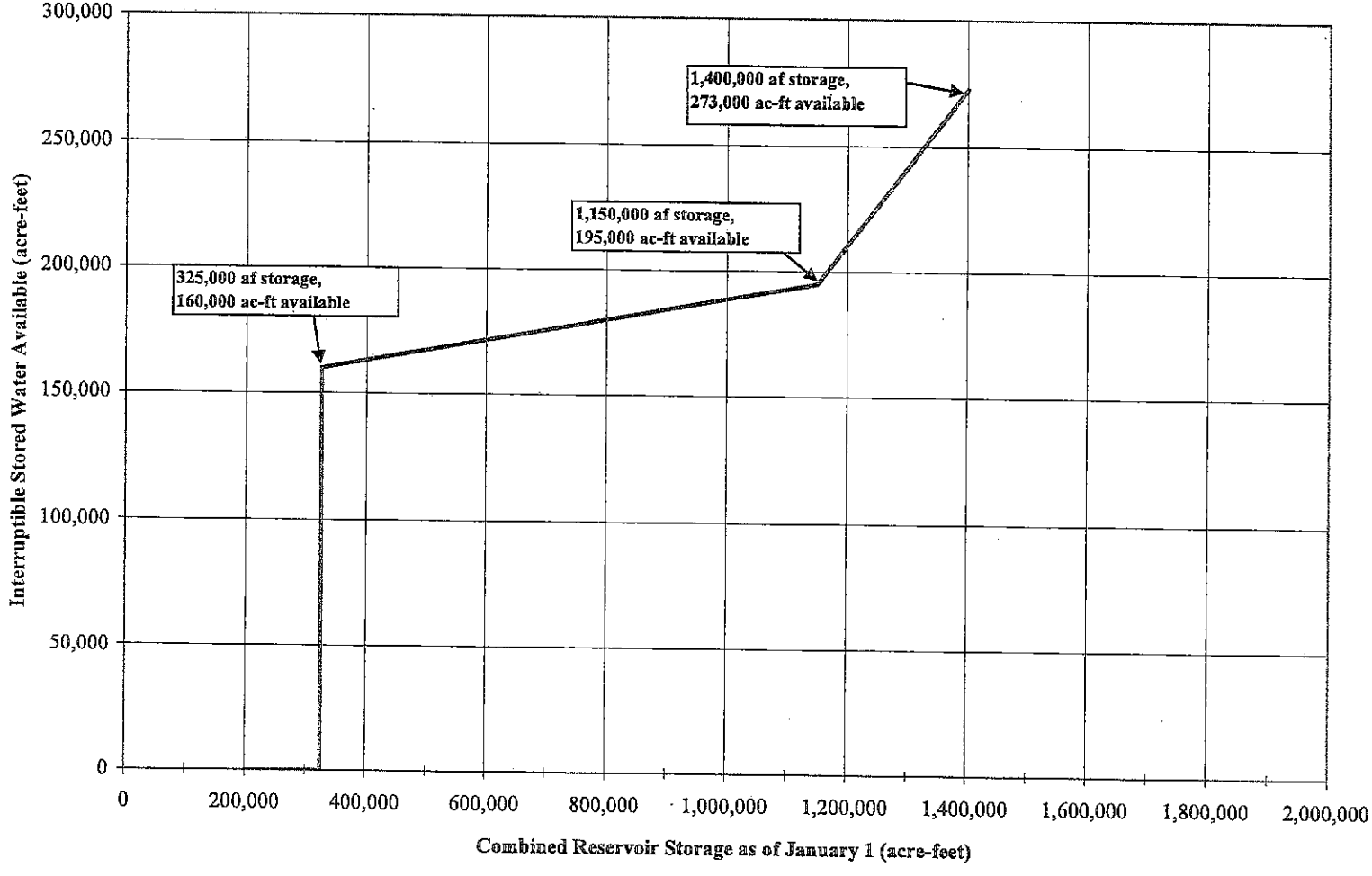
tentatively required to curtail second crop rice, which is cultivated after first crop rice is harvested in July and August. Thus, the curtailment plan has the added advantage that spring rains and runoff may increase water supplies and reduce demand and thereby allow an increase in the estimate of interruptible stored water available for second crop rice. Rice producers could relatively easily increase their second crop acres if they were aware of any increased water supply by June 15.

To achieve the estimated benefits of the management policy, it is necessary for the irrigation operations to reduce their water demands to correspond to reductions in the estimated interruptible stored water supplies, in accordance with the procedures in this WMP or the terms and conditions of contracts between LCRA and stored water users. Close coordination between LCRA and the operations will be needed. Should an operation choose not to reduce the acreage cultivated in response to the projected shortage of interruptible stored water supply, LCRA will only supply that operation with its estimated portion of the reduced interruptible stored water supply. No additional interruptible stored water will be released in that year for that irrigation operation once the diversion limit has been reached.

In addition to the above features, and consistent with state law, LCRA's customers must prepare and adopt a legally enforceable local drought contingency plan, which should include specifics concerning the actions to be taken to comply with LCRA's DMP/DCP regarding the curtailment of interruptible stored water supplies. LCRA staff is available to provide technical assistance with the preparation of required local plans.

FIGURE 4-1

Interruptible Stored Water Available During Curtailment
Based On January 1 Combined Storage in Lakes Buchanan and Travis



b.Irrigation Allocation Among the Irrigation Operations

As provided in Finding 25 of the September 7, 1989 Order of the Texas Water Commission approving LCRA's WMP, "the priority allocation and terms governing the interruption of supply of stored water for Garwood are based upon a contract between Garwood and LCRA."

LCRA has negotiated a contract with Pierce Ranch governing the interruption of the supply of stored water to Pierce Ranch. Interruption of the supply of stored water for other commitments similarly would be governed by contract or LCRA Board resolution.

There are many ways in which interruptible stored water demands may be curtailed through the annual contracts. The two most likely are a gradual curtailment with reductions indexed against beginning of year storage in Lakes Buchanan and Travis; or an abrupt total cutoff policy where the full demands are supplied if the beginning of year storage level in Lakes Buchanan and Travis was above a specific level, otherwise totally stop interruptible stored water sales for the next year.

The largest use for interruptible stored water is rice production. Rice producers must plan their crops for the next season based upon the projected interruptible stored water supply, even though more supply may actually be available in future months. The advantages of the gradual approach of curtailment are that the rice industry could use the water allocated to achieve the greatest benefit. Water could be used in first crop on the hope that conditions in the spring would refill the river and lakes. The disadvantage is that some curtailment would occur when it was not really necessary in years when the critical drought was not repeated. Lakes Buchanan and Travis would refill and spill because the drought ends before conditions become as severe as the critical Drought of Record.

The advantages of the "all or nothing" approach are that there would be more years when the full demands would be met and minor droughts would not affect available supplies. Disadvantages would be that in some years there would be no interruptible stored water and most rice producers would risk substantial or total loss of their crops if sufficient run-of-river water was not available throughout the growing season.

In years when there is not sufficient projected interruptible stored water available to meet all irrigation needs, the interruptible stored water will be allocated to the irrigation operations so that all operations have the same percentage shortage in their total interruptible stored water demand. The calculation of the annual demand of interruptible stored water will be based on a projection of relatively dry weather and low streamflow conditions in the next year.

The allocation of interruptible stored water supply to the individual irrigation operations is discussed above in Section C.3.b. Briefly, allocation of interruptible stored water supply to the individual irrigation operations for the 2003 update of the WMP is according to the following formula:

Interruptible Stored Water Supply = 0.5*Average annual interruptible stored water usage over past 10 years + 0.5*Highest year of interruptible stored water usage within past 10 years.

Using the last ten years of interruptible stored water usage, each irrigation operation was determined to be entitled to the following percentages of interruptible stored water supplies available:

Gulf Coast	.425
Lakeside	.425
Garwood	.063
Pierce Ranch	.088

Based on this allocation, a table of acreage was developed for the three major irrigation operations showing the likely allocation of various amounts of interruptible stored water between first and second rice crop. Pierce Ranch was not included in the table since there is not a reasonably accurate predictive equation for water use at Pierce Ranch. To represent Pierce Ranch's needs, water use and acreage were assumed at 9 and 6 %, respectively, of the combined water use and acreage, respectively, of the other three operations.

c. Irrigation Allocation Within the Irrigation Operations

Because Pierce Ranch has entered into a long-term interruptible stored water contract with LCRA, Pierce Ranch will determine how water will be allocated within its own operation. Within each LCRA irrigation operation, LCRA and its customers, through the advisory committees, will mutually determine which of the following allocation methods to follow:

Volumetric method – The total volume of water available to each operation will be divided by the operation's total recent base history to establish an amount available per acre, not to exceed 5.25 acre-feet. Each customer's actual first crop per acre usage for each landmass will then be subtracted from the per acre farm level availability and the balance, if any, will be made available to the customer for second crop production. Additional water made available due to any customers choosing not to irrigate either first or second crop will be equitably distributed to customers who irrigate other crops within the operation.

Acreage Method – The irrigation operation choosing this method would irrigate first crop acreage, but prior to the initial contracting process, would determine the maximum first crop acreage that could be irrigated with allocated water supplies. The first crop acreage for the particular irrigation operation would be determined by dividing the total water available to the particular irrigation operation by a first crop acre-foot per acre water use duty as agreed upon

between LCRA and the respective advisory committee. Contracted first crop acreage would be limited to this amount and would be made available to individual customers pro rata, based on their recent irrigation history as described below. For irrigation operations using volumetric measurement, any use of water in excess of the first crop acre-feet per acre duty would be subject to a surcharge. Prior to contracting for second crop water, the acreage available for second crop would be determined and contracted for on a pro rata basis, in a manner similar to that used for first crop, including a duty and surcharge. During a curtailment, water would be available for rice only, except at the Gulf Coast irrigation operation, where water would also be available for turf grass. Other supplemental agricultural interruptible demands within an operation would also be considered on a limited basis and only to the extent that water is available within the canal system which is not needed for rice irrigation.

Each customer's average base acreage history is to be determined based upon an averaging period agreed to by the farmer advisory committees. The averaging periods are as follows: Garwood – five (5) years; Gulf Coast – two (2) years; and Lakeside – six (6) years.

At the Lakeside and Garwood irrigation operations, the base acreage history shall be based upon the lands irrigated such that a customer shall not be entitled to irrigate lands in a curtailment year that were not previously irrigated by that customer, unless the current landowner of the land that contributed to the base acreage history grants express written consent, and such consent is provided to LCRA with customer's application. In the event that a customer no longer farms land which has a history of being farmed, that history shall be credited to the current landowner or a successor tenant farmer unless the landowner has granted consent for such base acreage to follow the customer to additional lands as described above.

At the Gulf Coast irrigation operation, the base acreage history shall follow the LCRA customer, and not be restricted to a particular landmass.

Allocation of curtailed interruptible stored water to the various users within the irrigation operation will be based on the amount of irrigated acreage on each landmass. This water use will be determined by accounting for established crop rotations during the defined averaging period and will include only those years during that same period that water was used on the landmass. Irrigation operations personnel will maintain this information for each irrigated landmass. Separate base acreage histories will be maintained for rice and turf grass. During periods of curtailment, irrigation customer contracts will be limited to the base acreage as determined by the method described above and any reductions necessary will be made from this base acreage.

d.Drought More Severe Than Drought of Record

In the event that the LCRA Board of Directors declares a drought to be more severe than the Drought of Record, limits would be placed on first crop production. If that occurred, the

following key elements of limiting first crop would stand:

- On Jan. 1 of each consecutive critical drought year, the projected run-of-river flow and interruptible stored water would be calculated and the water volume available to each operation would be projected.

- Each irrigation operation would decide with LCRA which allocation method to use, either the maximum acreage plan or the maximum volume plan.

- The application and contracting process would have a final deadline of February 15th of each year of the drought period that is more critical than the Drought of Record.

e. Termination of Water Allocation Policy

The water allocation model and water allocation plan for agricultural irrigation will terminate when the combined stored volume of Lakes Buchanan and Travis exceeds 1.4 million acre-feet.

The first crop water allocation process described here would terminate when LCRA reallocates interruptible stored water to the irrigation operations after the Board declares the drought worse than the Drought of Record to be over.

f. Procedures for Water Use Accounting

LCRA will employ its ordinary and standard water measurement procedures to account for water used during curtailment periods. During the implementation of the water allocation policies, LCRA will notify each customer of the amount of acreage for which LCRA will provide water. LCRA staff will perform actual field surveys to verify that each customer was not planting more than the allocated acreage. Customers planting excess acreage will be required to prevent irrigation waters from entering excess acreage through construction of appropriate outside levees enclosing only permitted acreage.

g. Transfer of Water Among Individual Users

Water allocation among individual users within individual operations is not a property right and there are no procedures or policies for individual users to obtain that right. All waters available during the critical drought would be allocated on a pro-rata basis to the landmasses contracted to irrigate during that critical drought year and either the maximum volume or maximum acreage for that irrigation operation would be consistent with that plan.

h. Variances

Within each LCRA irrigation operation, the LCRA General Manager or his designee is authorized, after consultation with the operation's advisory committee, to move and adjust the

averaging period for base acreages within farm service agency farms units to account for established field rotations and contemporary changes in management practices so long as such adjustments do not result in a net increase in acreage history.

i. Enforcement

All LCRA interruptible stored water contracts include a provision requiring that, in cases of a shortage of water resulting from drought, the water be distributed in accordance with LCRA's WMP and Texas Water Code section 11.039.

Interruptible stored water customers within the irrigation operations failing to comply with the pro-rata allocation requirements (curtailment plan) shall be subject to a civil action to enjoin the non-compliant customers for breach of contract. Additionally, the use of water in excess of the customer's per acre duty as described in section C.3.c above is subject to a surcharge.

3. Curtailment of Interruptible Stored Water Demands for Other than Irrigation Operations

LCRA will limit additional sales or commitments of interruptible stored water, other than for the four irrigation operations' Conservation Base acreage or other priority allocation, based on the combined volume of water in Lakes Buchanan and Travis at certain times of the year.

The supply of interruptible stored water made available outside the irrigation operations for the January through June period will be based on the January 1 storage levels in Lakes Buchanan and Travis taken separately. The supply for the July through December period for such sales will be based on the minimum of the maximum storage levels in April, May, and June in Lakes Buchanan and Travis, taken separately. No such sales will be allowed if either lake is less than 94% of its maximum conservation capacity. If both lakes are at their maximum conservation capacity as calculated above for either six-month period, then such interruptible stored water sales will be limited to a total of 30,000 acre-feet for that year. For projected lake volumes between 94% and 100% of conservation capacity, such interruptible stored water sales would be limited proportionately, based on the storage reservoir with the lowest percentage of capacity as calculated above.

4. Curtailment of Firm Water Demands

LCRA is required by TCEQ and the Texas Water Code to follow water supply allocation procedures to insure that there is no shortage or deficiency of stored water to meet firm demands during a repeat of the Drought of Record. Given the relatively small demand on firm water supplies at present, the possibility of a firm water shortage occurring is remote for the foreseeable future.

LCRA cannot determine with absolute certainty whether a particular drought event will be more or less severe than the Drought of Record. Therefore, LCRA will engage its customers in a public education campaign and seek voluntary reduction of firm demands from its firm

customers in the early stages of a drought, as more specifically described below.

LCRA cannot invoke mandatory curtailments of firm water demand unless a particular drought event is determined to be more severe than the Drought of Record or some other water emergency that drastically reduces the available firm water supply. LCRA Water Supply Planning staff has developed a simplified "drought monitoring procedure" for identifying a drought worse than the Drought of Record for the Highland Lakes watershed. Historical inflow data for the contributing watershed of the Highland Lakes were used in the development of this procedure.

a. Policy Recommendation for Firm Water Demand Curtailment

1) Recommendation 1: LCRA encourages its firm water customers to implement long-term water conservation measures year-round to meet the goals included in their water conservation plans. LCRA will implement a public awareness campaign on water use and conservation.

2) Recommendation 2: Whenever total storage in Lakes Buchanan and Travis is at or below 1.4 million acre-feet, LCRA requests its firm water customers implement the voluntary drought restrictions contained in their drought contingency plans, with a target reduction goal of 5 percent (5%).

3) Recommendation 3: Whenever the total storage in Lakes Buchanan and Travis is at or below 900,000 acre-feet, LCRA will ask all its firm water customers to implement mandatory water use reduction measures in their Drought Contingency Plans, with a target reduction goal of ten to twenty percent (10 – 20%). LCRA will also begin discussions with firm water customers to develop a specific stored water curtailment plan, to be approved by the LCRA Board and TCEQ.

4) Recommendation 4: A mandatory pro rata curtailment of a minimum of twenty percent (20%) of LCRA's firm water customers' demands pursuant to Texas Water Code §11.039 will be implemented when the LCRA Board determines that the river system is experiencing a drought more severe than the Drought of Record. If lake levels continue to drop below 600,000 acre-feet, the mandatory pro rata curtailment percentage may be increased as determined by the LCRA Board LCRA will curtail and distribute the available supply of firm water among all of its firm water supply customers on a pro rata basis according to the amount of firm water to which they are legally entitled under the terms of their contract and consistent with the curtailment plan approved by the LCRA Board and TCEQ. All uses of interruptible stored water will be totally cutoff prior to and during any mandatory pro rata curtailment of firm stored water supplies.

In addition to the above features, this curtailment policy for firm water demands, LCRA will require each of its firm water customers to prepare and adopt a legally enforceable local drought contingency plan that specifies the actions to be taken to comply with this DMP/DCP regarding

the curtailment of firm supplies. Such plans should be developed pursuant to LCRA guidelines and submitted for LCRA review and acceptance within a reasonable time.

b. Monitoring and Enforcement

LCRA will monitor customers' compliance with the required demand reduction goals and will take enforcement action as necessary against noncompliant customers. Monitoring and enforcement of water-use restrictions at the end-user level generally will be the customers' responsibility.

c. Variances

LCRA's General Manager or his designee may, in writing, grant a temporary variance to the pro rata water allocation requirement of this DMP/DCP if it is determined that failure to grant such a variance would cause an emergency condition adversely affecting the public health, welfare or safety and if one or more of the following conditions are met:

- Compliance with the plan cannot be technically accomplished during the duration of the water supply shortage or other condition for which the plan is in effect.
- Alternative methods can be implemented that will achieve the same level of reduction in water use.

Persons requesting an exemption from the provisions of the DMP/DCP shall file a petition for variance with the LCRA General Manager or his designee within five (5) days after pro rata allocation has been invoked. All petitions for variances shall be reviewed by the LCRA Board of Directors and shall include the following:

- Name and address of the petitioner(s).
- Detailed statement with supporting data and information as to how the pro rata allocation of water under the policies and procedures established in the LCRA DMP/DCP adversely affects the petitioner or what damage or harm will occur to the petitioner or others if the petitioner complies with the pro rata reduction requirements of the plan.
- Description of the relief requested.
- Period of time for which the variance is sought.
- Alternative measures the petitioner is taking or proposes to take to meet the intent of the plan and the compliance date.

- Other pertinent information.

Variances granted by the LCRA Board of Directors shall be subject to the following conditions, unless waived or modified by the LCRA Board of Directors:

- Variances shall include a timetable for compliance.
- Variances granted shall expire when pro-rata reduction requirements are no longer in effect, unless the petitioner has failed to meet specified requirements.

No variance shall be retroactive or otherwise justify any violation of the LCRA DMP/DCP occurring prior to the issuance of the variance(s).

d.Notification of TCEQ Executive Director

The LCRA General Manager or his designee will notify the TCEQ Executive Director within five (5) business days of implementation of any mandatory provisions in the DMP/DCP.

5. Declaration and Cancellation of a Drought More Severe Than the Drought of Record

The LCRA Board of Directors will declare a drought worse than the drought of record when the following three conditions are simultaneously met: (a) drought at least 24 consecutive months (24 months since both Lakes Buchanan and Travis were at their maximum allowable water conservation storage levels); and (b) the cumulative inflow deficit since the beginning of the drought exceeds the envelope curve for cumulative inflow deficits by at least 5% for six consecutive months; and (c) the combined storage in Lakes Buchanan and Travis is less than 600,000 acre-feet.

Curtailments of interruptible stored water due solely to the declaration of a drought worse than the drought of record of duration less than 36 months is only effective on the following January 1 or July 31, whichever occurs first following the declaration by the LCRA Board of Directors. Droughts more than 36 months in length have no restrictions as to when supply reductions can be implemented.

The LCRA Board of Directors will cancel such a declaration if any of the following conditions are met: (a) the cumulative inflow deficit since the beginning of the drought is less than the envelope curve for cumulative inflow deficits by at least 5% for six consecutive months; or (b) the combined storage in Lakes Buchanan and Travis is greater than 1.4 million acre-feet of water, which is simply the recommended threshold for curtailment of interruptible stored water during a repetition of the drought of record. Prior to declaring a drought worse than the drought of record, LCRA will re-evaluate this threshold level to determine if a more accurate conservation storage level in lieu of 1.4 million acre-feet can be determined.

6. Public Notice

LCRA will carry out a public information campaign that is appropriate to the particular curtailment contemplated. This could include some or all of the following efforts: (1) news releases, (2) news updates to area media, (3) interviews with local radio and television stations, (4) responses to requests for information, (5) distribution of water conservation education materials, (6) advertisements in local newspapers to inform the public about current water supply and usage and our water management planning strategies, (7) improvements to LCRA's automated telephone message system to provide information on lake levels, and (8) public service announcements on local radio stations.

7. Impacts of the Recommended Management Policy

a. Firm Water Demands and Supplies

All projected year 2010 demands for firm water are fully satisfied under these simulated critical drought conditions. The largest firm water demand is for the City of Austin. The majority of Austin's projected annual demand of 201,400 acre-feet is met from run-of-river flows diverted under its senior water rights.

Approximately 65% of the demand during the 1947-1956 critical drought years is estimated to be supplied by these flows with the remainder supplied by firm stored water.

b. Interruptible Stored Water Demands and Supplies

With the increase in projected firm water needs for 2010, there is less water for interruptible stored water supply from Lakes Buchanan and Travis since firm water needs take priority over interruptible stored water uses. To avoid shortages to firm water users, it is recommended that interruptible stored water supplies from Lakes Buchanan and Travis be reduced during the critical drought years from what is available under the WMP approved in 1999. This reduction in supplies primarily impacts irrigation.

Under the recommended management policy, all interruptible stored water available during a repetition of the Drought of Record is used by the four downstream irrigation operations, except for that portion committed to maintaining instream flows and estuarine freshwater inflows.

With the curtailment threshold raised from the current value of 1.1 to 1.4 million acre-feet, the projected first crop demand of 83,700 acres will be fully met under the proposed changes, as it is under the WMP approved in 1999. However, there will be a substantial reduction in the irrigation acreage supplied for second crop under the proposed curtailment policy. The WMP approved in 1999 provides sufficient water to irrigate an average of 56,500 acres of second crop each year during a repetition of the Drought of Record. The proposed plan would provide water only for an average of 32,700 acres of second crop under the same drought conditions. Approximately 92 percent (21,800 acres) of this decrease in acreage is due to the increased

projected municipal demands, with the remainder (2,000 acres) due to the proposed change in environmental releases for estuarine inflows. In spite of this reduction, irrigators would use, during a repeat of the Drought of Record, an average of 168,400 acre-feet annually, or 75 percent of all interruptible stored water used for irrigation and environmental protection.

The simulated acreage cultivated in first and second crops are given for all four operations combined and individually in Figures 4-2 thru 4-6, at the end of this Chapter. As noted previously, however, the actual interruptible stored water curtailments may differ from the values reflected by the cultivated acreage as shown in this simulation, depending on the facts as they then exist and the terms and conditions of the contracts between LCRA and users.

The recommendation concerning instream flows reflects the philosophy adopted in the initial WMP and continuation in the amendments to the WMP that instream flows be curtailed whenever there is a curtailment of interruptible stored water to the four major irrigation operations. Since the curtailment threshold for irrigation supplies is recommended to rise from 1.1 to 1.4 million acre-feet, LCRA has proposed that the curtailment storage threshold for instream flows also be revised upwards the same amount. By synchronizing these curtailment trigger points, the WMP reflects reduced supplies available to maintain instream flows, including both supplies released for irrigation that simultaneously benefit instream flows as well supplies dedicated to maintain streamflows for ecological benefit.

The recommended intermediate estuarine inflow policy would provide for releases of stored water from Lakes Buchanan and Travis of up to 256,700 acre-feet (150 percent of Critical FIN) annually to Matagorda Bay in years whenever the combined storage in Lakes Buchanan and Travis on January 1 is between 1.1 and 1.7 million acre-feet. By increasing the releases of stored water from Lakes Buchanan and Travis in years when the January 1 storage is within this given range, the estuarine ecosystem receives more freshwater inflows during moderate droughts than it would be under the present WMP.

The WMP, with the proposed revisions herein, will have essentially the same total stored water commitments for environmental purposes as currently provided in the present WMP. During a repetition of the DOR, the present WMP would provide an annual average of 56,000 acre-feet for both instream flows and estuarine inflows. With the proposed changes, the WMP would provide about 56,500 acre-feet annually during the same period and for the same purposes.

The proposed increase in the firm water allocated for environmental purposes from about 16,000 to 33,400 acre-feet is required to properly account for the stored water dedicated for environmental purposes. Whenever irrigation interruptible stored water supplies are curtailed, stored water used for environmental protection has be accounted as firm water since irrigation has priority use of available interruptible stored water supplies. Since the proposed storage threshold for curtailment of irrigation supplies is significantly greater than the present threshold, there will be more years in the DOR when irrigation supplies are curtailed, hence increasing the environmental flows that have to be assigned to firm water supplies.

The proposed additional 17,400 acre-feet firm water commitment for environmental purposes would be provided from the presently uncommitted firm yield of 60,952 acre-feet. The remaining firm yield available after this allocation would be 43,462 acre-feet. This amount is in addition to 50,000 acre-feet reserved by the Board for future uses. The total proposed firm water allocation of 33,400 acre-feet for environmental purposes represents 8 percent of the total firm supply from Lakes Buchanan and Travis.

c. Lake Storage Levels

For the simulated repetition of the Drought of Record, the total combined storage of Lakes Buchanan and Travis was reduced to very low levels in the worst drought years (Figure 4-8), even with the partial curtailment of interruptible stored water supplies. Approximately 200,000 acre-feet of stored water remains in Lakes Travis and Buchanan combined at the lowest storage content. The simulated lake water surface elevations and storage levels are given in Figures 4-9 and 4-10, for Lakes Buchanan and Travis, respectively. The minimum lake water surface levels during the simulation period are about 960 feet msl on Lake Buchanan and 578 feet msl on Lake Travis. The average lake water surface elevations (for the repetition of the 1941-1965 period hydrology) are projected to be 1005 feet msl on Lake Buchanan, and 657 feet msl on Lake Travis.

The simulated minimum water levels in Lakes Travis and Buchanan are lower than the historical low levels of 614 feet and 983 feet, respectively. The greater drawdown on the lakes in the simulated operation is largely because of greater water demands and lower storable inflows than occurred historically. The projected year 2010 water demands are significantly greater than those that occurred historically in the 1941-1965 period. Firm water demands during the actual drought of record were only a small fraction of those projected by year 2010. Additionally, the rice producers only cultivated one crop of rice prior to about 1963. The current practice of producing two crops each year has increased the water demands of irrigation over those of the 1947-1956 critical drought period.

The second factor causing the simulated storage levels to be lower than historical levels is a difference in the storable inflows. The simulated operation uses historical inflows adjusted for any flow reductions caused by water diverted for upstream water rights, particularly major reservoirs including O. H. Ivie Reservoir. Most of the large reservoirs upstream of the Highland Lakes were not in operation during the critical drought period. During any repetition of the Drought of Record, these upstream reservoirs would likely significantly reduce storable inflows.

d. Flows in the Colorado River

For a repetition of the hydrologic conditions in the 1947-1956 critical drought years, the estimated average flow of the Colorado River at Bay City is about 471,000 acre-feet annually with the projected 2010 demands. For a repetition of the 1941-1965 period, the simulated annual flow at Bay City averages 1.22 million acre-feet. Of this total, a portion of the flow consists of dedicated releases of stored water from Lakes Buchanan and Travis to meet the Target and

Critical freshwater inflow needs and a portion consists of stored water released to meet critical instream flow needs at several upstream locations.

The dedicated firm and interruptible stored water releases for the 1947-1956 critical period amount to an average of 56,500 acre-feet per year of which 36,000 acre-feet is for maintaining instream flows.

F. Annual Implementation of Drought Management and Drought Contingency Plans

1. Annual Review and Revisions

As part of the WMP, the DMP/DCP is subject to review each year. The DMP/DCP may be revised at any time subject to approval by the LCRA Board and the TCEQ. Changing water supply and demand conditions on the lower Colorado River will be reflected as necessary in future amendments to the WMP.

2. Administration

The curtailment of interruptible stored water supply will occur through the annual contracting process in November through January of each year. The curtailment of firm water will depend on storage levels and will be monitored continuously. Curtailment of interruptible stored water supply for Garwood and other entities supplied pursuant to long-term contracts will be accomplished pursuant to the terms of those contracts.

LCRA will monitor customer compliance with the required demand reduction goals and take enforcement action as necessary against noncompliant customers. Monitoring and enforcement of water use restrictions at the end-user level generally will be the customer's responsibility. At present, LCRA's ability to enforce curtailments of firm water demands is uncertain and may be limited to taking civil action to enjoin a non-compliant customer for breach of contract.

Figure 4-2: Simulated Irrigated Acreage - 4 Irrigation Operations Combined

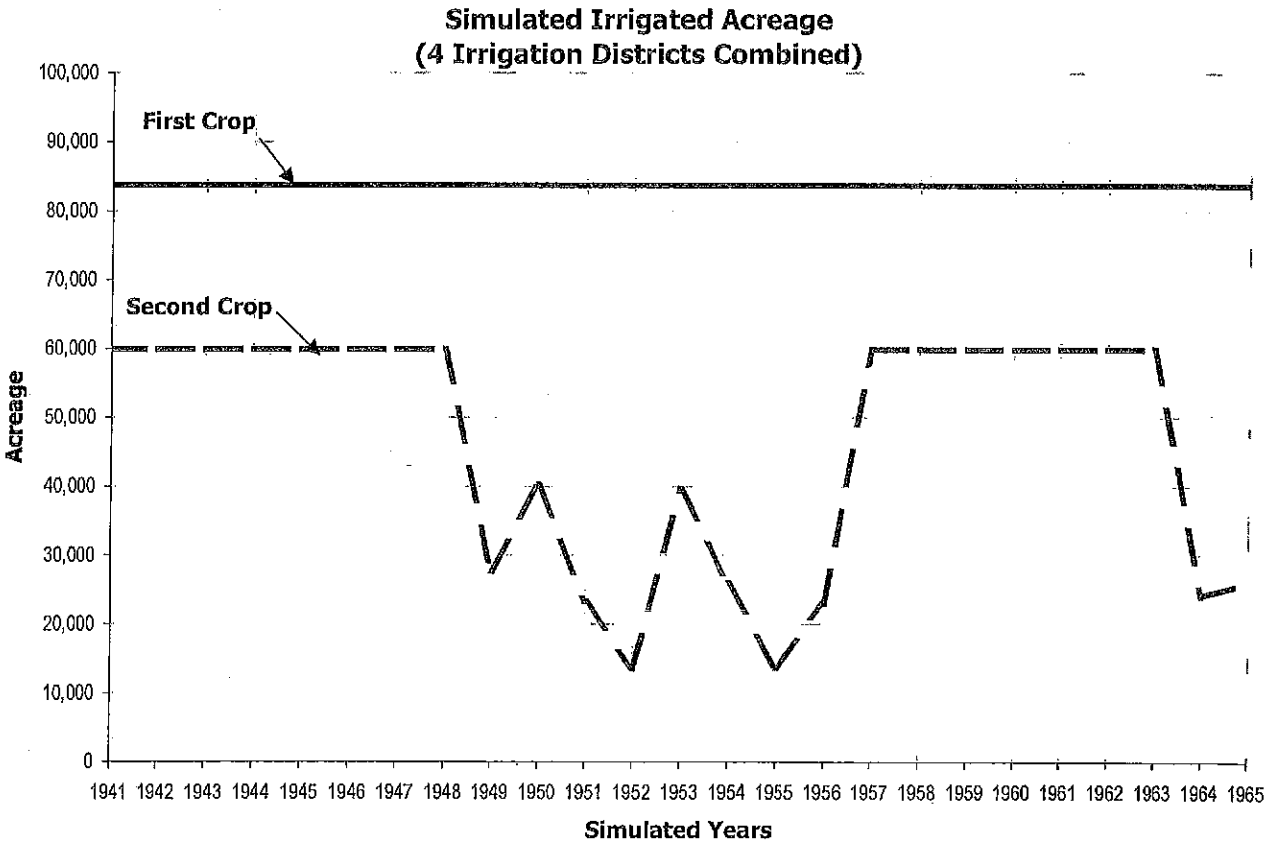


Figure 4-3: Simulated Irrigated Acreage - Gulf Coast

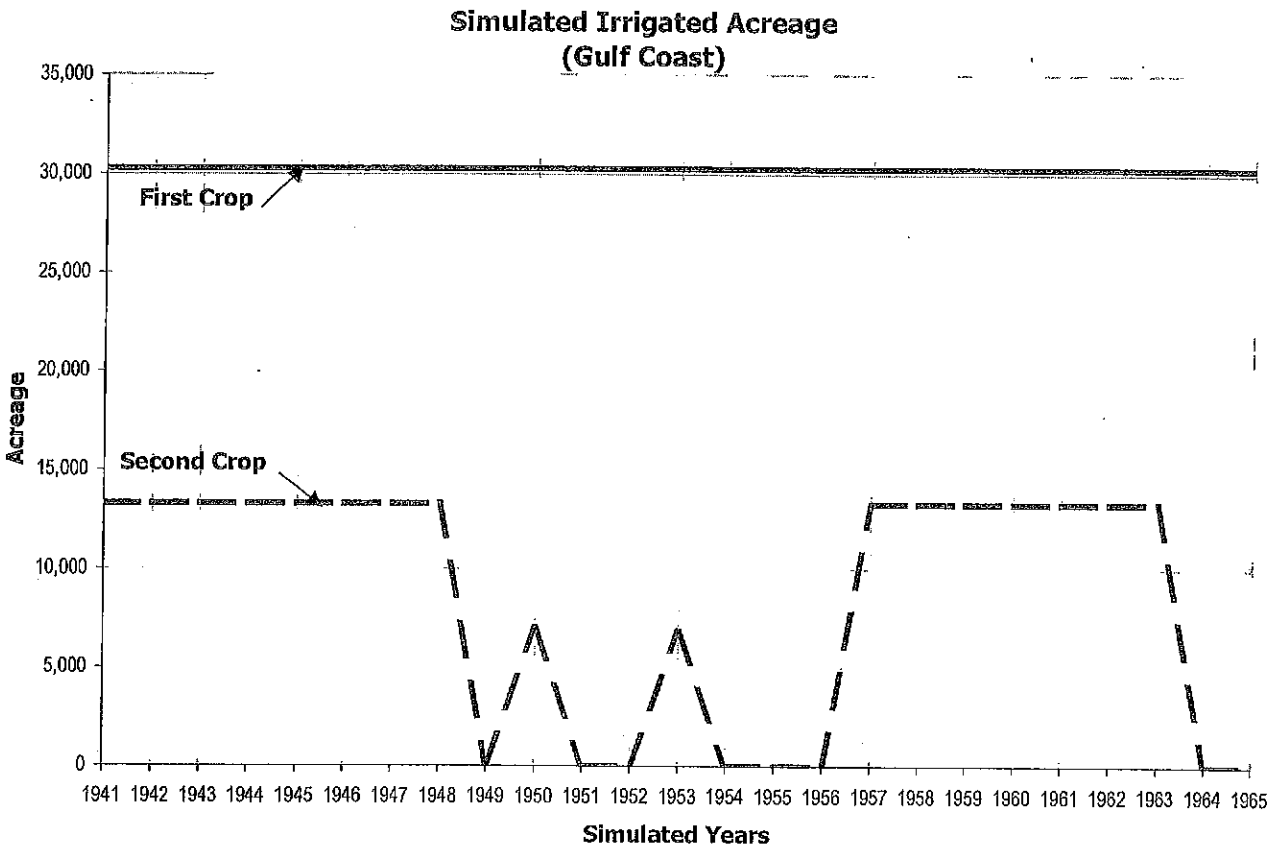


Figure 4-4: Simulated Irrigated Acreage - Lakeside

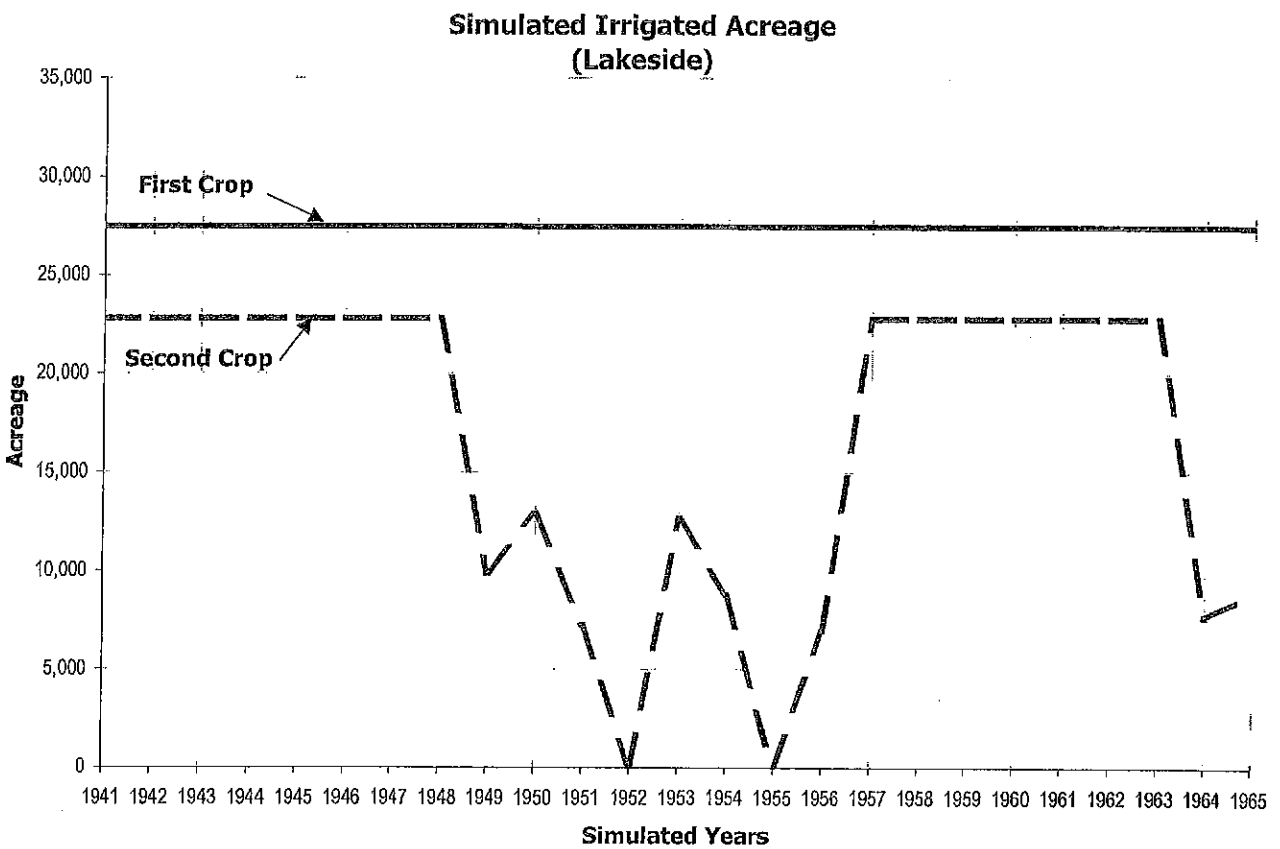


Figure 4-5: Simulated Irrigated Acreage - Garwood

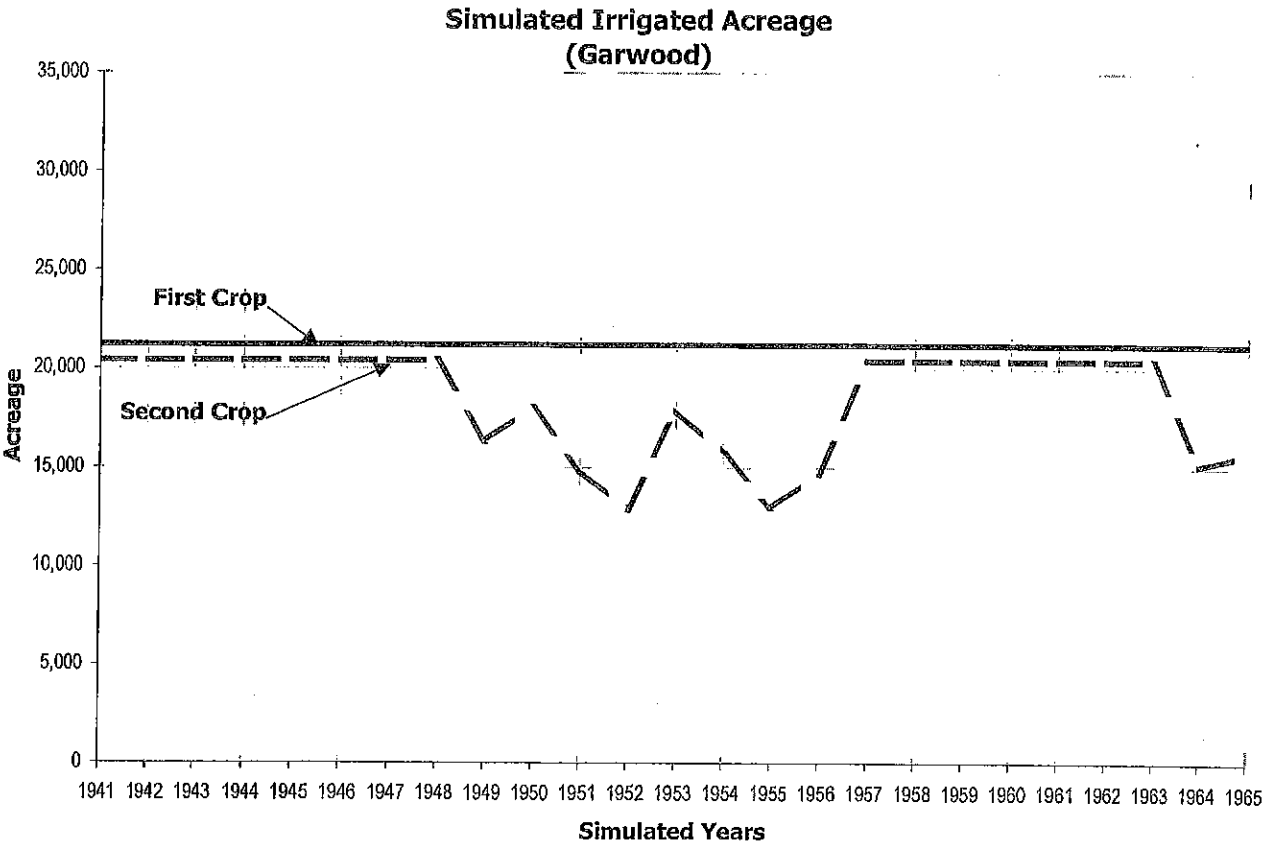


Figure 4-6: Simulated Irrigated Acreage - Pierce Ranch

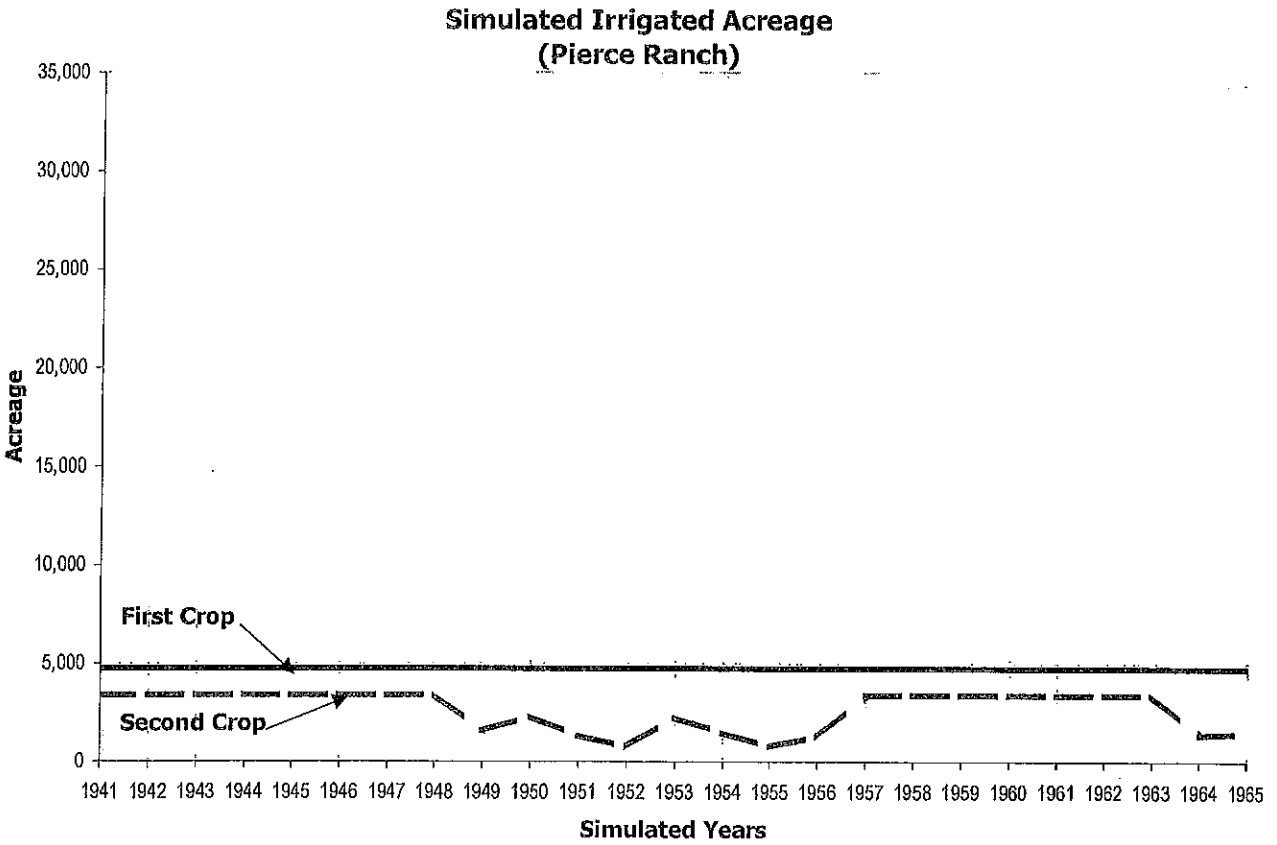


Figure 4-7: Simulated Travis and Buchanan Storage Condition

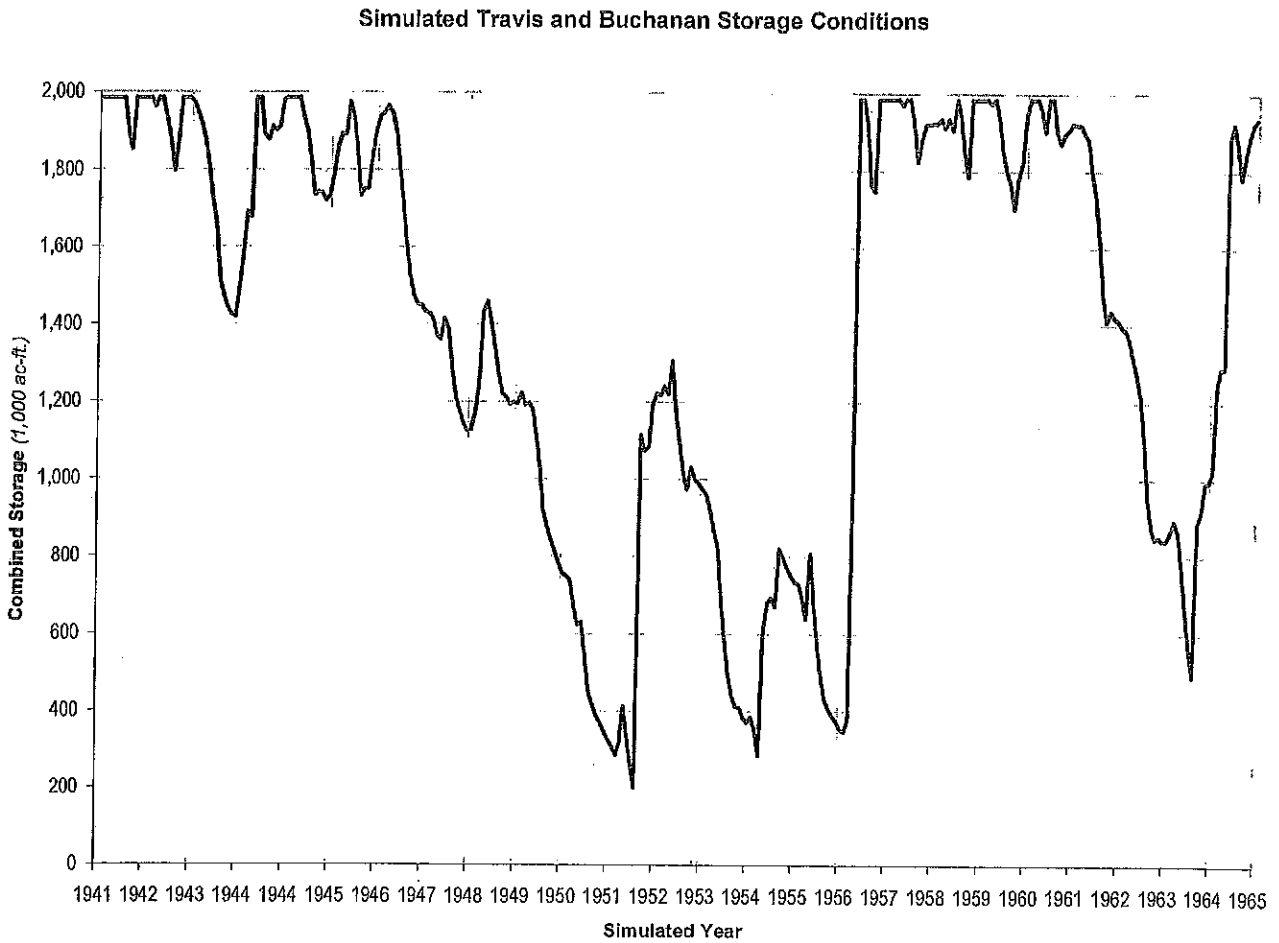


Figure 4-8: Lake Buchanan Simulated Elevation and Storage

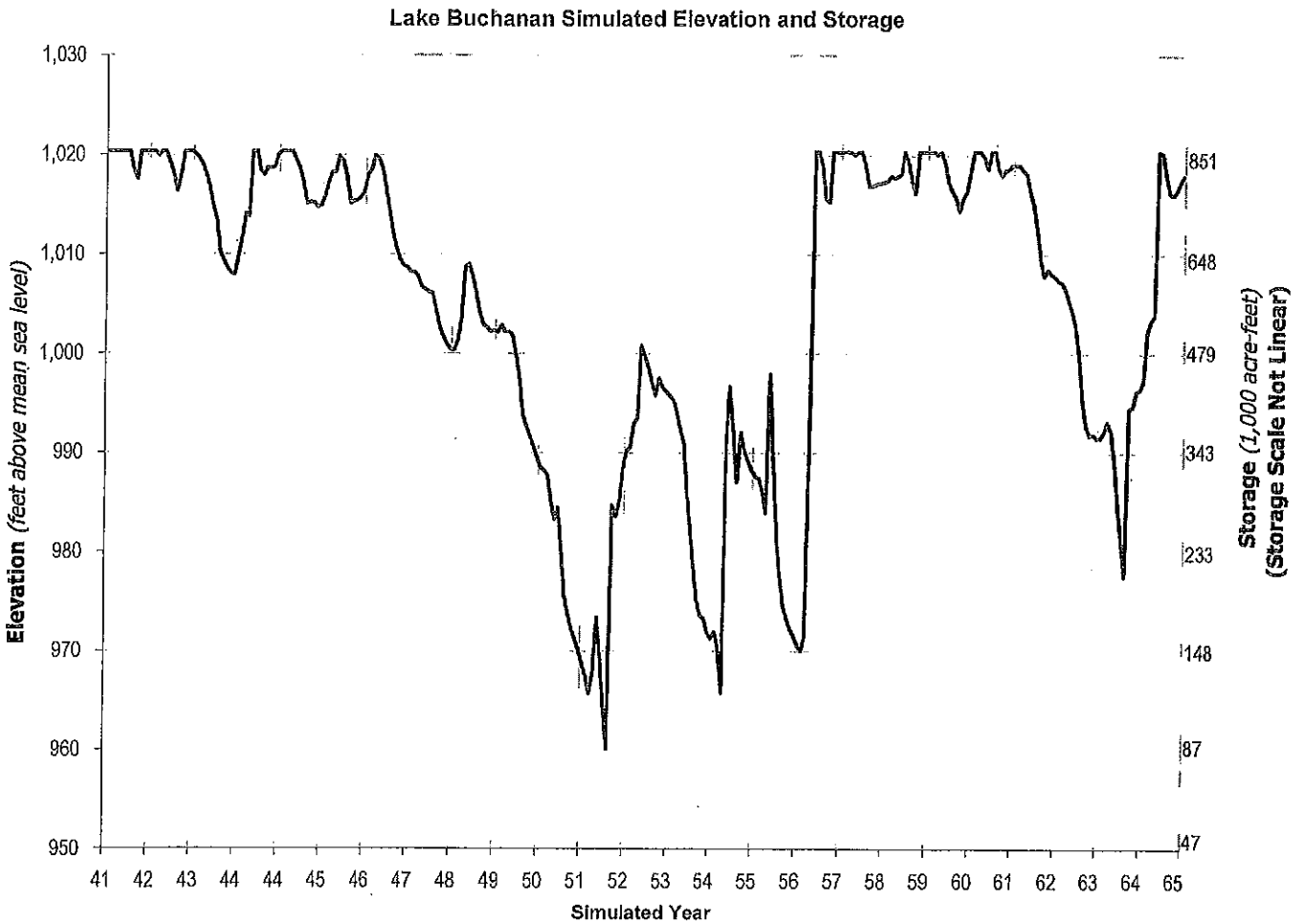
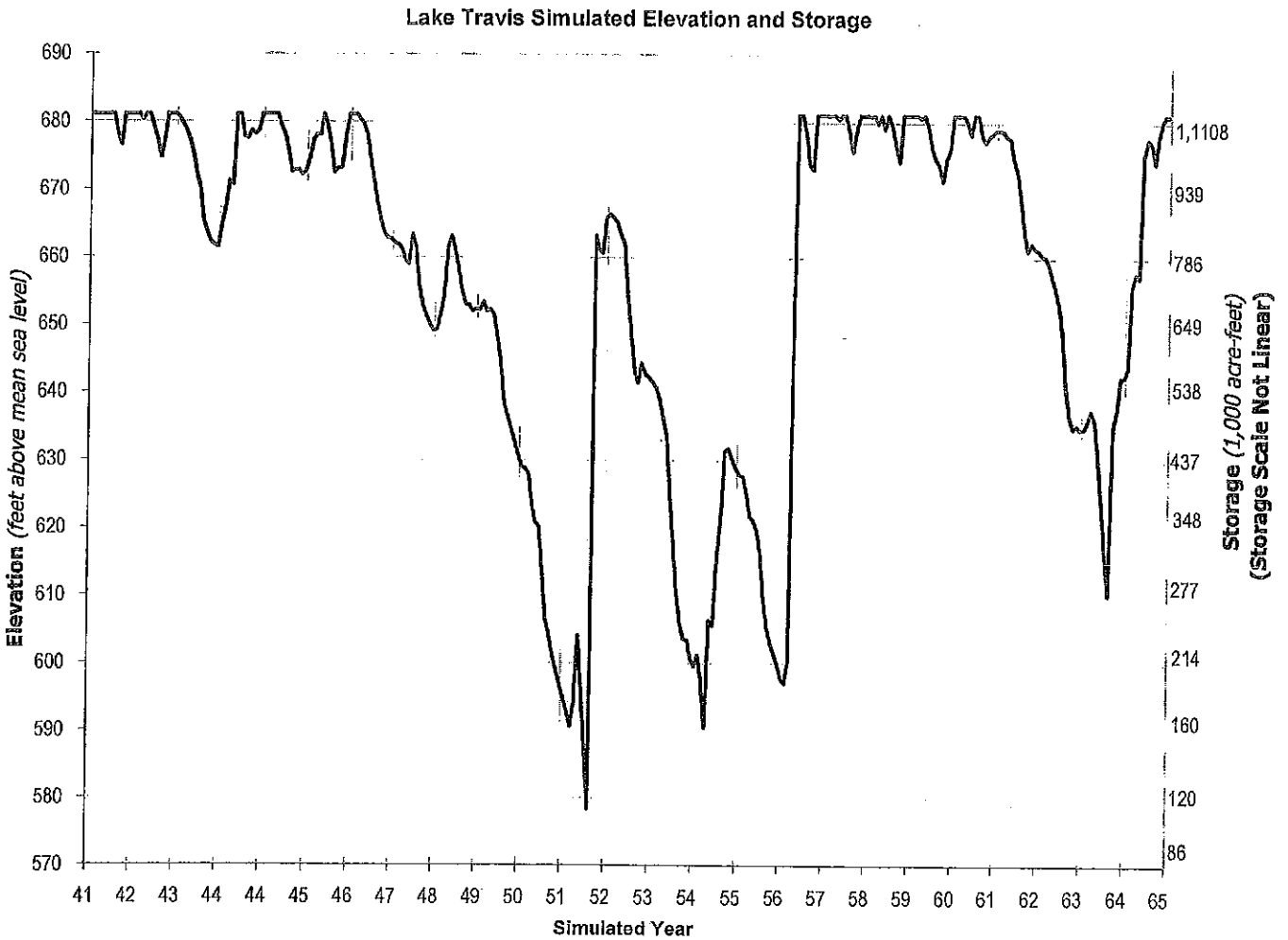


Figure 4-9: Lake Travis Simulated Elevation and Storage



TEXAS WATER COMMISSION

IN RE: CONSIDERATION OF THE LOWER COLORADO RIVER AUTHORITY'S WATER MANAGEMENT PLAN AND AMENDMENTS TO CERTIFICATES OF ADJUDICATION NOS. 14-5478 AND 14-5482	§ § § § § §	BEFORE THE TEXAS WATER COMMISSION

ORDER APPROVING LOWER COLORADO RIVER AUTHORITY'S WATER MANAGEMENT PLAN AND AMENDING CERTIFICATES OF ADJUDICATION NOS. 14-5478 AND 14-5482

On the 7th day of September, 1989, the Texas Water Commission ("Commission") held a public hearing to consider the Lower Colorado River Authority's Water Management Plan and applications to amend Certificates of Adjudication Nos. 14-5478 and 14-5482. At the hearing, the following were named as parties: the Lower Colorado River Authority; the Texas Parks and Wildlife Department; the City of Austin; the Garwood Irrigation Company; the Sierra Club, Lone Star Chapter; the Texas Farm Bureau; the Matagorda County Water Council; Houston Lighting and Power Company as Project Manager for the South Texas Project; Clear, Clean Colorado River Association; Pierce Ranch; the Village of Lakeway; the Executive Director of the Texas Water Commission; and the Public Interest Counsel of the Texas Water Commission. Having considered the evidence and arguments presented, the Commission makes the following Findings of Fact and Conclusions of Law:

FINDINGS OF FACT

1. Notice of the adjudicative public hearing was published on July 26, 1989, in the Blanco County News, Austin American-Statesman and the Colorado County Citizen, newspapers regularly published and generally circulated in Blanco, Travis and Colorado Counties, Texas, respectively; on July 27, 1989, in the San Saba News and Star, Llano News, Highlander and the Bay City Daily, newspapers regularly published and generally circulated in San Saba, Llano, Burnet, and Matagorda Counties, Texas, respectively; on July 28, 1989, in the Fayette County Record, a newspaper regularly published and generally circulated in Fayette County, Texas; on July 29, 1989, in the Wharton Journal-Spectator, a newspaper regularly published and generally circulated in Wharton County, Texas, and on July 31, 1989 in the Bastrop Advisor, a newspaper regularly published and generally circulated in Bastrop County, Texas, the only counties in which persons reside who may be affected by action taken as a result of the hearing. Said notice was published not less than thirty days before the date of the hearing.

2. On July 26, 1989, notice of the public hearing was sent by first-class mail to persons who may be affected by action taken as a result of the hearing and to each person as required by law.

3. The Lower Colorado River Authority (LCRA) is requesting approval of its Water Management Plan for the Lower Colorado River, Colorado River Basin in accordance with the Court's Final Judgment and Decree entered in Cause No. 115,414 A-1, 264th Judicial District, In Re: The Exceptions of the Lower Colorado River Authority and the City of Austin to the Adjudication of Water Rights in the Lower Colorado River Segment of the Colorado River Basin, and is further requesting approval of amendments to Certificates of Adjudication Nos. 14-5478 and 14-5482 to authorize LCRA to divert, release and use the water in Lakes Buchanan and Travis for additional beneficial uses including domestic, recreation, instream flow and bays/estuary purposes.

4. LCRA's Water Management Plan consists of two volumes. Volume I, Policies and Operations, describes the issues and conflicts in the demands on the Colorado River system and lays out the policies and management actions LCRA will use to accommodate the variety of demands on the system. Volume II, Technical Report, describes the models and data sources and the process used for the determination of the Combined Firm Yield and the Annual Rule Curve methodology. Volume II includes a set of Appendices consisting of the Court's Final Judgment and Decree, and the detailed data used to support the recommendations and conclusions discussed in Volumes I and II.

5. The Highland Lakes Reservoirs are operated by LCRA as a system for flood control and water supply. Mansfield Dam is the only structure with a dedicated flood pool and is operated during flooding according to flood-control regulations as published in the Code of Federal Regulations and under the supervision of the U.S. Corps of Engineers.

6. LCRA has a remote data acquisition system referred to as "Hydromet." The Hydromet allows for remote interrogation of a networked system of twenty-one self-reporting rainfall gages, twenty-two remotely monitored streamflow gages and six reservoir elevation gages. Twenty of the streamflow gages also gather rainfall information, giving a total of forty-one rainfall sites. The network is polled each hour, and all data is verified and stored in a real-time data base on a central computer system. Communications are a combination of microwave and UHF radio. The relational data provided by the Hydromet monitors flows above and below the lakes.

7. LCRA has a central computer system that is composed of two Digital Equipment Corporation MicroVAX II mini computers, one

of which is designated as an operations system located at the LCRA System Operations Control Center, and the other designated as a development system located at the Water Resources office. Real time data is logged and maintained on an on-line historical data base for one year. This is available for access by operations models, historical analyses, or other needs.

8. LCRA has developed several hydrologic models that are models used for routine operations of the system. Each model was developed to meet specific operational needs. The Daily Operations Model, analyzes the downstream inflow and demands by accessing streamflow data, totalling demands, and making multiple computer runs of the Model. The Flood Management Model is a user oriented operation tool which accesses real-time data and routes flood flows through the Highland Lakes. The Storage Projection Model uses historical inflow data to estimate the reliability of reservoir system storage subject to storage conditions and water demands.

9. The Daily Allocation Model will determine the extent to which releases from storage are diverted. It will perform a water balance every twenty-four hours at each river gage below Tom Miller Dam, and will allocate the natural flow of the river (whether or not it originated upstream or downstream of the lakes) to major water rights holders to the extent it is available. The remaining portion, if any, of each diversion is assumed to have been from water released from storage. Each amount is then totaled for the week, month and year to determine the total demand on storage.

10. Daily Operations are a joint effort between the System Operations Control Center (SOCC), Hydro Operations personnel located at the dams, and Water Operations personnel located at the Central Office complex. Water Operations personnel determine the required release by contacting downstream customers, operating the Daily Operations Model, and posting the daily release schedule. The SOCC then determines the optimum time and during the day to release the water based on the daily power peak demand, and orders the hydro generation units to begin and end at the necessary times. Hydro Operations personnel at each dam determine which unit to run at each dam.

11. The standard operating levels for the Highland Lakes are: Lake Buchanan, 1020.35 feet; Inks Lake, 887.30 +/- 0.4; Lake LBJ, 824.70 +/- 0.3; Lake Marble Falls, 736.60 +/- 0.4; Lake Travis, 681.00; and Lake Austin, 492.30 +/- 0.5. All levels are referenced to mean sea level.

12. The U. S. Corps of Engineers is evaluating potential flood damages to areas both upstream and downstream of Mansfield

Dam. LCRA is cooperating in this study. The Corps is also performing a reconnaissance study of possible additional flood control and water supply reservoirs. LCRA is cooperating in this study as well.

13. The Highland Lakes System consists of Lakes Buchanan, Inks, LBJ, Marble Falls, Travis and Austin.

14. LCRA's water rights for Lakes Buchanan, Inks, LBJ, Marble Falls and Travis are set forth in Certificates of Adjudication Nos. 14-5478, 14-5479, 14-5480, 14-5481 and 14-5482. LCRA operates Tom Miller Dam (the dam creating Lake Austin) pursuant to agreement with the City of Austin. Austin's water rights for Lake Austin are set forth in Certificate No. 14-5471.

15. LCRA's water rights on the Colorado River below the City of Austin are set forth in Certificates of Adjudication Nos. 14-5437, 14-5473, 14-5474, 14-5475, and 14-5476.

16. LCRA's right to use the waters of the Highland Lakes is subject to the terms and conditions as set out in the final judgment and decree dated April 20, 1988, in Cause No. 115, 414-A-1.

17. LCRA is committed to following the terms and conditions of the final judgment and decree dated April 20, 1988 in Cause No. 115, 414-A-1.

18. LCRA's first step in development of its Water Management Plan was a comprehensive review of LCRA's Board policies and existing programs that guide and shape the way LCRA manages the river system. The LCRA Board of Directors held a series of monthly public meetings and received testimony from LCRA staff, outside experts, and numerous representatives of diversified constituencies including state agencies, environmental groups, business, industry, agricultural interests, and wholesale electric customers. Based upon the evidence the Board received new comprehensive water policies were adopted by the LCRA Board. These policies form the foundation of the Plan.

19. LCRA's next step was the formulation of a Public Task Force. The LCRA staff and public task force met and worked together over a 6 month period.

20. A draft of the Technical Report (Volume II) of the Water Management Plan was transmitted to the Commission on December 30, 1988. A draft of both Volumes I and II of the Plan was submitted to the Commission's staff and distributed to the public in February 1989 for public comment. LCRA held public workshops followed by local meetings in Bay City, Eagle Lake

and at Buchanan Dam. Additionally, public discussions during LCRA Board meetings were held in March, April and May 1989. LCRA formally adopted the Plan in May 1989.

21. LCRA's proposed Water Management Plan was filed with the Commission on July 7, 1989. The Commission acknowledged receipt of LCRA's proposed Plan on July 18, 1989.

22. LCRA's Water Management Plan has essentially four criteria. One is that the Highland Lakes and the Colorado River downstream will be managed together as a single system for downstream water supply purposes. The second is that the beneficial use of the water derived from inflows below the Highland Lakes will be maximized. The third is that LCRA will stretch and conserve the waters stored in the Highland Lakes and advance water quality. The fourth is that adequate flows will be provided to maintain, and where reasonably possible, improve, fish, wildlife, and recreation resources in the Lower Colorado River and to maintain a proper ecological environment and health of related living marine resources in the Lavaca-Tres Palacios Estuary, to the extent it is affected by the lower Colorado River watershed.

23. LCRA will follow five guidelines in implementing its Water Management Plan including:

    a. All demands for water from the Colorado River downstream of the Highland Lakes will be satisfied to the extent possible by run-of-river flows of the Colorado River;

    b. Inflows will be passed through the Highland Lakes to honor downstream senior water rights only when those rights cannot be satisfied by the flow in the river below the Highland Lakes;

    c. The firm, uninterruptible commitments of water from Lakes Travis and Buchanan will not exceed the Combined Firm Yield;

    d. Water from Lakes Travis and Buchanan will be available on an interruptible basis only as long as LCRA's ability to meet the demand for uninterruptible water is not impaired;

    e. Water shall not be released through any dam solely for hydroelectric generation, except during emergency shortages of electricity, and during other times that such releases will be needed for another beneficial purpose.

24. LCRA has the ability to constantly monitor the amount of water in the river available to meet demands through the Hydromet

System which should allow full utilization of the flows originating below Lake Travis prior to making any releases from storage or passing inflows through the reservoirs.

25. Under the Water Management Plan the four downstream irrigation operations (Gulf Coast, Lakeside, Garwood, and Pierce Ranch) will have first priority for the interruptible water in the annual allocation process. This priority will be set by establishing a Conservation Base for LCRA's two irrigation districts. LCRA intends to negotiate a contract which will include a Conservation Base acreage with Pierce Ranch. The Conservation Base acreage for Gulf Coast, Lakeside and Pierce Ranch was determined on the basis of a ten-year (1976-1985) historical average of actual production acreage. The allocation of water for these three users is based on a duty of 5.25 acre-feet of water per acre irrigated. The priority allocation and terms governing the interruption of supply of stored water for Garwood are based upon a contract between Garwood and LCRA. The 5.25 acre-foot-per-acre duty also applies to Garwood irrigated acreage. In the annual allocation process Lakeside has a priority to interruptible stored water in an amount necessary to firm up run-of-river rights to 136,500 acre-feet per year; Gulf Coast an amount necessary to firm up run-of-river rights to 194,250 acre-feet per year and Garwood an amount necessary to firm up run-of-river rights to 168,000 acre-feet per year.

26. When the federal allocation for the number of acres of rice that can be grown exceeds the Conservation Base acreage of Lakeside and Gulf Coast, then in that year LCRA will provide back up stored water for up to 28,300 acres at Lakeside and 42,800 acres at Gulf Coast. These limits represent the maximum number of acres served by each of the two divisions during the 10 year historic period that was used to establish the Conservation Base. For the Lakeside Division, any acreage over 25,000 and up to 28,300 can be served from an alternate source.

27. Lake levels follow an annual cycle--that of filling the conservation storage space in the winter and spring months of the year to be drawn down by larger water uses during the summer months.

28. Because these multiple purpose reservoirs were not constructed for recreational use, the demands for stability in the reservoir levels by recreation interests present conflicts which are extremely difficult to accommodate. If limits are to be placed on how far down the reservoirs' water levels are allowed to decline, a corresponding limitation on the amount of water that is available to supply the other demands on the reservoir system must also be agreed to.

29. To the extent that the annual analysis of the amount of water in storage reveals that there are interruptible water supplies available after meeting the demands of the irrigation operations, interruptible water may be held in the reservoirs to better ensure the security of supply or to maintain lake levels.

30. If additional sales of interruptible water exceed the Conservation Base amounts and the priority allocation for Garwood would draw the lakes below these minimum levels the LCRA Board will not declare any additional interruptible water available for sale in that year. Those levels are 660 feet msl for Lake Travis and 1012 feet msl for Lake Buchanan. LCRA is not guaranteeing minimum lake levels.

31. Another item to help keep the levels of Lakes Buchanan and Travis as high as possible is the agreement that no maintenance, except for emergencies, which would require the lowering of Lakes LBJ, Marble Falls, and Inks will be permitted if the refilling of those lakes would draw the levels of Lakes Travis and Buchanan below the minimum levels. Periodic lowering and refilling of Lake Austin will be done pursuant to the Settlement Agreement (December 10, 1988) between LCRA and the City of Austin.

32. Downstream recreation interests may be enhanced by LCRA's commitment to maintain minimum instream flows. LCRA will develop additional boat launches and recreation areas on the river through LCRA's 10-county district in order to give the public better access to the Colorado River.

33. Hydroelectric power plants located in each of the dams owned and operated by LCRA total 242 megawatts of capacity. Hydropower generally has been subordinated to be a by-product of the release of water for other purposes. LCRA retains the right to make releases solely for hydropower production in times of emergency as part of the Water Management Plan operating policies.

34. LCRA and Texas Parks and Wildlife Department (TPWD) have entered into a Memorandum of Understanding (MOU), wherein the LCRA and TPWD have agreed that LCRA's Water Management Plan would have a goal of maintaining, and where reasonably possible, improving fish, wildlife, and recreation resources in the Lower Colorado Watershed and of maintaining a proper ecological environment and health of related living marine resources in the Lavaca-Tres Palacios Estuary, to the extent that it is affected by that watershed. Some of the provisions addressed in the MOU have been included in LCRA's Water Management Plan.

35. LCRA and TPWD currently are studying the instream flow issue. These studies are scheduled for completion in March 1991.

36. Until the instream flow studies are complete, LCRA will commit to maintaining a minimum monthly mean flow of 200 cfs throughout the lower basin. This flow may, at times, be satisfied from inflows into the river channel and releases made by LCRA to satisfy the demands of downstream users. To assure that sufficient water will be available to satisfy this instream flow demand, LCRA has allocated 25,000 acre-feet of firm water supply to back up this demand on the system and the demand for inflows into the bays and estuaries.

37. Fresh water inflows are essential to maintenance of the productivity of the bays and estuaries. Preliminary data indicate that the amount of inflows needed for the Lavaca-Tres Palacios Estuary may represent the largest single demand on the system. TPWD and the Texas Water Development Board (TWDB) are currently studying the issue of how much fresh water is necessary to maintain the productivity of the bays and estuaries. The study is scheduled for completion by the end of 1989 with public review scheduled during 1990.

38. Until the bays and estuaries study is completed, LCRA has committed to a minimum monthly mean flow of 200 cfs, a minimum seasonal mean flow of 375 cfs, and a minimum annual flow of 272,121 acre-feet for the bays and estuaries. Measurements are to be made at the USGS gage at Bay City. This flow may at times be satisfied from inflows into the river channel, releases of stored water by LCRA for downstream uses and runoff or tailwaters from the rice irrigation operations. These flows will be backed up with 25,000 acre-feet of firm supply water which is also available for instream flow demands.

39. The Texas Water Development Board (TWDB) and the U.T. Bureau of Economic Geology are currently studying the Carrizo-Wilcox and Gulf Coast Aquifers. LCRA is studying the feasibility of the use of groundwater resources in conjunction with interruptible surface water supplies including the evaluation of artificial recharge of depleted aquifer storage space.

40. Under the existing LCRA <u>Water Pricing Policy</u> the rates for purchasing water must recover the costs associated with the Water Management Plan including necessary funds for water quality and conservation activities.

41. The water to be captured by the Stacy Reservoir are waters that otherwise would have flowed into Lake Buchanan. LCRA determined that the appropriate approach at this time was to calculate the firm yield of the Stacy reservoir separately

from the Highland Lakes, then add it back in, to give the total combined firm yield for Lakes Buchanan and Travis.

42. LCRA used a standard single reservoir operation model to determine the firm yield of the Stacy Reservoir. Inputs to the model included: inflow, net evaporation, monthly water demand distribution, and area/capacity curve for the reservoir.

43. LCRA used a multiple reservoir operations model to determine the combined firm yield of Lakes Buchanan and Travis. User defined local water demands were assumed at each of the reservoirs. Inputs to the model included: inflows, net evaporation, local water demands, monthly water demand distribution, minimum and maximum allowable contents, and area/capacity curves for each reservoir.

44. The period of 1941-1965 was used in the determination of the combined firm yield which includes the worst drought of record encountered.

45. Hydrologic data was related to reservoir inflow. The inflow that actually occurred in the record drought was adjusted to simulate a future time period. The monthly values of inflow to Lakes Buchanan and Travis for the period of January 1940 through December 31, 1972 provided to LCRA by TWC water availability model were adjusted. Under the approach used at this time by LCRA to determine the combined firm yield, the simulated operations of Stacy Reservoir did not pass flow to fulfill downstream senior run-of-the-river water rights.

46. LCRA determined how much water was necessary to satisfy daily water demands at a specific location to the extent that flow is available in the river at that point on that specific day. LCRA found that the average annual unsatisfied demand was 520,657 acre-feet; the maximum annual unsatisfied demand was 674,095 acre-feet; and minimum annual unsatisfied demand was 340,500 acre-feet.

47. LCRA determined that the firm yield of the Stacy Reservoir is 90,546 acre-feet. The combined firm yield of Lakes Buchanan and Travis without inflow from upstream of Stacy Reservoir is 445,266 acre-feet/year. Adding the firm yield of Stacy Reservoir results in the combined firm yield for Lakes Buchanan and Travis of 535,812 acre-feet/year which represents the maximum average annual demand that can be met by these two lakes during a repetition of the most critical drought of record on the lower Colorado River. The combined firm yield may also be expressed as a total of 2,679,060 acre-feet over any five consecutive calendar-year period.

48. LCRA developed a rule curve which defines the ability of Lakes Buchanan and Travis to meet annual demands in excess of the combined firm yield, while reserving an adequate supply to meet firm demands.

49. Starting with the reservoirs full, various demands ranging from .781 million acre-feet to 1.5 million acre-feet were placed on the system for the period. It was found that even at a demand of 1.5 million acre-feet per year 100% of the demand was met in 46% of the years; 75% of the demand was met in 63% of the years; and the amount of .781 million acre-feet was met in 80% of the years.

50. This annual rule curve is considered conservative to the degree that the effect of a critical short-term drought equal to or less severe than historical will be negligible only if total firm demands are less than the combined firm yield.

51. The annual operations rule curve will analyze projected annual demands and based on October 1 lake levels will guarantee the supply of water for firm demands and identify an annual amount of water which may be used for non-firm purposes. It will be modified as firm demands increase, and as hydrologic conditions change in the Colorado River Basin.

52. The operational rule curve will be applied to the system on a monthly basis to determine how the system is responding to current conditions as compared to historical operations. This will allow LCRA to optimize reservoir operations on a real time basis and to determine if adjustments to the amount of interruptible water are necessary. This monthly analysis will help LCRA detect early signs of drought and allow LCRA to timely develop and implement drought contingency measures.

53. The amount of water required to meet the firm demand within the system for the preceding year will be calculated in early October. This amount will be compared to the projections for that year, and any variations will be noted and documented. LCRA will solicit information and projections of use from all of its firm supply contract holders and other firm uses provided for by resolution of the LCRA Board. This information will be used to develop a projection of firm demands for the coming year.

54. LCRA will assess the contents of Lakes Travis and Buchanan as of October 1 to project the storage levels for January 1 of the next year. Inflows into Lakes Travis and Buchanan from the upstream tributaries will be added to this preliminary storage level based on the minimum annual inflow from the period of drought. This process will allow LCRA to reserve sufficient water in the system to meet all firm demands for one year beyond the year being considered for allocations.

Estimates for firm demand commitments for the next year will be subtracted from the total water supply available. The amount of water remaining will then be available for interruptible allocation for that year.

55. In October, LCRA will publish the results of the allocation process, notify the LCRA Board, firm contract holders, the Texas Parks & Wildlife Department and any existing or potential interruptible contract holders. During the October LCRA Board meeting information will be presented to the Board and discussed.

56. The recommended annual allocation plan will be published and LCRA will consider public comments and will take into account any significant water events that may have occurred up to the date of publication. The annual allocation plan will be submitted as a recommendation for LCRA Board approval in November of each year.

57. The portion of the combined firm yield that is not yet committed and the firm uninterruptible water that is committed but not yet being used increases the interruptible water that is available each year. The water that is captured and stored from flood flows also adds to the amount of interruptible water that is available. Over time, as the current contracts draw fully on their commitments and the remainder of the firm yield is contracted for, there will be less interruptible water available on an annual basis.

58. LCRA has committed the following amounts out of the combined firm yield amount:

a. Stacy Reservoir - the maximum impact of Stacy Reservoir on the firm yield of Lakes Travis and Buchanan is an average of 90,546 acre-feet per year.

b. City of Austin - LCRA has agreed to firm up or supplement Austin's independent water rights to the extent of 290,156 acre-feet per year. A commitment of an average of 148,300 acre-feet per year of stored water is necessary to meet this demand.

c. Highland Lakes Water Sale Contracts - municipal and industrial contracts total 104,754 acre-feet per year.

d. Cooling Water for LCRA Power Plants - LCRA Board Resolution of January 22, 1987 committed 15,000 acre-feet for Ferguson; 10,750 acre-feet for Sim Gideon and 38,101 acre-feet for Fayette Power Project for a total of 63,851 acre-feet per year.

e. South Texas Project (STP) - LCRA has a contract to supply industrial water to STP in an amount up to 102,000 acre-feet per year. The commitment is met first by run-of-river water, firmed-up by stored water from Lakes Buchanan and Travis. Simulated operations through the drought of record showed a demand for stored water in one year of 51,700 acre-feet. A commitment of an average of 5,680 acre-feet per year of stored water is necessary to meet this demand.

f. Instream Flows and Bay/Estuary Needs - LCRA is also committing (reserving) 25,000 acre-feet out of the combined firm yield to meet instream flows and bay and estuaries' needs.

59. LCRA is reserving 50,000 acre-feet of the remaining combined firm yield for future uses under LCRA's certificates of adjudication. This reservation will be until water supply and demand assessments for LCRA's 10-county district are completed or within three years whichever is sooner.

60. The uncommitted balance of the combined firm yield of Lakes Buchanan and Travis is 47,681 acre-feet per year.

61. LCRA is in the process of developing a drought management plan and will be submitting the plan to the Commission in 1990.

62. LCRA is conducting county-by-county assessments of alternative water supply sources. This data will be useful in the development of local drought management plans.

63. The goal of LCRA's conservation programs is to promote the development and application of practices and technologies that will improve water use efficiency, increase the beneficial re-use of water, and minimize the waste of water.

64. LCRA's water conservation programs are directed at the two largest users of water, irrigated agriculture and municipal.

65. LCRA's goal for conservation of water used by irrigated agriculture is to reduce agricultural demands for stored water from the Highland Lakes and reduce costs associated with the operation of LCRA-owned irrigation water delivery systems in Colorado, Wharton and Matagorda Counties.

66. LCRA's current irrigated agriculture conservation programs consist of activities aimed at improving the operating efficiency of irrigation water delivery systems and improving on-farm water use efficiency.

67. The major elements of the irrigation canal rehabilitation program include: improved operational control and management

of the system; vegetation removal and control; improved hydraulics characteristics of canals; installation of water control and measurement structures; and automation of water diversion facilities.

68. The irrigated canal rehabilitation program is expected to reduce water use by 30 percent within the Gulf Coast canal system. Preventive maintenance at Lakeside is expected to maintain canal efficiency.

69. The major elements of the on-farm water conservation program include: Direct support through funding and staff for the Cooperative Rice Water Management Research Program; assistance with the transfer of information from the research arena to the rice producer; conservation demonstrations such as the development and testing of an automated levee gate; and the inclusion of water conservation stipulations in LCRA's standard irrigation water sale contract.

70. Preliminary results indicate that on-farm water use can be reduced by 25 to 30 percent.

71. LCRA's municipal water conservation programs are directed towards implementation of urban water conservation and water re-use. Focus is towards encouraging and supporting local level initiatives by more than 300 public water utility systems within LCRA's statutory district.

72. The five major elements of LCRA's municipal water conservation programs are:

a. Direct technical assistance with the development and implementation of local water conservation programs including public awareness and education; water efficiency standards and guidelines for new construction (e.g., plumbing fixture efficiency standards); retrofit programs to improve water efficiency in existing developments; conservation-oriented water rates and other economic incentives; low-water-use landscaping (i.e., Xeriscape); and water re-use and recycling.

b. Distribution system audit and leak detection services for local water utilities serving fewer than 10,000 connections.

c. Integration of water conservation and re-use measures, as appropriate, with other LCRA programs and projects including LCRA water sale contracts; water resource planning and demand forecasting; water and wastewater utility service studies, projects, and service agreements; water rate design; environmental programs; and energy conservation programs.

d. Public awareness and education on the water conservation opportunities, benefits, and measures. On-going activities include distribution of brochures, fact sheets, and videos on water conservation; media promotion (e.g., news articles, public service announcements, talk shows, etc.); presentations to civic and service organizations; and workshops, seminars, and special events.

e. Demonstrations of advanced water conservation and re-use technologies and low-water-use landscaping techniques.

73. LCRA will no later than December 31, 1991 reference and summarize existing information on point and nonpoint pollution sources and loading on the Colorado River including inputs of nutrients, metals, pesticides, oxygen demanding substances and other contaminants that may affect water quality, fish wildlife and recreation resources in accordance with the MOU with TPWD.

74. LCRA will no later than December 31, 1991 identify new data needed to determine the effect of water quality on revision of minimum flow schedule and as soon as reasonably possible will modify its existing monitoring programs or new programs to collect such new data.

75. LCRA is evaluating the potential problems associated with anoxic hypolimnetic releases from reservoirs and the potential for related fish kills due to resulting low dissolved oxygen levels downstream. LCRA will no later than December 31, 1991 reference and summarize this evaluation.

76. LCRA has also applied to the Commission for an amendment to the Certificates of Adjudication Nos. 14-5478 and 14-5482 relating to Lakes Buchanan and Travis.

77. Certificates of Adjudication Nos. 14-5478 (Lake Buchanan) and 14-5482 (Lake Travis) authorize LCRA to divert and use water from Lakes Buchanan and Travis for municipal, industrial, irrigation and mining purposes. LCRA is authorized to use the water impounded in Lakes Buchanan and Travis for recreation purposes with no right of diversion or release. LCRA is authorized to use the bed and banks of the Colorado River, below Lakes Buchanan and Travis to convey water released from Lakes Buchanan and Travis for use by LCRA or others entitled to use such water in the amounts and for the purposes authorized in the Certificates. LCRA is also authorized to divert and use water through Buchanan Dam and Mansfield Dam for the purpose of hydroelectric power generation.

78. The Water Management Plan submitted by LCRA to the Commission for its consideration includes proposed reservoir operating

procedures whereby LCRA will divert or release waters stored in Lakes Buchanan and Travis for several additional purposes of use including domestic, recreation, instream flow and bays/estuary purposes.

79. In order to manage Lakes Buchanan and Travis as proposed in the Water Management Plan, LCRA's Certificates of Adjudication Nos. 14-5478 and 14-5482 need to be amended to authorize LCRA to divert, release and use the water in Lakes Buchanan and Travis for additional beneficial uses including domestic, recreation, instream flow and bay/estuary purposes.

80. As part of these amendments, LCRA is not requesting an additional amount of water. The proposed amendments will not result in an additional consumptive use of state water.

81. A "firm" demand is a contractual obligation or other commitment of LCRA's which must be met 100% of the time through the drought of record. Total firm demands will need to be less than or equal to the combined firm yield to be protected throughout recurrence of the drought of record.

82. Interruptible or "nonfirm" demands are LCRA's contractual obligations or other commitments for stored water which contractually do not have to be met 100% of the time. They will be met to the extent additional water is available each year after firm demands are satisfied.

83. LCRA has formally adopted standard water sale contract forms, and procedures and rules for administering water sale contracts. Existing contracts are written for firm supply of water, subject only to the general laws of availability. A second standard form contract for interruptible supply is presently being developed.

84. LCRA currently has no contracts upstream from the Highland Lakes, except those with upstream reservoirs with junior rights to the Highland Lakes which are more or less operation agreements.

85. Existing upstream operating agreements should be considered firm contracts, and their effect on the combined firm yield should be quantified as was Stacy Reservoir's effect.

86. Junior rights senior to November 1, 1987, will be honored as required by the Court's Judgment and Decree with interruptible supplies. Their diversions will be allocated similar to downstream senior rights.

87. A report which documents LCRA's compliance with the Water Management Plan during the previous year will contain information regarding the adequacy of the hydrologic and

hydraulic data monitoring system as to intensity and accuracy; accuracy of reported or monitored activities; adequacy of the operating rule curve and the adequacy of the daily allocation model and any additional information the Executive Director may request.

88. Under the approach used by LCRA at this time, the combined firm yield of Lakes Buchanan & Travis is 535,812 acre-feet/year. This amount may also be expressed as an average of a total of 2,679,060 acre-feet per year over any five consecutive calendar-year period.

89. LCRA's proposed Water Management Plan does not presently propose any new projects taking, storing or diverting water in excess of 5,000 acre-feet per year.

90. The use of an operational rule curve, as developed by LCRA, is an acceptable approach to insure utilization of the lakes' storage while at the same time guaranteeing that firm demands will be met dependably year after year.

91. LCRA's procedures and guidelines for the allocation of firm water and interruptible water supplies are acceptable, with the understanding that the allocation procedures may be amended at a later time to reflect the results of the instream flow and bay/estuary studies; provided, however, that the Commission shall retain jurisdiction to resolve all disputes regarding allocation of stored water that may arise in the future.

92. LCRA's initiatives regarding point and non-point sources of pollution are commendable.

93. The priorities in LCRA's Water Management Plan for interruptible water are subject to changes after the completion of the studies on the instream flows and bays/estuaries.

94. LCRA's proposed system operations under LCRA's Water Management Plan are consistent with the special conditions set forth in the Court's Final Judgment and Decree regarding LCRA's rights to use the waters of Lakes Buchanan and Travis.

CONCLUSIONS OF LAW

1. The public hearing was held under the authority and in accordance with Chapter 11 of the Texas Water Code, as amended and the Texas Water Commission Permanent Rules.

2. The Texas Water Commission has jurisdiction to consider LCRA's proposed Water Management Plan and applications to amend its Certificates of Adjudication.

3. LCRA's proposed Water Management Plan recognizes the necessity of beneficial inflows from the Colorado River into the Lavaca-Tres Palacios Estuary consistent with Section 11.147 of the Texas Water Code.

4. LCRA's proposed Water Management Plan recognizes the necessity of providing for the protection of fish and wildlife habitats and the water quality of the river as required by Section 11.147 of the Texas Water Code.

5. LCRA's proposed Water Management Plan recognizes the Commission's statutory authority to require water conservation and provides for water conservation consistent with Section 11.134(b)(4) of the Texas Water Code.

6. LCRA's applications to amend its Certificates of Adjudication Nos. 14-5478 and 14-5482 authorizing LCRA to use the waters of Lakes Buchanan and Travis for additional beneficial purposes do not contemplate an additional consumptive use of state water or an increased rate or period of diversion.

7. In order to effectuate the policies of this State relating to the conservation and best utilization of the water resources of this State as set forth in Chapter 11 of the Texas Water Code, LCRA's proposed Water Management Plan should be approved and LCRA's applications to amend Certificates of Adjudication Nos. 14-5478 and 14-5482 should be granted.

NOW, THEREFORE, BE IT ORDERED BY THE TEXAS WATER COMMISSION THAT:

1. LCRA's proposed Water Management Plan is approved with the following conditions:

   a. The Water Management Plan shall be subject to the continuing right of supervision of the Commission, and the Commission, on its own motion, may reconsider any element of the plan at any time in the future.

   b. LCRA's responsibility and authority under the Water Management Plan is limited to operational control of the Highland Lakes and LCRA's facilities downstream, and is limited by the terms of this Order.

   c. LCRA's responsibility and authority under the Water Management Plan is subject to and shall not conflict with the authority of any watermaster operation the Commission may establish on the Colorado River.

   d. LCRA shall make available to the Commission all real-time, historical or allocated streamflow data collected by LCRA.

e. LCRA shall supply interruptible water, in accordance with the provisions and conditions specified in the Final Judgement and Decree, to any downstream water right with a priority date junior to December 1, 1900 and senior to November 1, 1987 that authorizes the diversion of not more than 3000 acre-feet of water per year. Priority shall be given to these water rights in the same manner that LCRA allocates water to the major irrigation operations downstream (Lakeside, Gulf Coast, Garwood and Pierce Ranch).

f. All sales, agreements or LCRA Board commitments for the use of water in or from the Highland Lakes shall be submitted to the Commission within 45 days of the effective date of the document.

g. LCRA shall submit a drought contingency plan within one year from the date the Commission signs this order approving the Water Management Plan. Such plan shall be subject to the review and approval of the Commission.

h. LCRA shall allocate 25,000 acre-feet per annum of its firm water supply to supplement and maintain a minimum monthly mean flow of 200 cfs throughout the lower Colorado River measured at the USGS gage at Bastrop for instream flow purposes and a minimum monthly mean flow of 200 cfs, a minimum seasonal mean flow of 375 cfs and a minimum annual flow of 272,121 acre-feet measured at the USGS gage at Bay City for freshwater inflow to the Lavaca-Tres Palacios estuarine system.

i. Prior to any diversion of surface water for recharge purposes, LCRA shall obtain the necessary authorizations from the Commission.

j. LCRA shall prepare and submit to the Commission, on or before March 1 of each year beginning with March 1, 1990, a report which documents compliance with the approved Water Management Plan and any special conditions thereto during the previous year. Such report shall be in a form approved by the Executive Director.

k. After the instream study by LCRA and TPWD is completed, but in any event no later than March, 1992, LCRA will submit an application to amend its Water Management Plan to reflect the results of the instream flow studies and the studies and evaluations referenced in Findings of fact #73, 74, & 75 above. LCRA shall do all things necessary to ensure that such application is administratively and technically complete within 6 months of submission. The Commission agrees to hold a hearing within one year of the date of LCRA's submission to

consider the amendments of the Plan, or, if the studies are not complete, to determine why such studies are not complete.

l. After completion of the TWDB and TPWD study on freshwater inflows into the bays and estuaries, as applicable to the Lavaca-Tres Palacios Estuary, and in any event no later than March, 1993, LCRA will submit an application to amend its Water Management Plan to reflect the results of the bays/estuary study. LCRA shall do all things necessary to ensure that such application is administratively and technically complete within 6 months of submission. The Commission agrees to hold a hearing within one year of the date of LCRA's submission to consider the amendments of the Plan, or, if the studies are not complete, to determine why such studies are not complete.

m. The combined firm yield as found by the Commission in this Order is subject to adjustment and refinement from time to time as additional studies and simulations are developed that more accurately reflect assumptions and operations as required by law.

n. The Commission retains jurisdiction to resolve any and all disputes regarding the allocation of stored water from Lakes Travis and Buchanan, notwithstanding the procedures and guidelines set forth in the Water Management Plan.

2. LCRA's applications to amend Certificates of Adjudication Nos. 14-5478 and 14-5482 are granted with the following conditions:

a. LCRA's certificates of adjudication shall reflect the combined annual firm yield of Lakes Travis and Buchanan to be as found by the Commission in this Order, and as may be modified by the Commission from time to time.

b. For purposes of perfection, LCRA's authorization to divert, release or use water for recreation purposes is limited to that quantity of water actually sold for that purpose whether used in, or released, or diverted from Lakes Buchanan and Travis.

3. The Chief Clerk of the Texas Water Commission forward a copy of this Order, subject to the filing of motions for rehearing, to all parties.

4. If any provision, sentence, clause or phrase of this Order is for any reason held to be invalid, the invalidity of any portion shall not affect the validity of the remaining portions of the Order.

5. Nothing in the Water Management Plan or this Order shall be construed to impair, or to authorize LCRA or any other person or entity to impair, senior or superior water rights in the Colorado River Basin.

Signed this 20th day of September, 1989.

TEXAS WATER COMMISSION

Buck J. Wynne, III, Chairman

(SEAL)

Brenda W. Foster, Chief Clerk

THE STATE OF TEXAS
COUNTY OF TRAVIS

TEXAS WATER COMMISSION

I hereby certify that this is a true and correct copy of a Texas Water Commission document, the original of which is filed in the permanent records of the Commission.

Given under my hand and the seal of office on JAN 6 1992

Gloria A. Vasquez, Chief Clerk
Texas Water Commission

CONSIDERATION OF THE	§	BEFORE THE
LOWER COLORADO RIVER	§	TEXAS WATER COMMISSION
AUTHORITY'S DROUGHT	§	
MANAGEMENT PLAN	§	

ORDER APPROVING LOWER COLORADO
RIVER AUTHORITY'S DROUGHT MANAGEMENT PLAN

On the 18th day of December, 1991, the Texas Water Commission ("Commission") held a public hearing to consider the Lower Colorado River Authority's ("LCRA") proposed Drought Management Plan. At the hearing, the following were named as parties: the Lower Colorado River Authority; the Texas Parks and Wildlife Department ("TPWD"); the City of Austin; Garwood Irrigation Company; the Sierra Club, Lone Star Chapter; the Matagorda County Water Council; Houston Lighting and Power Company as Project Manager for the South Texas Project; the Executive Director of the Texas Water Commission; and the Public Interest Counsel of the Texas Water Commission. Having considered the proposed agreed order of the parties, the Commission makes the following Findings of Fact and Conclusions of Law:

FINDINGS OF FACT

1. Notice of the public hearing was published on October 10, 1991 in the Blanco County Record Courier, a newspaper regularly published and generally circulated in Blanco County, Texas; October 9, 1991 in the Austin American-Statesman, a newspaper regularly published and generally circulated in Travis County, Texas; on October 9, 1991 in the Colorado County Citizen, a newspaper regularly published and generally circulated in Colorado County, Texas; on October 10, 1991 in the San Saba News and Star, a newspaper regularly published and generally circulated in San Saba County, Texas; on October 10, 1991 in the Llano News, a newspaper regularly published and generally circulated in Llano County, Texas; on October 10, 1991 in the Highlander, a newspaper regularly published and generally circulated in Burnet County, Texas; on October 10, 1991 in the Bay City Daily Tribune, a newspaper regularly published and generally circulated in Matagorda County, Texas; on October 8, 1991 in the Fayette County Record, a newspaper regularly published and generally circulated in Fayette County, Texas; on October 5, 1991 in the El Campo Leader-News, a newspaper regularly published and generally circulated in Wharton County, Texas; and on October 7, 1991 in the Bastrop Advertiser, a newspaper regularly published and generally circulated in Bastrop County, Texas. These ten counties are

the only counties in which persons reside who may be affected by action taken as result of the hearing. Said notice was published not less than thirty (30) days before the date of the hearing.

2. On September 26, 1991, notice of the public hearing was sent by first-class mail to persons who may be affected by action taken as a result of the hearing and to each person as required by law.

3. LCRA is requesting approval of its Drought Management Plan for the Lower Colorado River, Colorado River Basin, in accordance with the Commission's September 7, 1989 Order approving LCRA's Water Management Plan and amending Certificates of Adjudication Nos. 14-5478 and 14-5482. LCRA's Water Management Plan was developed and submitted by LCRA in accordance with the Final Judgment and Decree entered by the court in Cause No. 115,414 A-1, 264th Judicial District, In Re: The Exceptions of the Lower Colorado River Authority and the City of Austin to the Adjudication of Water Rights in the Lower Colorado River Segment of the Colorado River Basin.

4. LCRA's proposed Drought Management Plan was filed with the Commission on October 19, 1990.

5. LCRA's procedures and guidelines set forth in the Water Management Plan and the Drought Management Plan for the allocation of firm water and interruptible water supplies are acceptable as conditioned by the provisions of this Agreed Order and with the understanding that the allocation procedures may be amended by the Commission at a later time for any justifiable reason including, but not limited to, an amendment to reflect the results of the instream flow and bay and estuary studies; provided, however, that the Commission shall retain jurisdiction to resolve all disputes regarding allocation of stored water that may arise in the future.

6. The priorities in LCRA's Water Management Plan and Drought Management Plan for interruptible water are subject to change after the completion of the studies on the instream flows and bays and estuaries required by conditions (k) and (l) of the September 7, 1989 Order.

7. Because of the water-availability and water-demand conditions that presently exist, it appears that 25,000 acre-feet of stored water per year probably will be adequate in the near future to firm up the minimum flows for instream flows and bays and estuaries set forth in condition (h) of the Commission's September 7, 1989 Order. Pursuant to conditions (k) and (l) of the Commission's September 7, 1989 Order, LCRA is required to submit applications to amend the Water Management Plan and the Drought Management Plan following completion of studies on instream flows and bays and estuaries

required by March 1992, and March 1993, respectively. Accordingly, it is unnecessary for the Commission to determine at this time whether the Commission, by its September 7, 1989 Order or otherwise, intended to give LCRA the authority or impose upon it the obligation to release more than 25,000 acre-feet of stored water in any one year to firm up those minimum flows.

8. Based on available studies and information, it is uncertain whether LCRA's proposed plan to begin curtailment of interruptible stored water supplies at a January 1 trigger level of 1.4 million acre-feet of water in storage is appropriate, in that it may provide more protection to firm supplies of stored water than is necessary. However, because of the water-availability and water-demand conditions that presently exist, it is likely that such level will not be reached in the near future. Accordingly, it is unnecessary for the Commission to determine at this time whether, or to what extent, such trigger level provides more protection to firm supplies than is necessary.

9. LCRA asserts that nothing in the Drought Management Plan should be construed to modify or impair in any way any contractual obligation of LCRA to supply water.

CONCLUSIONS OF LAW

1. The public hearing was held under the authority and in accordance with Chapter 11 of the Texas Water Code, as amended and the Texas Water Commission Permanent Rules.

2. The Texas Water Commission has jurisdiction to consider and take action on LCRA's proposed Drought Management Plan.

3. It is unnecessary at this time to determine whether the Commission, by its September 7, 1989 Order or otherwise intended to give LCRA the authority or impose upon it the obligation to release more than 25,000 acre-feet of stored water in any one year for instream flows and bays and estuaries. By approving the Drought Management Plan and entering this Order, the Commission specifically is not deciding these issues.

NOW, THEREFORE, BE IT ORDERED BY HE TEXAS WATER COMMISSION. THAT:

1. LCRA's proposed Drought Management Plan is approved with the following conditions:

   a. LCRA's Drought Management Plan is subject to LCRA's Water Management Plan and all findings, conclusions and conditions contained within the Commission's September 7, 1989 Order approving the Water

Management Plan including, without limitation, any findings, conclusions and conditions contained in this Order that are also contained within the September 7, 1989 Order.

b. The Drought Management Plan shall be subject to the continuing right of supervision of the Commission, and the Commission, on its own motion, may reconsider any element of the plan at any time in the future.

c. LCRA's responsibility and authority under the Drought Management Plan is limited to operational control of the Highland Lakes and LCRA's facilities downstream, and is limited by the terms of this Order and the Commission's September 7, 1989 Order.

d. LCRA is required to pass all inflows to the Highland Lakes to the extent necessary to satisfy the demands of all downstream senior rights, and nothing in the Drought Management Plan or this order shall be construed to modify or impair this obligation.

e. LCRA shall prepare and submit to the Commission, on or before March 1 of each year beginning with March 1, 1992, a report which documents compliance with the approved Drought Management Plan and any special conditions thereto during the previous year. Such report shall be in a form approved by the Executive Director.

f. After the instream study by LCRA and TPWD is completed, but in any event not later than March, 1992, LCRA shall submit an application to amend its Water Management Plan and its Drought Management Plan to reflect the results of the instream flow studies and the studies and evaluations referenced in Findings of Fact Nos. 73, 74, and 75 of the Commission's September 7, 1989 Order. Such application shall also propose conditions for implementing or cancelling the declaration of a drought to be worse than the drought of record. LCRA shall do all things necessary to ensure that such application is administratively and technically complete within six months of submission. The Commission agrees to hold a hearing within one year of the date of LCRA's submission to consider the amendments of the Plans, or if the studies are not complete, to determine why such studies are not complete.

g. After completion of the Texas Water Development Board ("TWDB") and TPWD study on freshwater inflows into the bays and estuaries, as applicable to the Lavaca-Tres Palacios Estuary, and in any event not later than March, 1993, LCRA shall submit an application to amend its Water Management Plan and its Drought Management Plan to reflect the results of the bays/estuary study. LCRA shall do all things necessary to ensure that such application is administratively and technically complete within six months of submission. The Commission agrees to hold a hearing within one year of the date of LCRA's submission to consider the amendments of the Plans, or, if the studies are not complete, to determine why such studies are not complete.

h. The combined firm yield as found by the Commission in Finding of Fact No. 47 of its September 7, 1989 Order is subject to adjustment and refinement from time to time as additional studies and simulations are developed that more accurately reflect assumptions and operations as required by law.

i. LCRA's proposed plan to begin curtailment of interruptible stored water at a January 1 trigger level of 1.4 million acre-feet of water in storage, and other aspects of LCRA's proposed curtailment plan, are subject to adjustment from time to time as additional studies and simulations may be developed that more accurately address the need to curtail interruptible supplies.

j. The Commission retains jurisdiction to resolve any and all disputes regarding the allocation of stored water from Lakes Travis and Buchanan, notwithstanding the procedures and guidelines set forth in the Water Management Plan and/or the Drought Management Plan.

2. The Chief Clerk of the Texas Water Commission shall forward a copy of this Order subject to the filing of motions for rehearing, to all parties.

3. If any provision, sentence, clause or phrase of this Order is for any reason held to be invalid, the invalidity of any portion shall not affect the validity of the remaining portions of the Order.

4. Nothing in the Drought Management Plan or this Order shall be construed to impair, or to authorize LCRA or any other person or entity to impair, senior or superior water rights in the Colorado River Basin.

Issued: DEC 2 3 1991

TEXAS WATER COMMISSION

John Hall, Chairman

ATTEST:

Gloria A. Vasquez, Chief Clerk

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THE STATE OF TEXAS
COUNTY OF TRAVIS

TEXAS WATER COMMISSION

I hereby certify that this is a true and correct copy of a Texas Water Commission document which is filed in the permanent records of the Commission.
Given under my hand and the seal of office on

JAN 11 199

Gloria A. Vasquez, Chief Clerk
Texas Water Commission

CONSIDERATION OF THE LOWER COLORADO RIVER AUTHORITY'S APPLICATION TO AMEND ITS WATER MANAGEMENT PLAN AND DROUGHT MANAGEMENT PLAN	§ § § § §	BEFORE THE TEXAS WATER COMMISSION

AGREED ORDER APPROVING AMENDMENTS TO LOWER COLORADO RIVER AUTHORITY'S WATER MANAGEMENT PLAN AND DROUGHT MANAGEMENT PLAN

On the 2nd day of December, 1992, the Texas Water Commission ("Commission") considered the Lower Colorado River Authority's ("LCRA") application to amend its Water Management Plan and Drought Management Plan, and having heard evidence and arguments concerning the proposed order, the Commission makes the following Findings of Fact and Conclusions of Law:

Findings of Fact

1) Notice of the public hearing was published on September 3, 1992, in the Johnson City Record-Courier, a newspaper regularly published and generally circulated in Blanco County, Texas; on August 23, 1992 in the Austin American-Statesman, a newspaper regularly published and generally circulated in Travis County, Texas; on August 26, 1992 in the Colorado County Citizen, a newspaper regularly published and generally circulated in Colorado County, Texas; on August 27, 1992 in the San Saba News & Star, a newspaper regularly published and generally circulated in San Saba County, Texas; on September 3, 1992 in the Llano News, a newspaper regularly published and generally circulated in Llano County, Texas; on August 27, 1992 in the Marble Falls Highlander, a newspaper regularly published and generally circulated in Burnet County, Texas; on

August 25, 1992 in the Bay City Daily Tribune, a newspaper regularly published and generally circulated in Matagorda County, Texas; on August 25, 1992 in the Fayette County Record, a newspaper regularly published and generally circulated in Fayette County, Texas; on August 22, 1992 in the El Campo Leader-News, a newspaper regularly published and generally circulated in Wharton County, Texas; and on August 27, 1992 in the Bastrop Advertiser, a newspaper regularly published and generally circulated in Bastrop County, Texas. These ten counties are the only counties in which persons reside who may be affected by action taken as a result of the hearing. Said notice was published not less than thirty (30) days before the date of the hearing.

2) On August 11, 1992, notice of the public hearing was sent by first-class mail to persons who may be affected by action taken as a result of the hearing and to each person as required by law.

3) LCRA's Application to Amend its Water Management Plan and Drought Management Plan ("Application") was received by the Commission on May 29, 1992 and July 15, 1992.

4) LCRA's Application was accepted by the Commission as administratively complete on July 23, 1992.

5) The Lake Travis Chamber of Commerce requested LCRA to amend its Water Management Plan to change the trigger level of Lake Travis from 660 feet msl to 667 feet msl; to limit new interruptible water contracts to the volume of water saved in the rice irrigation conservation program; and to revise the description of the lake's economy.

6) In response to the request by the Lake Travis Chamber of Commerce, LCRA proposes to amend the Water Management Plan to

eliminate the trigger levels of 660 feet msl for Lake Travis and 1012 feet msl for Lake Buchanan; to limit sales of interruptible stored water, other than for the four major irrigation districts' Conservation Base or Priority Allocation acreage, based on the projected volume of water in Lakes Buchanan and Travis as of January 1, of each year. No such sales would occur if either lake is less than 94% of its maximum conservation capacity. If both lakes are projected to be at their maximum conservation capacity on January 1, then such interruptible water sales would be limited to a total of 80,000 acre-feet for that year. For projected lake volumes between 94% and 100% of the conservation capacity, such interruptible water sales would be limited proportionately, based on the storage reservoir with the lowest projected percentage of capacity on January 1. LCRA also proposes to increase the Conservation Base acreage for the Gulf Coast Irrigation Division from 37,000 acres to 50,000 acres and set the Priority Allocation acreage for Pierce Ranch at 10,476 acres.

7) LCRA's Drought Management Plan presently allows for the cancellation of curtailments of interruptible stored water to the four major irrigation districts if the combined storage of Lakes Buchanan and Travis is at least 1.4 million acre-feet on July 1.

8) LCRA proposes to amend LCRA's Drought Management Plan to provide that curtailment of interruptible stored water for the four major irrigation districts may be cancelled at any time during the year prior to July 31. The criteria for cancelling the curtailments is that the combined storage of Lakes Buchanan and Travis is projected to be equal to or greater than 1.4 million acre-feet of water anytime in July.

9) LCRA's Water Management Plan presently allows LCRA to reserve 50,000 acre-feet of the remaining combined firm yield of Lakes Buchanan and Travis for future uses under LCRA's certificates of adjudication. This reservation will be until water supply and demand assessments for LCRA's 10-county statutory district are completed or within three years, whichever is sooner.

10) LCRA has completed the water supply and demand assessments for its 10-county statutory district. The results of these studies indicate new surface water demands of approximately 39,000 acre-feet annually by the year 2013.

11) LCRA is presently in the process of updating these water supply and demand assessments to include the results of the 1990 federal census. To allow LCRA additional time to complete such updated assessments, it is reasonable to allow LCRA to continue to reserve 50,000 acre-feet of the remaining combined firm yield of Lakes Buchanan and Travis for future uses under its certificate of adjudication, through December 31, 1993.

12) The Commission's September 7, 1989 Order approving LCRA's Water Management Plan, directed LCRA in accordance with Findings of Fact No. 73, 74, and 75, to reference and summarize information on point and non-point pollution sources and loading on the Colorado River, identify new data needed to determine water quality effects on revision of the minimum flow schedule, and evaluate potential problems associated with anoxic hypolimnetic releases from reservoirs and the potential for related fish kills due to resulting low dissolved oxygen levels downstream. LCRA has completed these studies and evaluations. The instream flow schedule set forth in this Agreed Order was developed in response to those studies and evaluations.

13) The Commission's December 23, 1991 Order approving LCRA's Drought Management Plan directed LCRA to propose conditions for implementing and cancelling a declaration of a drought worse than the drought of record.

14) LCRA proposes that its Drought Management Plan be amended to provide that the LCRA Board of Directors will declare a drought worse than the drought of record when the following three conditions are simultaneously met:

(a) drought at least 36 consecutive months (36 months since both Lakes Buchanan and Travis were last full); and

(b) the cumulative inflow deficit since the beginning of the drought exceeds the envelope curve for cumulative inflow deficits by at least 5% for six consecutive months; and

(c) the combined storage of Lakes Buchanan and Travis is less than 600,000 acre-feet.

The LCRA Board of Directors will cancel such a declaration if any of the following conditions are met:

(d) the cumulative inflow deficit since the beginning of the drought is less than the envelope curve for cumulative inflow deficits by at least 5% for six consecutive months; or

(e) the combined storage in Lakes Buchanan and Travis is greater than 1.4 million acre-feet of water.

15) LCRA and TPWD have completed their instream flow needs study for the lower Colorado River. Based upon this study LCRA proposes that LCRA's Water Management Plan and Drought Management Plan be amended as follows:

(a) LCRA's existing commitment of 25,000 acre-feet of firm yield water supply, to supplement and maintain instream flows, be increased to an average of 31,800 acre-feet annually during any 10 consecutive year period.

(b) LCRA will maintain the daily river flows below the City of Austin's Longhorn Dam at no less than the subsistence/critical flows in all years.

(c) When the combined storage of Lakes Buchanan and Travis is projected to be above 1.4 million acre-feet of water on January 1, or if interruptible stored water curtailments are cancelled, LCRA will maintain during that calendar year or portion thereof target flows to the extent of inflows each day to the Highland Lakes as measured by upstream gages.

(d) Interruptible water contracts will be totally cutoff when the minimum January 1 storage of Lakes Buchanan and Travis is at or below 325,000 acre-feet of water.

16) The schedule of instream flows for the Colorado River downstream of the City of Austin's Longhorn Dam is as follows:

	Subsistence/ Critical Flows (cfs)		Target Flows (cfs)		
Month	Austin	Bastrop	Bastrop	Eagle Lake	Egypt
January	46[c]	120	370	300	240
February	46[c]	120	430	340	280
March	46[c]	500[b]	560	500[a]	360
April	46[c]	500[b]	600	500[a]	390
May	46[c]	500[b]	1030	820	670
June	46[c]	120	830	660	540
July	46[c]	120	370	300	240
August	46[c]	120	240	200	160
September	46[c]	120	400	320	260
October	46[c]	120	470	380	310
November	46[c]	120	370	290	240
December	46[c]	120	340	270	220

[a] Since target flow at Eagle Lake (based on overall community habitat availability) were insufficient to meet Blue Sucker (Cycleptus elongatus) spawning requirements during March and April target flows were superseded by critical flow recommendations for this reach.

[b] This flow should be maintained for a continuous period of not less than six weeks during these months. A flow of 120 cfs will be maintained on all days not within the six week period.

[c] LCRA will maintain a mean daily flow of 100 cfs at the Austin gage at all times, to the extent of inflows each day to the Highland Lakes as measured by upstream gages, until the combined storage of Lakes Buchanan and Travis reaches 1.4 million acre-feet of water. A mean daily flow of 75 cfs, to the extent of inflows each day to the Highland Lakes as measured by upstream gages, will

then be maintained until the combined storage of Lakes Buchanan and Travis reaches 1.0 million acre-feet of water. When the combined storage of Lakes Buchanan and Travis is reduced below 1.0 million acre-feet of water, then a subsistence/critical flow of 46 cfs will be maintained at all times regardless of inflows.

In addition, if the subsistence/critical flow of 46 cfs should occur for an extended period of time, then operational releases will be made by LCRA to temporarily alleviate the subsistence/critical flow conditions. Specifically, should the flow at the Austin gage be below a 65 cfs daily average for a period of 21 consecutive days, LCRA will make operational releases from storage sufficient to maintain daily average flow at the Austin gage of at least 200 cfs for two consecutive days. If this operational release condition persists for three consecutive cycles (69 days), then a minimum average daily flow of at least 75 cfs will be maintained for the next 30 days.

17) The priorities in LCRA's Water Management Plan and Drought Management Plan for use of interruptible water are subject to change after the completion of the studies on bay and estuary inflows referenced in condition (1) of the September 7, 1989 Order Approving LCRA's Water Management Plan.

18) Until such time that the Commission amends the requirement for freshwater inflows into the Lavaca Tres-Palacios Estuary as a result of the completion of the Texas Water Development Board and Texas Parks and Wildlife Department study on freshwater inflows LCRA shall continue to maintain a minimum monthly mean flow of 200 cfs, a minimum seasonal mean flow of 375 cfs and a minimum annual flow of 272,121 acre-feet measured at the USGS gage at Bay City for freshwater inflow to the Lavaca-Tres Palacios estuarine system.

Conclusions of Law

1) The Commission considered this Agreed Order under the authority and in accordance with Chapter 11 of the Texas Water Code, as amended and 31 Texas Administrative Code ("TAC") § 295 et. al.

2) The Texas Water Commission has jurisdiction to consider and take action on LCRA's application to amend its Water Management Plan and Drought Management Plan.

NOW, THEREFORE, BE IT ORDERED BY THE TEXAS WATER COMMISSION THAT:

1) LCRA's proposed amended Water Management Plan and Drought Management Plan are approved with the following conditions:

   a) LCRA's amended Water Management Plan is subject to all findings, conclusions, and conditions contained in the Commission's September 7, 1989 Order approving the Plan, except to the extent specifically provided otherwise by this Agreed Order.

   b) LCRA's amended Drought Management Plan is subject to all findings, conclusions, and conditions, contained in the Commission's December 23, 1991 Order approving the Plan, except to the extent specifically provided otherwise by this Agreed Order.

   c) Nothing in this Agreed Order shall be construed to impair any party's right to contest or seek clarification of, at anytime, any issue in connection with LCRA's Water Management Plan and Drought Management Plan. The Commission takes notice that the Sierra Club has contested the issue of priority of use of interruptible water and that contest has been remanded for hearing.

Nothing in this Agreed Order shall be construed as deciding that issue. Furthermore, if in that hearing, the priority of use for interruptible water, as it relates to instream flows, is determined by the Commission to be different than that set forth in those Plans, any party shall have the express right to reopen the issue of instream flow requirements by submitting a written request for hearing to the Office of Hearings Examiners.

2) The Chief Clerk of the Texas Water Commission shall forward a copy of this Agreed Order subject to the filing of motions for rehearing, to all parties.

3) If any part of this Agreed Order is for any reason held to be invalid, the invalidity of any portion shall not affect the validity of the remainder of the Agreed Order.

4) Nothing in LCRA's Water Management Plan and Drought Management Plan or this Agreed Order shall be construed to impair, or to authorize LCRA or any other person or entity to impair, senior or superior water rights in the Colorado River Basin.

ISSUED: DEC 1 8 1992

TEXAS WATER COMMISSION

John Hall, Chairman

ATTEST:

Gloria A. Vasquez, Chief Clerk

BJ12\05

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

THE STATE OF TEXAS
COUNTY OF TRAVIS
I hereby certify that this is a true and correct copy of a Texas Natural Resource Conservation Commission document, which is filed in the permanent records of the Commission.
Given under my hand and the seal of office on
MAR 04 1999
La Donna Castañuela, Chief Clerk
Texas Natural Resource Conservation Commission

DOCKET NO. 98-1387-WR

CONSIDERATION OF THE	§	BEFORE THE
LOWER COLORADO RIVER AUTHORITY'S	§	TEXAS NATURAL RESOURCE
APPLICATION TO AMEND ITS WATER	§	CONSERVATION COMMISSION
MANAGEMENT PLAN INCLUDING ITS	§	
DROUGHT MANAGEMENT	§	
PLAN	§	

ORDER APPROVING AMENDMENTS TO LOWER COLORADO RIVER AUTHORITY'S WATER MANAGEMENT PLAN INCLUDING ITS DROUGHT MANAGEMENT PLAN

On the 24th day of February, 1999, the Texas Natural Resource Conservation Commission ("Commission") considered the Lower Colorado River Authority's ("LCRA") application to amend its Water Management Plan including its amended Drought Management Plan ("WMP"), and having heard evidence and arguments concerning the proposed order, the Commission makes the following Findings of Fact and Conclusions of Law:

Findings of Fact

1) Notice of the public comment meeting and notice of the Commission's Agenda Date on proposed amendments to LCRA's WMP was published on December 17, 1998, in the Johnson City Record-Courier, a newspaper regularly published and generally circulated in Blanco County, Texas; on December 18, 1998 in the Austin American-Statesman, a newspaper regularly published and generally circulated in Travis County, Texas; on December 23, 1998 in the Colorado County Citizen, a newspaper regularly published and

generally circulated in Colorado County, Texas; on December 17, 1998 in the San Saba News & Star, a newspaper regularly published and generally circulated in San Saba County, Texas; on December 17 and 24, 1998 in the Llano News, a newspaper regularly published and generally circulated in Llano County, Texas; on December 18, 1998 in the Marble Falls Highlander, a newspaper regularly published and generally circulated in Burnet County, Texas; on December 20, 1998 in the Bay City Daily Tribune, a newspaper regularly published and generally circulated in Matagorda County, Texas; on December 18, 1998 in the Fayette County Record, a newspaper regularly published and generally circulated in Fayette County, Texas; on December 19, 1998 in the El Campo Leader-News, a newspaper regularly published and generally circulated in Wharton County, Texas; and on December 19, 1998 in the Bastrop Advertiser, a newspaper regularly published and generally circulated in Bastrop County, Texas. These ten counties are the only counties in which persons reside who may be affected by action taken by the Commission on the proposal amendments. Said notice was published not less than thirty (30) days before the Commission's Agenda Date.

2) On December 16 , 1998, notice of the public comment meeting and the Commission's Agenda Date was sent by first-class mail to persons who may be affected by action taken by the Commission and to each person as required by law.

3) By Commission order of September 20, 1989, the Commission conditionally approved LCRA's WMP. By Commission order of December 23, 1991, the Commission conditionally approved LCRA's Drought Management Plan, which is included as part of LCRA's WMP. Amendments to the plans were conditionally approved by Commission agreed order of December 18, 1992. These prior orders of the Commission required LCRA to submit an application to amend its WMP to reflect the results of a bay/estuary study to be completed

by Texas Water Development Board (TWDB) and Texas Parks & Wildlife Department (TPWD). In 1993, LCRA, TWDB, TPWD, and TNRCC entered into a cooperative agreement to complete the study. The study was completed in 1997 and LCRA filed its proposed amendments to the WMP to reflect the results of the study.

4) LCRA's application to Amend its WMP including its Drought Management Plan ("Application") was received by the Commission on May 29, 1997; addenda were received December 29, 1997 and September 29, 1998.

5) LCRA's Application was accepted by the Commission as administratively complete on November 13, 1998.

6) On January 5, 1999 the Commission held a public comment meeting. One person presented oral comments, which were not in opposition to the proposed amendments. No written public comments were provided by any person.

7) No protests and no requests for a contested case hearing have been filed with the Commission regarding the proposed amendments.

8) LCRA's WMP currently requires LCRA to meet an interim freshwater inflow need to the Lavaca-Tres Palacios Estuary, also known as the Lavaca-Colorado Estuary or the Matagorda Bay System of 272,000 acre-feet annually, as measured at the USGS Bay City gage.

9) LCRA's proposed amendments to the WMP would require LCRA to:

(a) release monthly inflows otherwise available for storage in the Highland Lakes to meet monthly target freshwater inflow needs of the Matagorda Bay System totaling 1.03 million acre-feet per year, as measured at the USGS Bay City gage, if January 1 storage levels in Lakes Travis and Buchanan combined is greater than 1.7 million acre-feet;

(b) release monthly inflows otherwise available for storage in the Highland Lakes to meet monthly critical freshwater inflow needs of the Matagorda Bay System totaling 171,100 acre-feet per year, as measured at the USGS Bay City gage, in all years; and

(c) stored water releases will be a combination of firm and interruptible stored water supplies. Firm water will be supplied in years when the four major irrigation districts' stored water supplies are curtailed. Interruptible stored water will be supplied in all other years.

10) LCRA's WMP currently requires LCRA to use up to a maximum of 318,000 acre-feet of firm stored water over any ten (10) consecutive years for instream flows and freshwater inflow needs of the Matagorda Bay System. The WMP currently provides for a total commitment of 31,800 acre-feet per year from the Combined Firm Yield of Lakes Travis and Buchanan for instream flows and freshwater inflow needs of the Matagorda Bay System.

11) LCRA's proposed amendments to the WMP are as follows:

(a) total commitments of the Combined Firm Yield from the Highland Lakes for instream flow maintenance will be an average of 12,860 acre-feet per year, with a maximum of 36,720 acre-feet in any one year; 58,700 acre-feet in any two consecutive years; 76,800 acre-feet in any three or four consecutive years; 106,100 acre-feet in any five consecutive years and 128,600 acre-feet in any six to ten consecutive years. Total commitments of the Combined Firm Yield from the Highland Lakes for freshwater inflows to the Matagorda Bay System will be an average of 3,090 acre-feet per year, with a maximum of 11,200 acre-feet in any one year; 19,700 in any two consecutive years; 24,200 acre-feet in any three or four consecutive years; 28,200 acre-feet in any five consecutive years and 30,900 acre-

feet in any six to ten consecutive years. The total firm stored water commitment for both purposes will be an average of 15,950 acre-feet per year. Estimated interruptible stored water supplied during the critical drought for both purposes will be an average of an additional 40,060 acre-feet per year.

12) Currently under the WMP the LCRA Board of Directors will declare a drought worse than the drought of record when three (3) conditions are simultaneously met. First, a drought of at least 36 consecutive months since both Lakes Travis and Buchanan were last full. Second, the cumulative inflow deficit since the beginning of the drought exceeds the envelope curve for cumulative inflow deficits by at least 5% for six consecutive months. Third, the combined storage of Lakes Travis and Buchanan is less than 600,000 acre-feet.

13) Because of the severity of the 1996 drought LCRA proposes the following amendments to the WMP:

(a) reduce the 36 month minimum to 24 months;

(b) curtailments of interruptible stored water due solely to the declaration of a drought to be worse than drought of record of less than 36 months in duration is only effective on the following January 1 or July 31, whichever occurs first following the declaration by the LCRA Board of Directors. Droughts more than 36 months in length have no restrictions as to when supply reductions can be implemented;

(c) prior to implementing curtailment of firm water supplies during droughts worse than drought of record, LCRA will meet with its firm water customers and develop a specific stored water curtailment plan approved by the LCRA Board of Directors and the Commission.

(d) Such a declaration will be canceled when the combined storage in Lakes Travis and Buchanan is greater than 1.1 million acre-feet of water, which is simply the recommended threshold for curtailment of interruptible water during a repetition of the drought of record. Prior to declaring a drought worse than the drought of record, the LCRA will re-evaluate this threshold level to determine if a more accurate cancellation storage level in lieu of 1.1 million acre-feet can be determined.

14) LCRA's WMP currently states that the storage level for initial curtailment of interruptible stored water for the four (4) major irrigation districts (Lakeside, Gulf Coast, Garwood and Pierce Ranch) will commence when the combined storage in Lakes Travis and Buchanan is less than or equal to 1.4 million acre-feet projected on January 1.

15) LCRA's proposed amendment reduces the combined storage level from 1.4 to 1.1 million acre-feet projected on January 1.

16) LCRA's WMP currently provides that the allocation of interruptible stored water to users other than the four (4) major irrigation districts is made annually based on projected January 1 storage levels in Lakes Travis and Buchanan taken separately. The maximum supply of interruptible stored water available currently under the WMP is 80,000 acre-feet per year.

17) LCRA's proposed amendments will change the allocation of interruptible stored water to users other than the four (4) major irrigation districts to a semiannual allocation as follows:

(a) the supply for January through June is based on January 1 storage levels in Lakes Travis and Buchanan taken separately;

(b) the supply for July through December is based on the minimum of the maximum storage levels in April, May and June in Lakes Travis and Buchanan taken separately.

(c) maximum supply available under LCRA's proposed amendments is 30,000 acre-feet per year.

18) LCRA's WMP currently provides that the LCRA Board of Directors has committed to reserving 50,000 acre feet of the remaining Combined Firm Yield of the Highland Lakes through December 31, 1993 for future uses within LCRA's service area.

19) LCRA's proposed amendment is to reserve 50,000 acre-feet of water of the remaining Combined Firm Yield of the Highland Lakes for future uses within LCRA's service area indefinitely, as reflected in current LCRA Board of Directors policy.

20) On March 29, 1996 the Commission issued its Order severing a portion of the water rights authorized by Certificate No. 14-2564 (Hudson et ux) and combining it with all of the water rights authorized by LCRA's Certificate No. 14-5478, (Lake Buchanan) as amended. Certificate No. 14-5478C was issued to LCRA on the same date and authorizes LCRA to transfer downstream 532 acre-feet of water for use by LCRA out of Lake Buchanan with consumption use limited to 500 acre-feet per year.

21) Because the priority date of the water severed from Certificate No. 14-2564 and purchased by LCRA is 1929, senior to the 1938 Lake Buchanan priority date, LCRA is requesting that the WMP be amended to reflect an increase of 500 acre-feet in the Combined Firm Yield of Lakes Buchanan and Travis from 535,812 acre-feet to 536,312 acre-feet.

22) On June 2, 1997, the Commission issued its Order severing the water rights authorized by Certificate No. 14-5477B from Certificate No. 14-5477(Pierce Ranch), as amended, and combined it with LCRA's water rights authorized by Certificate No. 14-5475. (LCRA's Lakeside Irrigation Service Area)

23) LCRA proposed amendments to the WMP reflect the Commission's June 2, 1997 Order.

24) LCRA is proposing throughout the current WMP several non-substantive amendments to reflect factual changes that have occurred during the period 1993-1997 relating to water demands, both actual and projected; changes to models; operations procedures; LCRA Board Policy and general background information. All of these proposed non-substantive amendments to the current WMP are detailed in mark-ups of the current WMP dated May 28, 1997, December 29, 1997 and September 29, 1998 that have been filed with the Commission by the LCRA.

CONCLUSIONS OF LAW

1) The Commission considered this Order under the authority and in accordance with Chapter 11 of the Texas Water Code, as amended, and 30 Texas Administrative Code ("TAC") § 295 et. al.

2) The Commission has jurisdiction to consider and take action on LCRA's application to amend its Water Management Plan.

NOW, THEREFORE, BE IT ORDERED BY THE TEXAS NATURAL CONSERVATION COMMISSION THAT:

1) LCRA's proposed amended Water Management Plan, which includes LCRA's amended Drought Management Plan as reflected in LCRA's detailed mark-ups of the current WMP dated May 28, 1997, December 29, 1997 and September 29, 1998, is approved with the following conditions:

   a) LCRA's amended Water Management Plan is subject to all findings, conclusions, and conditions contained in the Commission's September 20, 1989 Order approving the Plan, except to the extent specifically provided otherwise by this Order.

   b) LCRA's amended Drought Management Plan is subject to all findings, conclusions, and conditions, contained in the Commission's December 23, 1991 Order approving the Plan, except to the extent specifically provided otherwise by this Order.

   c) LCRA's amended Water Management Plan, including LCRA's amended Drought Management Plan, is subject to all findings, conclusions, and conditions contained

in the Commission's December 18, 1992 Agreed Order approving amendments to the Plans, except to the extent specifically provided otherwise by this Order.

d) Any party shall have the right, at any time, to petition the Commission to seek to amend or clarify any issue in connection with LCRA's amended Water Management Plan, which includes LCRA's amended Drought Management Plan. Nothing in this Order shall be construed to impair any party's right to contest or seek clarification of, at anytime, any issue in connection with LCRA's amended Water Management Plan, which includes LCRA's amended Drought Management Plan.

e) The Commission takes notice that in 1993 the Sierra Club contested the issue of priority of use of interruptible water and that contest has been remanded to the State Office of Administrative Hearings ("SOAH") for hearing and is still pending.

f) Nothing in this Order shall be construed as deciding the issue pending at SOAH. Furthermore, if as a result of that hearing, the priority of use for interruptible water, as it relates to instream flows, is determined by the Commission to be different than that set forth in these Plans, any party shall have the express right to reopen the issue of instream flow and bay and estuary inflow requirements by submitting a written request for hearing to the Commission.

2) The Chief Clerk of the Texas Natural Resource Conservation Commission shall forward a copy of this Order subject to the filing of motions for rehearing, to all parties.

3) If any part of this Order is for any reason held to be invalid, the invalidity of any portion shall not affect the validity of the remainder of the Order.

4) If the Texas Parks and Wildlife Department, the Texas Water Development Board, or the Commission, acting on their own motion or as a result of a petition filed by any party, shall

determine that there is a need for any updates to the freshwater inflow needs as a result of a new study for the Matagorda Bay System, the LCRA shall amend its amended Water and Drought Management Plans and submit these proposed amendments to the Commission for review and approval within one (1) year of completion of such new studies. Any party may reopen the issue of bay and estuary inflows by submitting a written request for hearing to the Commission within thirty (30) days of receiving notice of the filing of the new studies or any proposed amendment to the Plans.

5) Nothing in LCRA's Amended Water Management Plan and Amended Drought Management Plan or this Order shall be construed to impair, or to authorize LCRA or any other person or entity to impair, senior or superior water rights in the Colorado River Basin.

ISSUED: MAR 01 1999

TEXAS NATURAL RESOURCE
CONSERVATION COMMISSION

Robert J. Huston, Chairman

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

AGREED ORDER APPROVING AMENDMENTS TO LOWER COLORADO RIVER AUTHORITY'S WATER MANAGEMENT PLAN

On the 27th day of January, 2010, the Texas Commission on Environmental Quality ("Commission") considered the Lower Colorado River Authority's ("LCRA") application (Application No. 5838) to amend its Water Management Plan (WMP) and having heard evidence and arguments concerning Application No. 5838 and the proposed order, the Commission makes the following Findings of Fact and Conclusions of Law:

FINDINGS OF FACT

1) LCRA's Application No. 5838 to amend the WMP was received by the Commission on May 16, 2003, and was declared administratively complete on May 7, 2004.

2) Notice of the application to amend the WMP and of the public meeting on the proposed amendments to the WMP was published on September 27, 2004, in the Austin American-Statesman, a newspaper regularly published and generally circulated in Travis County, Texas; on September 29, 2004, in the Colorado County Citizen, a newspaper regularly published and generally circulated in Colorado County, Texas; on October 10, 2004, in the Matagorda County Tribune, a newspaper regularly published and generally circulated in Bastrop County, Texas; on October 10, 2004, in the Bay City Tribune, a newspaper regularly published and generally circulated in Matagorda County, Texas; on October 1, 2004, in the Fayette County Record, a newspaper regularly published and generally circulated in Fayette County, Texas; on September 29, 2004, in the El Campo Leader-News, a newspaper regularly published and generally circulated in Wharton County, Texas; and on September 25, 2004, in the Bastrop Advertiser, a newspaper regularly published and generally circulated in Bastrop County, Texas. These counties are the only counties in which persons reside who may be affected by action taken by the Commission on the proposed amendments.

3) On September 14, 2004, notice of an application to amend the WMP and notice of the public meeting was sent by first-class mail to the water right holders of record in the Colorado River Basin as required by law.

4) On November 8, 2004, the Commission held a public meeting. One person presented oral comments, and five (5) entities provided written comments in opposition to the proposed amendments.

5) The following persons/entities filed protests and requested a contested case hearing with the Commission regarding the proposed amendments: STP Nuclear Operating Company; City of Austin; Texas Parks and Wildlife Department; Sierra Club, Lone Star Chapter; and the National Wildlife Federation.

6) The applicant, LCRA, has requested numerous editorial and organization changes to the WMP designed to correct errors, improved readability and achieve internal consistency in the documents. All of these proposed non-substantive amendments to the WMP are detailed in mark-ups of the existing approved WMP dated May 16, 2003, June 10, 2004, April 29, 2005, March 1, 2006, April 24, 2009, November 25, 2009, and December 17, 2009, that were filed with Commission by the LCRA.

7) LCRA's proposed amendments to the WMP fall within four areas: curtailment policy for interruptible stored water supplies; allocation of stored water for environmental protection; incorporation of LCRA's Drought Contingency Plan into the WMP; and update of the WMP Appendices.

8) LCRA's proposed amendments to the WMP show the 2000 reported surface water demands by its firm customers from all sources of supply as approximately 296,600 acre-feet annually. The ten-year projected firm demands (through 2010), developed in 2000, were approximately 360,071 acre-feet per year - an increase of 63,471 acre-feet per year. The primary reason for this projected increase is additional water use around the Highland Lakes. Since LCRA filed its application in 2003, its obligations to provide firm supply to the STP Nuclear Operating Company (STPNOC) have been clarified in an Amended and Restated Contract which, among other things, obligates LCRA to provide no more than 20,000 acre-feet per year (rolling five-year average) of firm supply for up to two nuclear generating units and up to 40,000 acre-feet per year (rolling five-year average) of firm supply for more than two generating units, with staged deliveries based on STPNOC's reservoir level subject only to LCRA bay and estuary restrictions and according to a Water Delivery Plan. Contractual Permit No. 327A was issued by the Commission on August 31, 2009, based on the Amended and Restated Contract and the included Water Delivery Plan. The total estimated firm demands for all LCRA customers to be satisfied under this WMP are sufficient to address any additional firm demand that STPNOC might have in the timeframe for which these present amendments to the WMP are intended to be effective, after taking into consideration firm water allocated for environmental purposes.

9) With this large projected increase in firm water demand, and because firm water demands take priority over all other uses, LCRA requested the proposed amendments to the WMP to provide a compensating reduction in interruptible supplies. This reduction will be achieved by revising the annual interruptible water supply curtailment policy. LCRA's proposal to amend curtailment policy is as follows:

(a) If the total water in storage in either Lakes Buchanan or Travis is less than 94% on January 1 or June 1, then interruptible water supplies will not be made available to any customers located outside the four downstream irrigation operations (Pierce Ranch, Garwood, Gulf Coast, and Lakeside).

(b) If the total combined water in storage in Lakes Buchanan and Travis on January 1 is equal to or greater than 1,400,000 acre-feet, then LCRA will supply the interruptible stored water demands of the downstream four irrigation operations. This is based on the assumption that the maximum annual demand for the interruptible stored water acreage of 83,700 acres projected for 2010, under a 1 in 5 dry year condition, was 273,000 acre-feet. Using that as the greatest interruptible stored water demand, a set of smaller interruptible stored water supplies were assumed to generate a set of first and second crop acreages expected to be cultivated by each particular irrigation operations.

(c) Curtailment of interruptible supply to the irrigation operations will commence when the total combined January 1 storage in Lake Buchanan and Travis is less than 1,400,000 acre-feet. When the combined storage in Lakes Buchanan and Travis on January 1 is between 1,400,000 acre-feet and 1,150,000 acre-feet, the interruptible stored water supply available will vary beginning at 273,000 acre-feet available at 1.4 million acre-feet of storage and decreasing at a rate of approximately 31,200 acre-feet for each 100,000 acre-foot decrease in combined storage until a value of 195,000 acre-feet available at a combined storage of 1.15 million acre-feet. When the combined storage in Lakes Buchanan and Travis on January 1 is less than 1,150,000 acre-feet, the interruptible stored water supply made available to the irrigation operations will vary beginning at 195,000 acre-feet available at 1.15 million acre-feet of storage and decreasing at a rate of approximately 4,250 acre-feet for each 100,000 acre-foot decrease in combined storage until a value of 160,000 acre-feet available at a combined storage of 325,000 acre-feet. This curtailment is depicted in Figure 4-1 of the Water Management Plan.

(d) Cutoff of the interruptible stored water supply for any purpose for the coming year will occur when the combined storage in Lakes Buchanan and Travis on January 1 is less than or equal to 325,000 acre-feet.

(e) If at any time during the year the total storage in Lakes Buchanan and Travis, combined, is less than or equal to 200,000 acre-feet, then all use of interruptible stored water will be stopped.

(f) During any period of curtailment or cutoff of interruptible supplies to the irrigation operations that is instituted on January 1, LCRA will cancel such curtailment at any time during the year prior to July 31, if the combined storage in Lakes Buchanan and Travis is projected to be equal to or greater than 1,400,000 acre-feet anytime in July. Further, the remaining available interruptible stored water supplies for the year may be reallocated, at this time, between irrigation operations if such allocations do not adversely affect any irrigation operation.

(g) During periods of curtailment, LCRA will allow each irrigation operation the option of either: (1) using up to a maximum authorized volume of interruptible stored water allocated to that operation, or (2) using sufficient water to cultivate a level of acreage agreed upon among the customers within each irrigation operation and LCRA.

10) LCRA's proposed amendments to the WMP also include a change in the procedure for supplying water for instream flow needs at certain locations downstream of Lady Bird Lake.

(a) To the extent that inflows are legally available for storage in Lakes Buchanan and Travis, LCRA will release such inflows to help satisfy target instream flow needs, as set out in Table 2-1 of the WMP, whenever the combined water storage in Lakes Buchanan and Travis on January 1 is at or above 1,400,000 acre-feet.

(b) LCRA will make such releases from Lakes Buchanan and Travis as are needed to help maintain critical instream flows, as set out in Table 2-1 of the WMP, at certain locations downstream of Lady Bird Lake. The level of releases to help maintain critical instream flows will not be limited by the inflows that are legally available for storage in Lakes Buchanan and Travis.

(c) In rare instances, LCRA's ability to meet the instream flow requirements set forth in this WMP may be impaired by certain unavoidable constraints such as the capacity of its hydro-generation units and hydro-generation scheduling mandates as well as unforeseen diversions, unforeseen changes in flow conditions downstream, and adjustments to the ratings of the applicable gages.

11) LCRA's proposed amendments to the WMP include a change in the reservoir operation procedure for providing water for estuarine fresh water inflow needs. The proposed amendment adds an intermediate level of supply for estuarine freshwater inflows that provides for a slightly more gradual reduction of the supply made available to Matagorda Bay than contained in the previously approved WMP. LCRA is required to release water from Lakes Buchanan and Travis to help maintain monthly estuarine inflows in accordance with the following procedure only to the extent that inflows are legally available for storage in Lake Buchanan and Travis as measured at the upstream gages:

(a) when the combined storage in Lakes Buchanan and Travis on January 1 is greater than or equal to 1,700,000 acre-feet, LCRA will release those storable inflows up to but not exceeding the amount needed to provide target freshwater inflow needs; and

(b) when the combined storage in Lakes Buchanan and Travis on January 1 is less than 1,700,000 acre-feet and greater than 1,100,000 acre-feet, LCRA will release those storable inflows up to but not exceeding the amount needed to provide one hundred and fifty percent of the critical freshwater inflow needs; and

(c) when the combined storage in Lakes Buchanan and Travis on January 1 is equal to or less than 1,100,000 acre-feet, LCRA will release those storable inflows up to but not exceeding the amount needed to provide critical freshwater inflows in all years.

12) The proposed amendments are deemed by LCRA as a balance between a modest incremental decrease in irrigation water supplies during drought conditions and modest increased inflow to Matagorda Bay during non-drought years to help maintain ecologically important freshwater inflows to the Bay.

13) Based on LCRA's determination of a balance of environmental and irrigation impacts, the recommended amendments to the WMP include an increase of stored water released for estuarine freshwater inflow. This increase would be provided in years when the January 1 storage level in Lakes Buchanan and Travis is between 1,100,000 and 1,700,000 acre-feet (55 and 86 percent full, respectively).

14) Among the issues raised in the hearing requests filed regarding the proposed amendments was the degree to which the amendments reflected consideration of the best information on environmental flow needs available at that time. While that issue remains in dispute, all parties agree that credible and extensive scientific information relating to environmental flow needs is available at

this time that is not incorporated in this order, but should be considered in developing and implementing an updated version of the WMP in the near future. That credible scientific information includes but is not limited to the August 2006 Matagorda Bay Freshwater Inflow Needs Study; the October 10, 2008 Matagorda Bay Health Evaluation; the March 31, 2008 Lower Colorado River, Texas Instream Flow Guidelines; and data collected by LCRA, TPWD, TWDB, and other agencies and researchers.

15) During the critical drought, LCRA proposes that the total stored water provided for environmental protection remain essentially the same as provided under the previously approved WMP. However, LCRA's proposed amendments provide that more of this commitment be met with firm, rather than interruptible stored water. The firm stored water so designated would increase from 16,950 acre-feet to 33,440 acre-feet. This additional firm commitment would be provided from available, but uncommitted supplies from Lakes Buchanan and Travis.

16) The LCRA Drought Contingency Plan (DCP), as required by Commission rules (30 Texas Administrative Code §§ 288.20 *et seq.*), was approved by the LCRA Board of Directors and submitted to the Commission in April 2000. The 2000 DCP was based on Chapter 4 of the WMP. Under current Commission rules, the DCP must be updated every five years. The DCP filed by LCRA with the Commission in 2000 was updated and approved by the LCRA Board of Directors and submitted to the Commission in April 2005. Consistent with the requirements of Chapter 288 of the Commission rules, LCRA also reviewed its DCP prior to May 1, 2009, but did not make any further changes to the DCP at that time. In December 2009, the LCRA Board approved further modifications to the DCP to reflect customer comment received in response to recent severe drought conditions. LCRA has submitted redline changes to Chapter 4 of the WMP that incorporates these recent changes.

17) On March 29, 1996 the Commission issued an Order severing a portion of the water rights authorized by Certificate of Adjudication No 14-2564 and combining them with LCRA's Certificate of Adjudication No. 14-5478 (Lake Buchanan). Certificate of Adjudication 14-5478C was issued to LCRA on the same date and authorized LCRA to transfer 532 acre-feet of water downstream to Lake Buchanan and consumptively use 500 acre feet per year of this water. Because the priority date of the severed water was senior to LCRA's rights to divert water from Lake Buchanan, LCRA requested and was granted on March 4, 1999, an increase in the Combined Firm Yield of Lakes Buchanan and Travis from 535,812 acre-feet to 536,312 acre-feet.

18) On August 29, 2003, LCRA filed a request with the Commission to cancel Certificate of Adjudication 14-5478C and for the Commission to rescind the March 29, 1996 Order severing water rights from Certificate Adjudication 14-2564 and combining them with LCRA's water rights authorized by Certificate of Adjudication 14-5478. On March 22, 2004, LCRA filed a Request to Abandon Certificate of Adjudication 14-5478C. Based on the abandonment, LCRA proposes that the WMP be amended to reflect a Combined Firm Yield of 535,812 acre-feet of water, which is the amount of the Combined Firm Yield prior to the issuance of Certificate of Adjudication 14-5478C.

19) The WMP contains two appendices: Volume I, which includes relevant LCRA Board policies, and Volume II, which contains technical information on the WMP and previous amendments. Changes to Volume I will reflect revisions made to LCRA Board polices since 1999. Changes to Volume II will reflect changes in agreements between LCRA and the Colorado River Municipal Water District, delete obsolete appendices, and update LCRA's standard form contracts and raw water contract rules.

20) LCRA supports this Order. In order to provide some certainty and to ensure prompt action on a new revision to the WMP, each of the parties identified in Finding of Fact No. 5 agree not to oppose the approval of this Order.

CONCLUSIONS OF LAW

1) The Commission considered this Order under the authority and in accordance with Chapter 11 of the Texas Water Code, as amended, and 30 Texas Administrative Code ("TAC") Chapter 295.

2) The Commission has jurisdiction to consider and take action on LCRA's application to amend the WMP.

NOW, THEREFORE, BE IT ORDERED BY THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY THAT:

1) LCRA's amended Water Management Plan is approved with the following conditions:

   a) LCRA's amended Water Management Plan is subject to all findings, conclusions, and conditions contained in the Commission's Order dated September 20, 1989, December 23, 1991, December 18, 1992 and March 1, 1999, approving and amending the WMP, except to the extent that this Order specifically provides otherwise.

   b) Notwithstanding any other provision in the revised Water Management Plan, for purposes of establishing LCRA's obligations to supply interruptible stored water for agricultural use within the four major irrigation operations and to provide water for instream flows and freshwater inflows in calendar year 2010, the following shall apply:

      1. LCRA's obligations to provide water for instream flows and freshwater inflows in January 2010 shall be governed by the Water Management Plan in effect on January 1, 2010.

      2. From February 1, 2010 through December 31, 2010, LCRA's obligations shall be governed by the WMP in effect on February 1, 2010. In providing interruptible stored water for agricultural use within the four major irrigation operations and in providing water for instream flows and freshwater inflows during this period, LCRA's obligations shall be determined based on the combined storage in Lakes Buchanan and Travis on February 1, 2010.

   c) LCRA shall implement the provisions of the amended Water Management Plan regarding the provision of instream flows in a manner so as maintain, on an instantaneous basis, instream flows of 46 cfs and 500 cfs critical flows as set forth in Table 2-1 during the times those respective flow values are in effect. During those times when the target instream flow requirements as set forth in Table 2-1 of the WMP are in effect, LCRA will schedule the passage of inflows to lakes Buchanan and Travis that are legally available for storage to maintain the target flows as a daily average. Furthermore, during those times when target instream flow requirements are in effect and when such inflows are sufficient to allow LCRA to satisfy the daily target flow requirement at the Bastrop gage, LCRA will also schedule the passage of

these inflows to maintain the following minimum flows, as measured at any time at the Bastrop gage:

Month	Minimum Flow (cfs) 100% of the time	Minimum Flow (cfs) 95% of the time
January	266	
February	269	
March	233	
April	244	287
May	492	579
June	355	418
July	295	347
August	165	
September	201	
October	208	
November	241	
December	264	

It is hereby recognized that, in rare instances, LCRA's ability to meet the instream flow requirements set forth in this WMP may be impaired by certain unavoidable constraints such as the capacity of its hydro-generation units and hydro-generation scheduling mandates as well as unforeseen diversions, unforeseen changes in flow conditions downstream, and adjustments to the ratings of the applicable gages.

d) For purposes of estimating required releases of water from Lakes Buchanan and Travis to meet the instream flow or freshwater inflow requirements of this WMP, LCRA shall rely on stage data obtained from the gaging system jointly maintained and operated by the U.S. Geological Survey and LCRA for determining these requirements. If the ratings used to convert stage to flow published by LCRA and the USGS are not identical at the time required releases are estimated, LCRA shall have discretion to rely on the latest updated rating of the gage.

e) The approval of the amended WMP does not reflect a final determination, or create a presumption, that the environmental flow provisions contained therein are adequate or appropriate based upon more recent information available at this time.

f) Because of the importance of updating the environmental flow and drought curtailment provisions of the WMP to reflect the best available science and information, LCRA shall promptly initiate, by not later than July 1, 2010, a revision process designed to develop further proposed amendments to the Water Management Plan. The revision process should be reasonably calculated to allow meaningful participation by interested basin stakeholder groups and to achieve regional consensus, where possible.

LCRA shall file an application for approval of proposed amendments with the Executive Director by not later than July 1, 2013. That application shall include a summary of the steps taken by LCRA to further public participation and to achieve consensus, where possible, in developing the proposed amendments. To the extent that the Executive Director determines such application is not administratively complete, LCRA shall make reasonable and good faith efforts to timely provide any

additional information necessary to have the application declared administratively complete at the earliest possible time.

Those proposed amendments shall address, at a minimum, the following:

1. Interruptible curtailment procedures needed to ensure that LCRA can satisfy projected firm customer demand should intense drought conditions such as those experienced over the past several decades recur;

2. An evaluation of the adequacy of the criteria for declaring a drought worse than drought of record;

3. An evaluation of the minimum combined storage of water in Lakes Buchanan and Travis necessary or appropriate to protect firm customers through a repeat of the drought of record or under conditions worse than a drought of record;

4. Incorporation of appropriate changes to reflect LCRA's agreements and obligations to STPNOC under the Settlement Agreement and Amended and Restated Contract, including the Water Delivery Plan;

5. LCRA's agreement with the City of Austin regarding return flows, consistent with Section VIII(C)(1) of the Settlement Agreement by and between the City of Austin and the LCRA Regarding Joint Water Resource Management and the Resolution of Certain Regulatory Matters Pending at the TCEQ, dated June 18, 2007;

6. Revisions to provisions governing the manner in which LCRA provides water from Lakes Buchanan and Travis to address environmental flow needs that shall use the best available scientific information, including the information referenced in Finding of Fact 15, and shall provide water for such needs to the maximum extent reasonable and practicable when considering all public interests as set forth in Texas Water Code §11.147 and any applicable environmental flow standards adopted pursuant to Texas Water Code § 11.1471. Such revisions shall include:

   i. a mechanism for adjusting the manner in which LCRA provides water for environmental flow needs that addresses significant improvements in storage conditions during the course of a year;

   ii. a mechanism for limiting harmful intra-daily fluctuations of instream flows to prevent significant adverse impacts from periods of low flows; and

iii. specification, to the maximum extent reasonable, of an overall instream flow regime.

The Commission hereby directs the Executive Director's staff to make all reasonable efforts to complete its technical review of the application for proposed amendments to the Water Management Plan by not later than one year after the date of LCRA's application is declared administrative complete and, as part of that staff review process, to allow other interested persons who request the opportunity to do so to submit, consistent with the timeline established by Commission staff, information regarding environmental flow issues and other issues addressed by the amendments for consideration. To facilitate the prompt completion of the technical review, LCRA shall respond fully to all requests from the Executive Director's staff for additional information within 30 days after receipt of those requests unless otherwise agreed upon by the Executive Director's staff. Upon completion of the technical review, the application and associated hearing requests, if any, on that application will be given high priority and set for prompt consideration and action by the Commission.

g) Consistent with 30 Tex. Admin. Code Ch. 288, LCRA shall review and update, as appropriate, in accordance with the schedule required by such rules, those portions of Chapter 4 that relate to its Drought Contingency Plan (DCP) that do not change the triggers or amount of curtailment of interruptible supply or the triggers related to instream flows and bay and estuary inflows. Changes to other portions of the DCP, including any changes to LCRA's specific, quantified targets for water use reductions of firm customers required by chapter 288, do not constitute an amendment to the Water Management Plan requiring notice and an opportunity for contested case hearing, but must otherwise comply with the public notice requirements of Chapter 288 of the Commission's rules. Prior to implementing any mandatory firm water customer curtailment allowed under Texas Water Code section 11.039, LCRA shall work with its firm customers to develop a specific water curtailment plan, which must be approved by the LCRA Board and the Commission pursuant to other applicable procedures.

h) Nothing in this Order shall be construed to impair or limit any party's right to contest the LCRA's proposal for incorporating the results of existing or future freshwater inflow or instream flow studies in any future proceedings relating to amendments of the Water Management Plan.

i) Nothing in this Order, other than Findings of Fact 17 and 18, shall be construed as addressing the calculation of the combined firm yield of Lakes Buchanan and Travis and no party shall be deemed to have waived the right to contest in any future proceeding the calculation of the combined firm yield of Lakes Buchanan and Travis solely as a result of this Order.

j) The Commission acknowledges the challenges to the adequacy of the environmental flow provisions included in the proposed amendments to the Water Management Plan previously raised by the Texas Parks and Wildlife Department, National Wildlife Federation, and the Lone Star Chapter of the Sierra Club. Those parties have agreed that compliance by LCRA with the provisions of this Order would eliminate the need for a Commission proceeding

to resolve those challenges. However, in the event that LCRA fails to meet any requirement set out in decretal paragraph (f) above, the Commission expressly recognizes that the issues raised by those challenges will again require consideration. Accordingly, any of those parties may, if it has reason to believe LCRA has failed to meet any such requirement, file, with the Office of the Chief Clerk, a written request seeking a hearing on the adequacy of environmental flow provisions approved by this Order and detailing the alleged failure by LCRA to comply with the requirements of decretal paragraph (f). Any such hearing request shall be set for prompt consideration by the Commission and, subject to compliance with routine requirements for hearing requests, shall be granted unless the Commission determines that LCRA has fully complied with the requirements of decretal paragraph (f).

k) LCRA agrees to be bound by the terms, conditions and provisions contained herein and such agreement is a condition precedent to the approval of the proposed amendments.

l) LCRA shall conform the text of the Water Management Plan to be consistent with the provisions of this Order.

2) The Chief Clerk of the Texas Commission on Environmental Quality shall forward a copy of this Order, to all parties.

3) If any part of this Order held to be invalid, the invalidity of any portion shall not affect the validity of the remainder of the Order.

4) Nothing in LCRA's Water Management Plan, as amended, or this Order shall be construed to impair, or to authorize LCRA or any other person or entity to impair, senior or superior water rights in the Colorado River Basin.

For the Commission

DATE ISSUED JAN 27 2010

APPLICATION OF THE LOWER COLORADO RIVER AUTHORITY FOR EMERGENCY AUTHORIZATION	§ § § §	**BEFORE THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY**

AFFIDAVIT OF DAVID WHEELOCK

THE STATE OF TEXAS §
§
COUNTY OF TRAVIS §

Before me, the undersigned authority, personally appeared David Wheelock, a person known by me to be competent and qualified in all respects to make this affidavit, who being by me first duly sworn, deposed as follows:

1. I am over 21 years of age, of sound mind, and have never been convicted of a felony or crime of moral turpitude. I am fully competent and qualified in all respects to make this affidavit.

2. The facts stated in this affidavit are within my personal knowledge and are true and correct. The tabs attached to this affidavit and referred to herein are incorporated by reference.

3. I, David Wheelock, am an individual residing in Travis County, Texas.

4. I have a Bachelor of Science in Civil Engineering from the University of Texas at Austin and a Master of Science in Civil Engineering with a water resources specialty from the University of Texas at Austin. I am a registered Professional Engineer in the State of Texas. A true and correct copy of my resume, detailing my prior work history and education, is attached hereto under Tab 1.

5. I have worked for the Lower Colorado River Authority ("LCRA") for more than three years. At LCRA, I have been responsible for the development and maintenance of various plans and permits directly affecting LCRA's water supply. I currently manage LCRA's water rights portfolio and active permit applications, Water Management Plan amendment process, groundwater development initiatives, and am the designated representative to the Region K Regional Water Planning Group. I am personally familiar with LCRA's raw water system, its water rights, and the TCEQ-approved LCRA Water Management Plan ("WMP"), which governs LCRA's operations of lakes Buchanan and Travis. In my position, I am responsible for understanding LCRA's raw water customer water needs now and in the future. In my position, I have also been involved in evaluating various alternative water supplies for LCRA's firm water customers.

6. My opinions stated herein are based on my over thirty years of experience in water supply development, water supply planning, and regulation of water rights in the state of Texas. I have also relied upon a variety of information provided to me by LCRA staff, which is of a nature typically relied upon in my profession, as described below and for which true and correct copies are attached and incorporated herein:

   a. Map of LCRA Water Service Area, attached hereto under Tab 2;

   b. Summary of Water Supply Alternatives, attached hereto under Tab 3, prepared by LCRA staff;

   c. Excerpts of the 2010 LCRA Water Management Plan;

   d. Affidavit of Ron Anderson, including attachments;

   e. Affidavit of Bryan Cook, including attachments;

   f. Affidavit of Ryan Rowney, including attachments;

   g. Affidavit of Nora Mullarkey Miller, including attachments; and

   h. Affidavit of Bob Rose, including attachments.

7. Based on the foregoing review and the reasons stated herein, my expert opinion on the following issues is set forth below:

   a. <u>LCRA Firm Customer Demands</u>.

      i. LCRA provides raw water from the firm water supply lakes Buchanan and Travis to over 60 retail and wholesale potable water suppliers that together serve over one million people. See Map of LCRA's Service Area, attached here under Tab 2. LCRA's municipal raw water customers include, but are not limited to, the Cities of Austin, Burnet, Cedar Park, Leander, Marble Falls, Pflugerville, Lakeway, Bee Cave, Horseshoe Bay, other Highland Lakes cities, water supply corporations, special districts (including LCRA's own water utility systems), and investor-owned utilities. In addition, LCRA provides water to several electric utilities—LCRA, Bastrop Energy Partners, Austin Energy, Gen-Tex Corporation, and South Texas Project Nuclear Operating Company—from the firm water supply of lakes Buchanan and Travis. These electric utilities provide power into the electrical grid in Texas operated by the Electric Reliability Council of Texas ("ERCOT") and provide electricity to customers in Texas. LCRA also provides firm raw water to several industries located downstream of the Highland Lakes, including Oxea Chemical and Underground Services Markham.

ii. The maximum historical annual amount of water use by firm water customers from lakes Buchanan and Travis during 2000 through 2011 was about 247,000 acre-feet in 2011. (*See* Affidavit of Ryan Rowney.)

b. Emergency Relief – Only Reasonable Alternative to Protect Firm Supply

i. There are no reasonably available and feasible practicable alternative water supplies or water management or conservation strategies that could be obtained or implemented at this time that would replace the volume of water that LCRA might otherwise have to release from the lakes if the requested relief is not granted that LCRA is not already pursuing. As demonstrated by the summary of alternatives attached hereto under Tab 3, most of the supplies identified would produce insufficient or uncertain quantities of supply, are constrained by existing contractual commitments, would create other operational issues for customers, and/or are subject to a high level of regulatory uncertainty and lengthy permitting process if not obtained on an emergency basis. In most cases, these alternatives would take years to develop and transport to the area of use. In short, none of the additional strategies identified can be implemented in time to prevent LCRA's need for the relief requested in its application.

ii. In the past three years, LCRA has sought and obtained emergency relief from its Water Management Plan, significantly reducing the demand for water from the Highland Lakes. While such actions have been important in maintaining LCRA's existing supply, the authorization sought in this application would allow LCRA to retain additional inflows in the lakes to help meet firm customer demands during this severe drought and could help delay pro rata curtailment of firm customers.

iii. For three years, 2012, 2013 and 2014, LCRA has obtained temporary permits to allow LCRA to use its downstream water rights to meet some of the needs of firm water customers downstream of the Highland Lakes, to the extent that those supplies are not being used to meet agricultural needs in the four irrigation operations. However, the amount of demand that can be met using these downstream water rights is limited by the availability of run-of-river flows and subject to environmental flow requirements. LCRA was able to divert about 4,000 acre-feet in 2012 under the temporary authorizations, and about 1,000 acre-feet in 2013. In addition, in 2011 LCRA obtained a permanent amendment to its Gulf Coast water right (14-5476) that allows use for industrial purposes. In 2012 and 2013, about 9,000 acre-feet and 10,000 acre-feet, respectively, of industrial demands were met with that amended water right These authorizations have the potential to

conserve water in the Highland Lakes, but as demonstrated by the amounts used in 2012 and 2013, the amounts are limited.

iv. LCRA and its customers are taking action to bring on some additional supplies. LCRA has recently obtained groundwater production permits in Bastrop County and is currently installing wells which will meet a portion of the demand at the Lost Pines Power Park. In response to the drought, the City of Burnet has turned to its groundwater wells to meet a portion of the city's demand. These additional supplies, while important, are not of the scale to offset potential shortages under worsening drought conditions.

v. Release of the water stored in the other lakes LCRA manages is not a feasible alternative to the relief requested. Several are cooling water reservoirs with operational constraints. Lake LBJ is the cooling water reservoir for the replacement Ferguson Power Plant which will be brought online in 2014. If Lake LBJ is lowered, it would have to be replenished prior to commissioning either with inflows, if any, from the Llano River (that could otherwise be captured in Lake Travis if Lake LBJ were full), or releases from Lake Buchanan. Lowering Lake Bastrop introduces multiple issues; including that any released surface water would need to be replenished with either surface water, including releases from Lakes Travis and Buchanan if no rains come, or a limited supply of groundwater, and operational and timing issues related to the ability to release and replenish water in the lake on a schedule needed for generation reliability. Releases from other intervening lakes could raise operational issues for LCRA's firm customers over a timeframe that cannot be readily addressed. And moreover, releases from Lake Buchanan may ultimately be required if local inflows do not materialize.

c. Appropriateness of Emergency Relief Requested. It is my opinion that the water that would otherwised be released to meet the 500 cfs requirement in the 2010 WMP should be preserved for the critical needs of LCRA's firm water customers in the event the drought persists.

Further affiant sayeth not.

DAVID WHEELOCK, AFFIANT

SWORN TO AND SUBSCRIBED before me on the 21st day of March, 2014.

TABETHA JASKE
Notary Public, State of Texas
My Commission Expires
January 11, 2018

Notary Public in and for the State of Texas

My Commission Expires: 1-11-2018

Tab 1

David C. Wheelock, PE
Manager, Water Supply and Conservation
Lower Colorado River Authority

David Wheelock is a key member of LCRA's water resources planning and management team.

He is an experienced water resources engineer and manager in water planning with river authorities and in consulting. He has been in responsible charge of managing wholesale raw water systems, contract administration, hydrologic modeling, water rights modeling, water supply planning, acquisition of water supplies, reservoir management, dam safety and hydroelectric generation development. Mr. Wheelock has participated in the development and implementation of strategic plans, setting direction and goals, advising senior management, and working with local entities, governments, and engineering firms to create solutions to water resource problems.

EXPERIENCE

Manager, Water Supply and Conservation, Lower Colorado River Authority — Austin, TX 2010-2013

From 2010-2011, supervised the Water Resources Planning and Management Department and the Water Conservation Department. As such, he was responsible for the development and maintenance of various plans and permits directly affecting LCRA's wholesale water supply. He obtained a number of important water right amendments, including changes to senior water rights to better manage the resource.

Currently, Mr. Wheelock is managing LCRA's water rights portfolio and active permit applications, Water Management Plan amendment process, groundwater development initiatives, and is the designated representative to the Region K Regional Water Planning Group.

Water Services Manager, Brazos River Authority — Waco, TX 2004 - 2010

Supervised the Water Services Department in the day-to-day management of eleven water supply reservoirs to meet contractual commitments and permit requirements. Was responsible for the administration of water supply contracts, compliance with state water right permits, controlling releases for water supply and during flood events, support for water rights applications (i.e. System Operations Permit application), and water supply planning.

Principal Engineer, Brazos River Authority — Waco, TX 2002 - 2004

In-house consultant to the General Manager, Regional Managers, and the Planning & Development Department in performing and implementing the goals of the Authority, as well as support for on-going operations. Provided leadership for planning, permitting, and design functions throughout the Authority's area of operations; communicating technical aspects of the vision and goals of the Authority; working closely with Authority technical staff; reviewing plans/specifications for new work and rehabilitation of existing projects; and, carrying out duties in accordance with the Authority's Strategic Plan.

Vice President, HDR Engineering, Inc. — Austin, TX 1993-2002

Project management, marketing, and leadership responsibilities for major water resource planning efforts of river authorities and state government, including: Brazos G Regional Water Planning Area (Texas Water Development Board SB 1 and SB 2 initiatives); Trans-Texas Water Program, including Austin, San Antonio, and Williamson County study areas (LCRA, BRA, SARA, SAWS); Williamson County Water Supply Facilities Plan (BRA); Western Canyon Regional

Water System (GBRA); and, Tarrant County Water Management Plan (TRWD). Other projects include planning and conceptual engineering for the Corpus Christi area (NRA, City of Corpus Christi); project management for rehabilitation of DeCordova Bend Dam flood control gates (Lake Granbury - BRA), rehabilitation of critical components of the flood control gates Morris Sheppard Dam (Possum Kingdom Reservoir - BRA), hydroelectric evaluation and assessment at Morris Sheppard Dam, and resident engineer for outlet works replacement at Red Bluff Dam on the Pecos River (Red Bluff Water District).

Self-Employed Consulting Engineer — Annapolis, MD 1992-1993

Self-employed consulting engineer providing services to construction and government clients. Services included construction management, scheduling, structural design, and estimating for dam rehabilitation and water resource projects.

Chief Engineer, Synergics, Inc. — Annapolis, MD 1990-1992

In responsible charge of technical and management duties for design and construction of dam rehabilitation and hydroelectric projects. .

Vice President, Gebhard Engineers — Austin, TX 1984-1990

Project manager and engineer for a number of water resource projects, including two hydroelectric plants in New Hampshire; waterline projects; feasibility assessment of numerous hydroelectric sites; major wastewater interceptor and tunnel; hydrology studies in New Mexico and Arizona; and, general civil and water resource projects.

Project Manager, Meyer-Lytton-Allen, Inc. — Austin, TX 1983-1984

Responsible for the engineering and construction of a number of land development and commercial development projects in Central Texas, including water and wastewater pumping stations, water pipelines, and stormwater drainage facilities.

Project Engineer, Turner Collie & Braden, Inc. — Austin, TX 1979-1983

Responsible for the design and construction of a variety of municipal water and wastewater treatment projects, including floating water intakes; water transmission pipelines; wastewater treatment plant rehabilitations; well systems; sludge handling and digestion facilities; and regional treated water system; resident project engineer for construction of water and wastewater treatment plants.

EDUCATION and REGISTRATIONS

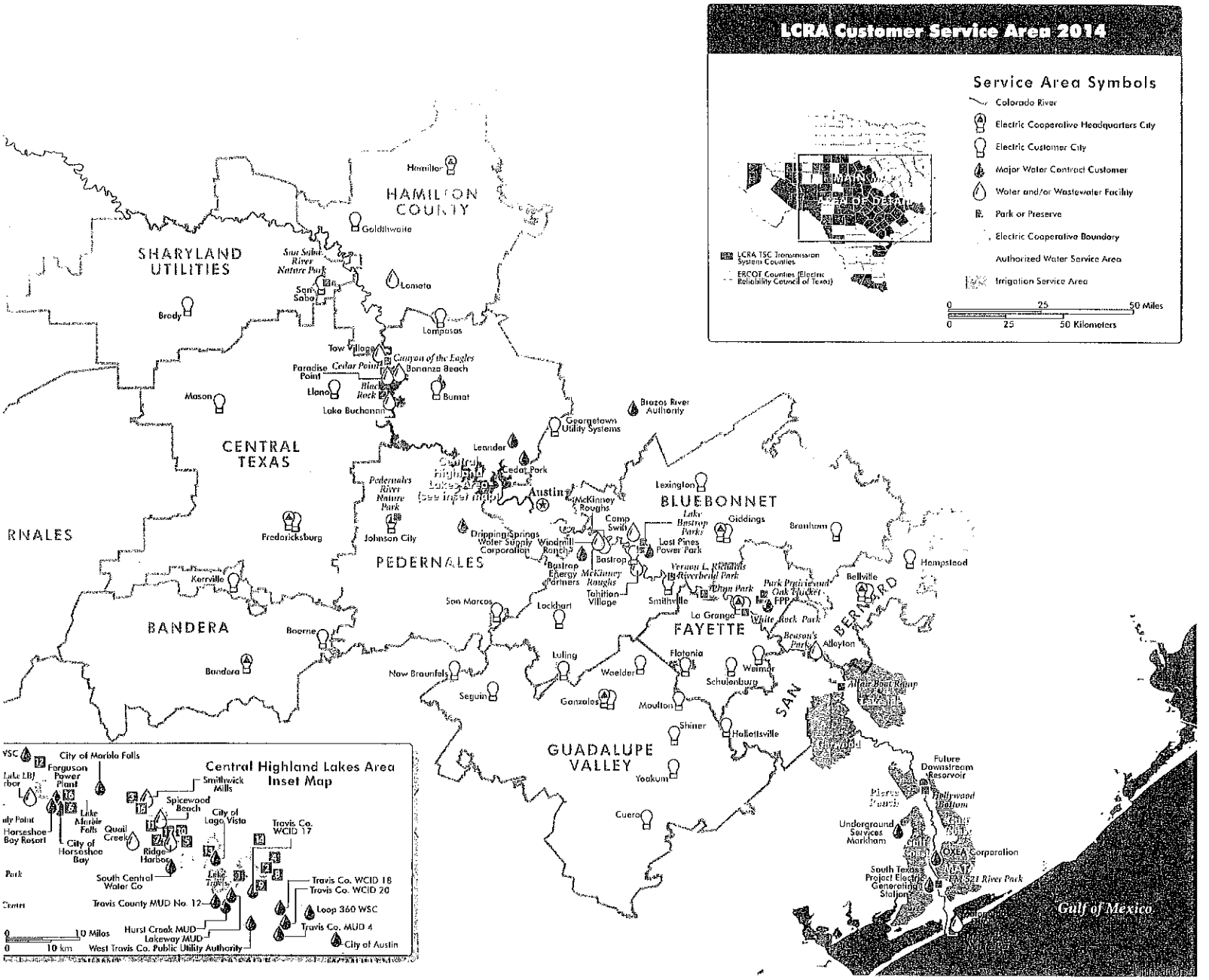
BSCE, University of Texas at Austin, 1979.
MSCE – Water Resources, University of Texas at Austin, 1986.

Registered Professional Engineer: Texas (#54303); inactive registrations: Arizona; Arkansas; Maryland; New Hampshire; Pennsylvania; Virginia.

PROFESSIONAL ASSOCIATIONS

American Water Works Association – past Chair of Standards Committee on Slide Gates.
American Society of Civil Engineers – past Director – Texas Section.

Member, SB 1094 State-wide Water Conservation Implementation Task Force.


LCRA Customer Service Area 2014
Service Area Symbols
Colorado River
Electric Cooperative Headquarters City
Electric Customer City
Major Water Contract Customer
Water and/or Wastewater Facility
Park or Preserve
Electric Cooperative Boundary
Authorized Water Service Area
Irrigation Service Area
LCRA TSC Transmission System Counties
ERCOT Counties (Electric Reliability Council of Texas)
0 25 50 Miles
0 25 50 Kilometers
HAMILTON COUNTY
Hamilton
Goldthwaite
SHARYLAND UTILITIES
San Saba River Nature Park
San Saba
Lometa
Brady
Lampasas
Tow Village
Canyon of the Eagles
Paradise Point
Cedar Point
Bonanza Beach
Llano
Black Rock
Burnet
Mason
Lake Buchanan
Brazos River Authority
Georgetown Utility Systems
CENTRAL TEXAS
Leander
Cedar Park
Central Highland Lakes Area (see inset map)
Pedernales River Nature Park
Austin
McKinney Roughs
Lexington
BLUEBONNET
Lake Bastrop Parks
Giddings
Brenham
Camp Swift
Lost Pines Power Park
Fredericksburg
Johnson City
Dripping Springs Water Supply Corporation
Windmill Ranch
Bastrop
Hempstead
PEDERNALES
Bastrop Energy Partners
McKinney Roughs
Vernon L. Richards Riverbend Park
Bellville
Kerrville
Tahitian Village
Smithville
Park Prairieland
Oak Thicket FPP
San Marcos
Lockhart
La Grange
White Rock Park
BANDERA
Boerne
FAYETTE
Bastrop's Park
Alleyton
Bandera
Luling
Flatonia
Weimar
New Braunfels
Waelder
Schulenburg
Seguin
Gonzales
Moulton
Shiner
Hallettsville
GUADALUPE VALLEY
Yoakum
Future Downstream Reservoir
Cuero
Hollywood Bottom
Underground Services Markham
OXEA Corporation
South Texas Project Electric Generating Station
Sea Star River Park
Gulf of Mexico
Central Highland Lakes Area Inset Map
City of Marble Falls
Ferguson Power Plant
Smithwick Mills
Spicewood Beach
Lake Marble Falls
City of Lago Vista
Travis Co. WCID 17
Quail Creek
Horseshoe Bay Resort
City of Horseshoe Bay
Ridge Harbor
South Central Water Co
Travis Co. WCID 18
Travis Co. WCID 20
Travis County MUD No. 12
Loop 360 WSC
Travis Co. MUD 4
Hurst Creek MUD
Lakeway MUD
West Travis Co. Public Utility Authority
City of Austin
0 10 Miles
0 10 km

Potential Alternatives to the Emergency Relief Requested by LCRA's Emergency Applications

LCRA has explored several alternative water supplies that might be available to alleviate strain on LCRA's water supply reservoirs, lakes Buchanan and Travis, caused by the persistent drought conditions. These alternatives are generally described below.

None of these alternatives could be obtained in sufficient supply or on a schedule that could serve to eliminate the need for immediate relief that LCRA seeks in its applications.

Moreover, it is important to note that LCRA lacks readily available funding to acquire or implement many of these alternatives, which means that rate increases for firm customers would be required to pay for these supplies at the same time LCRA may be significantly curtailing their access to water from lakes Buchanan and Travis.

1. **Utilize water from LCRA's Lakes Inks, LBJ, and Marble Falls.** These lakes are not currently authorized for municipal use, so amendments may be required to make full use of these supplies on a more permanent basis – a process that could take several years. If LCRA were to simply stop exercising its right to refill these lakes, but still allow the lakes to be maintained at levels that would not have significant impacts to cities and industries around them, it estimates that perhaps a one-time supply of about 34,000 acre-feet (AF) could be made available. Reduction in storage could also have significant impacts on hydroelectric generation capabilities.

2. **Conservation incentives and customer buyouts of nonessential uses (irrigation, recreation firm contracts).** LCRA has approximately 11,000 AFY under contract for firm irrigation and recreational use. LCRA may consider providing further financial incentives to these customers to reduce water use, but given the nominal amount of supply that might be made available, such alternatives would not be sufficient to alleviate the need for emergency relief.

3. **Aggressive municipal conservation.** This would include identifying and addressing water loss areas (i.e., toilets, shower heads, leaking pipes, etc.). In LCRA's experience, this requires solid partnerships with customers, a good method for calculating water savings (which is elusive) and a strong education and enforcement program (which is costly to the customers and requires time to become effective). Benchmarking and experience tells us that to achieve meaningful water savings, it often takes 1-2 years or more. While LCRA will continue to encourage water conservation, this alternative does not eliminate the need for emergency relief requested to avert the very near-term prospect of reducing storage levels beyond a protective level. The estimated cost of this long term program to achieve a 20% demand reduction is $220,000,000.

4. **Groundwater.** Many areas within LCRA's water service area have local groundwater conservation districts that regulate the use and permitting of groundwater supplies. Although groundwater appears to be available in many areas, the uncertainty associated with the long-term availability of such groundwater supplies in light of an unsettled regulatory environment renders any significant reliance on groundwater as an alternative supply a relatively high risk option. Within Matagorda County, which is governed by the Coastal Plains Groundwater Conservation District, LCRA estimates that it might be able to obtain agreements to lease up to 10,000 AFY of groundwater from existing wells or drill new wells to serve existing industrial customers in Matagorda County. Further, it might be able to do the same in and around Fayette County for purposes of securing supplies to meet some or all of the existing power plant water demands in that area. Groundwater development in Fayette County is regulated by the Fayette County Groundwater Conservation District. Similarly, LCRA has explored options for obtaining groundwater from the Carrizo-Wilcox aquifer to the east of Austin. Both the Lost Pines and Post Oak Savannah Groundwater Conservation districts have jurisdiction over large parts of the aquifer close to LCRA's service area. LCRA has recently obtained a groundwater permit in the Lost Pines Groundwater Conservation District for up to 10,000 AFY to use at LCRA's power facilities in Bastrop County. However, LCRA must still install a number of groundwater wells in order to produce the water.

   It takes approximately 9-12 months to secure written agreements with landowners and often takes several years to obtain new groundwater permits or permit amendments from local groundwater conservation districts, the need for emergency relief is not diminished. Further, to secure and develop any such supplies would take several years and thus would not avert the need for emergency relief.

   LCRA has recently learned that some limited supplies of groundwater are currently being delivered to Manor, a small city east of Austin, and that there may be some small amount of additional supply available for use at that point. It is estimated that 6-18 months, minimum, would be required to implement this alternative – not soon enough to eliminate the need for emergency relief.

5. **Off-Channel Reservoir**. Engineering work is underway on a new reservoir to be built in the lower Colorado River basin. LCRA is moving forward with plans to build the new reservoir to replace some supplies currently met from the Highland Lakes, improve agricultural water reliability and efficiency, and increase LCRA's overall water supply.

   The new reservoir in Wharton County will capture water downstream and hold it for beneficial use by downstream industrial and agricultural customers. This is the

first project that will allow LCRA to capture and store significant amounts of water downstream that can be used by multiple customers.

The reservoir will be able to hold about 40,000 acre-feet, but could be filled and used multiple times over the course of a year, making it capable of adding 90,000 acre-feet of firm water to the region's supply. The preliminary cost estimate for the reservoir is $206 million, and it currently scheduled to be on-line in 2017 – which may not be early enough to help with the current drought, and definitely not early enough to help lake levels in 2014.

6. **Wastewater reuse program in the Highland Lakes.** Enhanced direct reuse of wastewater around the Highland Lakes could reduce demand by about 5,000 AFY over the next 1-2 years. This amount of savings is not sufficient over the near term to alleviate the need for emergency relief. The estimated cost for an enhanced direct wastewater reuse pilot project for 1,120 acre-feet of supply is $5,700,000.

7. **Line or pipe high loss canals utilized by industry.** Determining high loss areas of canals can be a challenge and estimating the amount of water savings difficult. Although LCRA has some very general information about its canal systems, it could not immediately implement a canal lining project that would serve to reduce water usage in such quantities as to avert the need for emergency relief.

8. **Interbasin transfers or water trucking/rail transport.** Interbasin transfers of water or transport of water by truck or rail from areas with a more plentiful supply is an option that poses no realistic likelihood of alleviating the need for the emergency relief requested. Moreover, there are very few options close to the lower Colorado River basin with much supply to spare. Even if such supply exists, the interbasin transfer permitting process and construction of the necessary infrastructure would significantly limit the ability to bring such supplies on line in a timely manner. The logistics of locating sufficient transporting equipment to meet the levels of demand would be very difficult if not impossible.

9. **Ocean or Brackish Groundwater Desalination.** Although ample supply is likely available, the time required to permit and construct such facilities is estimated to be 5-10 years. This alternative thus does not eliminate the need for emergency relief. The estimated cost of this alternative is $177,000,000 for 22,400 acre-feet of supply.

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

AMENDMENT TO
CERTIFICATE OF ADJUDICATION

APPLICATION NO. 14-5478C

CERTIFICATE NO. 14-5478C

Name	:	Lower Colorado River Authority	Address	:	3701 Lake Austin Blvd. Austin, Texas 78703
Filed	:	December 12, 1995	Granted	:	MAR 29 1996
Purpose	:	Municipal, Industrial, Irrigation, Mining, Domestic, Recreation, Instream Flows, Bay/Estuary, Livestock, Hydroelectric, and Recharge	County	:	Llano and Burnet
Watercourse	:	Colorado River	Watershed	:	Colorado River

WHEREAS, Certificate of Adjudication No. 14-5478, as amended, includes authorization for the Lower Colorado River Authority (LCRA) to maintain an existing dam and 992,475 acre-foot capacity reservoir on the Colorado River (Buchanan Dam and Lake Buchanan) for in-place recreational purposes and to divert and use not to exceed 1,500,000 acre-feet of water per annum from the reservoir and Lake Travis (included in Certificate No. 14-5482) for municipal, industrial, irrigation, mining, and hydroelectric generation purposes; and

WHEREAS, the certificate included a time priority of March 29, 1926 for the impoundment of water in the aforesaid reservoir, the use of the impounded water for recreation, and the use of released water for hydroelectric generation, and a time priority of March 7, 1938 was assigned to the diversion and use of water for all other authorized purposes; and

WHEREAS, the certificate was amended to authorize the diversion, use, and release of the waters in Lake Buchanan for domestic, recreation, instream flows, bay/estuary inflows; and

WHEREAS, the certificate was amended a second time to authorize the diversion, use, and release of the waters in Lake Buchanan for livestock and recharge purposes; and

WHEREAS, Certificate No. 14-2564 was issued on August 31, 1983 to Palladian Capital Corporation and authorized the diversion and use of not to exceed 1100 acre-feet and the use of 1035 acre-feet of water per annum from the Colorado River to irrigate a maximum of 352 acres of land out of an 825.6 acre tract located in the William Seckatz Survey No. 535, Abstract No. 1046, San Saba County, Texas; and

WHEREAS, Commission records show ownership of Certificate No. 14-2564 as follows:

1. Haskel G. Hudson & Norma Jeanne Hudson - Diversion of 626 acre-feet per annum and use of 589 acre-feet for irrigation of 200.34 acres out of a 435.74 acre tract; and
2. Luther W. Simpson & Irma Nell Simpson - Diversion of 474 acre-feet per annum and use of 446 acre-feet for irrigation of 151.66 acres out of 329.86 acre tract; and

WHEREAS, William J. Maddux holds an option to purchase the right to divert 532 acre-feet and use 500 acre-feet per annum of the water rights owned by Haskel G. Hudson and Norma Jeanne Hudson authorized by Certificate No. 14-2564; and

WHEREAS, pursuant to an agreement between William J. Maddux and the LCRA (applicants), an application to amend Certificate No. 14-5478 has been submitted and requests the Commission to amend the Certificate by:

1. Changing the place of diversion of 532 acre-feet of water and place of consumptive use for 500 acre-feet of water from the current location in San Saba County to a location approximately 35 miles downstream to Lake Buchanan to be used in the LCRA's authorized service area; and

2. Severing the diversion of 532 acre-feet and consumptive use of 500 acre-feet of water from Certificate No. 14-2564 and combine it with Certificate No. 14-5478, as amended, thereby assigning all current authorizations under Certificate No. 14-5478, as amended, to the additional water; and

WHEREAS, the Texas Natural Resource Conservation Commission finds that jurisdiction over the application is established; and

WHEREAS, the Texas Natural Resource Conservation Commission is of the opinion and so finds the proposed changes will not impair the rights of any person entitled to the use of a portion of the waters of the Colorado River Basin; and

WHEREAS, the Commission has complied with the requirements of the Texas Water Code and Rules of the Texas Natural Resource Conservation Commission in issuing this amendment.

NOW, THEREFORE, this amendment to Certificate No. 14-5478, as amended, is issued to the Lower Colorado River Authority, subject to the following provisions:

1. USE

In addition to the existing authorizations under Certificate No. 14-5478, as amended, certificate owner is authorized to divert 532 acre-feet and consumptively use not to exceed 500 acre-feet of water per annum from Lake Buchanan on the Colorado River with current purpose and place of use authorizations as delineated in Certificate No. 14-5478, as amended.

2. DIVERSION

Diversions will occur on the Colorado River from Lake Buchanan at currently authorized locations and diversion rates authorized in Certificate No. 14-5478, as amended.

3. SPECIAL CONDITIONS

This amendment is conditional upon the purchase and sale of the 532 acre-feet of water from Haskel G. and Norma Jeanne Hudson and the subsequent transfer of that portion of Certificate No. 14-2564 from William J. Maddux to the LCRA.

4. PRIORITY

This amendment is junior in time priority to all the water rights in the Colorado River watershed between the diversion points included in Certificate No. 14-2564 and Certificate No. 14-5478. The time priority of this amendment as it relates to all other water rights is December 31, 1929.

This amendment is issued subject to all terms, conditions and provisions contained in Certificate No. 14-5478, as amended, except as specifically amended herein.

This amendment is issued subject to all superior and senior water rights in the Colorado River Basin.

The Certificate owner agrees to be bound by the terms, conditions and provisions contained herein and such agreement is a condition precedent to the granting of this amendment.

All other matters requested in the application which are not specifically granted by this amendment are denied.

The right to use State water appropriated hereunder is limited to that amount which can be beneficially used by the water use permit owner for the authorized purpose but not to exceed the amount ecifically authorized. Non-beneficial use or waste of water is a violation of this amendment.

This amendment is issued subject to the Rules of the Texas Natural Resource Conservation Commission and to the right of continuing supervision of State water resources exercised by the Commission.

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

For the Commission

DATE ISSUED: MAR 29 1996

ATTEST:

Gloria A. Vasquez, Chief Clerk

AMENDMENT TO
CERTIFICATE OF ADJUDICATION

CERTIFICATE NO. 14-5478B			TYPE: AMENDMENT
Name:	Lower Colorado River Authority	Address:	P.O. Box 220 Austin, Texas 78767
Filed:	February 6, 1990	Granted:	February 21, 1990
Purposes:	Livestock and Recharge	Counties:	Llano and Burnet
Watercourse:	Colorado River	Watershed:	Colorado River Basin

WHEREAS, Certificate of Adjudication No. 14-5478 was issued to Lower Colorado River Authority on June 28, 1989 and authorized certificate owner to maintain Buchanan Dam and Lake Buchanan on the Colorado River in Llano and Burnet Counties and the diversion and use of water from Lake Buchanan and Lake Travis included in the Authority's Certificate No. 14-5482) for municipal, industrial, irrigation and mining purposes; and

WHEREAS, Certificate No. 14-5478A was issued on October 12, 1989 which authorized certificate owner to divert, use and release waters from Lake Buchanan for domestic, recreation, instream flows and bay/estuary purposes in addition to uses listed above; and

WHEREAS, certificate owner has requested an amendment to Certificate No. 14-5478, as amended, to add authority to divert, use and release the waters in Lake Buchanan for livestock and recharge purposes; and

WHEREAS, the Texas Water Commission finds that jurisdiction over the application is established; and

WHEREAS, no person protested the granting of this application; and

WHEREAS, the Commission has complied with the requirements of the Texas Water Code and Rules of the Texas Water Commission in issuing this amendment; and

NOW, THEREFORE, this amendment to Certificate No. 14-5478, as amended, is issued to the Lower Colorado River Authority, subject to the following provisions:

USE

In addition to the authorizations included in Certificate No. 14-5478, as amended, to divert and use water from Lake Buchanan for municipal, industrial, irrigation, mining, domestic, recreation, instream flows and bay/estuary purposes, certificate owner is authorized to divert, use and release the waters in Lake Buchanan for livestock and recharge purposes.

This amendment is issued subject to all terms, conditions and provisions contained in Certificate No. 14-5478, as amended, except as specifically amended herein.

This amendment is issued subject to all superior and senior water rights in the Colorado River Basin.

Certificate owner agrees to be bound by the terms, conditions and provisions contained herein and such agreement is a condition precedent to the granting of this amendment.

All other matters requested in the application which are not specifically granted by this amendment are denied.

This amendment is issued subject to the Rules of the Texas Water Commission and to the right of continuing supervision of State water resources exercised by the Commission.

TEXAS WATER COMMISSION

DATE ISSUED: MAR 08 1990

B. J. Wynne, III, Chairman

ATTEST:

Brenda W. Foster, Chief Clerk

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

AN ORDER severing a portion of the water rights authorized by Certificate No. 14-2564 and combine it with all of the water rights authorized by Certificate No. 14-5478, as amended, and amending Certificate No. 14-5478, as amended, under Certificate No. 14-5478, as amended, designating such as Certificate No. 14-5478C.

An application by the Lower Colorado River Authority and William J. Maddux was presented to the Executive Director of the Texas Natural Resource Conservation Commission for consideration of approval. The applicants request authorization to sever and combine a 532 acre-foot portion the water rights authorized by Certificate No. 14-2564, with the water rights authorized by Certificate No. 14-5478, as amended, under Certificate No. 14-5478, as amended.

The Commission has jurisdiction to consider this matter and after hearing all of the evidence pertaining to the matter, the Commission is of the opinion and so finds that the 532 acre-foot portion water rights authorized by Certificate No. 14-2564 should be severed from said certificate and combined with the water rights authorized by Certificate No. 14-5478, as amended, designating such combination as Certificate No. 14-5478C.

NOW THEREFORE, BE IT ORDERED BY THE TEXAS NATURAL RESOURCE CONSERVATION COMMISSION that the 532 acre-foot portion of water rights authorized by Certificate No. 14-2564 is hereby severed from Certificate No. 14-2564 and combined with the water rights authorized by Certificate No. 14-5478, as amended, by amendment to be so designated as Certificate No. 14-5478C.

All other terms and conditions contained in Certificate No. 14-5478, as amended, which are not specifically contrary to the terms of Certificate No. 14-5478, as herein combined, and to be so designated as Certificate No. 14-5478C by amendment, shall remain in full force and effect.

The Chief Clerk of the Commission is directed to forward a certified copy of this order to Mr. Gene Richardson, of the Lower Colorado River Authority, to Mr. William J. Maddux, to the County Clerk of Llano and Burnet County, and to the Commission Records Systems file of both of the certificates herein combined.

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

For the Commission

DATE ISSUED: MAR 29 1996

ATTEST:

Gloria A. Vasquez, Chief Clerk

AMENDMENT TO
CERTIFICATE OF ADJUDICATION

CERTIFICATE NO. 14-5478A		TYPE:	AMENDMENT
Name:	Lower Colorado River Authority	Address:	P.O. Box 220 Austin, Texas 78767
Filed:	September 6, 1989	Granted:	September 7, 1989
Purposes:	Domestic, Recreation, Instream Flows and Bay/Estuary Use	Counties:	Llano and Burnet
Watercourse:	Colorado River	Watershed:	Colorado River Basin

WHEREAS, Certificate of Adjudication No. 14-5478 was issued to Lower Colorado River Authority on June 28, 1989, and authorized the certificate owner to maintain Buchanan Dam and Lake Buchanan on the Colorado River in Llano and Burnet Counties and the diversion and use of water from Lake Buchanan and Lake Travis (included in the authority's Certificate No. 14-5482) for municipal, industrial, irrigation and mining purposes; and

WHEREAS, in conjunction with submittal of the Water Management Plan required by the Final Judgement and Decree in Case No. 155, 414-A-1 of the 264th Judicial District Court of Bell County, certificate owner has also requested an amendment to Certificate No. 14-5478 to add authority to divert, use and release the waters in Lake Buchanan for domestic, recreation, instream flow and bay/estuary inflow purposes; and

WHEREAS, the Texas Water Commission finds that jurisdiction over the application is established; and

WHEREAS, no person protested the granting of this application; and

WHEREAS, the Commission has complied with the requirements of the Texas Water Code and Rules of the Texas Water Commission in issuing this amendment.

NOW, THEREFORE, this amendment to Certificate No. 14-5478 is issued to the Lower Colorado River Authority, subject to the following provisions:

1. USE

   a. In addition to the authorizations included in Paragraph 2.B., USE of Certificate No. 14-5478 to divert and use water from Lake Buchanan for municipal, industrial, irrigation and mining purposes, certificate owner is authorized to divert, use and release waters from Lake Buchanan for domestic, recreation, instream flows and bay/estuary purposes.

   b. The combined firm yield for Lakes Travis and Buchanan is as found by the Commission by Order approved on September 7, 1989, approving the Water Management Plan as may be modified by the Commission from time to time.

2. SPECIAL CONDITIONS

   a. For purposes of perfection, use of water for recreation purposes is limited to that quantity of water actually sold for that purpose whether used in, or released or diverted from, Lakes Buchanan or Travis.

   b. Certificate owner shall follow the provisions of the Water Management Plan as approved by Order of the Commission on September 7, 1989, and the terms and conditions of the Order.

This amendment is issued subject to all terms, conditions and provisions contained in Certificate No. 14-5478, except as specifically amended herein.

This amendment is issued subject to all superior and senior water rights in the Colorado River Basin.

Certificate owner agrees to be bound by the terms, conditions and provisions contained herein and such agreement is a condition precedent to the granting of this amendment.

All other matters requested in the application which are not specifically granted by this amendment are denied.

This amendment is issued subject to the Rules of the Texas Water Commission and to the right of continuing supervision of State water resources exercised by the Commission.

TEXAS WATER COMMISSION

DATE ISSUED: October 12, 1989

B. J. Wynne, III, Chairman

ATTEST:

Brenda W. Foster, Chief Clerk

CERTIFICATE OF ADJUDICATION

CERTIFICATE OF ADJUDICATION: 14-5478

OWNER: Lower Colorado River Authority
P. O. Box 220
Austin, Texas 78767

COUNTIES: Llano and Burnet

PRIORITY DATES: March 29, 1926 and March 7, 1938

WATERCOURSE: Colorado River

BASIN: Colorado River

WHEREAS, by final judgment and decree of the 264th Judicial District Court of Bell County, Texas, in Cause No. 115,414-A-1, In Re: The Exceptions of the Lower Colorado River Authority and the City of Austin to the adjudication of water rights in the Lower Colorado River Segment of the Colorado River Basin dated April 20, 1988, a right was recognized under Permit 954, Permit 1259 and Permit 1260 authorizing the Lower Colorado River Authority to appropriate waters of the State of Texas as set forth below:

NOW, THEREFORE, this certificate of adjudication to appropriate waters of the State of Texas in the Colorado River Basin is issued to the Lower Colorado River Authority (hereinafter called LCRA), subject to the following terms and conditions:

1. IMPOUNDMENT

LCRA is authorized to maintain an existing dam and reservoir on the Colorado River (Buchanan Dam and Lake Buchanan) and impound therein not to exceed 992,475 acre-feet of water. The dam is located in the Carl Conrad Mertz Survey, Abstract 510 and the Johann L. Henne Survey, Abstract 326 in Llano County and the Abraham Large Survey, Abstract 532; the F.H.R. Day Survey, Abstract 262 and the D. R. Banta Survey, Abstract 1215, in Burnet County, Texas.

2. USE

A. LCRA is authorized to use the water impounded in the aforesaid Lake Buchanan for recreation purposes with no right of diversion or release for this purpose.

B. LCRA is authorized to divert and use not to exceed 1,500,000 acre-feet of water per annum from the aforesaid reservoir and Lake Travis (Certificate of Adjudication 14-5482) for municipal, industrial, irrigation and mining purposes, subject to the following conditions:

(1) LCRA shall prepare and submit to the Commission, on or before December 31, 1988, a proposed reservoir operation

plan which shall include such studies and other information as may be required by the Commission to determine the Combined Firm Yield of Lakes Travis and Buchanan (as defined by Fact Finding No. 22 for Lake Buchanan in the "Modified Findings and Conclusions Defining LCRA's Water Rights with Respect to the Highland Lakes", Attachment No. 2 to Judgment in Cause No. 115,414-A-1) and demonstrate LCRA's compliance with, and its ability to comply with, these conditions (the "Management Plan"). In making its decision on the adoption of a Management Plan, the Commission shall consider all relevant public policies including, without limitation, the following:

(a) Recognition of the necessity of beneficial inflows from the Colorado River into the Lavaca-Tres Palacios Estuary consistent with §11.147 of the Texas Water Code;

(b) Protection of fish and wildlife habitats consistent with §11.147 of the Texas Water Code;

(c) Consideration of the effects, if any, on existing instream uses and water quality consistent with §11.147 of the Texas Water Code;

(d) Mitigation of adverse impacts, if any, on wildlife habitats inundated by new reservoir construction;

(e) Mitigation of adverse environmental impacts, if any, caused by new projects taking, storing or diverting in excess of 5,000 acre-feet per year consistent with §11.152 of the Texas Water Code; and

(f) Recognition of the Commission's statutory authority to require water conservation under §11.134(b)(4).

The Commission shall consider LCRA's proposal prior to adopting the initial Management Plan. The Management Plan may be amended from time to time upon the request of LCRA or on the Commission's own motion. The initial proceeding to consider the adoption of the Management Plan, and any major amendment thereof, shall be pursuant to contested case procedures. Any proceeding to consider the adoption or major amendment of the Management Plan shall be preceded by notice and opportunity to request a hearing in accordance with the Commission's regulations applicable to water rights permitting proceedings. The Texas Parks and Wildlife Department, at its option, may be a party in any such proceeding, in the same manner as it would be a party to a proceeding before the Commission incident to an

application for a permit governed by §11.147 of the Texas Water Code. The Commission shall name as other parties persons who establish a justiciable interest in the proceeding. In making a final decision on the adoption of a Management Plan and any amendment thereof, the Commission, in addition to other information, evidence, and testimony presented, shall consider all information, evidence, and testimony presented by the Texas Parks and Wildlife Department, including, without limitation, any memorandum of understanding between LCRA and Texas Parks and Wildlife Department relating to the management of the Highland Lakes.

(2) LCRA shall prepare and submit to the Commission, on or before March 1 of each year beginning with March 1, 1990, a report which documents compliance with the Management Plan and these conditions during the previous year. Such report shall be in a form approved by the Executive Director of the Commission.

(3) Except as provided in Paragraph (9) below, LCRA shall not supply or commit to supply any water under this certificate or under Certificate of Adjudication 14-5482 to any other party except pursuant to a written contract between LCRA and such party that defines such commitment.

(4) LCRA shall not supply or commit to supply any water under this certificate or under Certificate of Adjudication 14-5482 to itself for use by itself or other parties except pursuant to resolution adopted by LCRA's Board of Directors that defines such commitment.

(5) Each commitment by LCRA to supply water under this Certificate or under Certificate of Adjudication 14-5482 shall be considered to be on a firm, uninterruptible basis unless the contract, resolution or special condition defining such commitment specifically provides that such commitment "is subject to interruption or curtailment".

(6) LCRA shall not commit to supply water under this certificate or under Certificate of Adjudication 14-5482 on a firm, uninterruptible basis in excess of the Combined Firm Yield of Lakes Travis and Buchanan. During the period beginning as of January 1, 1988 until such time as the Management Plan is submitted and approved by the Commission, LCRA shall not enter into any contract or adopt any resolution by which it commits to supply any water under this certificate or under Certificate of Adjudication 14-5482 on a firm, uninterruptible basis, unless:

(a) The aggregate of all firm, uninterruptible commitments of water under this certificate or under Certificate of Adjudication 14-5482, including the commitment made pursuant to such contract or resolution, does not exceed 2,500,000 acre-feet of water over any five consecutive calendar-year period; or

(b) The commitment made pursuant to such contract or resolution is for municipal use, and such commitment does not exceed 10,000 acre-feet of water per annum; or

(c) Such contract or resolution is specifically approved by either the Executive Director or the Commission pursuant to the Special Condition contained in this paragraph (6).

(7) LCRA shall interrupt or curtail the supply of water under this certificate or under Certificate of Adjudication 14-5482 pursuant to commitments that are specifically subject to interruption or curtailment, to the extent necessary to allow LCRA to satisfy all demands for water under such certificates pursuant to all firm, uninterruptible commitments. Commitments to supply water on a non-firm, interruptible basis may be interrupted or curtailed as necessary either on a pro rata basis or in accordance with a system of priorities, as may be set forth in various contracts and resolutions that define such commitments.

(8) LCRA shall not impose its priority under this certificate or under Certificate of Adjudication 14-5482 against any junior permanent water right with a priority date senior to November 1, 1987, except to the extent that:

(a) LCRA would have the right to impose such priority against such water right if LCRA's right under this certificate or under Certificate of Adjudication 14-5482 to divert and use water from Lakes Travis and Buchanan were limited to the Combined Firm Yield of such lakes; or

(b) The holder of such water right has agreed, or in the future agrees, otherwise.

(9) LCRA shall supply water under this certificate or under Certificate of Adjudication 14-5482 to or for the benefit of any downstream water right with a priority date junior to December 1, 1900 and senior to November 1, 1987 that authorizes the diversion of not more than 3000 acre-feet of water per annum, to the extent that:

(a) The holder of such water right applies to the Commission for release of such water; and

(b) The Commission finds that, but for the exercise of priority claims under Certificates of Adjudication 14-5471, 14-5472 (as pertains to rights recognized pursuant to CF-330), 14-5475, 14-5476 and 14-5477.

[1] Water would be available for diversion from the natural flow of the Colorado River or tributary thereof at an authorized point of diversion under such water right; and

[2] Applicant's water right would entitle him to divert such water;

provided, however, that LCRA shall not be obligated to supply more than 20,000 acre-feet of water in any year pursuant to this condition (9); that this commitment is subject to interruption or curtailment pro rata with other long-term interruptible commitments of LCRA; and that LCRA shall not be obligated to supply water under this condition to or for the benefit of a temporary or term permit beyond the initial term thereof.

(10) LCRA may from time to time apply to the Commission for amendment of the conditions outlined in paragraph 2B(1) through 2B(9) above pursuant to Commission rules.

(11) The rights recognized in Paragraph 2B are duplicative of, and not in addition to, those rights recognized under Certificate of Adjudication 14-5482 relating to LCRA's rights in Lake Travis.

C. LCRA is authorized to use the bed and banks of the Colorado River, below the aforesaid dam to convey water released from Lake Buchanan for use by LCRA or others entitled to use such water in the amounts and for the purposes authorized herein.

D. LCRA is authorized to divert and use water through Buchanan Dam for the purpose of hydroelectric power generation, subject to the following conditions:

(1) Such right is subordinated to the extent set forth in TEX. REV. CIV. STAT. ANN. art. 8280-107, as amended, Tex. Laws 1975, ch. 74 at 179, as such act may be amended from time to time (the "LCRA Act").

(2) Such right is further subordinated, to the extent that it may not be subordinated pursuant to the LCRA Act, as follows:

(a) LCRA shall not release water through Buchanan Dam solely for the purpose of hydroelectric generation, except during emergency shortages of electricity, and during other times to the extent that such releases will not impair LCRA's ability to satisfy all existing and projected demands for water from Lakes Travis and Buchanan under this certificate and under Certificate of Adjudication 14-5482 pursuant to all firm, uninterruptible commitments and all non-firm, interruptible commitments; and

(b) To the extent that water is released through Buchanan Dam solely for the purpose of hydroelectric generation, such right is specifically subordinated, as to priority, to all present and future upstream rights to use the waters of the Colorado River and its tributaries for municipal, domestic, industrial, irrigation and/or mining purposes, except during emergency shortages of electricity, and during other times to the extent that the holder of any such upstream right has agreed, or in the future agrees, otherwise.

E. LCRA is authorized to maintain and operate its existing pump-back unit, located below the aforesaid dam on Inks Lake, as an aid in utilizing the water authorized herein for hydroelectric generation purposes.

3. DIVERSION

A. Location:

(1) On the perimeter of the aforesaid reservoir.

(2) Releases through the dam.

B. Maximum rate:

(1) Unspecified from the perimeter of reservoir.

(2) 3630.00 cfs (1,633,500 gpm) for hydroelectric generation.

4. PRIORITY

A. The time priority of LCRA's right is March 29, 1926 for the impoundment of water in the aforesaid reservoir, the use of the impounded water for recreation and the use of released water for hydroelectric generation.

B. The time priority of LCRA's right is March 7, 1938 for the diversion and use of water for all other purposes authorized herein.

5. SPECIAL CONDITION

Owner shall maintain a suitable outlet in the aforesaid dam authorized herein to allow the free passage of water that Owner is not entitled to divert or impound.

The location of pertinent features related to this certificate are shown on Pages Nos. 21 and 25 of the Middle Colorado River Segment Certificates of Adjudication Maps, copies of which are located in the office of the Texas Water Commission, Austin, Texas.

This certificate of adjudication is issued subject to all terms, conditions and provision in the final judgment and decree of the 264th Judicial District Court of Bell County, Texas, in Cause No. 115,414-A-1, In Re: The Exceptions of the Lower Colorado River Authority and the City of Austin to the adjudication of water rights in the Lower Colorado River Segment of the Colorado River Basin dated April 20, 1988 and supersedes all rights of the Owner asserted in that cause.

This certificate of adjudication is issued subject to senior and superior water rights in the Colorado River Basin.

Certificate of Adjudication 14-5478

This certificate of adjudication is issued subject to the Rules of the Texas Water Commission and its continuing right of supervision of State water resources consistent with the public policy of the State as set forth in the Texas Water Code.

TEXAS WATER COMMISSION

B. J. Wynne, III, Chairman

DATE ISSUED:

JUN 28 1989

ATTEST:

Brenda W. Foster, Chief Clerk

AMENDMENT TO
CERTIFICATE OF ADJUDICATION

CERTIFICATE NO.	*12-5482C*		*TYPE: AMENDMENT*
Name:	*Lower Colorado River Authority*	*Address:*	*PO BOX 220 AUSTIN TX 78767-0220*
Filed:	*September 17, 1991*	*Granted:*	*October 9, 1991*
Purposes:	*Industrial and Irrigation*	*County:*	*Travis*
Watercourse:	*Colorado River*	*Watershed:*	*Colorado River Basin*

WHEREAS, Certificate No. 14-5482, as amended, was issued to Lower Colorado River Authority (LCRA) and authorized the certificate owner to maintain Mansfield Dam and Lake Travis on Colorado River in Travis County and the diversion and use of water from Lake Travis and Lake Buchanan (included in LCRA's Certificate No. 14-5478) for municipal, industrial, irrigation, mining, domestic, recreation, instream flows, bay/estuary, livestock and recharge purposes; and

WHEREAS, applicant seeks to amend Certificate No. 14-5482, as amended, to establish a diversion point and maximum diversion rate on Lake Austin (authorized by Certificate No. 14-5471 and owned by the City of Austin) for the purposes of diverting water released from Lake Travis for (industrial use) heat transfer or cooling purposes and for irrigation of landscaped areas surrounding LCRA's proposed office complex; and

WHEREAS, the Texas Water Commission finds that jurisdiction over the application is established; and

WHEREAS, no person protested the granting of this application; and

WHEREAS, the Commission has complied with the requirements of the Texas Water Code and Rules of the Texas Water Commission in issuing this amendment.

NOW, THEREFORE, this amendment to Certificate No. 14-5482 is issued to the Lower Colorado River Authority, as follows:

1. USE

Certificate owner is authorized to divert and use 1470 acre-feet of water per annum for industrial and irrigation purposes at the certificate owner's proposed office complex.

2. DIVERSION

In addition to the authorized points of diversion in Certificate No. 14-5482, as amended, certificate owner is authorized to use the following point of diversion:

A. Location:

(3) At a point on the eastern end of Tom Miller Dam on the Colorado River, Travis County, the same being S 79° E, 1135 feet from the north corner of the Henry P. Hill Grant, Abstract No. 14.

B. Maximum rate:

(3) 4.0 cfs (1800 gpm).

3. POINT OF RETURN

At a point S 74° E, 1170 feet from the aforesaid survey corner.

4. SPECIAL CONDITION

Certificate owner shall maintain annual records indicating that water used under this amendment conforms to Article 5.1.2.(b) and 5.1.3.(b) of LCRA's Water Conservation Rules and the records shall be made available to representatives of the Executive Director of the Texas Water Commission upon reasonable request.

This amendment is issued subject to all terms, conditions and provisions contained in Certificate No. 14-5482, except as specifically amended herein.

This amendment is issued subject to all superior and senior water rights in the Colorado River Basin.

Certificate owner agrees to be bound by the terms, conditions and provisions contained herein and such agreement is a condition precedent to the granting of this amendment.

All other matters requested in the application which are not specifically granted by this amendment are denied.

Certificate owner shall use those practices, techniques and technologies that will reduce the loss or waste of water and improve the efficiency and use of water so that only so much water as can be beneficially used will be diverted. Furthermore, diversion and use will occur only when reasonably necessary because of prevailing climatic conditions and subject to the terms and conditions of this amendment.

This amendment is issued subject to the Rules of the Texas Water Commission and to the right of continuing supervision of State water resources exercised by the Commission.

TEXAS WATER COMMISSION

John Hall

John Hall, Chairman

DATE ISSUED: OCT 31 1991

ATTEST:

Gloria A. Vasquez

Gloria A. Vasquez, Chief Clerk

AMENDMENT TO
CERTIFICATE OF ADJUDICATION

CERTIFICATE NO. 14-5482B			TYPE: AMENDMENT
Name:	Lower Colorado River Authority	Address:	P.O. Box 220 Austin, Texas 78767
Filed:	February 6, 1990	Granted:	February 21, 1990
Purposes:	Livestock and Recharge	County:	Travis
Watercourse:	Colorado River	Watershed:	Colorado River Basin

WHEREAS, Certificate of Adjudication No. 14-5482 was issued to Lower Colorado River Authority on June 28, 1989 and authorized certificate owner to maintain Mansfield Dam and Lake Travis on the Colorado River in Travis County and the diversion and use of water from Lake Travis and Lake Buchanan (included in the Authority's Certificate No. 14-5478) for municipal, industrial, irrigation and mining purposes; and

WHEREAS, Certificate No. 14-5482A as issued on October 12, 1989 which authorized certificate owner to divert, use and release waters from Lake Travis for domestic, recreation, instream flows and bay/estuary purposes in addition to uses listed above; and

WHEREAS, certificate owner has requested an amendment to Certificate No. 14-5482, as amended, to add authority to divert, use and release the waters in Lake Travis for livestock and recharge purposes; and

WHEREAS, the Texas Water Commission finds that jurisdiction over the application is established; and

WHEREAS, no person protested the granting of this application; and

WHEREAS, the Commission has complied with the requirements of the Texas Water Code and Rules of the Texas Water Commission in issuing this amendment; and

NOW, THEREFORE, this amendment to Certificate No. 14-5482, as amended, is issued to the Lower Colorado River Authority, subject to the following provisions:

USE

In addition to the authorizations included in Certificate No. 14-5482, as amended, to divert and use water from Lake Travis for municipal, industrial, irrigation, mining, domestic, recreation, instream flows and bay/estuary purposes, certificate owner is authorized to divert, use and release the waters in Lake Travis for livestock and recharge purposes.

This amendment is issued subject to all terms, conditions and provisions contained in Certificate No. 14-5482, as amended, except as specifically amended herein.

This amendment is issued subject to all superior and senior water rights in the Colorado River Basin.

Certificate owner agrees to be bound by the terms, conditions and provisions contained herein and such agreement is a condition precedent to the granting of this amendment.

All other matters requested in the application which are not specifically granted by this amendment are denied.

This amendment is issued subject to the Rules of the Texas Water Commission and to the right of continuing supervision of State water resources exercised by the Commission.

TEXAS WATER COMMISSION

B. J. Wynne, III, Chairman

DATE ISSUED: MAR 0 8 1990

ATTEST:

Brenda W. Foster, Chief Clerk

AMENDMENT TO
CERTIFICATE OF ADJUDICATION

CERTIFICATE NO. 14-5482A		TYPE:	AMENDMENT
Name:	Lower Colorado River Authority	Address:	P.O. Box 220 Austin, Texas 78767
Filed:	September 6, 1989	Granted:	September 7, 1989
Purposes:	Domestic, Recreation, Instream Flows and Bay/Estuary Use	County:	Travis
Watercourse:	Colorado River	Watershed:	Colorado River Basin

WHEREAS, Certificate of Adjudication No. 14-5482 was issued to Lower Colorado River Authority on June 28, 1989, and authorized the certificate owner to maintain Mansfield Dam and Lake Travis on the Colorado River in Travis County and the diversion and use of water from Lake Travis and Lake Buchanan (included in the authority's Certificate No. 14-5478) for municipal, industrial, irrigation and mining purposes; and

WHEREAS, in conjunction with submittal of the Water Management Plan required by the Final Judgement and Decree in Cause No. 155, 414-A-1 of the 264th Judicial District Court of Bell County, certificate owner has also requested an amendment to Certificate No. 14-5482 to add authority to divert, use and release the waters of Lake Travis for domestic, recreation, instream flow and bay/estuary inflow purposes; and

WHEREAS, the Texas Water Commission finds that jurisdiction over the application is established; and

WHEREAS, no person protested the granting of this application; and

WHEREAS, the Commission has complied with the requirements of the Texas Water Code and Rules of the Texas Water Commission in issuing this amendment.

NOW, THEREFORE, this amendment to Certificate No. 14-5482 is issued to the Lower Colorado River Authority, subject to the following provisions:

1. USE

a. In addition to the authorizations included in Paragraph 2.B., USE of Certificate No. 14-5482 to divert and use water from Lake Travis for municipal, industrial, irrigation and mining purposes, certificate owner is authorized to divert, use and release waters from Lake Travis for domestic, recreation, instream flows and bay/estuary purposes.

b. The combined firm yield for Lakes Travis and Buchanan is as found by the Commission by Order approved on September 7, 1989, approving the Water Management Plan as may be modified by the Commission from time to time.

2. SPECIAL CONDITIONS

a. For purposes of perfection, use of water for recreation purposes is limited to that quantity of water actually sold for that purpose whether used in, or released or diverted from, Lakes Buchanan or Travis.

b. Certificate owner shall follow the provisions of the Water Management Plan as approved by Order of the Commission on September 7, 1989, and the terms and conditions of that Order.

This amendment is issued subject to all terms, conditions and provisions contained in Certificate No. 14-5482, except as specifically amended herein.

This amendment is issued subject to all superior and senior water rights in the Colorado River Basin.

Certificate owner agrees to be bound by the terms, conditions and provisions contained herein and such agreement is a condition precedent to the granting of this amendment.

All other matters requested in the application which are not specifically granted by this amendment are denied.

This amendment is issued subject to the Rules of the Texas Water Commission and to the right of continuing supervision of State water resources exercised by the Commission.

TEXAS WATER COMMISSION

B. J. Wynne, III, Chairman

DATE ISSUED: October 12, 1989

ATTEST:

Brenda W. Foster, Chief Clerk

Adj 5482

CERTIFICATE OF ADJUDICATION

CERTIFICATE OF ADJUDICATION: 14-5482

OWNER: Lower Colorado River Authority
P. O. Box 220
Austin, Texas 78767

COUNTY: Travis

PRIORITY DATES: March 29, 1926 and March 7, 1938

WATERCOURSE: Colorado River

BASIN: Colorado River

WHEREAS, by final judgment and decree of the 264th Judicial District Court of Bell County, Texas, in Cause No. 115,414-A-1, In Re: The Exceptions of the Lower Colorado River Authority and the City of Austin to the adjudication of water rights in the Lower Colorado River Segment of the Colorado River Basin dated April 20, 1988, a right was recognized under Permit 951, Permit 952, Permit 1259 and Permit 1260 authorizing the Lower Colorado River Authority to appropriate waters of the State of Texas as set forth below:

NOW, THEREFORE, this certificate of adjudication to appropriate waters of the State of Texas in the Colorado River Basin is issued to the Lower Colorado River Authority (hereinafter called LCRA), subject to the following terms and conditions:

1. IMPOUNDMENT

LCRA is authorized to maintain an existing dam and reservoir on the Colorado River (Mansfield Dam and Lake Travis) and impound therein not to exceed 1,170,752 acre-feet of water. The dam is located in the John S. Choate Survey 461, Abstract 186 and the C. B. Townsend Survey 192, Abstract 2640, Travis County, Texas.

2. USE

A. LCRA is authorized to use the water impounded in the aforesaid Lake Travis for recreation purposes with no right of diversion or release for this purpose.

B. LCRA is authorized to divert and use not to exceed 1,500,000 acre-feet of water per annum from the aforesaid reservoir and Lake Buchanan (Certificate of Adjudication 14-5478) for municipal, industrial, irrigation and mining purposes, subject to the following conditions:

(1) LCRA shall prepare and submit to the Commission, on or before December 31, 1988, a proposed reservoir operation plan, which shall include such studies and other information as may be required by the Commission to determine the Combined Firm Yield of Lakes Travis and Buchanan (as

defined By Fact Finding No. 29 for Lake Travis in the "Modified Findings and Conclusions Defining LCRA's Water Rights with Respect to the Highland Lakes", Attachment No. 2 to Judgment in Cause No. 115,414-A-1) and demonstrate LCRA's compliance with, and its ability to comply with, these conditions (the "Management Plan"). In making its decision on the adoption of a Management Plan, the Commission shall consider all relevant public policies including, without limitation, the following:

(a) Recognition of the necessity of beneficial inflows from the Colorado River into the Lavaca-Tres Palacios Estuary consistent with §11.147 of the Texas Water Code;

(b) Protection of fish and wildlife habitats consistent with §11.147 of the Texas Water Code;

(c) Consideration of the effects, if any, on existing instream uses and water quality consistent with §11.147 of the Texas Water Code;

(d) Mitigation of adverse impacts, if any, on wildlife habitats inundated by new reservoir construction;

(e) Mitigation of adverse environmental impacts, if any, caused by new projects taking, storing or diverting in excess of 5,000 acre-feet per year consistent with §11.152 of the Texas Water Code; and

(f) Recognition of the Commission's statutory authority to require water conservation under §11.134(b)(4).

The Commission shall consider LCRA's proposal prior to adopting the initial Management Plan. The Management Plan may be amended from time to time upon the request of LCRA or on the Commission's own motion. The initial proceeding to consider the adoption of the Management Plan, and any major amendment thereof, shall be pursuant to contested case procedures. Any proceeding to consider the adoption or major amendment of the Management Plan shall be preceded by notice and opportunity to request a hearing in accordance with the Commission's regulations applicable to water rights permitting proceedings. The Texas Parks and Wildlife Department, at its option, may be a party in any such proceeding, in the same manner as it would be a party to a proceeding before the Commission incident to an application for a permit governed by §11.147 of the Texas Water Code. The Commission shall name as other parties persons who establish a justiciable interest in the

proceeding. In making a final decision on the adoption of a Management Plan and any amendment thereof, the Commission, in addition to other information, evidence, and testimony presented, shall consider all information, evidence, and testimony presented by the Texas Parks and Wildlife Department, including, without limitation, any memorandum of understanding between LCRA and Texas Parks and Wildlife Department relating to the management of the Highland Lakes.

(2) LCRA shall prepare and submit to the Commission, on or before March 1 of each year beginning with March 1, 1990, a report which documents compliance with the Management Plan and these conditions during the previous year. Such report shall be in a form approved by the Executive Director of the Commission.

(3) Except as provided in Paragraph (9) below, LCRA shall not supply or commit to supply any water under this certificate or under Certificate of Adjudication 14-5478 to any other party except pursuant to a written contract between LCRA and such party that defines such commitment.

(4) LCRA shall not supply or commit to supply any water under this certificate or under Certificate of Adjudication 14-5478 to itself for use by itself or other parties except pursuant to resolution adopted by LCRA's Board of Directors that defines such commitment.

(5) Each commitment by LCRA to supply water under this certificate or under Certificate of Adjudication 14-5478 shall be considered to be on a firm, uninterruptible basis unless the contract, resolution or special condition defining such commitment specifically provides that such commitment "is subject to interruption or curtailment".

(6) LCRA shall not commit to supply water under this certificate or under Certificate of Adjudication 14-5478 on a firm, uninterruptible basis in excess of the Combined Firm Yield of Lakes Travis and Buchanan. During the period beginning as of January 1, 1988 until such time as the Management Plan is submitted and approved by the Commission, LCRA shall not enter into any contract or adopt any resolution by which it commits to supply any water under this certificate or under Certificate of Adjudication 14-5478 on a firm, uninterruptible basis, unless:

(a) The aggregate of all firm, uninterruptible commitments of water under this certificate or under Certificate of Adjudication 14-5478, including the

commitment made pursuant to such contract or resolution, does not exceed 2,500,000 acre-feet of water over any five consecutive calendar-year period; or

(b) The commitment made pursuant to such contract or resolution is for municipal use, and such commitment does not exceed 10,000 acre-feet of water per annum; or

(c) Such contract or resolution is specifically approved by either the Executive Director of the Commission or the Commission pursuant to the condition contained in this Paragraph (6).

(7) LCRA shall interrupt or curtail the supply of water under this certificate or under Certificate of Adjudication 14-5478 pursuant to commitments that are specifically subject to interruption or curtailment, to the extent necessary to allow LCRA to satisfy all demands for water under such certificates pursuant to all firm, uninterruptible commitments. Commitments to supply water on a non-firm, interruptible basis may be interrupted or curtailed as necessary either on a pro rata basis or in accordance with a system of priorities, as may be set forth in various contracts and resolutions that define such commitments.

(8) LCRA shall not impose its priority under this certificate or under Certificate of Adjudication 14-5478 against any junior permanent water right with a priority date senior to November 1, 1987, except to the extent that:

(a) LCRA would have the right to impose such priority against such water right if LCRA's right under this certificate or under Certificate of Adjudication 14-5478 to divert and use water from Lakes Travis and Buchanan were limited to the Combined Firm Yield of such lakes; or

(b) The holder of such water right has agreed, or in the future agrees, otherwise.

(9) LCRA shall supply water under this certificate or under Certificate of Adjudication 14-5478 to or for the benefit of any downstream water right with a priority date junior to December 1, 1900 and senior to November 1, 1987 that authorizes the diversion of not more than 3000 acre-feet of water per annum, to the extent that:

(a) The holder of such water right applies to the Commission for release of such water; and

(b) The Commission finds that, but for the exercise of priority claims under Certificates of Adjudication 14-5471, 14-5472 (as pertains to rights recognized pursuant to CF-330), 14-5475, 14-5476 and 14-5477.

[1] Water would be available for diversion from the natural flow of the Colorado River or tributary thereof at an authorized point of diversion under such water right; and

[2] Applicant's water right would entitle him to divert such water;

provided, however, that LCRA shall not be obligated to supply more than 20,000 acre-feet of water in any year pursuant to this condition (9); that this commitment is subject to interruption or curtailment pro rata with other long-term interruptible commitments of LCRA; and that LCRA shall not be obligated to supply water under this condition to or for the benefit of a temporary or term permit beyond the initial term thereof.

(10) LCRA may from time to time apply to the Commission for amendment of the conditions outlined in paragraph 2B(1) through 2B(9) above pursuant to Commission rules.

(11) The rights recognized in Paragraph 2B, are duplicative of, and not in addition to, those rights recognized under Certificate of Adjudication 14-5478 relating to LCRA's rights in Lake Buchanan.

C. LCRA is authorized to use the bed and banks of the Colorado River below the aforesaid dam to convey water released from Lake Travis for use by LCRA or others entitled to use such water in the amounts and for the purposes authorized herein.

D. LCRA is authorized to divert and use water through Mansfield Dam for the purpose of hydroelectric power generation, subject to the following conditions:

(1) Such right is subordinated to the extent set forth in TEX. REV. CIV. STAT. ANN. art. 8280-107, as amended, Tex. Laws 1975, ch. 74 at 179, as such act may be amended from time to time (the "LCRA Act").

(2) Such right is further subordinated, to the extent that it may not be subordinated pursuant to the LCRA Act, as follows:

(a) LCRA shall not release water through Mansfield Dam solely for the purpose of hydroelectric generation, except during emergency shortages of electricity, and during other times to the extent that such releases will not impair LCRA's ability to satisfy all existing and projected demands for water from Lakes Travis and Buchanan under this certificate and under Certificate of Adjudication 14-5478 pursuant to all firm, uninterruptible commitments and all non-firm, interruptible commitments; and

(b) To the extent that water is released through Mansfield Dam solely for the purpose of hydroelectric generation, such right is specifically subordinated, as to priority, to all present and future upstream rights to use the waters of the Colorado River and its tributaries for municipal, domestic, industrial, irrigation and/or mining purposes, except during emergency shortages of electricity, and during other times to the extent that the holder of any such upstream right has agreed, or in the future agrees, otherwise.

3. DIVERSION

A. Location:
(1) On the perimeter of the aforesaid reservoir.

(2) Releases through the dam.

B. Maximum rate:
(1) Unspecified from the perimeter of said reservoir.

(2) 5530.00 cfs (2,488,500 gpm) for hydroelectric generation.

4. PRIORITY

A. The time priority of LCRA's right is March 29, 1926 for the impoundment of water in the aforesaid reservoir, the use of the impounded water for recreation and the use of released water for hydroelectric generation.

B. The time priority of LCRA's right is March 7, 1938 for the diversion and use of water for all other purposes authorized.

5. SPECIAL CONDITION

Owner shall maintain a suitable outlet in the aforesaid dam authorized herein to allow the free passage of water that Owner is not entitled to divert or impound.

The location of pertinent features related to this certificate are shown on Page 31 of the Middle Colorado River Segment Certificates of Adjudication Maps and Page 1 of the Lower Colorado River Segment Certificates of Adjudication Maps, copies of which are located in the office of the Texas Water Commission, Austin, Texas.

This certificate of adjudication is issued subject to all terms conditions and provisions in the final judgment and decree of the 264th Judicial District Court of Bell County, Texas, in Cause No. 115,414-A-1, In Re: The Exceptions of the Lower Colorado River Authority and the City of Austin to the adjudication of water rights in the Lower Colorado River Segment of the Colorado River Basin dated April 20, 1988 and supersedes all rights of the Owner asserted in that cause.

This certificate of adjudication is issued subject to senior and superior water rights in the Colorado River Basin.

This certificate of adjudication is issued subject to the Rules of the Texas Water Commission and its continuing right of supervision of State water resources consistent with the public policy of the State as set forth in the Texas Water Code.

TEXAS WATER COMMISSION

B. J. Wynne, III, Chairman

DATE ISSUED:

JUN 28 1989

ATTEST:

Brenda W. Foster, Chief Clerk

APPLICATION OF THE LOWER COLORADO RIVER AUTHORITY FOR EMERGENCY AUTHORIZATION	§ § § §	**BEFORE THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY**

AFFIDAVIT OF RYAN ROWNEY

THE STATE OF TEXAS	§
	§
COUNTY OF TRAVIS	§

Before me, the undersigned authority, personally appeared Ryan Rowney, a person known by me to be competent and qualified in all respects to make this affidavit, who being by me first duly sworn, deposed as follows:

1. I am over 21 years of age, of sound mind, and have never been convicted of a felony or crime of moral turpitude. I am fully competent and qualified in all respects to make this affidavit.

2. The facts stated in this affidavit are within my personal knowledge and are true and correct.

3. I, Ryan Rowney, am an individual residing in Burnet, Texas.

4. A true and correct copy of my resume, detailing my prior work history, is attached hereto under Tab 1.

5. I have worked for LCRA for 30 years. For the last 30 years, I have worked in LCRA's Water Operations. My current title is Vice President, Water Operations.

6. As part of my duties at LCRA, my department provides planning services for the water utility and I am responsible for all operations within Water Operations including operations of the dams forming the Highland Lakes and operations of LCRA's Gulf Coast, Lakeside, and Garwood irrigation divisions. In addition, staff under my supervision is responsible for ensuring compliance with LCRA's instream flow and freshwater inflow obligations under the Water Management Plan.

7. My opinions stated herein are based on my familiarity with LCRA's operations, as well as my understanding of LCRA's contractual obligations to the farmers within LCRA's Garwood division and to Pierce Ranch, a wholesale interruptible irrigation customer. I also have a general familiarity with LCRA's firm customers' operations. I have also relied upon a variety of information provided to me by LCRA staff, which is of a nature typically relied upon in my profession, as described below and for which true and correct copies are either attached or referenced to other portions of LCRA's emergency request and incorporated by reference herein:

a. Affidavit of Ron Anderson, including attachments

b. Affidavit of Bob Rose, including attachments

c. Affidavit of David Wheelock, including attachments

d. Affidavit of Nora Mullarkey Miller, including attachments

8. IMPACTS OF DROUGHT ON IRRIGATION OPERATIONS.

a. Over the past two years, LCRA has significantly cut back the water supply available to downstream irrigation customers who rely on interruptible water supplies. In 2012 and 2013, consistent with emergency relief granted by TCEQ, LCRA did not supply any water from the Highland Lakes to the Gulf Coast and Lakeside irrigation divisions. These actions preserved a significant amount of supply in lakes Buchanan and Travis. For example, if LCRA had followed the 2010 WMP in 2013, LCRA would have made available for diversion about 165,000 acre-feet of additional stored water from lakes Buchanan and Travis for the downstream irrigation operations at diversion points from the river. With an estimated 20 percent delivery loss, the additional amount released would have been about 198,000 acre-feet.

b. On February 26, 2014, the Texas Commission on Environmental Quality approved emergency relief from the 2010 WMP that cuts off interruptible stored water to the Gulf Coast, Lakeside and Pierce Ranch irrigation operations through at least May 26. If the 2010 WMP were in effect, LCRA would be preparing to release water to the Gulf Coast, Lakeside and Pierce Ranch operations, with the potential to make about 160,000 acre-feet of water from lakes Buchanan and Travis available for diversion by those operations.

9. IMPACTS OF DROUGHT ON FIRM WATER CUSTOMERS.

a. Ensuring adequate supply for LCRA's firm customers is critical. The maximum historical annual amount of reported water use to meet firm customer demands from the firm supplies of lakes Buchanan and Travis during 2000 through 2012 was approximately 247,000 acre-feet in 2011. In addition, about 33,000 acre-feet of firm water was supplied to help meet environmental flow needs in 2011. The maximum amount of interruptible water released from lakes Buchanan and Travis during this same period occurred in 2011 and totaled about 433,000 acre-feet. The maximum total amount released or used from the Highland Lakes, about 714,000 acre-feet, occurred in 2011. In 2012, firm water use from lakes Buchanan and Travis by LCRA customers was about 148,000 acre-feet; about 31,000 acre-feet was supplied to help meet environmental flow needs; and about 9,000 acre-feet of interruptible water was supplied to farmers in the Garwood irrigation division. Total use of water from lakes Buchanan and Travis in 2012 was about 188,000 acre-feet. In 2013, water use from lakes Buchanan and Travis by LCRA's firm water customers was about 173,148 acre-feet; about 33,465 acre-feet was supplied to help meet environmental flow needs; and about 22,346 acre-feet of interruptible water was released to supply farmers in the

Garwood irrigation division. Total use of water from lakes Buchanan and Travis in 2013 was about 228,959 acre-feet.

b. LCRA owns four water treatment plants whose raw water supply is Lake Travis or Lake Buchanan as noted in Table 1

Table 1. LCRA Water Treatment Plants Supplied from Lakes Buchanan or Travis

System Name	Intake Location	Estimated Population Served	Service Area
Paradise Point Water System	Lake Buchanan	350	Paradise Point
Lake Buchanan Water System	Lake Buchanan	1,410	Service area around the south and west sides of Lake Buchanan
Smithwick Mills Water System	Lake Travis	160	Smithwick Mills
Ridge Harbor Water System	Lake Travis	400	Ridge Harbor

c. LCRA also owns the Spicewood Beach Water System. This groundwater-based system is influenced by the water levels in Lake Travis. As a result of the low lake levels, the production of the groundwater wells has diminished significantly. Water has been trucked to Spicewood Beach on a daily basis. The costs to date have exceeded $800,000.

d. Based on my knowledge of the treatment systems in and around lakes Buchanan and Travis, LCRA's water systems are representative of the types of potable water systems that obtain raw water from the lakes.

e. The table attached under Tab 2 shows the lowest elevations that LCRA's raw water intakes can currently draw from Lake Buchanan or Lake Travis. The table also shows the approximate amounts spent over the past few years to make adjustments to reach those elevations. In addition, the table provides information regarding the lowest intake elevation planned to date and the estimated costs for achieving those elevations. In some cases, lower elevations might be achieved at significantly greater costs, or LCRA may resort to hauling water for essential drinking and sanitation purposes for the smaller systems.

f. LCRA has 15 customers that currently take raw water for municipal purposes from Lake Travis that are not a part of LCRA's water utility systems. I reviewed information maintained by LCRA that identifies what LCRA believes to be the

elevations of our customers' intake structures. The depth of those intakes ranges from 545 feet mean sea level (msl) to 645 feet msl on Lake Travis.

g. If the levels in Lake Travis or Lake Buchanan drop below the current lowest pumping elevations as indicated in the chart attached under Tab 2, LCRA must take actions to either lower the pumping elevation, or find alternative supplies for the LCRA water utility systems described in this affidavit. For smaller systems such as Paradise Point, Smithwick Mills, or Ridge Harbor, the alternative is likely to be to haul water from a water utility with a viable source. Temporary measures would likely need to be taken by LCRA's raw water customers that have their own intake facilities to extend the facilities to reach water at lower elevations. It is my understanding that firm customers are actively spending or planning to spend funds to allow their intakes to operate at lower elevations. At least one customer has looked into hauling water should Lake Travis levels drop below the lows of September 2013.

h. Based on this information, it is my opinion that the current drought presents an imminent threat to public health and safety for the LCRA water systems if the lake levels or releases drop more quickly than arrangements for alternative intakes or supplies can be implemented. This is also likely the case for several of LCRA's raw water customers on Lake Travis.

i. In addition to the water systems described above that draw surface water from lakes Buchanan or Travis, LCRA also owns one retail system that draws supply water from one of the pass-through lakes between Lake Buchanan and Lady Bird Lake. That system, Sandy Harbor Water System, is supplied from Lake LBJ via the City of Horseshoe Bay treatment plant facilities and serves a population of approximately 245.

10. IMPACT OF DROUGHT ON HIGHLAND LAKES INFLOWS.

a. Inflows to the Highland Lakes over the past several years are among the lowest on record. The average annual inflows over the past six years, from 2008 through 2013, have been about 416,336 acre-feet per year, or about 33.8 percent of the long-term average from 1942 through 2013.

b. Shown in Table 2 is a comparison of the lowest ten years of gauged inflows into lakes Buchanan and Travis with the 2013 year-to-date inflows through November and the average annual inflows since 1942. Inflows for 2011 into the lakes were the lowest annual inflows on record, about 10% of average inflows. Calendar years 2008, 2009, 2011, 2012 and 2013 are all among the lowest 10 years of inflows to the Highland Lakes. Inflows from just one year from the historic Drought of Record (1950) fall within the 10 years of lowest inflows.

Table 2. Ten Lowest Annual Inflows into the Highland Lakes (acre-feet per calendar year)

Year	Amount
2011	127,802
2013	215,138
2008	284,462
2006	285,229
1963	392,589
2012	393,163
1983	433,312
1999	448,162
2009	499,732
1950	501,926
Average (1942-2013)	1.23 million

c. As of March 1, 2014, total combined storage in lakes Buchanan and Travis, and inflows during the preceding January and February were both lower than any of the previous three years as shown in Table 3.

Table 3. March 1 Storage and Preceding Months' Inflows

Year	Combined Storage in Lakes Buchanan and Travis on March 1 (acre-feet)	Total Gauged Inflows During the Preceding January and February (acre-feet)
2011	1,534,658	37,464
2012	846,820	109,877
2013	822,271	23,909
2014	761,270	20,257

d. Monthly inflows have been below average in 45 of the past 46 months as shown in Table 4.

Table 4. Monthly Inflows to Lakes Buchanan and Travis from May 2010 to February 2014

Month	Inflows (acre-feet)	Percent of Monthly Average	Month	Inflows (acre-feet)	Percent of Monthly Average
May 2010	95,821	46.8%	Apr 2012	19,477	18.6%
June 2010	33,517	20.3%	May 2012	83,699	40.9%
July 2010	59,905	69.8%	June 2012	12,599	7.6%
Aug 2010	10,783	16.8%	July 2012	8,712	10.2%
Sept 2010	86,952	84.7%	Aug 2012	2,041	3.2%
Oct 2010	14,385	11.8%	Sept 2012	12,006	11.7%
Nov 2010	13,899	19.8%	Oct 2012	19,338	15.8%
Dec 2010	16,845	24.7%	Nov 2012	6,042	8.6%
Jan 2011	21,158	32.6%	Dec 2012	6,854	10.0%
Feb 2011	16,306	19.3%	Jan 2013	15,117	23.3%
Mar 2011	13,811	15.1%	Feb 2013	8,792	10.4%
Apr 2011	9,175	8.7%	Mar 2013	10,741	11.8%
May 2011	11,182	5.5%	Apr 2013	11,127	10.6%
June 2011	1,340	0.8%	May 2013	29,265	14.3%
July 2011	734	0.9%	June 2013	5,608	3.4%
Aug 2011	403	0.6%	July 2013	17,423	20.3%
Sept 2011	922	0.9%	Aug 2013	1,593	2.5%
Oct 2011	29,927	24.5%	Sept 2013	30,161	29.4%
Nov 2011	6,874	9.8%	Oct 2013	48,444	39.6%
Dec 2011	15,969	23.4%	Nov 2013	18,092	27.5%
Jan 2012	35,178	54.2%	Dec 2013	18,775	27.5%
Feb 2012	74,699	88.2%	Jan 2014	11,813	18.2%
Mar 2012	112,517	123.1%	Feb 2014	8,444	10.0%

e. Additionally, the inflows in the current drought over periods ranging from 12 months to 72 months are lower than lowest such periods within the historical Drought of Record as shown in Table 5.

Table 5. Comparison of inflows in current drought to Drought of Record

	Lowest inflows for time period in ongoing drought		**Lowest inflows for time period in 1950s Drought of Record**	
Time Period	Period ending	Inflows (acre-feet)	Period ending	Inflows (acre-feet)
12 months	Sept. 2011	120,160	Apr. 1951	408,784
24 months	Mar. 2013	503,989	Mar. 1952	1,006,681
36 months	Sept. 2013	695,099	Aug. 1952	1,636,088
48 months	Feb. 2014	1,351,593	Aug. 1952	3,035,846
60 months	Aug. 2013	2,147,157	Aug. 1952	4,128,806
72 months	Feb. 2014	2,443,346	Apr. 1955	5,193,016

f. As a result of extremely low inflows into the lakes, record high temperatures, high evaporation rates, and higher than anticipated interruptible demands, the combined storage in the lakes dropped significantly in 2011, and in a very short timeframe. In 2012 and 2013, even with interruptible stored water cut off from the Gulf Coast, Lakeside and Pierce Ranch irrigation divisions, the lake levels have not recovered. (*See* Tab 3.) The combined storage in lakes Buchanan and Travis fell to the lowest level in the current drought, 637,123 acre-feet or 31.7 percent capacity on Sept. 19, 2013. For the 12-month period from Sept. 1, 2012 to Sept. 1, 2013, combined storage had dropped by about 229,000 acre-feet; and from June 1 to Sept. 1, 2013, combined storage dropped by about 118,000 acre-feet. As of March 1, 2014, combined storage was about 761,000 acre-feet or 37.9 percent capacity. On March 19, 2014, combined storage was about 757,000 acre-feet or 37.7 percent capacity. The last time both lakes Buchanan and Travis were simultaneously at their maximum allowable conservation storage was February 13, 2005.

g. Heavy, widespread rainfall in the Llano River and San Saba River watersheds above the Highland Lakes on Sept. 19 and 20, 2013 averaged two to three inches, with some rain gages reporting totals as high as six or seven inches. However, this rain event only yielded approximately 24,000 acre-feet of inflow

to the lakes. This low inflow total is symptomatic of the drought's severity which included dry soils that absorb most of the rainfall that does occur. By comparison, an event in March 2007 with about 40 percent *less* rainfall yielded almost 100,000 acre-feet of inflows to lakes Buchanan and Travis. A later event in March 2007 with about 15 percent more rainfall produced about 275,000 acre-feet of inflows to the lakes.

h. Two large rain events occurred in the lower Colorado River Basin watershed in October 2013. However the majority of rainfall and runoff occurred below the watersheds of lakes Buchanan and Travis. Gauged inflows to lakes Buchanan and Travis for October and November totaled about 69,000 acre-feet, as compared to flow that originated downstream and went past Bay City, totaling 355,000 acre-feet for those two months.

11. EVAPORATION FROM THE HIGHLAND LAKES

a. Annual evaporation from the six Highland Lakes (lakes Buchanan, Inks, LBJ, Marble Falls, Travis and Austin) during 2010, 2011, 2012 and 2013 are presented below:

Year	**Total Evaporative Loss(acre-feet per year)**
2010	183,923
2011	192,404
2012	144,759
2013	120,899

12. LCRA'S RELEASES FOR INSTREAM FLOW NEEDS

a. The 2010 Water Management Plan includes an obligation to make storable inflows and previously stored water from lakes Buchanan and Travis available to help meet instream flow needs below Lady Bird Lake. The current obligation is to maintain instream flows of 120 cubic feet per second (cfs), with a six-week requirement of 500 cfs, from Bastrop to Eagle Lake. (*See* 2010 Water Management Plan at 2-17, 4-12.)

b. In 2012, LCRA released 31,285 acre-feet of water from lakes Buchanan and Travis for environmental flow needs. This included 28, 235 acre-feet to meet instream flow obligations and 3,050 acre-feet to meet bay and estuary inflow obligations. Of the 28,235 acre-feet for instream flow obligations, 22,991 acre-feet was released to meet the 500 cfs requirement.

c. In 2013, LCRA released 33,465 acre-feet of water from lakes Buchanan and Travis for environmental flow needs. This included 18,779 acre-feet to meet

instream flow obligations and 14,686 acre-feet to meet bay and estuary inflow obligations. Of the 18,779 acre-feet for instream flow obligations, 15,678 acre-feet was released to meet the 500 cfs requirement.

d. A 500 cfs requirement could result in a release up to about 21,000 acre-feet this year for the Blue Sucker if conditions are similar to 2012 and 2013. The requested emergency relief reducing the requirement to 300 cfs could reduce the requirement by about 17,000 acre-feet.

e. The 2010 WMP includes annual an multi-year caps on the amount of firm water to be made available for instream flow needs. The one year cap is 51,100 acre-feet; the two year cap is 85,700 acre-feet; and the three year cap is 114,200 acre-feet. (*See* 2010 WMP at 3-5.) Based on the amount of dedicated releases for instream flows in 2012 and 2013, for 2014, the operative cap is the one year cap.

f. From Feb. 1 through Mar. 18, 2014, as reported by the United States Geological Survey (USGS), the average mean daily discharge at Bastrop was 335 cfs, and the minimum mean daily discharge was 281 cfs. Similarly at Columbus, the average mean daily discharge was 458 cfs, and the minimum mean daily discharge was 297 cfs.

13. EFFICIENCY IMPROVEMENTS. In 2012, LCRA implemented process improvements that have improved the efficiency of releases from the Highland Lakes for downstream water needs. These include: 1) a smaller increment of instantaneous releases from Tom Miller Dam, which allows for more precisely meeting instream flow requirements as well as other demands; and 2) improvements to models and procedures for determining the downstream demand and the estimated amount of flows originating downstream.

Further affiant sayeth not.

RYAN ROWNEY, AFFIANT

SWORN TO AND SUBSCRIBED before me on the 21st day of March, 2014.

TABETHA JASKE
Notary Public, State of Texas
My Commission Expires
January 11, 2018

Notary Public in and for the State of Texas

My Commission Expires: 1-11-2018

Tab 1

Ryan B. Rowney
P.O. Box 220
Austin, TX 78767
(512)730-6874

EXPERIENCE

LOWER COLORADO RIVER AUTHORITY, Austin, TX **October 1983 to Present**

Vice President, Water Operations (Sept. 2011 to Present)
Responsible for all areas of Water Operations including Hydro Operations, Irrigation Operations, River Operations, Water and Wastewater Operations, Water Surface Management and Water Customer Support. Provides safety oversight for Water Operations and reports directly to the Executive Vice President of Water.

Responsible for the operations and maintenance of LCRA's six dam and 13 hydroelectric (hydro) generation units, 1,100 miles of irrigation canals, nine irrigation pump stations, LCRA's system of rain and stream gauges, and LCRA water and wastewater systems.

Responsible for the development and reporting of drought and lake conditions to the General Manager and the LCRA Board of Directors on a monthly basis.

Manager of Dam & Hydroelectric Operations (Mar. 2004 to Sept. 2011)
Operate and maintain LCRA's network of dam and hydro generating assets while providing leadership and direction to staff. Manage flood operations. Develop strategic and operating goals and objectives in line with LCRA's overall goals and objectives. Ensure adherence to safety procedures and policies. Provide leadership and direction to dam and hydro related utility maintenance activities.

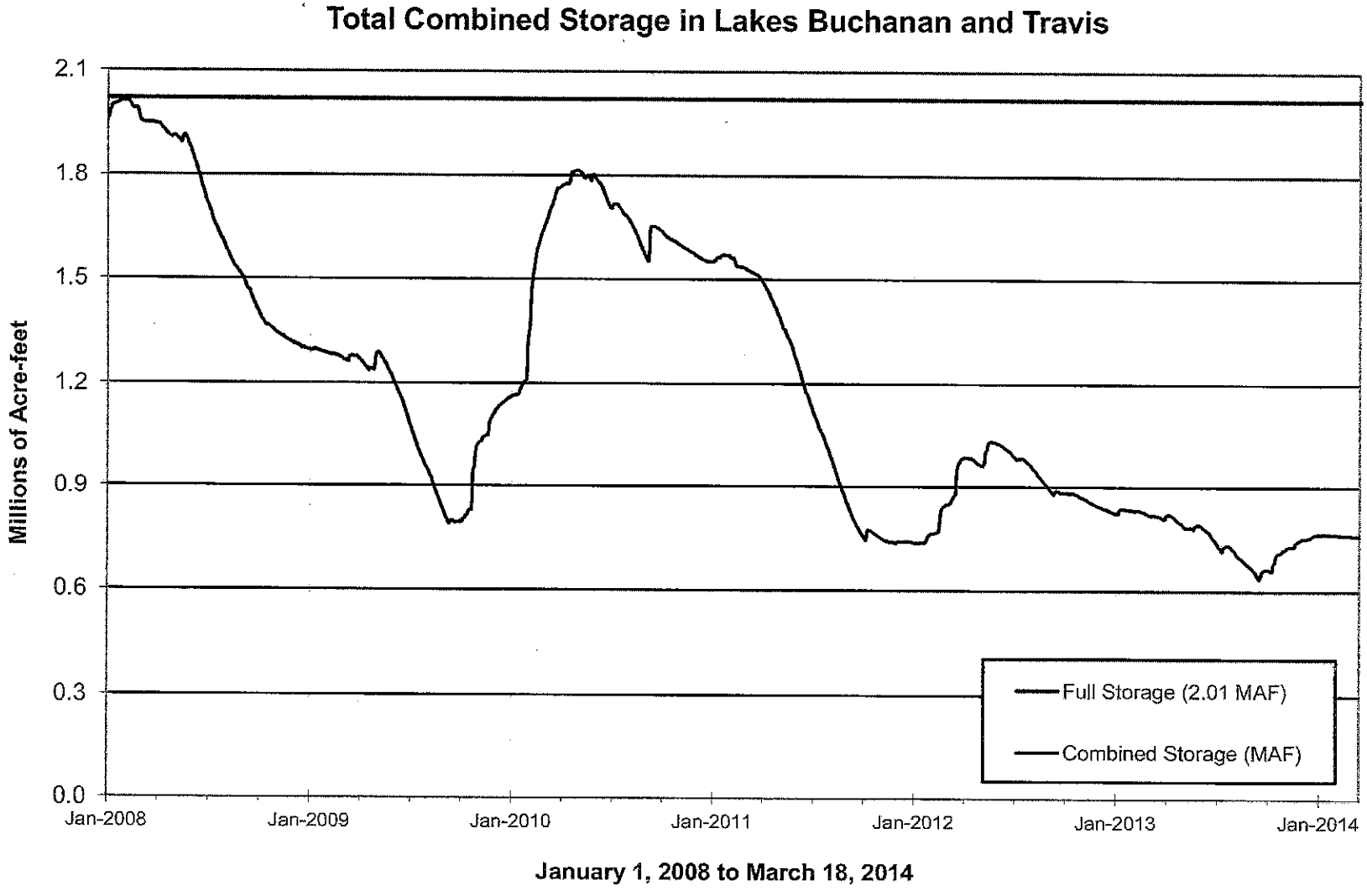
Superintendent of Dam & Hydroelectric Operations (May 2001 to Mar. 2004)
Supervise, coordinate and direct activities of dam and hydro staff. Act as liaison with the LCRA River Operations Center (ROC), LCRA Generation Desk (GenDesk) and LCRA System Operations Control Center (SOCC) to ensure the most efficient use of Hydro unit operations and flood management. Supervise the overall maintenance of the six Highland Lakes dams, the Lometa reservoir and pump station, thirteen hydroelectric turbine generators and all WWW treatment plants and associated water lines. Supervise the overall maintenance of all LCRA floodgates and related equipment.

Tab 2

LCRA Water Utility Intake Drought Response Summary

System Name	Intake Location	Current Lowest Pumping Elevation	Next Planned Lowest Pumping Elevation	Approximate Cost to Further Move Intakes/New Source	Additional Comments
Paradise Point Water System	Upstream third of Lake Buchanan	985 ft msl	975 ft msl	≈ $50,000	A new intake will need to be constructed when lake levels drop to about 985. The solution will likely include new submersible pumps enclosed in a screened intake pipe. Additional raw water piping and electrical work will be required.
Lake Buchanan Water System	Buchanan Dam	981 ft msl	940 ft msl	≈ $10,000	Spent approximately $60,000 in 2009 to add a new intake location. Treatment plant can be supplied provided there is water in the Buchanan Dam penstock. Additional costs will be incurred to add rails and pipe needed to lower the intake if Lake Buchanan drops below 981 ft msl.
Smithwick Mills Water System	Far upstream reach of Lake Travis	645 ft msl			Plant intake is located in a low spot that can continue to draw water as long as sufficient periodic releases are made from Starke Dam. Plan to truck water if necessary.
Spicewood Beach Regional Water System	Groundwater	Well Bottom elevation of 630 ft msl		≈$ 10,000 to $90,000 per month for water contract hauling; or $10,000 to $40,000 per month plus $80,000 to purchase tanker truck. Or $1.0MM for a new surface water plant.	Aquifer level is somewhat correlated to the level of Lake Travis adjacent to Spicewood. There has been decline in well production. Trucking water as necessary.
Ridge Harbor Water System	Upstream third of Lake Travis	625 to 627 ft msl	622 to 625 ft msl	≈$50,000	LCRA will need to construct a second intake when the lake levels drop to around 625 ft msl. The solution will likely include a new submersible pump with additional raw water piping and electrical work.

Tab 3


Total Combined Storage in Lakes Buchanan and Travis
Millions of Acre-feet
2.1
1.8
1.5
1.2
0.9
0.6
0.3
0.0
Jan-2008
Jan-2009
Jan-2010
Jan-2011
Jan-2012
Jan-2013
Jan-2014
Full Storage (2.01 MAF)
Combined Storage (MAF)
January 1, 2008 to March 18, 2014

APPLICATION OF THE LOWER COLORADO RIVER AUTHORITY FOR EMERGENCY AUTHORIZATION	§ § § §	**BEFORE THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY**

AFFIDAVIT OF RON ANDERSON

THE STATE OF TEXAS	§
	§
COUNTY OF TRAVIS	§

Before me, the undersigned authority, personally appeared Ron Anderson, a person known by me to be competent and qualified in all respects to make this affidavit, who being by me first duly sworn, deposed as follows:

1. I am over 21 years of age, of sound mind, and have never been convicted of a felony or crime of moral turpitude. I am fully competent and qualified in all respects to make this affidavit.

2. The facts stated in this affidavit are within my personal knowledge and are true and correct. The tabs attached to this affidavit and referred to herein are incorporated by reference.

3. I, Ron Anderson, am an individual residing in Austin, Texas.

4. I have a Bachelor of Science in Engineering and a Master of Business Administration from the University of Texas at Austin. I am a Registered Professional Engineer in the State of Texas with specialization in Civil and Software Engineering. I am recognized as a Diplomate in Water Resources Engineering by the American Academy of Water Resource Engineers. A true and correct copy of resume, detailing my prior work history and education, is included as Tab 1.

5. I have worked for the Lower Colorado River Authority (LCRA) for twelve years where I have worked on water supply planning issues for Central Texas. My current title is Chief Engineer.

6. As part of my duties at the LCRA, I track current issues affecting water supply, manage studies and modeling projects related to water supply quality and availability, enhance water supply forecasting capabilities, and evaluate water management procedures.

7. My opinions stated herein are based on my familiarity with LCRA's water supply operations and my evaluation of potential future inflows to the Highland Lakes. I have also relied upon a variety of information provided to me by LCRA staff, which

is of a nature typically relied upon in my profession, as described below and for which true and correct copies are either attached or referenced to other portions of LCRA's emergency request and incorporated by reference herein:

a. Affidavit of Bob Rose, including attachments;

b. Affidavit of Ryan Rowney, including attachments;

c. Affidavit of David Wheelock, including attachments;

d. Affidavit of Nora Mullarkey Miller, including attachments.

8. The 2010 Water Management Plan includes three criteria, all of which must be met at the same time for the LCRA Board to make a declaration of Drought Worse than Drought of Record (DWDR). (*See* 2010 WMP at p.4-34.) These criteria are indicators that can be evaluated in real-time. The three criteria are:

   i. Duration of drought is more than 24 months, which is determined by counting the number of consecutive months since both lakes Buchanan and Travis were last full (i.e. "duration" criterion);

   ii. Inflows to the lakes are less than inflows during the Drought of Record (i.e. "intensity" criterion); and

   iii. Lakes Buchanan and Travis combined storage is less than 600,000 acre-feet of water.

9. One of the three criteria for the LCRA Board to make a DWDR declaration is the drought intensity as compared to the Drought of Record. Specifically, the inflow deficit must be at least five percent worse than the average inflow deficit over a similar period of time during the Drought of Record for at least six months. As part of my job responsibilities at LCRA, I track this criterion, which is depicted in the graphic under Tab 2. Based on this analysis, the current inflow deficit has exceeded the inflow deficit of the Drought of Record by at least five percent for more than six months. In fact, at times during the current drought, the inflow deficit has been as much as 90 percent more than the standard from the Drought of Record. (*See* Tab 2.) The intensity of the current drought can also be seen by a more simplified comparison of the cumulative inflows since 2008 as compared to the Drought of Record. (*See* Tab 3.)

10. As shown in the Affidavit of Ryan Rowney, additional inflow statistics demonstrate the severity of the ongoing drought over the past six years as compared to any period of up to six years in the Drought of Record. (*See* Affidavit of Ryan Rowney.)

11. The inflow deficit and the inflow statistics for the past six years reveal a hydrologic condition that, for the past six years, is more severe than any hydrologic condition evaluated as part of the 2010 WMP.

12. I have evaluated the likelihoods of lake contents dropping to 600,000 acre-feet and the drought intensity criteria continuing to qualify for a DWDR declaration using multiple hydrologic scenarios representing potential future inflows. (*See* Tab 4 for a description of the modeling tool.) Modeling methods are generally consistent within +/- 2 percent.

13. Based on my analysis and the foregoing review, it is my expert opinion that:

    a. As of March 1, 2014, if severe drought conditions continue, even with the emergency order suspending the release of interruptible stored water to the Gulf Coast, Lakeside and Pierce Ranch irrigation operations, the criteria for a DWDR declaration (including combined storage in lakes Buchanan and Travis falling below 600,000 acre-feet) may be met as early as June 2014. (*See* Tab 5.)

    b. As of March 1, 2014, even if releases of interruptible stored water to the Gulf Coast, Lakeside and Pierce Ranch irrigation operations are cut off for all of 2014, there is about a 29 percent chance of triggering a DWDR declaration by the end of 2014. If, in addition, the instream flow requirement for the Blue Sucker is reduced from 500 cubic feet per second (cfs) to 300 cfs, there is about a 21 percent chance of triggering a DWDR declaration by the end of 2014.

    c. The actual combined storage in Lakes Buchanan and Travis as of March 1, 2014 as compared to the combined storage in June 2011 has trended along the 99th percentile exceedance trace for periods before the 2012 spring inflows and has returned to extreme levels recently. (*See* Tab 6.)

14. If conditions similar to 2011 were to occur over the next 12 months, total evaporation from lakes Buchanan, Inks, LBJ, Marble Falls, Travis, Austin and Lady Bird Lake over the next 12 months would be between 140,000 and 150,000 acre-feet.

Further affiant sayeth not.

Ron Anderson

RON ANDERSON, AFFIANT

SWORN TO AND SUBSCRIBED before me on the 20th day of March, 2014.

TABETHA JASKE
Notary Public, State of Texas
My Commission Expires
January 11, 2018

Tabetha Jaske

Notary Public in and for the State of Texas

My Commission Expires: 1-11-2018

Tab 1

Ronald E. Anderson, PE, MBA, D.WRE

LCRA, P.O. Box 220, MS L210
Austin, Texas 78767-0220

phone: (512) 578-3572
e-mail: ron.anderson@lcra.org

EXPERIENCE
2001-present

Lower Colorado River Authority
Chief Engineer/Water Resources Managment

Water Supply Forecasting
- Develops stochastic model to forecast water supply availability.
- Communicates water supply forecasts online through custom reports.
- Collaborates with academic researchers to enhance forecast methods.

Lower Basin Reservoir Project, Project Sponsor
- Maintain project direction and benefits of developing 90,000 AF/yr of new supply
- Communicate project needs and obtain timely decisions to maintain schedule
- Communicate project benefits
- Support the Project Manager and the project team.

New Supply Development, Modeling Lead
- Overseeing consultant evaluation of lower basin balancing reservoirs reliability.
- Developing models to optimally size off channel storage reservoirs in irrigation divisions.
- Providing technical expertise in facility planning, siting and preliminary design for balancing reservoir projects.

2010-2014 Drought Response
- Develop scenario responses for drought response consideration.
- Provide stakeholders with updated reservoir level projections and risk assessment.
- Communicate with stakeholders about potential impacts.

Highland Lakes Water Management Plan Update. Technical Lead
- Procured and managed professionals to review drought of record monitoring methods
- Procured and managed professionals to develop simulation models
- Developed quality assurance procedures for project team
- Review water supply simulations and provide technical documentation.

Emerging Issues
- Responsible for scanning the political and scientific developments that might impact the future operations of the Colorado River and development of power generation.

Water Supply Model Development Project. Project Manager
- Coordinated development of the new innovative water rights solver feature to support daily river operations and allocation simulation.
- Chartered and developed project controls for the $1 million water supply planning mode development using the RiverWare platform.
- Procured engineering professionals to conduct the work.
- Conducted workshops for internal and external training.

Water Supply Reliability Team Lead

- Lead a team of internal and external professionals to review and evaluate existing and proposed plans for water supply management.
- Developed a stochastic forecasting model of the water supply for medium range planning of response to drought conditions.
- Evaluated procedures for management and operations under a drought conditions worse than the drought of record.

LCRA-SAWS Water Project

- Project Manager during pre-planning period. Responsible for project costs estimation, project controls, project consultant procurement, and project communications coordination.
- Project Controls Manager during project planning period. Responsible for setting up project financial, document, and communication controls for over $1 million in planning activities.
- Project Engineer and Technical Studies Coordinator for project study period. Responsible for quality assurance of key study scopes and products. Responsible for coordination and integration of related LCRA Projects with technical studies as well as assisting with public, stakeholder, and agency communications.
- Responsible for review and evaluation of technical studies' consultant performance.
- Studies activities include: surface water modeling, groundwater modeling, agricultural conservation, facilities engineering, environmental assessment, water quality assessment, bay health, socio-economic, waterfowl, climate change, uncertainty, and permitting.

Brazos River Authority

1998-2001 *Senior Planning Manager*
1997-1998 *Senior Water Resources Planner*

HDR Engineering, Inc.

1995-1997 *Project Manager*
1986-1995 *Engineer/Computer Modeler*

EDUCATION

Master of Business Administration, University of Texas at Austin, 1993
Post Graduate Studies, Free Surface Flow, 1987, Operations Research, 1988, University of Texas
Bachelor of Science in Engineering, University of Texas at Austin, 1986

PROFESSIONAL CREDENTIALS & ASSOCIATIONS

- Registered Software Engineer, State of Texas
- Registered Civil Engineer, State of Texas
- Member, American Society of Civil Engineers, Environmental and Water Resources Institute
- Diplomate, American Academy of Water Resources Engineers

SELECTED PUBLICATIONS & PRESENTATIONS

Anderson, R.E. and Rose, B. *Searching for Predictive Climate Signals for River Flows in the Lower Colorado River Basin,* USCID Water Resources World Congress 2012.

Anderson, R.E. and Gooch, T. *Review of Drought Worse Than Drought of Record Monitoring Methods for the Lower Colorado River in Texas,* ASCE/EWRI Water Resources World Congress 2011.

Anderson, R.E. and Walker, D. *Use of Stochastic Modeling during the 2008 and 2009 Drought on the Lower Colorado River in Texas,* ASCE/EWRI Water Resources World Congress 2011.

Water Resource Implications of Climate Change in Central Texas, Austin Climate Protection Conference & Expo 2010

Beyond the Drought of Record: Supply Forecasting for Difficult Times, Texas Water Conservation Association Fall Meeting, 2009.

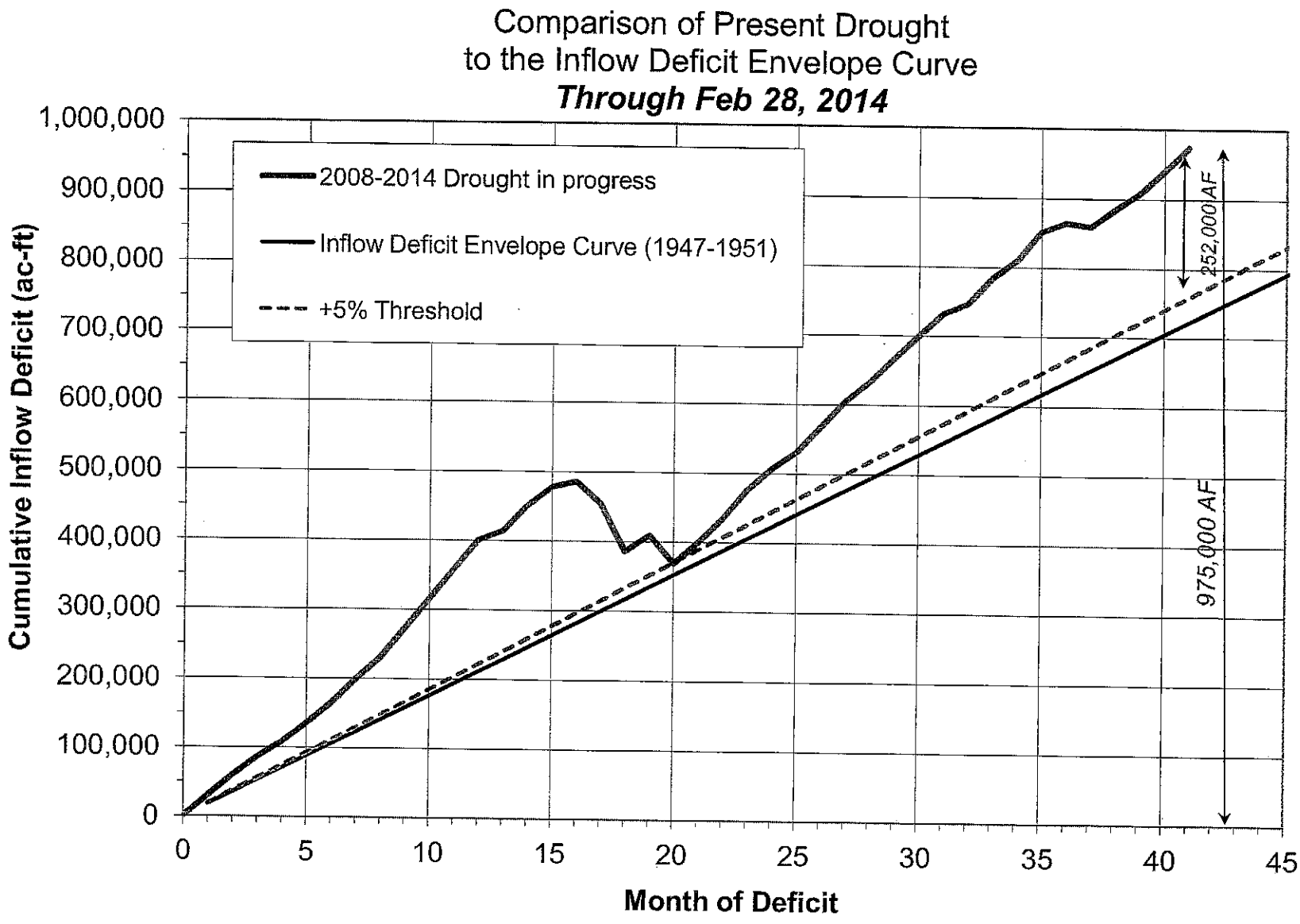
Anderson, R.E. and Walker, D. *Stochastic Forecasting of Conservation Storage on the Lower Colorado River in Texas,* Texas Water 2009.

Co-Author, *Assessing Potential Implications of Climate Change for Long-Term Water Resources Planning in the Colorado River Basin, Texas*, American Geophysical Union Annual Conference Poster, 2008.

Current and Future Drought Assessment Activities, Drought Benchmarking Conference, 2007.

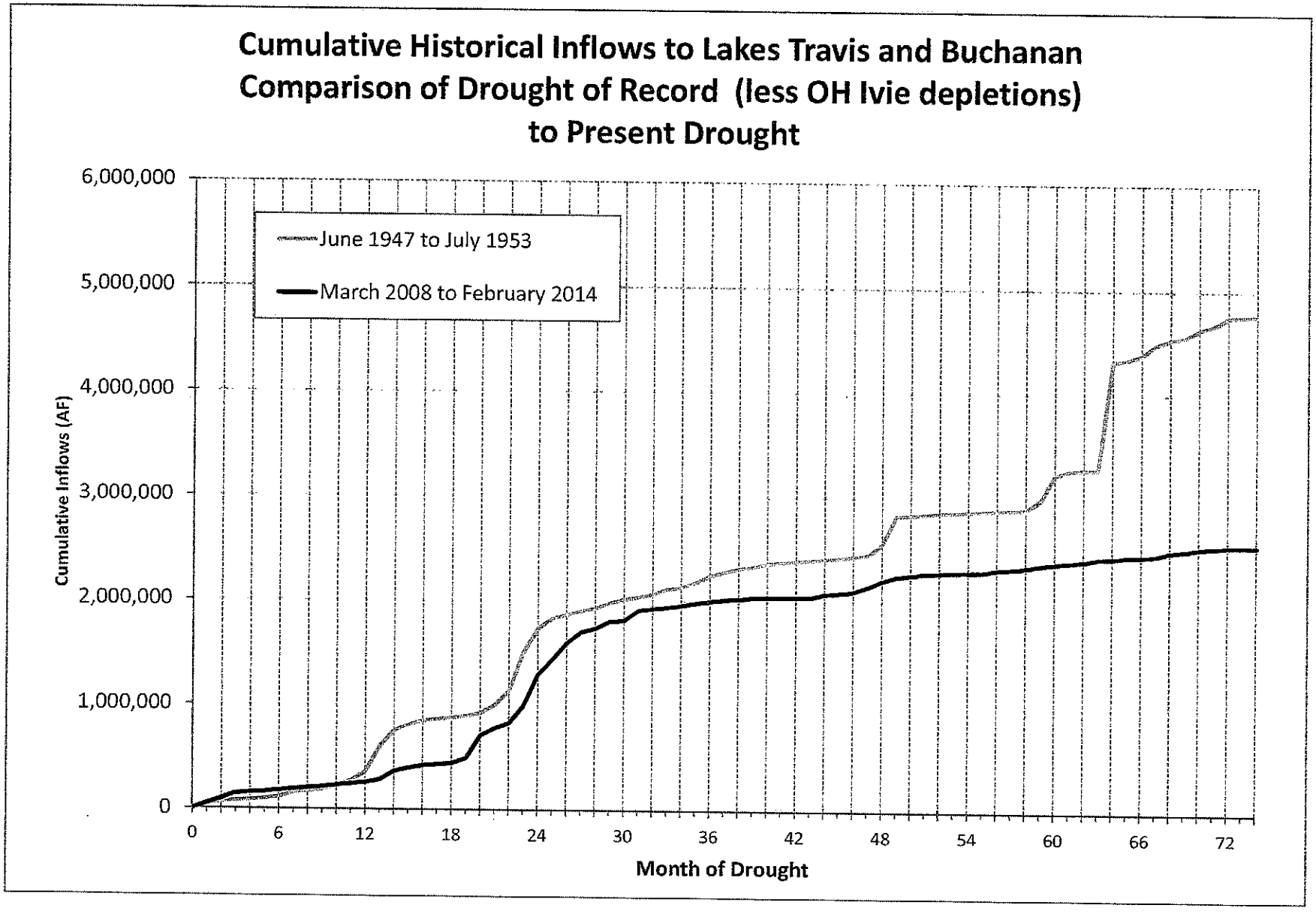
Co-Author, *Matagorda Bay Freshwater Inflow Needs Study*, LCRA, TCEQ, TPWD, and TWDB, August 2006.

Tab 2



2/28/2014
Subject to Revsion

Tab 3


Cumulative Historical Inflows to Lakes Travis and Buchanan
Comparison of Drought of Record (less OH Ivie depletions)
to Present Drought
June 1947 to July 1953
March 2008 to February 2014
Cumulative Inflows (AF)
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
0
6
12
18
24
30
36
42
48
54
60
66
72
Month of Drought

LCRA's Use of Stochastic Modeling to Forecast Future Combined Storage
February 28, 2014

Introduction

No one can predict the future, but decision makers in all walks of life have to make judgments based on their best analysis of likely future conditions. This can be particularly difficult in situations where multiple factors and their interplay can influence the outcome of important events.

Because of the complications involved in this type of decision making, many industries rely on computer models called stochastic models to evaluate the likelihood of future conditions. This type of model is able to take a number of factors and data into account to generate a large number of potential future outcomes. Each individual outcome is as statistically likely as any other. Therefore, when all outcomes are plotted on a graph, areas where potential outcomes are denser depict a range of future results that is more likely. Conversely, areas on the graph where potential outcomes are less dense depict a range of future results that is less likely. The number of outcomes in a range can be expressed as a statistical probability for the future.

The insurance and financial industries are among those that use this type of computer model to help make their decisions. LCRA has been using and refining its stochastic modeling for six years to help make water management decisions. LCRA's model has been reviewed internally by staff and externally by Dr. John Carron of Hydros Consulting and Dr. David Watkins of the Michigan Technological University. The methods have also been peer reviewed and published at multiple professional conferences of the American Society of Civil Engineering, American Water Works Association, and U.S. Committee on Irrigation and Drainage.

LCRA uses the model to show possible future combined storage levels of lakes Travis and Buchanan. LCRA also uses the results of the model to calculate potential future lake elevations. During drought, this is a popular tool for many of our firm water customers with intakes on the lakes. These customers use future lake level probabilities in their decision making process when determining whether or not to extend or move their intake structures.

What goes into LCRA's model?
LCRA uses the following sets of data in its stochastic model:

Current conditions: Each month when the projections are updated, the current levels of Travis and Buchanan serve as the starting point for the model.

Historical hydrology: LCRA currently uses the hydrological record from 1940 to 2014. Upstream inflows, downstream run-of-river flows and evaporation records for every month of that period are incorporated into the model. This includes the 10-year drought of the 1950s known as the state's Drought of Record and the drought of 2011, which is the most severe single-year drought on record. This data set is updated as each year of data becomes available.

Drought year firm customer demands: LCRA uses firm customer base demands in its model that are similar to demands experienced in 2008 and 2012 (no major new firm customers have entered into agreements since then). Drought year demands are appropriate when evaluating the impacts of drought on the water supply because drought conditions increase the demand for stored water that would otherwise be met through rainfall.

Interruptible customer requests: LCRA uses the 2011 planted acreage in the four irrigation operations to determine how much water downstream interruptible customers would require if all agricultural irrigation demands are met. This acreage is used to determine demands under an open supply scenario as well as to evaluate the level of curtailment under conditions that do not allow open supply.

2010 Water Management Plan: When determining how much interruptible stored water will be provided to the downstream irrigation districts, LCRA uses the assumptions of the current Water Management Plan. If a new Water Management Plan is approved or TCEQ approves an amendment to the current plan such as emergency relief, LCRA would use the new management assumptions in the model.

A measurement of El Niño/Southern Oscillation index: The El Niño/Southern Oscillation is a cyclic warming and cooling of the sea surface temperatures in the Pacific Ocean near the equator that can affect the weather in Texas. If the Pacific warms enough, it can produce an El Niño weather pattern that increases the chances of wetter than normal weather in Central Texas, particularly during the fall and winter. If the Pacific is cool enough, it can produce a La Niña weather pattern that increases chances of dry weather in central Texas. The El Niño/Southern Oscillation index (ONI) is a measurement of this cycle. LCRA uses the measurement in its model to help predict whether future conditions should be weighted toward a wet, dry or

neutral scenario. Predictions of the index are provided by the Climate Prediction Center and updated monthly.

Last two months of inflows: As explained above, LCRA's model uses historical inflow data for the last 74 years to help evaluate the likelihood of possible future conditions. The model specifically uses inflow data from the last two months to help determine one very important factor: the chances that the region's weather pattern could change significantly from one month to the next.

Historical data shows the tendency for the weather to stay the same from one month to the next in Texas, particularly during the winter months and to a lesser extent in May and October. If the weather is wet one month, it tends to stay wet the next month. Conversely, if it is dry one month, it tends to stay dry the next. This is the norm, but of course, it doesn't always hold true. As we all know, the weather does eventually change.

Through years of improving the model, LCRA staff has found that the best way to evaluate the likelihood of a significant change in the weather is to (1) use the most recent two months of inflows to determine if there is a wet, dry or neutral weather pattern and (2) look at the historical record to determine how often the weather pattern has changed from one month to the next. The model is able to use this data to determine the probability that the local weather will change significantly from one month to the next (from wet to dry, dry to wet, neutral to dry, etc.).

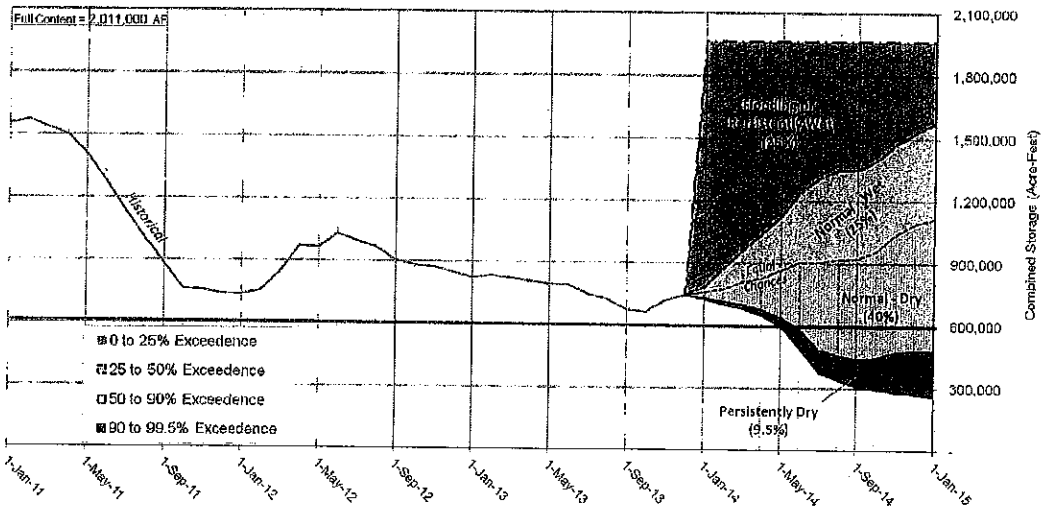
How does the model work?

The model proceeds month by month re-ordering the historical hydrology according to a rational method that preserves the historical observed switching patterns (wet, neutral, dry) and preserves the cumulative historical frequency of inflows to the highland lakes. That is the stochastic part of the model. Then it simulations operations of the system to meet demands and determines the monthly lake storage. That is the accounting part of the model. The model does this 2,000 times. These multiple scenarios are then summarized into graphical products.

What comes out of the model?

As discussed above, LCRA's stochastic model uses the factors we've described to calculate a large number (2,000) of possible future scenarios for the combined storage of lakes Travis and Buchanan. By plotting those 2,000 points on a graph, we are able to determine ranges that are more likely and less likely. LCRA uses that information to produce a graph that shows future combined storage ranges under different inflow conditions and management actions.

Consider the following graphic produced from the results of our model:



This graphic depicts potential future combined storage scenarios. It is divided into four ranges associated with the general weather conditions that would lead to the ranges of combined storage. We have titled them: Flooding or Persistently Wet; Normal-Wet; Normal-Dry; and Persistently Dry.

The legend with the graphic contains a percentage range associated with each category. This range corresponds with the percentage of the 2,000 future scenarios that falls into each category. Here's what it tells us:

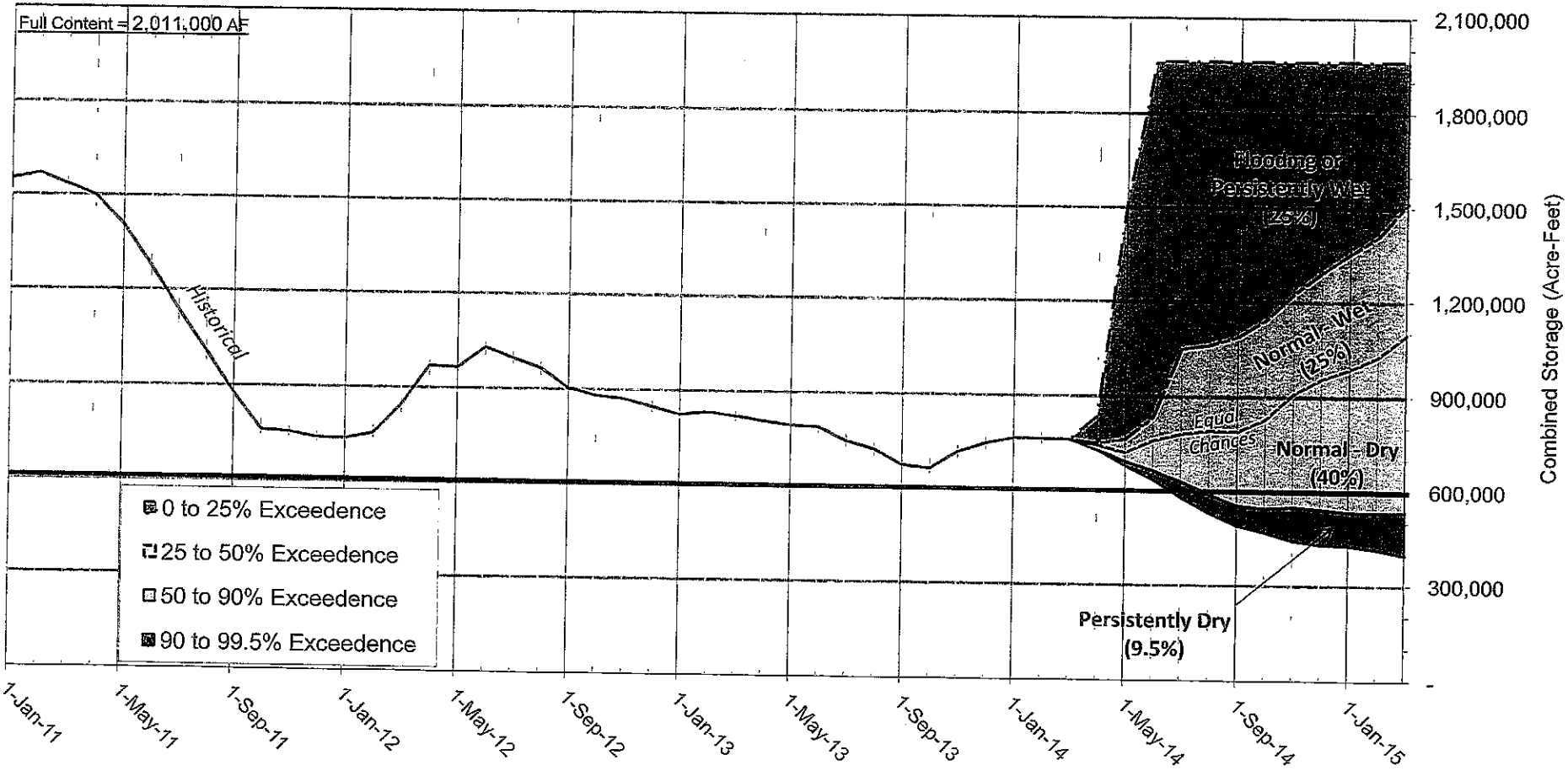
- The Flooding or Persistently Wet range contains 25 percent, or 500, of the potential outcomes;
- The Normal-Wet range contains 25 percent, or 500, of the potential outcomes;
- The Normal-Dry range contains 40 percent, or 800, of the potential outcomes;
- The Persistently Dry range contains 9.5 percent, or 190, of the potential outcomes; and
- The Equal Chances line means that 50 percent of the potential outcomes, or 1,000, are above the line and 50 percent are below.

- A small number of outliers, 0.5 percent or 10 of the potential outcomes, are not depicted on the graphic.

As the graphic shows, the model cannot predict the future. What it does show is how likely a range of combined storage is in the future based on the historical hydrological record and other information contained in the model. This information is intended to help LCRA staff, Board members, and stakeholders make informed water management decisions.

Tab 5

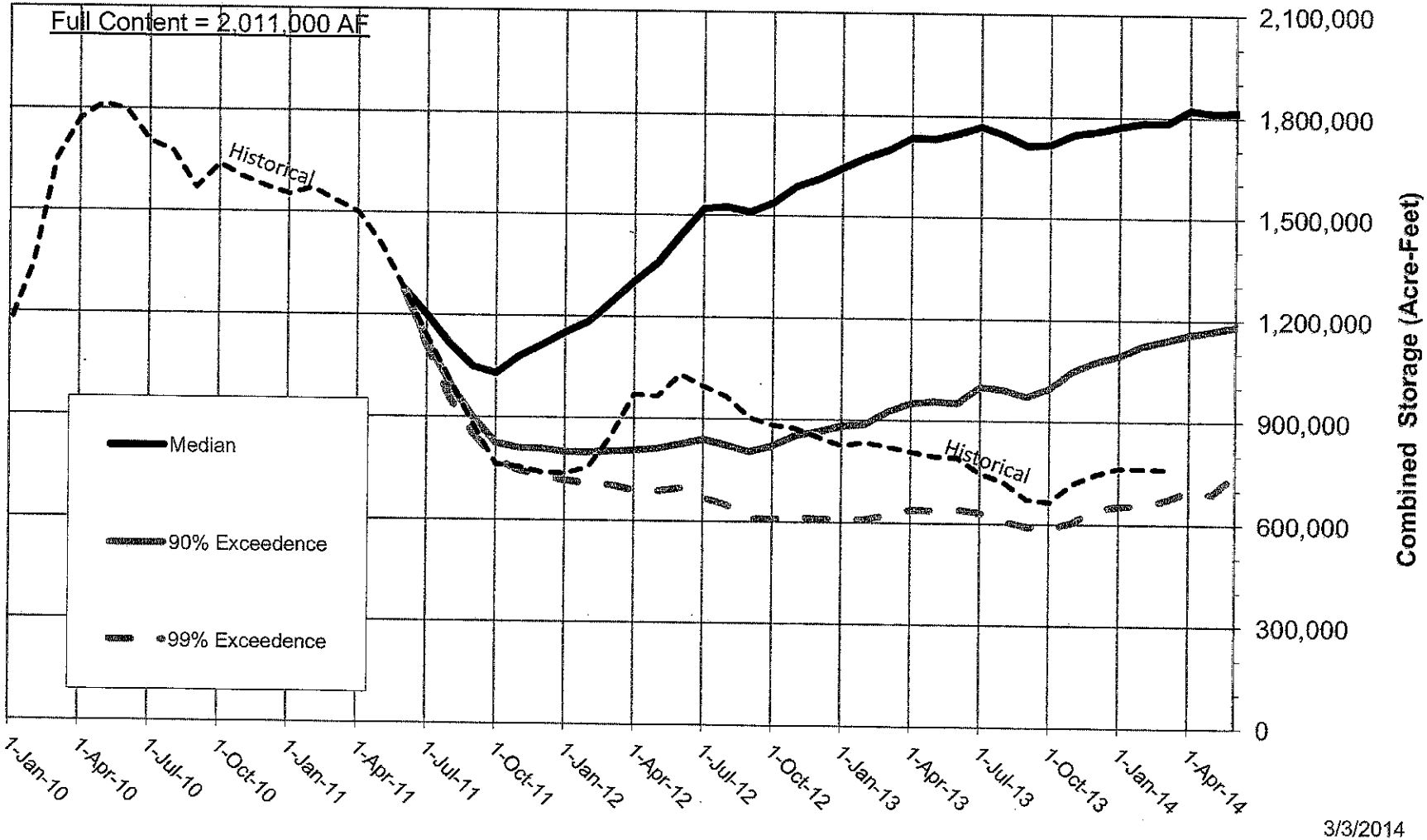
Lakes Travis and Buchanan Combined Storage Outlook With Emergency Order in 2014



Notes:
1. Buchanan maximum pool of 1018 for maintenance for forecasted period.

Tab 6

Stochastic Outlook for Travis and Buchanan Combined Storage
From June 2011 to Present Compared to Actual Storage
WITH EMERGENCY ACTION IN 2012 thru 2014



3/3/2014
Subject to Revision
REA

APPLICATION OF THE LOWER COLORADO RIVER AUTHORITY FOR EMERGENCY AUTHORIZATION	§ § § §	**BEFORE THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY**

AFFIDAVIT OF BOB ROSE

THE STATE OF TEXAS	§
	§
COUNTY OF TRAVIS	§

Before me, the undersigned authority, personally appeared Robert H. Rosenzweig, also known as Bob Rose, a person known by me to be competent and qualified in all respects to make this affidavit, who being by me first duly sworn, deposed as follows:

1. I am over 21 years of age, of sound mind, and have never been convicted of a felony or crime of moral turpitude. I am fully competent and qualified in all respects to make this affidavit.

2. The facts stated in this affidavit are within my personal knowledge and are true and correct.

3. I, Bob Rose, am an individual residing in Austin, Texas.

4. I am the Chief Meteorologist for the Lower Colorado River Authority ("LCRA"). I have held this position since 1995. I have worked as a meteorologist in Texas for 30 years. A true and correct copy of my resume, detailing my prior work history and education, is attached hereto under Tab 1.

5. As part of my duties at the LCRA, I regularly review and summarize short-term and long-term weather predictions and drought indices for the Central Texas region. My opinion is based on my experience in the field and a review of data and forecasts from the National Weather Service's Climate Prediction Center, National Oceanic and Atmospheric Administration's (NOAA's) Earth System Research Laboratory, Texas State Climatologist Dr. John Nielsen-Gammon and Research Scientist Gregory J. McCabe.

6. Extraordinary drought conditions have gripped much of Texas, including the Colorado River basin for more than three (3) years, dating back to October of 2010. The drought has been unprecedented relative to the long-term climate record in a number of ways: record low precipitation, extreme, record-setting summer heat and enormous wildfires. The drought conditions include both meteorological drought (taking into account rainfall and temperature) and hydrologic drought (taking into account streamflow and evaporation).

7. Rainfall. According to the Texas State Climatologist, Dr. John Nielsen-Gammon, on a statewide basis, rainfall during the 12 month period from Oct. 1, 2010 to Sep. 30, 2011 was the lowest ever recorded, dating back to 1895. (Available at http://climatexas.tamu.edu/files/2011_drought.pdf.) My review of rainfall data indicates the following:

a) Total average rainfall across Texas from Oct. 1, 2010 to Sept. 30, 2011 was 11.18 inches, just 38 percent of the long-term average. This is much lower than the previous record of 13.91 inches occurring between October 1955 and September 1956.

b) Statewide rainfall over the period between October 2010 and September 2012 totaled 40.21 inches, 15.73 inches below normal, or 73 percent of normal. This is the 5th driest such 24-month period on record dating back to 1895. (Available at http://www.ncdc.noaa.gov/temp-and-precip/ranks.php?periods%5B%5D=24&parameter=pcp&state=41&div=0&year=2012&month=9.)

c) Statewide rainfall in 2013 was near normal with a total of 26.01 inches, 1.07 inches below normal. It was the 51st driest out of 120 years of records. (Available at http://www.ncdc.noaa.gov/temp-and-precip/ranks.php?periods%5B%5D=12&parameter=pcp&state=41&div=0&year=2013&month=12 last visited on March 17, 2014.) However, the sporadic nature of rain events (over the past three years) has continued to produce well below average runoff. (*See* Affidavit of Ryan Rowney.)

d) Statewide rainfall for the three-year period of November 2010 to October 2013 was well below normal, totaling 65.51 inches. This total is 18.47 inches below normal or 78 percent of normal. This is the 7th driest such period on record dating back to 1895. (Available at http://www.ncdc.noaa.gov/temp-and-precip/ranks.php?periods%5B%5D=36&parameter=pcp&state=41&div=0&year=2013&month=10.)

e) Two heavy rain events occurred during October 2013, but both of these events occurred primarily downstream of the watershed to the Highland Lakes. The first event occurred on October 12 and 13, producing up to a foot of rain over southwest Austin and southwest Travis County. The second event occurred on October 30 and 31, producing widespread totals of 8 to 12 inches over parts of Travis, Hays and Comal Counties. The majority of the runoff from both rain events drained into the Colorado River below Austin.

f) This year has started off unusually dry with January through February statewide rainfall totaling 1.02 inches, 2.02 inches below normal. This is the 5th driest January-February on record dating back to 1895. (Available at http://www.ncdc.noaa.gov/temp-and-precip/ranks.php?periods%5B%5D=2&parameter=pcp&state=41&div=0&year=2014&month=2 last visited on March 17, 2014.)

g) In Austin, January through February 2014 rainfall has also been unusually dry. The two-month rainfall totaled 1.55 inches, 2.69 inches below normal. This has been 3rd driest January through Februrary on record, dating back to 1891.

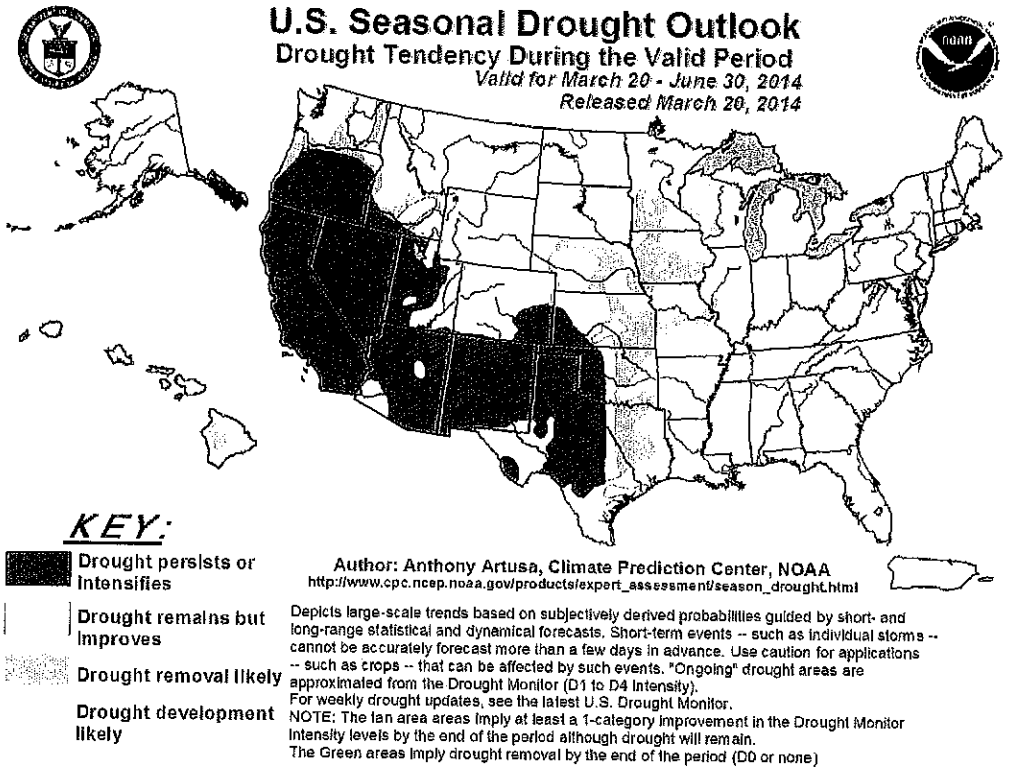
8. According to the latest U.S. National Drought Monitor, a product of the National Weather Service, the U.S. Department of Agriculture, and the National Drought Mitigation Center, much of the Texas Hill Country was designated as being in "severe drought," the second of four drought classifications. The Hill Country counties of Gillespie and Kerr were designated as being in "extreme" drought, the third of four drought classifications. Much of Central Texas was depicted as being in moderate drought, the first of four drought classifications. Meanwhile, the coastal plains region was shown as being "abnormally dry" due to significant rains in late February and early March. Note, the Drought Monitor does not specifically depict the state's hydrologic drought, which is considerably worse than depicted.

9. Heat. Another factor that has contributed to the severity of the ongoing drought has been the unprecedented heat. For Texas, the average temperature between June 1 and August 31 of 2011 was the hottest summer average temperature ever recorded in Texas and the second hottest summer average temperature for any state in the US dating back to 1895. Summer 2011 was also, by far, the hottest summer on record for Austin. Statewide, calendar year 2011 was the second hottest year ever recorded and the hottest year on record for Austin. The combination of well below normal rainfall and unprecedented heat created some of the most severe drought conditions ever recorded. (*See* http://www.ncdc.noaa.gov/sotc/drought/2011/9, last visited July 1, 2013 and http://www.srh.noaa.gov/images/ewx/wxevent/sum2011.pdf, last visited July 1, 2013.) These conditions even surpassed the drought conditions of the 1950s. The unprecedented hot temperatures combined with numerous sunny days to create much higher than normal losses from evaporation. Abnormally warm temperatures also continued in 2012. Statewide, the summer of 2012 was the 10th hottest summer on record. And it was the 11th hottest summer on record for Austin. Statewide, 2012 tied with 1921 for the warmest year ever recorded in Texas history. For Austin, summer temperatures in 2012 were the 9th warmest on record. Summer temperatures for Austin in 2013 were the 5th warmest on record.

10. Weather Forecast Sources. In developing my forecast, I have relied on various sources, including the National Weather Service's Climate Prediction Center, NOAA's Earth Science Research Laboratory, Texas State Climatologist John Nielsen-Gammon and Gregory McCabe, Research Scientist.

a) The National Weather Service's Climate Prediction Center (CPC) 3-Month Drought Outlook calls for the drought to persist across the Hill Country between the months of April and June. Limited drought improvement is forecast for the middle Texas coast and the Interstate 35 corridor. *See* Figure 1.

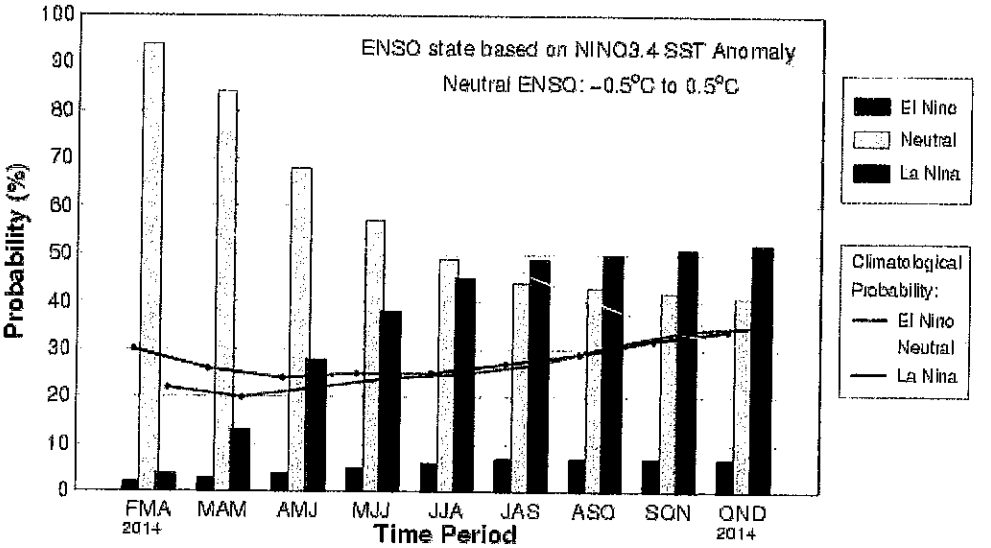
Figure 1.



According to CPC forecasters, "There are conflicting and/or weak climate signals for precipitation in the central and southern Plains [this includes Texas, generally] during both April and April, May and June, so EC (equal chances) is deemed the best bet. Near to above-normal temperatures are anticipated during these same periods. Climatologically, a significant fraction (55-60 percent) of the annual precipitation is received in this region during the AMJ time frame. With no clear precipitation signal from the CPC outlooks, it is reasoned that the lower Plains is more susceptible to the influx of low-level Gulf moisture and frontal boundaries, and has the best odds for drought removal. The odds of getting drought improvement or removal rapidly diminishes westward across the High Plains [this generally refers to the Texas Panhandle region]. (*See* Tab 2, available at http://www.cpc.ncep.noaa.gov/products/expert_assessment/sdo_discussion.html.)

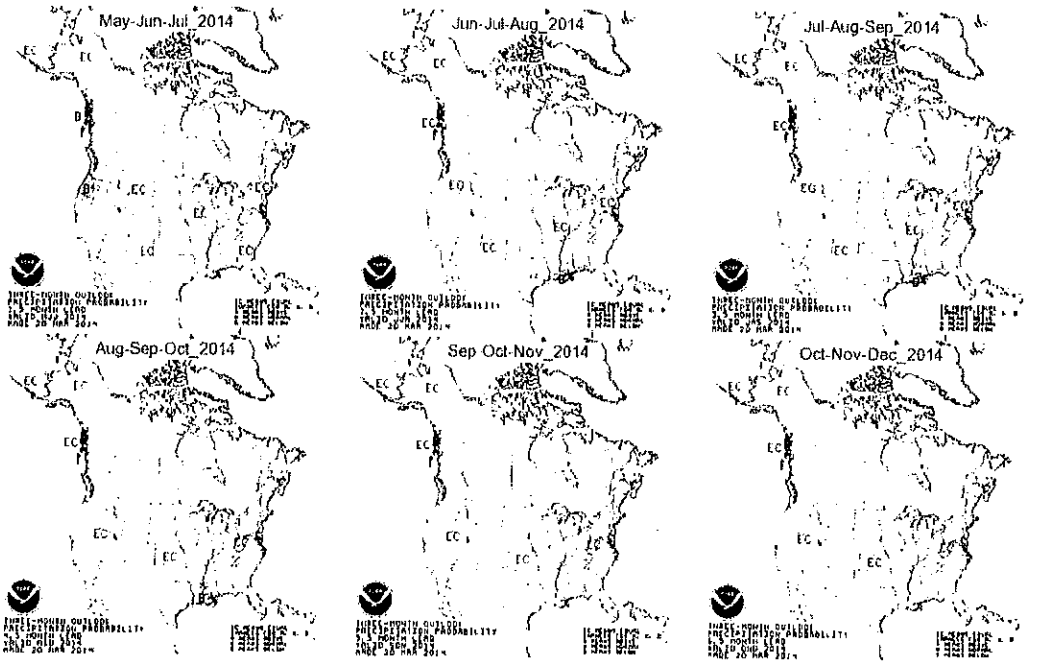
Looking out longer-term, The International Research Institute, a partner of the National Weather Service's Climate Prediction Center, forecasts at least a 50 percent probability for ENSO neutral conditions to continue in the tropical Pacific through the middle of summer. A 50 percent or greater chance for an El Niño is forecast beginning late summer and continuing through fall. (*See* Figure 2, available at http://iri.columbia.edu/climate/ENSO/currentinfo/QuickLook.html.)

Figure 2,
Early-Mar CPC/IRI Consensus Probabilistic ENSO Forecast



b) The latest National Weather Service precipitation outlook generally calls for equal chances for above, below, or near normal precipitation across Central and South Texas this spring and summer. *See* Figure 3. Climate Prediction Center forecasters state: "Much of the outlook is designated as equal chances, or climatological probabilities for above, near or above- median seasonal accumulated precipitation. The primary driver for April-May-June outlook was dynamical model guidance from the CFS, NMME and IMME (forecast models), with the greatest probabilities across northern California and and Alaska Panhandle where agreement was generally the best." (*See* Tab 3, available at http://www.cpc.ncep.noaa.gov/products/predictions/90day/fxus05.html.)

Figure 3. National Weather Service Precipitation Outlook

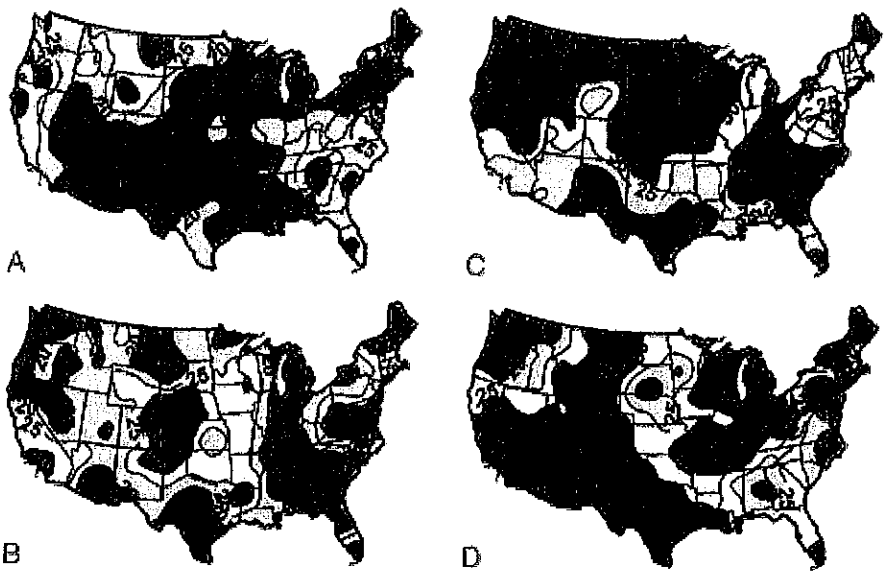


c) Sea surface temperatures in the tropical Pacific are currently neutral but these waters have been slowly warming over the past couple of months. Most all long-range climate forecast models indicate this warming trend will continue through spring months of 2014. Most long-range forecast models indicate the Pacific will reach the threshold for a weak El Niño sometime this summer. As a result, the Climate Prediction Center has issued an El Niño Watch, meaning that it places the odds of El Niño developing by autumn at just over 50 percent. Klaus Wolter, a researcher at NOAA's Earth Systems Research Laboratory, tracks the development El Niño using the Multivariate ENSO Index (MEI), which he formulated with ESRL colleagues. Wolter says he's "even more bullish" than NOAA/CPC on the odds of an El Niño event later this year. An experimental forecast scheme based on the MEI shows a 67% chance of El Niño for the July–September period. See (http://www.esrl.noaa.gov/psd/enso/mei/ last visited on March 18, 2014).

Should the El Niño develop, it is not expected to have a significant impact on Central Texas weather until the late summer or fall. Furthermore, the development of El Niño in 2014 is still far from certain. Tropical Pacific waters reached the threshold for an El Niño in August of 2012 but sea surface temperatures unexpectedly cooled in September and October, and the El Niño failed to develop. By November of 2012, the Climate Prediction Center canceled the El Niño watch as Pacific waters continued to cool. In the current regime of a negative Pacific Decadal Oscillation (PDO), the development of an El Niño is far from certain as the overall oceanic pattern tends to fight the build up of unusually warm water in the tropical region.

d) In 2004, McCabe et. al. published a statistical study of drought frequency in the lower 48 states versus the PDO and Atlantic Multidecadal Oscillation (AMO). (*See* Figure 3, below and Tab 4, available at http://www.pnas.org/content/101/12/4136.long.) Currently, the Pacific Ocean is in the midst of a negative phase of the PDO where waters on the eastern side of the Pacific are unusually cool. At the same time, waters in the North Atlantic Ocean are unusually warm, a result of the positive phase of the AMO. Oceanic conditions in both the Atlantic and Pacific Oceans seem to influence long-term drought conditions within the U.S. Scientists monitoring both oceans have been able to match the changing phases of multi-decadal oscillations within each ocean to the presence or absence of drought across the US. McCabe pointed out the difference between the dust bowl drought in the 1930s when the PDO and AMO were both positive and the multi-year drought of the 1950s over the south central and southwestern US when the PDO was cold and the AMO was warm.

Figure 3. Drought probability for the four classes of Pacific Decadal Oscillation and Atlantic Multidecadal Oscillation



A is Cold (-)AMO and Warm (+) PDO. B is Cold (-) AMO and Cold (-) PDO.
C is Warm (+) AMO and Warm (+) PDO. D is Warm (+) AMO and Cold (-) PDO.

The current conditions are indicative of classification D which indicates persistent drought for Texas and the southwestern United States. McCabe in 2004 wrote, "Should the current positive AMO (warm North Atlantic) conditions persist into the upcoming decade, we suggest two possible drought scenarios that resemble the continental-scale patterns of the 1930s (positive PDO) and 1950s (negative PDO) drought."

11. Weather Forecast. Based on my experience and a review of data and forecasts from the sources listed above, it is my opinion a general pattern of near normal to slightly below normal rainfall will be in place across Central and South Texas

this spring into early summer. Although the tropical Pacific Ocean is forecast to trend toward an El Niño over the next few months, atmospheric influences from a neutral tropical Pacific Ocean in combination with a negative Pacific Decadal Oscillation are expected to produce a weather pattern where some storms move into Texas, but the primary storm track stays generally just north of Central Texas and the Hill Country. While this pattern will offer some opportunities for rain throughout the spring and summer months, the rain is not expected to be heavy enough to cause significant drought improvement. With similar oceanic conditions in the Pacific and Atlantic to what was in place in the 1950s, it is quite possible that Texas is in the grip of a multi-year drought period, along the lines of what was observed in the drought years of the 1950s. Most long-range forecast models are showing a trend toward the development of a weak El Niño this summer. Should the El Niño develop, it could cause a wetter weather pattern by fall of 2014. In the meantime, I do not foresee a significant change in the rainfall pattern across Central and South Texas this spring and summer.

Further affiant sayeth not.

Bob Rose

BOB ROSE, AFFIANT

SWORN TO AND SUBSCRIBED before me on the 20th day of March, 2014.

TABETHA JASKE
Notary Public, State of Texas
My Commission Expires
January 11, 2018

Tabetha Jaske

Notary Public in and for the State of Texas

My Commission Expires: 1-11-2018

Tab 1

BOB ROSE

P.O. Box 220
Austin, TX 78767-0220
bob.rose@lcra.org

EDUCATION

Texas A&M University, College Station, Texas
Bachelor of Science in Meteorology 1979.

PROFESSIONAL EMPLOYMENT

Jan 1995 to Present — *Chief Meteorologist,* **Lower Colorado River Authority, Austin, Texas**

- Responsible for the daily forecast of weather conditions and temperatures affecting the Lower Colorado River Authority's power generation, electrical transmission, flood control and water supply operations.
- Produce a daily weather blog about Central Texas weather: http://www.lcra.org/water/conditions/weather/weather_column.html
- Write daily operational weather briefs to keep all departments of LCRA apprised of expected weather conditions.
- Provide advance notice significant weather event e mails to emergency management officials, county judges along with city and state agencies.
- Present a bi-weekly video weather blog about Central Texas weather. Give numerous talks to various civic groups and organizations about the weather.
- Provide weather information to a number of newspapers and media outlets across Central Texas about regional weather.

Feb 1988 to Jan 1995 — *Meteorologist,* **KVUE-TV (ABC), Austin, Texas**

- Responsible for the morning and midday newscasts for 4 years, weekend newscasts for 3 years.
- Prepared a weekly astronomical report called Skywatch, and did occasional science and environmental reporting.

Sep 1978 to Jan 1988 — *Weekend Meteorologist,* **KBTX-TV, Bryan, Texas (ABC/CBS).**

- Responsible for the forecasting, preparation and presentation of the 10 PM weekend weathercasts.

PROFESSIONAL MEMBERSHIPS

Member, American Meteorological Society. TV Seal #501, AMS Certified Broadcast Meteorologist.
Member, Austin-San Antonio chapter, American Meteorological Society
Currently serving on the Board for Private Sector Meteorology with the American Meteorological Society

RELATED ACTIVITES:

A regular contributor to the National Drought Monitor.
Member of the Southern Climate Impacts Planning Program (SCIPP)
Travis and Williamson County Coordinator for CoCoRaHS

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Discussion for the Seasonal Drought Outlook

Tools used in the U.S. Seasonal Drought Outlook (SDO) included the official Climate Prediction Center (CPC) temperature and precipitation outlooks for April 2014, the long lead forecast for April - June 2014, various short- and medium-range forecasts and models such as the 5-day and 7-day precipitation totals from the Weather Prediction Center, 6-10 day and 8-14 day CPC forecasts, the NAEFS precipitation outlooks, the soil moisture tools based on the Constructed Analog on Soil (CAS) moisture, dynamical models (CFSv2, NMME, and IMME), the 384-hour total precipitation forecasts from several runs of the GFS, the four-month Palmer drought termination and amelioration probabilities, climatology, and initial conditions. The phase of ENSO is expected to remain neutral, with a gradual transition to a borderline El Nino by the end of the period.

Persistent upper-level ridging across western North America continued to promote drought conditions across California, the Great Basin, the Desert Southwest, and the southern Rockies. Despite recent precipitation nearly statewide across California 2-4 weeks ago, the most recent two-week period has been dry over the southern half of the state, with Percent of Normal Precipitation (PNP) values ranging within the lowest 10 percent. The wet season is rapidly coming to a close for southern California, and little if any precipitation is predicted for the upcoming two-week forecast period. For the state as a whole, California received only about 25-50 percent of the precipitation that it typical gets during the Water-Year so far (which started on October 1, 2013). In the hardest hit region of south-central California, 10 to 20 inches of precipitation are needed to bring the Long-term Palmer Drought Severity Index (PDI) back up to -0.5 or higher, which is one way of determining the end of a drought. Climatologically, the Great Basin, Desert Southwest, and the southern Rockies are also experiencing the tail end of their winter wet season, especially after April. May and June are generally dry prior to the traditional onset of the Southwest Summer Monsoon in July. CPC's 30-day and 90-day outlooks, for April and April-June, respectively, call for enhanced odds of below-median precipitation across California, with Equal Chances (EC) elsewhere. With above-normal temperatures also favored throughout this region, Persistence and/or Intensification of drought is anticipated.
Forecast confidence for California, Great Basin, Desert Southwest, and the southern Rockies is moderate to high.

The Pacific Northwest has seen a succession of cyclonic storm systems in recent weeks, in the wake of relatively warm and dry conditions which prevailed earlier this winter in association with the persistent West Coast ridge. PNP values ranged from 125-300 percent over the past 2 weeks, with the higher values over Washington, and the lower values over Oregon and southeast Idaho. Mountain snowpack (as of March 1, 2014) ranged between 70-110 percent of median (Washington, southeast Idaho, and the northern interior of Oregon), and only within the lowest 25 percent in the southern interior of Oregon. Above-median precipitation is favored by CPC's 6-10 day and 8-14-day outlooks. CPC's 30-day and 90-day outlooks both favor above-normal temperatures for Oregon, near- to above-normal temperatures for Washington,

and EC for southeast Idaho. There are slightly elevated odds of below-median precipitation for Oregon and Washington, and EC is indicated for southeast Idaho. With the climatological rainy season still in progress for a while in the Pacific Northwest, there are opportunities for at least a 1-category improvement across much of this region (which in some cases equates with drought removal), with the possible exception of interior Oregon.
Forecast confidence for the Pacific Northwest is moderate.

Long-term dryness and drought continues to influence the central and southern Plains, in particular the High Plains. PNP values range between 5-25 percent of normal across much of this region, with the notable exception of southern and coastal Texas, which received heavy rainfall (several inches) from frontal systems draped along the Gulf Coast region (14-day PNP values range from 150-400 percent). The PDI shows that 3-6 inches of rain are needed in the drier Texas Panhandle to end the current drought. Some of the impacts of the current drought include significantly reduced surface moisture, which is beginning to affect early-planted crops from the Texas Panhandle into central Texas. Forty to 50 percent (or more) of rangelands in both Texas and Oklahoma are starting the growing season in poor to very poor condition. Low reservoir levels are also a concern. The elevations of Lakes Buchanan and Travis (along the Colorado River in Texas) rival the record and near-record low levels of the early 1950's and the mid 1960's. The 6-10 day and 8-14 day precipitation outlooks both favor elevated odds of near- to below-median precipitation over the Texas Panhandle and far southwestern Texas, and above-median precipitation over southern and coastal sections of Texas. There are conflicting and/or weak climate signals for precipitation in the central and southern Plains during both April and AMJ, so EC is deemed the best bet. Near- to above-normal temperatures are anticipated during these same periods. Climatologically, a significant fraction (55-60 percent) of the annual precipitation is received in this region during the AMJ time frame. With no clear precipitation signal from the CPC outlooks, it is reasoned that the lower Plains is more susceptible to the influx of low-level Gulf moisture and frontal boundaries, and has the best odds for drought removal. The odds of getting drought improvement or removal rapidly diminishes westward across the High Plains.
Forecast confidence for the central and southern Plains is low to moderate.

The Upper and Middle Mississippi Valley: Temperatures during the past 30-days have averaged between 6-10 degrees F below-normal over the Upper Mississippi Valley, and 3-5 degrees F below-normal over the Middle Mississippi Valley, in what has been a long winter for this region. From about central Iowa northward, soils are frozen down to 5 feet in some locations. Like last April, this frozen soil will take a while to thaw, especially given the cold temperature outlook for the next few weeks, which will delay planting in this region. According to the National Operational Hydrologic Remote Sensing Center (NOHRSC) snow cover across Minnesota and Wisconsin generally ranges from 10-20 inches, with 20-40 inches on the ground in the Arrowhead region of Minnesota and northern Wisconsin. In drier areas, such as Iowa and northeast Missouri, the PDI shows 3-6 inches of precipitation is needed to bring conditions back to normal. The extended-range outlooks (6-10 day and 8-14 day) anticipate enhanced odds of below-normal temperatures and above-median precipitation for the northern half of the Mississippi Valley. Below-normal temperatures are favored for the Upper Mississippi Valley in both April and April-June. For the Middle Mississippi Valley, near- to below-normal temperatures are favored. Climatologically, these areas experience a ramping up of precipitation in AMJ, receiving between 50-60 percent of their annual total. Removal of drought throughout this region is based on the extended-range outlooks and climatology, since there are no clear indications for precipitation in CPC's 30-day and 90-day outlooks.
Forecast confidence for the upper and middle Mississippi Valley is low to moderate.

Contrary to the previously issued (February 20th) Seasonal Drought Outlook, there are no drought areas (D1 or higher) to modify in Alaska, so no outlook was made.

Periods of enhanced rainfall during the winter rainy season have promoted drought reduction across the Hawaiian Islands. Small areas of lingering drought are expected to be removed from the Big Island and Kahoolawe, with at least a 1-category improvement anticipated for Molokai. CPC's precipitation outlook for the AMJ season favors above-median precipitation for the tail end of the Hawaiian wet season.
Forecast confidence for Hawaii is moderate to high.

Forecaster: A. Artusa

Next Seasonal Drought Outlook issued: April 17, 2014 at 8:30 AM EDT

NOAA/ National Weather Service
National Centers for Environmental Prediction
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PROGNOSTIC DISCUSSION FOR LONG-LEAD SEASONAL OUTLOOKS
NWS CLIMATE PREDICTION CENTER COLLEGE PARK MD
830AM EDT THURSDAY MAR 20 2014

SUMMARY OF THE OUTLOOK FOR NON-TECHNICAL USERS

THE MAIN FACTORS THAT USUALLY INFLUENCE THE SEASONAL CLIMATE OUTLOOK INCLUDE:
1) EL NINO AND LA NINA - WHICH TOGETHER COMPRISE EL NINO/SOUTHERN OSCILLATION OR ENSO. IMPACTS OF THESE EVENTS ARE SUMMARIZED BY SEPARATING 3-MONTH OBSERVATIONS FROM 3 OR MORE DECADES INTO EL NINO, NEUTRAL, AND LA NINA SETS, AVERAGING EACH SEPARATELY, AND THEN COMPUTING ANOMALIES. THESE ARE CALLED "ENSO COMPOSITES", WHICH ARE USED AT TIMES TO SUBJECTIVELY MODIFY THE FORECAST.
2) TRENDS - APPROXIMATED BY THE OCN TOOL AS THE DIFFERENCE BETWEEN THE MOST RECENT 10-YEAR MEAN OF TEMPERATURE OR 15-YEAR MEAN OF PRECIPITATION FOR A GIVEN LOCATION AND TIME OF YEAR AND THE 30-YEAR CLIMATOLOGY PERIOD (CURRENTLY 1981-2010).
3) THE TROPICAL 30-60 DAY OSCILLATION - SOMETIMES CALLED MADDEN JULIAN OSCILLATION (MJO) - AFFECTS CLIMATE VARIABILITY WITHIN SEASONS.
4) THE NORTH ATLANTIC OSCILLATION (NAO) AND THE PACIFIC NORTH AMERICAN (PNA) PATTERNS - WHICH AFFECT THE TEMPERATURE ANOMALY PATTERN ESPECIALLY DURING THE COLD SEASONS. THESE PHENOMENA ARE CONSIDERED LESS PREDICTABLE ON A SEASONAL TIMESCALE THAN ENSO.
5) THE PACIFIC DECADAL OSCILLATION (PDO) - AN ENSO-LIKE PATTERN OF CLIMATE VARIABILITY AFFECTING THE TROPICS AND THE NORTH PACIFIC AND NORTH AMERICAN REGIONS, BUT WHICH VARIES ON A MUCH LONGER TIME-SCALE THAN ENSO.
6) PERSISTENTLY DRY OR WET SOILS IN THE SPRING AND SUMMER AND SNOW AND ICE COVER ANOMALIES IN THE WINTER. THESE FACTORS TEND TO PERSIST FOR LONG PERIODS AND ACT AS A KIND OF MEMORY IN THE CLIMATE SYSTEM.
7) STATISTICAL FORECAST TOOLS - CANONICAL CORRELATION ANALYSIS (CCA), SCREENING MULTIPLE LINEAR REGRESSION (SMLR), CONSTRUCTED ANALOGUE (CA) AND ENSEMBLE CCA (ECCA).
8) DYNAMICAL FORECAST MODELS - INCLUDING THE NCEP CLIMATE FORECAST SYSTEM (CFS). AN EXPERIMENTAL MODEL FORECAST SYSTEM, THE NATIONAL MULTI-MODEL ENSEMBLE, COMPRISED OF SEVERAL MODELS AND DESIGNATED NMME, MAY ALSO BE USED EXPERIMENTALLY AND SUBJECTIVELY UNTIL IT IS INCLUDED INTO THE CONSOLIDATION. AN INTERNATIONAL MODEL ENSEMBLE DESIGNATED IMME IS ALSO AVAILABLE.
9) CONSOLIDATION (CON) - AN OBJECTIVE, SKILL-WEIGHTED COMBINATION OF THE OCN, CCA, SMLR, ECCA, AND CFS FORECASTS IS USED AS A FIRST GUESS IN PREPARING THE FORECAST MAPS. THIS TECHNIQUE MAKES OPTIMUM USE OF THE KNOWN SKILL OF FORECAST TOOLS.

CURRENT ATMOSPHERIC AND OCEANIC CONDITIONS REMAIN ENSO-NEUTRAL AND THE LATEST ENSO OUTLOOK FAVORS ENSO-NEUTRAL CONDITIONS TO CONTINUE THROUGH THE NORTHERN HEMISPHERE SPRING OF 2014. HOWEVER, AN EL NINO WATCH HAS BEEN ISSUED WHICH INDICATES CONDITIONS ARE FAVORABLE FOR EL NINO DEVELOPMENT WITHIN THE NEXT SIX MONTHS.

THE TEMPERATURE OUTLOOK FOR APRIL-MAY-JUNE (AMJ) 2014 INDICATES ELEVATED ODDS OF ABOVE NORMAL TEMPERATURES FOR ALASKA AND A REGION FROM THE WESTERN PACIFIC NORTHWEST TO CALIFORNIA AND NEVADA, EASTWARD ALONG THE SOUTHERN TIER OF THE CONTINENTAL U.S. THERE ARE ELEVATED CHANCES OF BELOW NORMAL TEMPERATURES FROM MONTANA TO THE GREAT LAKES.

THE AMJ 2014 PRECIPITATION OUTLOOK CALLS FOR ENHANCED PROBABILITIES OF BELOW-MEDIAN PRECIPITATION FOR SOUTHEAST ALASKA AND ALONG THE ENTIRE WEST COAST, WITH THE HIGHEST PROBABILITIES FOR AREAS OF NORTHERN CALIFORNIA AND THE ALASKA PANHANDLE.

IN AREAS WHERE THE LIKELIHOODS OF SEASONAL MEAN TEMPERATURES AND SEASONAL ACCUMULATED PRECIPITATION AMOUNTS ARE SIMILAR TO CLIMATOLOGICAL PROBABILITIES, EQUAL CHANCES (EC) IS SHOWN.

BASIS AND SUMMARY OF THE CURRENT LONG-LEAD OUTLOOKS
NOTE: FOR GRAPHICAL DISPLAYS OF THE FORECAST TOOLS DISCUSSED BELOW SEE:
HTTP://WWW.CPC.NCEP.NOAA.GOV/PRODUCTS/PREDICTIONS/90DAY/TOOLS/BRIEFING

CURRENT ATMOSPHERIC AND OCEANIC CONDITIONS

OVER THE LAST SEVERAL WEEKS, CONSIDERABLE CHANGES HAVE OCCURRED ACROSS THE EQUATORIAL PACIFIC OCEAN, BOTH IN THE ATMOSPHERE AND IN THE OCEAN THAT HAVE INCREASED PROBABILITIES FOR THE DEVELOPMENT OF EL NINO LATER IN 2014. SEA SURFACE TEMPERATURES (SSTS) ACROSS THE EQUATORIAL WESTERN PACIFIC HAVE INCREASED AND ANOMALIES ARE NOW POSITIVE FROM NEAR NEW GUINEA TO JUST EAST OF THE DATE LINE AND RANGE FROM +0.5 TO +1.0 DEGREES C, WITH SOME AREAS NEAR THE DATE LINE GREATER THAN +1.0 DEGREES C. MOREOVER, THERE HAS BEEN TWO STRONG WESTERLY WIND BURSTS OVER THE WESTERN PACIFIC, ONE OCCURRING DURING LATE JANUARY AND ANOTHER SPANNING LATE FEBRUARY AND EARLY MARCH. THE FIRST WESTERLY WIND EVENT INITIATED A STRONG OCEANIC DOWNWELLING KELVIN WAVE WHICH IS IN THE PROCESS OF TRAVERSING THE PACIFIC OCEAN AT THE CURRENT TIME. AT DEPTH, POSITIVE OCEAN TEMPERATURES ARE EVIDENT FOR THE MAJORITY OF THE PACIFIC BASIN FROM 150E TO NEAR 110W AT DEPTHS RANGING FROM 75 M TO 200 M. THE GREATEST POSITIVE ANOMALIES REACH +6.0 DEGREES C NEAR 160W AT A DEPTH OF 150 M.

ANOMALOUS EQUATORIAL CONVECTION HAS CONTINUED TO SLOWLY EVOLVE EASTWARD WITH TIME OVER THE INDO-PACIFIC WARM POOL REGION SINCE LATE 2013. ENHANCED CONVECTION DURING THE LAST MONTH HAS BEEN CENTERED OVER THE WESTERN PACIFIC WITH SUPPRESSED CONVECTION THAT HAD BEEN DOMINANT NEAR THE DATE LINE DURING LATE 2013 HAVING SHIFTED SLIGHTLY EAST AND WEAKENING CONSIDERABLY.

PROGNOSTIC DISCUSSION OF SST FORECASTS

IN THE PAST MONTH THERE HAS BEEN A NOTICEABLE INCREASE IN CHANCES FOR EL NINO LATER THIS YEAR IN THE CONTEXT OF MODEL FORECASTS AS WELL. THE CPC SST CONSOLIDATION FORECAST NOW HAS THE SST ANOMALY FOR NINO3.4 BECOMING POSITIVE IN AMJ 2014 PRIMARILY DUE TO CFS AND CCA FORECASTS. IN FACT, THE CCA IS THE MOST AGGRESSIVE FOR EL NINO OF THE STATISTICAL SST FORECASTS WITH ITS ANOMALY FORECAST GREATER THAN +0.5 C FROM JJA 2014 THROUGH DJF 2014-15. THIS IS AN INTERESTING AND NOTABLE DIFFERENCE AS COMPARED TO LAST SPRING AND SUMMER WHEN THE STATISTICAL SST FORECASTS GENERALLY DIFFERED FROM DYNAMICAL MODELS, WHICH MORE STRONGLY FAVORED EL NINO DEVELOPMENT LAST AUTUMN. THE LATEST CFS NINO3.4 FORECAST INDICATES NEARLY ALL MEMBERS NOW INDICATE POSITIVE ANOMALIES THROUGHOUT THE PERIOD WITH THE ENSEMBLE MEAN CROSSING ABOVE +0.5 DEGREES C NEAR AMJ 2014 AND INCREASING TO +1.0 DEGREES C BY OND 2014. ENSEMBLE MEAN FORECASTS FROM THE IMME AND NMME INDICATE CROSSING THIS THRESHOLD IN JUNE AND JULY RESPECTIVELY.

AN EL NINO WATCH WAS ISSUED EARLIER IN MARCH INDICATING THAT CONDITIONS ARE FAVORABLE FOR THE DEVELOPMENT OF EL NINO SOMETIME IN THE NEXT SIX MONTHS. THE GREATEST ODDS FOR EL NINO DEVELOPMENT GENERALLY BEGIN FROM JAS 2014 ONWARDS, WITH PROBABILITIES FOR ENSO NEUTRAL CONDITIONS DURING THIS PERIOD SLIGHTLY OVER 40%.

PROGNOSTIC TOOLS USED FOR U.S. TEMPERATURE AND PRECIPITATION OUTLOOKS

THE TEMPERATURE AND PRECIPITATION OUTLOOKS WERE MADE CONSIDERING ENSO NEUTRAL CONDITIONS TO BE MOST LIKELY THROUGH SPRING INTO EARLY SUMMER. THEREAFTER, INCREASING CHANCES FOR EL NINO AND ASSOCIATED POTENTIAL IMPACTS WERE INCORPORATED AT LONGER LEADS BEGINNING IN JAS 2014 THROUGH THE JFM 2015 SEASON, BUT THE CHANGES, AT THIS TIME, ARE MINOR. AT EARLY LEADS, ESPECIALLY AMJ 2014, CONSIDERATIONS OF ANTECEDENT SOIL MOISTURE, SNOW COVER, ANOMALOUSLY DEEP FROZEN SOIL AND GREAT LAKES ICE COVERAGE CONTRIBUTED TO THE OUTLOOK. GUIDANCE FROM THE CFS AS WELL AS THE NMME AND IMME AND THEIR ASSOCIATED COMPONENTS CONTRIBUTED TO THE OUTLOOKS FROM AMJ THROUGH ASO 2014. THE CON TOOL WAS THE PRIMARY DRIVER FOR THE OUTLOOKS FROM SON 2014 ONWARDS, ALTHOUGH INCREASING CHANCES FOR EL NINO MODIFIED LAST MONTHS SET OF OUTLOOKS WHERE APPROPRIATE.

PROGNOSTIC DISCUSSION OF OUTLOOKS - AMJ 2014 TO AMJ 2015

TEMPERATURE

THE AMJ 2014 TEMPERATURE OUTLOOK INDICATES ELEVATED PROBABILITIES OF ABOVE-NORMAL SEASONAL MEAN TEMPERATURES FOR ALL OF ALASKA, WESTERN AREAS OF THE PACIFIC NORTHWEST, CALIFORNIA AND NEVADA AND EASTWARD ALONG THE SOUTHERN TIER OF THE CONUS. THE PROBABILITIES OF BELOW-NORMAL TEMPERATURES ARE ELEVATED FOR AREAS STRETCHING FROM CENTRAL MONTANA ACROSS THE NORTHERN PLAINS TO THE GREAT

LAKES. STATISTICAL TOOLS, DYNAMICAL MODEL GUIDANCE FROM THE CFS, NMME AND IMME, OCN AND THE CON ALL POINTED TO ABOVE-NORMAL TEMPERATURES FOR MANY AREAS IN THE HIGHLIGHTED REGION. IN ADDITION, DRY SOIL MOISTURE CONSIDERATIONS PLAYED A ROLE AS WELL, ESPECIALLY FOR CALIFORNIA AND PARTS OF THE SOUTHWEST. STATISTICAL FORECAST TOOLS KEYING ON ANOMALOUSLY WARM NORTH PACIFIC SSTS AND WET SOIL MOISTURE CONDITIONS ACROSS THE NORTHERN ROCKIES FAVORED BELOW-NORMAL TEMPERATURES FOR PARTS OF THE NORTHERN ROCKIES AND NORTHERN PLAINS AND THIS IS INDICATED BY THE CON TOOL. FURTHER EAST, SOME DYNAMICAL MODELS FAVOR CONTINUED TROUGHING ACROSS EASTERN NORTH AMERICA ESPECIALLY IN APRIL AND THIS ALONG WITH POTENTIAL IMPACTS FROM ANOMALOUSLY HIGH GREAT LAKES ICE COVER FAVOR EXTENSION OF THIS FORECAST AREA TO INCLUDE THE GREAT LAKES AREA. ANOMALOUSLY DEEP FROZEN SOIL IN MANY AREAS OF THE MIDWEST ALSO SUPPORT THIS FORECAST.

OUTLOOKS FROM MJJ THROUGH JAS 2014 WERE LARGELY UNCHANGED FROM THE PREVIOUS OUTLOOK AND INDICATE ELEVATED PROBABILITIES FOR ABOVE-NORMAL TEMPERATURES FOR THE WESTERN AND SOUTHERN CONUS, ALONG THE EASTERN SEABOARD AND FOR ALASKA, SUPPORTED BY THE CON AND DYNAMICAL MODEL GUIDANCE.

INCREASING CHANCES FOR EL NINO AS SUMMER APPROACHES 2014 HAVE RESULTED IN SOME ADJUSTMENTS AT LONGER LEADS, PRIMARILY BASED ON EL NINO COMPOSITES DURING VARIOUS SEASONS. ELEVATED CHANCES FOR ABOVE-NORMAL TEMPERATURES FOR AREAS ACROSS THE SOUTHERN TIER OF THE CONUS WERE REDUCED AND THEN ELIMINATED IN THE SOUTHWEST DURING ASO AND SON RESPECTIVELY. ABOVE-NORMAL TEMPERATURES FAVORED DURING THE LATE AUTUMN AND WINTER SEASONS WERE REMOVED ACROSS THE SOUTH AND REPLACED WITH EQUAL CHANCES, AS EL NINO TYPICALLY FAVORS BELOW-NORMAL TEMPERATURES IN THESE AREAS. IF PROSPECTS FOR EL NINO CONTINUE TO INCREASE, PROBABILITIES FOR BELOW-NORMAL TEMPERATURES ACROSS THE SOUTH MAY BE ELEVATED IN SUBSEQUENT OUTLOOKS. ALSO, DURING THE LATE AUTUMN AND WINTER SEASONS THROUGH JFM 2015, THE AREA OF ELEVATED ABOVE-NORMAL TEMPERATURES WAS EXTENDED WESTWARD TO THE NORTHERN ROCKIES.

IN AREAS WITHOUT SUBSTANTIAL AND RELIABLE CLIMATE SIGNALS, EQUAL CHANCES OF BELOW, NEAR AND ABOVE-NORMAL SEASONAL MEAN TEMPERATURES ARE INDICATED.

PRECIPITATION

CLIMATE SIGNALS FOR PRECIPITATION ARE QUITE WEAK AND WHAT SIGNALS ARE INDICATED FROM VARIOUS FORECAST TOOLS OFTEN CONFLICT, EVEN AT THE EARLIEST LEAD. MOREOVER, POTENTIAL TRANSITIONING TOWARDS EL NINO FURTHER ADDS UNCERTAINTY IN THE PRECIPITATION OUTLOOKS AS WE MOVE FORWARD INTO THE SUMMER MONTHS.

THE AMJ 2014 PRECIPITATION OUTLOOK INDICATES ENHANCED PROBABILITIES OF BELOW-MEDIAN SEASONAL ACCUMULATED PRECIPITATION FOR THE WEST COAST NORTHWARD TO INCLUDE THE ALASKA PANHANDLE AND PARTS OF SOUTHEAST ALASKA. MUCH OF THE OUTLOOK IS DESIGNATED AS EQUAL CHANCES, OR CLIMATOLOGICAL PROBABILITIES OF BELOW, NEAR AND ABOVE-MEDIAN SEASONAL ACCUMULATED PRECIPITATION. THE PRIMARY DRIVER FOR THE AMJ OUTLOOK WAS DYNAMICAL MODEL GUIDANCE FROM THE CFS, NMME AND IMME, WITH THE GREATEST PROBABILITIES ACROSS NORTHERN CALIFORNIA AND THE ALASKA PANHANDLE WHERE AGREEMENT WAS GENERALLY THE BEST. SIMILAR SUPPORT AND RATIONALE IS USED FOR MJJ 2014, BUT SOUTHERN PORTIONS OF THE HIGHLIGHTED AREA ARE REMOVED AS THESE AREAS HAVE ENTERED THEIR CLIMATOLOGICAL DRY SEASON IN EARNEST.

BEYOND MJJ 2014, THE UNCERTAINTY OF PRECIPITATION GUIDANCE INCREASES AND FEW CLEAR SIGNALS ARE INDICATED, ALTHOUGH INCREASING CHANCES FOR EL NINO HAVE RESULTED IN SOME ADJUSTMENTS AT LONGER LEADS PRIMARILY BASED ON EL NINO COMPOSITES. ELEVATED CHANCES FOR BELOW-MEDIAN PRECIPITATION IS HIGHLIGHTED FOR PARTS OF THE WESTERN GULF COAST FROM JJA THROUGH ASO 2014 (ALSO SUPPORTED BY THE NMME AND IMME) AS WELL AS THE REMOVAL OF THE DRY SIGNAL ACROSS PARTS OF THE SOUTHEAST CONUS DURING NDJ, DJF AND JFM SEASONS. EL NINO CONDITIONS FAVOR ABOVE-MEDIAN PRECIPITATION DURING THESE SEASONS AND AREAS. IF PROSPECTS FOR EL NINO CONTINUE TO INCREASE, ABOVE-MEDIAN PRECIPITATION MAY BEGIN TO BE NOTED ON SUBSEQUENT OUTLOOKS.

IN AREAS WHERE CLIMATE SIGNALS FOR PRECIPITATION ARE WEAK OR UNRELIABLE, EQUAL CHANCES OF BELOW, NEAR AND ABOVE MEDIAN SEASONAL ACCUMULATED PRECIPITATION ARE INDICATED.

FORECASTER: JON GOTTSCHALCK

THE CLIMATIC NORMALS ARE BASED ON CONDITIONS BETWEEN 1981 AND 2010, FOLLOWING THE WORLD METEROLOGICAL ORGANIZATION CONVENTION OF USING THE MOST RECENT 3 COMPLETE DECADES AS THE CLIMATIC REFERENCE PERIOD. THE PROBABILITY ANOMALIES FOR TEMPERATURE AND PRECIPITATION BASED ON THESE NEW NORMALS BETTER REPRESENT

SHORTER TERM CLIMATIC ANOMALIES THAN THE FORECASTS BASED ON OLDER NORMALS.

FOR A DESCRIPTION OF OF THE STANDARD FORECAST TOOLS - THEIR SKILL- AND THE FORECAST FORMAT PLEASE SEE OUR WEB PAGE AT
HTTP:/WWW.CPC.NCEP.NOAA.GOV/PRODUCTS/PREDICTIONS/90DAY/DISC.HTML
(USE LOWER CASE LETTERS)
INFORMATION ON THE FORMATION OF SKILL OF THE CAS FORECASTS MAY BE FOUND AT:
HTTP://WWW.CPC.NCEP.NOAA.GOV/SOILMST/FORECASTS.HTML (USE LOWERCASE LETTERS)
NOTES - THESE CLIMATE OUTLOOKS ARE INTENDED FOR USE PRIOR TO THE START OF THEIR VALID PERIOD. WITHIN ANY GIVEN VALID PERIOD OBSERVATIONS AND SHORT AND MEDIUM RANGE FORECASTS SHOULD BE CONSULTED.

THIS SET OF OUTLOOKS WILL BE SUPERSEDED BY THE ISSUANCE OF THE NEW SET NEXT MONTH ON APR 17 2014

1981-2010 BASE PERIOD MEANS WERE IMPLEMENTED EFFECTIVE WITH THE MAY 19, 2011 FORECAST RELEASE.
$$

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National Centers for Environmental Prediction
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Tab 4

Pacific and Atlantic Ocean influences on multidecadal drought frequency in the United States

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Edited by Inez Y. Fung, University of California, Berkeley, CA, and approved January 12, 2004 (received for review October 17, 2003)

More than half (52%) of the spatial and temporal variance in multidecadal drought frequency over the conterminous United States is attributable to the Pacific Decadal Oscillation (PDO) and the Atlantic Multidecadal Oscillation (AMO). An additional 22% of the variance in drought frequency is related to a complex spatial pattern of positive and negative trends in drought occurrence possibly related to increasing Northern Hemisphere temperatures or some other unidirectional climate trend. Recent droughts with broad impacts over the conterminous U.S. (1996, 1999–2002) were associated with North Atlantic warming (positive AMO) and northeastern and tropical Pacific cooling (negative PDO). Much of the long-term predictability of drought frequency may reside in the multidecadal behavior of the North Atlantic Ocean. Should the current positive AMO (warm North Atlantic) conditions persist into the upcoming decade, we suggest two possible drought scenarios that resemble the continental-scale patterns of the 1930s (positive PDO) and 1950s (negative PDO) drought.

Although long considered implausible, there is growing promise for probabilistic climatic forecasts one or two decades into the future based on quasiperiodic variations in sea surface temperatures (SSTs), salinities, and dynamic ocean topographies. Such long-term forecasts could help water managers plan for persistent drought across the conterminous United States (1). The urgency for such planning became evident when much of the U.S. was gripped by drought in 1996 and again in 1999–2003, evoking images of the dry 1930s and 1950s.

Analyses and forecasting of U.S. precipitation have focused primarily on the Pacific Ocean, and more specifically on oceanic indices such as those used to track the El Niño Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO). Much of the long-term predictability in North American climate, however, may actually reside in both observed and modeled multidecadal (50–80 years) variations in North Atlantic SSTs (2–7). Modeling studies indicate that multidecadal variability in North Atlantic climate is dominated by a single mode of SST variability (7). An important characteristic of this mode of SST variability is that the SST anomalies have the same sign across the entire North Atlantic Ocean and resemble the Atlantic Multidecadal Oscillation (AMO). The AMO is an index of detrended SST anomalies averaged over the North Atlantic from 0–70°N and has been identified as an important mode of climate variability (8). Warm phases occurred during 1860–1880 and 1930–1960, and cold phases occurred during 1905–1925 and 1970–1990. Since 1995, the AMO has been positive, but it is uncertain whether this condition will persist long enough to be considered a new warm phase. These large swings in North Atlantic SST's are probably caused by natural internal variations in the strength of ocean thermohaline circulation and the associated meridional heat transport (6, 7).

Recent analysis has shown that the AMO has a strong influence on summer rainfall over the conterminous U.S., and may modulate the strength of the teleconnection between the El Niño Southern Oscillation (ENSO) and winter precipitation (8). Positive AMO conditions (warm North Atlantic SSTs) since 1995, and the cold PDO episode from 1998 to 2002, have together raised concerns among scientists about the potential for an emerging megadrought that could pose serious problems for water planners. Here, we decompose drought frequency in the conterminous U.S. into its primary modes of variability without *a priori* consideration of climate forcing factors. These modes are then related both spatially and temporally to the PDO and AMO to determine the relative influence of the SST patterns tracked by these indices on the probability of drought. Consideration of the potential role of the Northern Hemisphere (NH) temperature or some other unidirectional trend also proved necessary to understand the variance in drought frequency. Given the time scales and current conditions of the three climate indices, we explore two possible drought scenarios for the upcoming decade.

Materials and Methods

Drought frequency for 20-year moving periods was calculated for each of the 344 climate divisions in the conterminous U.S. for the period 1900–1999. This period of record was chosen for analysis because it is common to all of the data sets used in this study (i.e., climate division precipitation, annual PDO, annual AMO, and annual NH temperature).

The climate division precipitation data were obtained from the National Climatic Data Center in Asheville, North Carolina via the internet at (http://www1.ncdc.noaa.gov/pub/data/cirs). The climate division data represent monthly means of climate station observations from regions within states that are considered to be climatically homogeneous (9). In addition, the data for the climate divisions have been corrected for time-of-observation bias (10). Although extreme climatic variations can occur in areas of complex terrain, such as the mountainous areas of the western U.S., standardized departures of temperature and precipitation from normal are spatially consistent within a climate division (9).

The PDO data were obtained from the University of Washington at (ftp://ftp.atmos.washington.edu/mantua/pnw_impacts/INDICES/PDO.latest), and the AMO data were obtained by personal communication with David Enfield (National Oceanographic and Atmospheric Administration Atlantic Oceanographic and Meteorological Laboratory, Miami). Mean annual NH temperature data also were used for part of the study and these data were obtained from the Climate Research Unit, East Anglia, U.K. (www.cru.uea.ac.uk/cru/data/temperature).

Drought conditions were considered to exist in a climate division if annual precipitation was in the lowest quartile (25%) of the 100-year record. Other definitions of drought frequency also were examined, such as the number of years with precipitation in the lowest 33% or the lowest 20% of the distribution, or annual Palmer Drought Severity Index (PDSI) values below specified thresholds; all approaches produced similar temporal and spatial results. For 20-year moving windows, the number of

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Abbreviations: SST, sea surface temperature; PDO, Pacific Decadal Oscillation; AMO, Atlantic Multidecadal Oscillation; NH, Northern Hemisphere.

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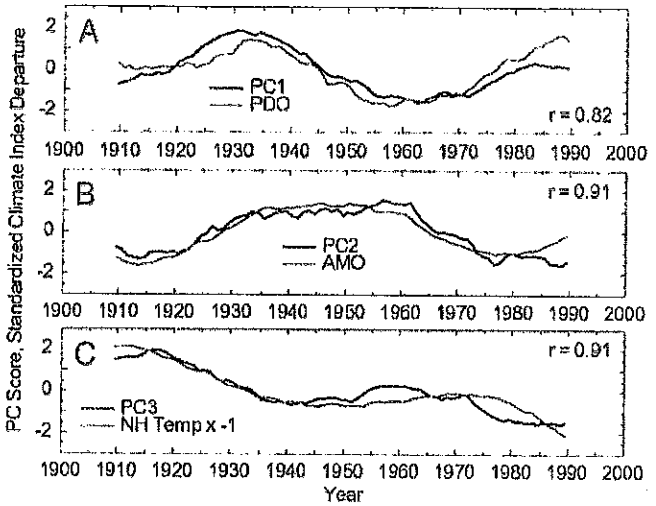

Fig. 1. Scores from the first three components (PC1, PC2, and PC3) of a rotated principal components analysis of 20-year moving drought frequency in the conterminous United States, compared to standardized departures of 20-year moving averages of the annual PDO, AMO, and NH temperature (NH Temp). The NH Temp values are multiplied by −1 for easy comparison with PC3 scores. All values are plotted at the centers of the window periods.

years with drought conditions was computed for each climate division and assigned to the center of the window period (10- and 30-year moving windows also were examined and produced results similar to those from the analysis of 20-year moving windows). The time series of 20-year moving drought frequencies (hereafter referred to as drought frequency) then were subjected to a rotated principal components analysis (RPCA) with varimax rotation to identify the primary modes of variability in the drought frequency data. The scores and loadings of the leading rotated principal components were subsequently examined and compared with 20-year moving averages of the PDO and AMO to better understand how these climate indices are related to the temporal and spatial variability of drought in the conterminous U.S.

Results and Discussion

The rotated principal components analysis (RPCA) of drought frequencies for the 344 climate divisions in the conterminous U.S. produced three leading components (PC1, PC2, and PC3) that explain 74% of the total variance in the drought frequency data; after varimax rotation, PC1 explains 24% of the total variance in drought frequency, PC2 explains 28%, and PC3 explains 22%. The score time series (Fig. 1) illustrate the temporal variability of the drought frequency components, and the loadings (Fig. 2*A–C*) illustrate the spatial pattern of drought frequency variability represented by each component.

The scores for PC1 (Fig. 1*A*) are positive for 20-year periods centered from around 1920 to the mid- to late 1940s, are negative from the late 1940s until the late 1970s, and are slightly positive after the 1970s. This decadal variability in drought frequency is similar to variability in the PDO (Fig. 1*A*). The correlation between PC1 scores and 20-year moving mean annual PDO is 0.82.

Because of the large autocorrelation inherent in smoothed time series, the degrees of freedom must be estimated to use standard statistical significance tests. Instead, an alternative approach was used to assess the significance of the correlations between the PC score and climate index time series. A Monte Carlo approach (11) was used that involves the shuffling of the raw climate index time series 1,000 times. Each shuffled time series was subsequently smoothed with a 20-year moving average and then correlations between the smoothed shuffled time series and the PC scores were computed. The 95th and 99th percentiles of the resulting correlations (0.69 and 0.83, respectively) then were compared with the correlations obtained between the PC scores and the observed 20-year moving average climate index time series. The results of this analysis indicated that the correlation ($r = 0.82$) between the time series shown in Fig. 1*A* is between the 98th and 99th percentile of correlations from the 1,000 trials, indicating a high level of statistical significance.

To further compare PC1 with PDO, the loadings of drought frequency for each climate division on PC1 (Fig. 2*A*) were compared with correlations between 20-year moving average annual PDO and drought frequency for each climate division (Fig. 2*D*). Comparison of these figures indicates that the patterns of the PC1 loadings and the PDO correlations are similar. Both indicate negative values for the southwestern U.S. that extend into the Rocky Mountain region and the south-central U.S. (Fig. 2 *A* and *D*). Negative values also are found in the northeastern U.S. Positive values are indicated in the northwestern U.S., the north-central plains, and most of the southeastern U.S. The correlation between these patterns is 0.92. The PDO has been shown previously to modulate winter precipitation in the U.S. (12–14), as well as summer drought and streamflow in the conterminous U.S. (15).

The strong correlation of the spatial patterns represented by the PC1 loadings and the PDO correlations (Fig. 2 *A* and *D*), when combined with the magnitude of the time series correlation, strongly supports the conclusion that the first mode of drought frequency identified in this study is a response to the multidecadal variability of the PDO. The annual response pattern is a combination of the winter and summer influences of PDO on precipitation. Although both seasons share a dipolar response in the northwest and southwest U.S., the response to the PDO in the Midwest is of a different sign in the summer and winter, weakening the annual response in that region.

The scores for PC2 increase from the early part of the record to the 20-year period centered around 1930. The score values remain relatively constant until after 1960, when they decline until the end of the period of record (Fig. 1*B*). This time series corresponds to the temporal variability of the AMO (Fig. 1*B*). The correlation between PC2 scores and 20-year moving average annual AMO is 0.91, which is significant at the 99th percentile.

Loadings for PC2 (Fig. 2*B*) and correlations between 20-year moving average annual AMO and drought frequency (Fig. 2*E*) are highly similar (the correlation between these patterns is 0.95). Maps of the PC2 loadings and the AMO correlations indicate positive values for most of the central two-thirds of the conterminous U.S. and suggest an almost nationwide covariance of drought frequency (Fig. 2 *B* and *E*). Previous research has shown that, during positive AMO conditions, the central U.S. receives below-average precipitation, particularly during summer (1, 8). The large positive correlations between smoothed AMO and drought frequency for the central U.S. (Fig. 2*E*) support this statement. This mode explains 28% of the variance in drought frequency, and covers a large geographical area with uniformly strong loadings. Correlations between smoothed AMO and similarly smoothed climate division precipitation (the inverse of drought frequency) produced a continental-scale pattern of negative correlations (8).

Scores for PC3 indicate a long-term negative trend (Fig. 1*C*). Areas with negative loadings had an increasing trend in drought frequency (Fig. 2*C*), whereas areas with positive loadings had a decreasing trend in drought frequency. Geographically, California, the northern Rocky Mountains, and the Ohio Valley (negative loadings) have experienced an increasing tendency for drought, whereas the Pacific Northwest, a band from New York

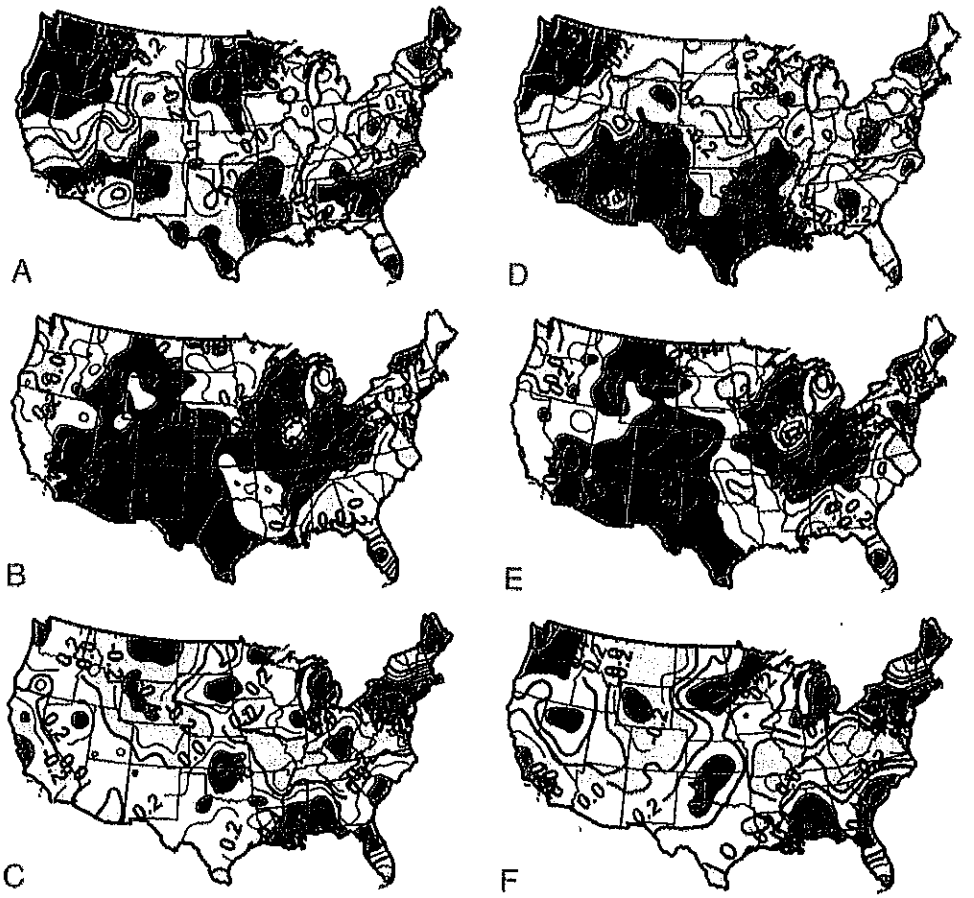

Fig. 2. (*A–C*) Loadings for the first three components of a rotated principal components analysis of 20-year moving drought frequency in the conterminous United States. (*D*) Correlations between 20-year moving drought frequencies and 20-year moving annual PDO. (*E*) Correlations between 20-year drought frequency and 20-year moving AMO. (*F*) Inverse of trends in 20-year drought frequency. The correlations in *F* were multiplied by −1 for easy comparison with other figures. Positive values are shaded red, and negative values are shaded blue. Darker shades indicate values >0.4 or <−0.4.

to the Upper Midwest, and the Gulf Coast (positive loadings) have had a decreasing tendency for drought.

The pattern of loadings for PC3 (Fig. 2*C*) is very similar to the spatial pattern of the inverse of trends in 20-year moving drought frequency (Fig. 2*F*) (correlation coefficient is 0.91). The trends in 20-year moving drought frequency were multiplied by −1 for direct comparison with the PC3 loadings and were computed as linear correlations with time.

The PC3 score time series does not appear to be related to known atmosphere–ocean modes of variability; instead, it matches well with both a trend line and the time series of mean annual NH temperature. In Fig. 1*C*, the NH temperatures were multiplied by −1 for direct visual comparison with the scores for PC3. Instrumental observations of NH temperatures indicate a generally increasing trend with some distinct inflections over the period of record used in this study (16); the inverse 20-year moving mean annual NH temperatures are significantly correlated with PC3 scores (correlation coefficient is 0.91, $P < 0.01$).

These results suggest that PC3 reflects a regional pattern of changes within the hydrologic cycle that may be related indirectly with increases in NH temperature, or may be trending in response to some other forcing that has not yet been identified. Climate modeling studies indicate that a substantial intensification of the global hydrologic cycle is likely in a warming world, although the regional patterns of temperature and precipitation responses are likely to be complex (16).

Because previous research showed relations between drought in the conterminous U.S. and El Niño/Southern Oscillation (ENSO) (17), we compared 20-year moving averages of annual NINO3.4 SSTs, representing ENSO conditions, with the PC scores of drought frequency examined in this study (NINO3.4 SSTs are averaged for the region from 5°N latitude to 5°S latitude and from 170°W longitude to 120°W longitude; these data were obtained via the internet from http://climexp.knmi.nl).

Correlations between the smoothed NINO3.4 time series and the PC scores were strongest for PC2 (−0.58). This correlation with PC2 scores is much weaker than the correlation between PC2 scores and the similarly smoothed AMO (0.91), and is not statistically significant.

To test the interpretation of the PCA analysis that PDO, AMO, and a trend such as that represented by NH temperature explain a large percent of the temporal and spatial variability in multidecadal drought frequency in the conterminous U.S., regressions were developed to estimate drought frequency for the 344 climate divisions of the conterminous U.S. The regressions were developed by using 20-year moving drought frequency as the dependent variable and 20-year moving average annual PDO, AMO, and NH temperature as the independent variables. The median coefficient of determination for the regressions for all 344 climate divisions was 0.72 (the mean was 0.68, the first quartile was 0.58, and the third quartile was 0.81), indicating that, on average, ≈70% of the temporal variability in drought fre-

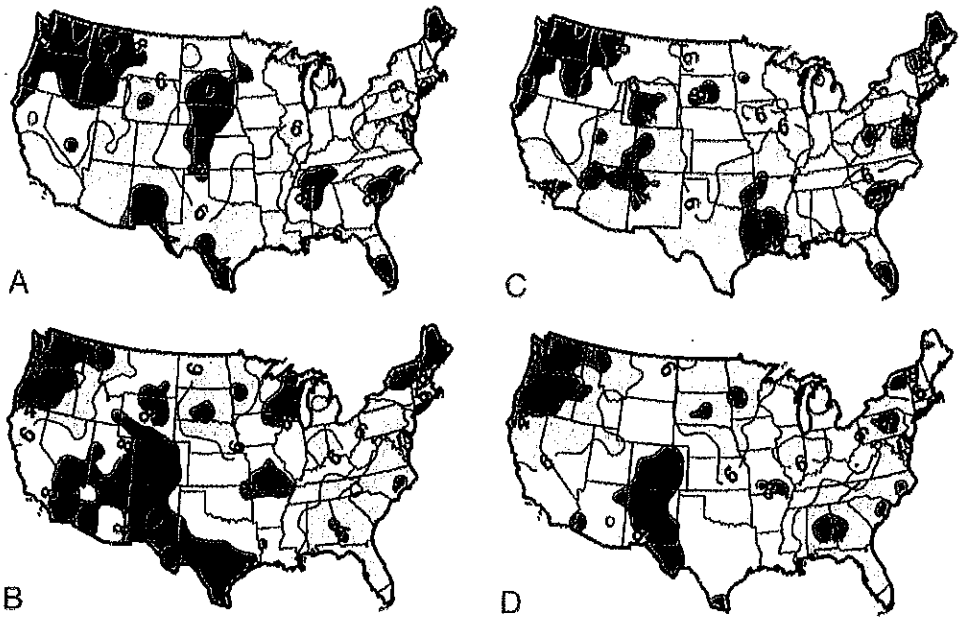

Fig. 3. Observed (*A* and *B*) and simulated (*C* and *D*) 20-year drought frequency (in years) for 1924–1943 (the 1930s drought) and 1947–1966 (the 1950s and 1960s droughts). Areas with drought frequencies of 6 years or more are indicated in red.

quency for the climate divisions is explained by the PDO, AMO, and NH temperature.

The reliability of the regressions to explain the spatial variability in drought frequency was evaluated by comparing observed and simulated drought frequency for specific periods (Fig. 3). Because 20-year moving periods were used to compute drought frequency, the period for 1924–1943 provided an example incorporating the 1930s drought, and the period 1947–1966 was chosen to encompass both the 1950s drought and the 1960s Northeast drought. Results indicate that the spatial distributions of drought frequency for these periods represented by the observed and simulated drought frequencies are highly similar. The correlation between the observed and simulated drought frequency values for the 1924–1943 period (Fig. 3 *A* and *C*) is 0.91 ($P < 0.01$), and for the 1947–1966 period (Fig. 3 *B* and *D*), the correlation is 0.92 ($P < 0.01$). The correlations between observed and simulated drought patterns for all 20-year periods examined in this study ranged from 0.70 to 0.95, with a median value of 0.88.

To validate the robustness of the regressions used to simulate the spatial patterns of drought for the 1924–1943 and the 1947–1966 periods, additional regressions were developed, excluding in each case the 20-year periods of interest. The correlations between the observed and simulated spatial patterns of drought using the new regressions were 0.83 ($P < 0.01$) for 1924–1943 and 0.86 ($P < 0.01$) for 1947–1966. These correlations, although somewhat smaller than those using all of the data, indicate that the regressions are robust.

These results indicate that, in addition to reliably explaining the temporal variability in drought frequency, the regression equations also reliably explain the spatial variability in drought frequency. Without inclusion of all three time series, the PDO, AMO, and NH temperature, the fidelity of the regression modeled drought frequency pattern with the observed pattern is substantially reduced.

So what are the prospects for drought under varying PDO and AMO regimes? Annual time series of PDO and AMO were used to identify periods of positive and negative PDO and AMO regimes (Fig. 4). Four periods were identified: (*i*) positive PDO and positive AMO (1926–1943), (*ii*) negative PDO and positive AMO (1944–1963), (*iii*) negative PDO and negative AMO (1964–1976), and (*iv*) positive PDO and negative AMO (1977–1994). Composite drought frequencies were computed for the four combinations of PDO and AMO regimes. The drought frequencies were determined by counting the number of years at each climate division with annual precipitation in the lowest quartile of the 1900–1999 record, and were expressed as a percent of the total number of years in each PDO/AMO regime category. Because the normal rate of occurrence of precipitation in the lowest quartile is 25% of the time, composite percentages >25% represent a greater than normal probability of drought, and values <25% characterize less than normal chances of drought.

Fig. 5 shows drought frequencies for the four general scenarios based on different combinations of the AMO and PDO. In the case of negative AMO, above normal drought frequency is restricted to a few regions, for example, to the Pacific Northwest and Maine during positive PDO (Fig. 5*A*) and southern California and the central High Plains during negative PDO (Fig. 5*B*). Irrespective of the PDO phase, positive AMO is associated with an above normal frequency of drought across large parts of the U.S. With positive AMO and positive PDO (Fig. 5*C*), the pattern is more reminiscent of the 1930s drought, sparing the Southwest but entraining the northern two-thirds of the U.S. With positive AMO and negative PDO (Fig. 5*D*), the pattern is that of the 1950s drought with the greatest impact in the Midwest, Southwest, and the Rocky Mountains/Great Basin area.

Because the AMO generally has greater multidecadal persistence than the PDO, North Atlantic warming that began in 1995 may continue. After a negative downturn in mid-1998, the PDO reversed sign in mid-2002. Given the current positive anomalies in North Atlantic SSTs (positive AMO), continuation of the present 1999–2003 drought is more likely than normal, and a decadal-scale drought may be emergent. The pattern of recent drought in the conterminous U.S. resembles a 1950s-like drought (positive AMO and negative PDO) (Figs. 3*B* and 5*D*). However, if the AMO continues to be positive and the PDO becomes

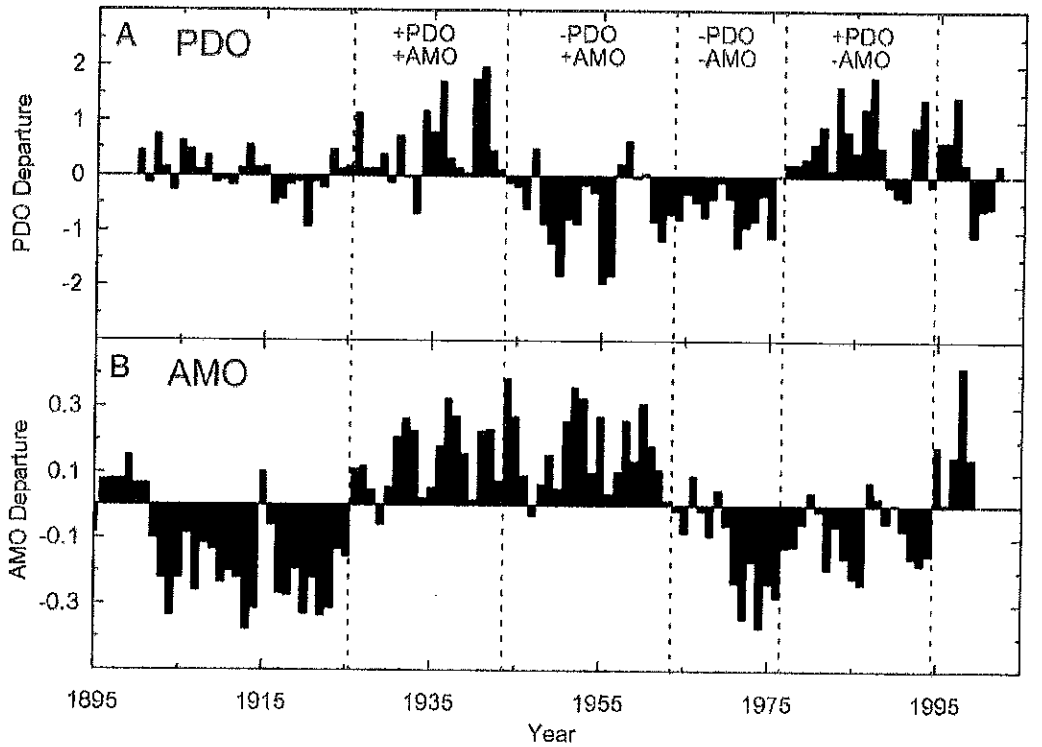

Fig. 4. Time series of the annual PDO and AMO. Shaded areas indicate combinations of positive (+) and negative (−) PDO and AMO periods.

positive, the drought pattern could shift to one more like the 1930s era (Figs. 3*A* and 5*C*). Although it is always prudent to be conservative about water resources, particularly in the semiarid West, it may be particularly necessary in the next decade.

Conclusions

Three rotated principal components explain 74% of the variance in 20-year moving frequencies of drought in the conterminous U.S. The first component is highly correlated with the PDO, and the second component is correlated with the AMO. These first two components explain nearly equal proportions of variance in the entire data set and, combined, explain 52% of the total variance. These results support previous research that has indicated the existence of a relation between these climate indices and drought variability in the U.S. The third component represents a complex pattern of positive and negative trends in U.S.

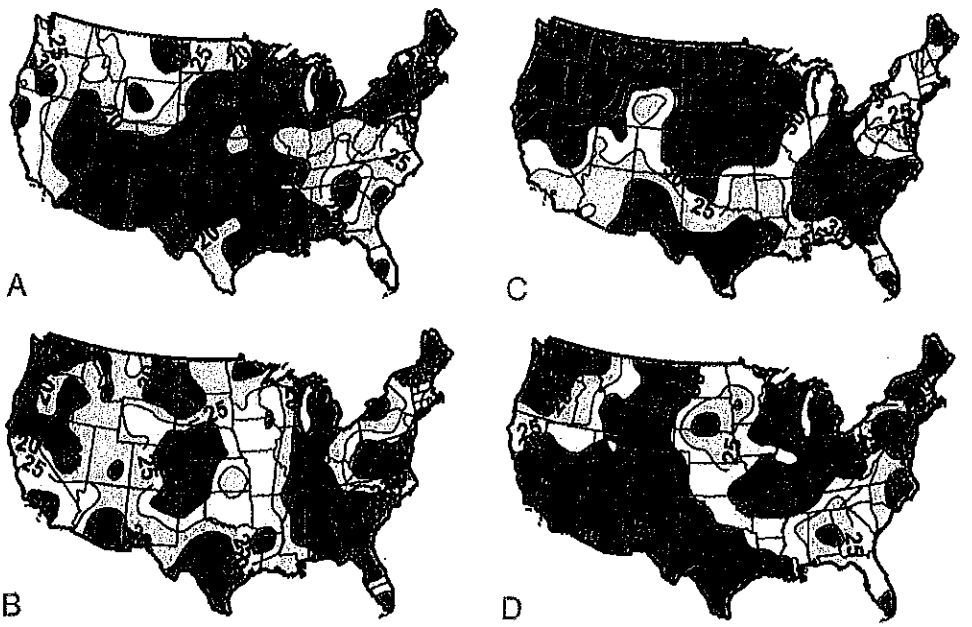

Fig. 5. Drought frequency (in percent of years) for positive and negative regimes of the PDO and AMO. (*A*) Positive PDO, negative AMO. (*B*) Negative PDO, negative AMO. (*C*) Positive PDO, positive AMO. (*D*) Negative PDO, positive AMO.

drought frequency over the 20th Century, and its score time series is highly correlated with both a trend line and the inverse NH temperature time series. The inclusion of all three time series, the PDO, AMO, and a trending geophysical indicator like NH temperature, appears to be crucial in generating multiple regression equations that can accurately simulate the historical 20-year patterns of drought frequency. This research indicates that persistence of the current positive AMO state may lead to continuing above normal frequencies of U.S. drought in the near future, with the pattern of drought modulated by the sign of the PDO.

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TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

AN ORDER affirming in part and modifying in part the Executive Director's emergency order authorizing the Lower Colorado River Authority to amend its Water Management Plan, Permit No. 5838, pursuant to section 11.139 of the Texas Water Code; TCEQ Docket No. 2014-0124-WR; SOAH Docket No. 582-14-2123

On January 27, 2014, the Executive Director (ED) of the Texas Commission on Environmental Quality (TCEQ or Commission) granted an application by the Lower Colorado River Authority (LCRA) for an emergency order to amend its 2010 Water Management Plan (WMP), Permit No. 5838, under Texas Water Code §§ 5.501, 11.138, and 11.139, and the Governor's Emergency Disaster Proclamation relating to drought. On February 12 and 26, 2014, the Commission considered whether to affirm, modify, or set aside the emergency order that the ED granted. A proposal for decision (PFD) was presented by William G. Newchurch and Travis Vickery, Administrative Law Judges (ALJs) with the State Office of Administrative Hearings (SOAH), who conducted a hearing concerning the application on February 12, 17, and 18, 2014, in Austin, Texas.

After considering the ALJs' PFD, the Commission adopts Findings of Fact and Conclusions of Law and affirms in part and modifies in part the Executive Director's emergency order, as set out below:

I. FINDINGS OF FACT

1. On December 10, 2013, LCRA filed a request for an emergency order to amend its 2010 WMP to change requirements for the release of water to irrigation operations downstream in 2014 due to persistent drought conditions in LCRA's five Highland Lakes (Lakes Buchanan, Inks, LBJ, Marble Falls, and Travis). LCRA requested the authority to provide no interruptible stored water to its Gulf Coast and Lakeside Divisions and Pierce Ranch if the combined storage of Lakes Buchanan and Travis is below 1.1 million acre feet (AF). Additionally, it requested the stored water releases be smaller for combined storage levels above 1.1 million AF than those set forth in the 2010 WMP.

2. LCRA has not requested authorization to reduce the amount of water provided from Lakes Buchanan and Travis specifically for instream flow and freshwater inflow purposes below the levels required, in the absence of an emergency order, in the 2010 WMP.

LCRA'S Water Rights and 2010 Water Management Plan

3. LCRA has the right to divert and use up to 1.5 million AF from Lakes Buchanan and Travis under Certificates of Adjudication Nos. 14-5478 and 14-5482. By court order, LCRA has developed a WMP, Permit No. 5838, currently dated 2010, which is part of LCRA's Water Rights and is required by these certificates.

4. The Certificates of Adjudication and the 2010 WMP govern LCRA's operation of Lakes Buchanan and Travis and dictate how LCRA makes water available from these lakes to help meet "firm" water customer needs, downstream interruptible irrigation demands, and environmental flow needs of the lower Colorado River and Matagorda Bay.

5. Certificates of Adjudication Nos. 14-5478 and 14-5482 state that "LCRA shall interrupt or curtail the supply of water . . . pursuant to commitments that are specifically subject to interruption or curtailment, to the extent necessary to allow LCRA to satisfy all demand for water under such certificates pursuant to all firm, uninterruptible water commitments." The WMP further describes how LCRA will manage and curtail supplies from the lakes during times of drought including through a repeat of the Drought of Record.

6. As established in the 2010 WMP, the combined firm yield of Lakes Buchanan and Travis is 535,812 acre feet per year (AFY). Of this amount, 90,546 AFY is committed to O.H. Ivie Reservoir, making 445,266 AFY of firm water supply available from Lakes Buchanan and Travis for LCRA's firm water customers.

7. As established in the 2010 WMP, until firm demand for water equals the combined firm yield, LCRA can supply water for irrigated agriculture on a limited basis. The maximum historical annual amount of reported firm water use from the firm supplies of Lakes Buchanan and Travis during 2000 through 2010 was 247,000 AF in 2011. The maximum interruptible water released from Lakes Buchanan and Travis during this same period occurred in 2011 and totaled about 433,000 AF. The maximum total amount released or used from the Highland Lakes, about 714,000 AF, occurred in 2011.

8. The firm water use by LCRA firm customers in 2012 from Lakes Buchanan and Travis was about 148,000 AF. An amount of 31,000 AF was supplied for the environment, and 9,000 AF of interruptible was supplied to farmers in the Garwood Irrigation Division. The total use for 2012 was about 188,000 AF. The firm water use by LCRA firm customers in 2013 from Lakes Buchanan and Travis was about 173,500AF; about 33,500 AF was supplied for the environment; and about 22,000 AF was supplied for the Garwood Irrigation Division. The total use in 2013 was about 229,000 AF.

9. To manage the supply, LCRA's 2010 WMP imposes several trigger points keyed to the total combined storage capacity of Lakes Buchanan and Travis that are intended to ensure the firm water supply is protected during droughts. The most relevant trigger points are set out in the following table:

Combined Storage of Lakes Buchanan and Travis	Date on Which Trigger is Decided	Action Taken
1.4 million acre feet	At any time	Request firm customers to implement voluntary drought response measures.
1.4 million acre feet	On Jan. 1	Environmental releases for instream flows reduced to meet critical needs for ecosystems for following year. Begin gradual curtailment of interruptible supply to four major irrigation operations.
900,000 acre feet	At any time	Request firm customers to implement mandatory water restrictions; develop firm customer curtailment plan.
600,000 acre feet	At any time	If criteria indicate a drought worse than the Drought of Record, then cease interruptible supply and begin curtailment of firm supply.

10. LCRA's 2010 WMP defines "Drought of Record" as "the drought that occurred during the critical drought period." "The Critical Drought Period" is defined as "the period of time during which the reservoir was last full and refilled, and the storage content was at its lowest minimum value."

11. Under the 2010 WMP, the LCRA Board may declare a Drought Worse than the Drought of Record (DWDR) if it finds that the following three conditions are simultaneously met:

    a. Duration of drought is more than 24 months, which is determined by counting the number of consecutive months since both Lakes Buchanan and Travis were last full;

    b. Inflows to the lakes are less than inflows during the drought of record; and

    c. Lakes Buchanan and Travis combined storage has less than 600,000 AF of water.

12. Under the 2010 WMP, once a drought has lasted more than 36 months and a DWDR has been declared by the LCRA Board, the interruptible stored water would be fully and immediately curtailed – making no stored water available for agricultural irrigation or other interruptible uses until lake levels recover or the inflows into the lakes increase substantially. Moreover, LCRA will implement pro rata curtailment of its firm water users once a DWDR is declared and after interruptible stored water (agriculture) uses have been curtailed.

13. Prior to a declaration of a DWDR, LCRA is obligated by the 2010 WMP to provide at least some interruptible water to its four major irrigation operations.

Current Conditions

14. The combined storage of Lakes Buchanan and Travis on December 1, 2013, was 746,000 AF, or 37% full. On February 1, 2014, the combined storage was 764,000 AF, or 38% full. The combined storage fell to the lowest level in the current drought on September 19, 2013, which was 637,123 AF or 31.7% full.

15. The primary factors affecting the current combined storage levels have been (1) unprecedented low inflows in this current drought, (2) the interruptible stored water amounts authorized for release under current LCRA 2010 WMP, particularly in 2011, and (3) emergency orders issued by the Commission in 2012 and 2013.

16. It is not merely the amount of inflows, but also the management of the system over a multiyear period that greatly affects the lakes' combined storage. In recent years, emergency orders departing from the 2010 WMP have proven critical to that management.

17. On September 19, 2013, the combined storage of these reservoirs fell to the second lowest point in the history of these lakes—637,000 AF—nearing 30% capacity and just shy of the record low at 621,000 AF. Thus in September the lakes rapidly approached the 600,000 AF emergency level at which point the LCRA Board would have declared a DWDR. Continuing to curtail interruptible stored water releases under the exceptional circumstances presented by this drought, which would drive lake storage below 600,000 AF is critical to avoiding both an imminent threat to public health and safety and a situation whereby interruptible water supply releases would force declaration of a DWDR and drive firm customers into curtailment.

18. The inflows into the lakes are at record lows. Annual inflows into Lakes Buchanan and Travis in four of the last five years are among the ten lowest years of inflow on record. Inflows into the lakes in 2011 were the lowest annual inflows on record, about 10% of average inflows. Inflows in 2012 were the fifth lowest on record, and inflows in 2013 were the second lowest on record. January 2014 inflows of 11,763 AF were the lowest since the 1950's.

19. The inflows into Lakes Buchanan and Travis during the current drought have been lower for time periods ranging from 12 months to 72 months than the lowest inflows for periods of similar duration during the historic Drought of Record. The total inflows for the past 72 months were only about half of the lowest 72 month inflow period in the Drought of Record.

20. A ranking of the top ten lowest calendar year historical inflows since the reservoirs went into operation in the early 1940's shows that five of those years—2008, 2009, 2011, 2012 and 2013 occur in the current drought, and the top three years for lowest inflows—2011, 2013, and 2008 are all from the current drought. The recent year of 2006 is the fourth lowest.

21. The inflows for January 2014, at 11,763 AF, are lower than the inflows in either January 2011 (21,158 AF) or 2013 (15,117 AF), which are the two lowest inflow years on record. Historically a January with low inflows is usually followed by low inflows for both February and March. This data indicates a high likelihood of drought persistence in the near future.

22. Extraordinary drought conditions in the form of rainfall and extreme heat have existed in much of Texas, including the Colorado River Basin for nearly three years. State Climatologist, Dr. John Nielsen-Gammon, recognized 2011 as the worst one year statewide drought on record. 2011 was the second hottest year statewide, and was the hottest summer on record for both Austin and Texas. Year 2012 tied with 1921 as the hottest on record statewide.

23. Annual evaporation from LCRA's five Highland Lakes plus Lake Austin for 2010 through 2013 is set forth below:

Year	Total Evaporation
2010	183,923 acre feet
2011	192,404 acre feet
2012	144,759 acre feet
2013	120,899 acre feet

24. Although there has been close to normal rainfall in some places in Central Texas since 2011, these events have failed to produce significant inflows into Lakes Buchanan and Travis. The rainfall has been sporadic, and the soils have not remained saturated enough to allow for runoff in substantial amounts. Widespread heavy rains in the past few months have failed to produce significant inflows into the lakes.

25. This low inflow total is symptomatic of the drought's severity, including dry soils that absorb most of the rainfall that does occur. For example, heavy, widespread rainfall in the Llano River and San Saba River watersheds above the Highland Lakes on September 19 and 20, 2013, averaged two to three inches with some rain gages reporting totals as high as six or seven inches. However, this rain event only yielded approximately 24,000 AF of inflow to the lakes. By comparison, an event in March 2007 with about 40% less rainfall yielded almost 100,000 AF of inflows to Lakes Buchanan and Travis.

26. The weather forecasts do not indicate significant rainfall in the near future. Recent atmospheric and oceanic observations continue to indicate ENSO-neutral conditions and the outlook calls for this to persist into summer of 2014. The latest National Weather Service precipitation forecast indicates that precipitation across the Texas Hill Country is likely to remain normal with equal chances for above, below, or near normal precipitation. These forecasts indicate that the western edge of a below-average precipitation forecast area encroaches on Central Texas. This boundary does not quite reach areas which could produce significant inflows to Lakes Buchanan and Travis. It is not expected that precipitation will be heavy enough to cause significant drought improvement.

27. The most recent U.S. Seasonal Drought Outlook indicates the persistence of drought conditions above Lakes Buchanan and Travis through the end of April 2014. It is not expected that precipitation will be heavy enough to cause significant drought improvement. Climatological outlooks also indicate that temperatures will trend above normal through the summer, which tends to correlate with higher evaporation rates and lower overall precipitation.

28. The hydroclimatic conditions outlined above have created a circumstance where Lakes Buchanan and Travis have been unable to recover in any significant manner, even with an emergency cutoff of nearly all water supply for downstream irrigation in 2012 and 2013.

29. The first and second criteria for declaring a DWDR have been met. The drought has lasted for more than 24 months. Duration of drought for purposes of a DWDR declaration is determined by counting the number of consecutive months since both Lakes Buchanan and Travis were last full, which was February 13, 2005. The cumulative inflow deficit criterion has also been met.

30. The current drought conditions are outside the range of hydrologic conditions that were considered during formulation of the 2010 WMP.

31. The Governor of Texas issued an Emergency Disaster Proclamation on July 5, 2011, certifying that exceptional drought conditions posed a threat of imminent disaster in specified counties in Texas. This proclamation has been renewed monthly, most recently on February 14, 2014, and includes nearly every county bordering or that contributes inflow to the Highland Lakes. These areas are in severe drought or worse. The Emergency Disaster Proclamation also states that "As provided in Section 418.016 of the [Texas Government Code], all rules and regulations that may inhibit or prevent prompt response to this threat are suspended for the duration of the state of disaster."

LCRA's Firm Customers

32. LCRA provides raw water out of the combined firm yield of Lakes Buchanan and Travis to over 60 retail and wholesale potable water suppliers that together serve over one million people. In addition, LCRA provides water to several electric utilities from the firm water supply of Lakes Buchanan and Travis. These electric utilities provide electricity into the electrical grid in Texas operated by the Electric Reliability Council of Texas (ERCOT) and provide electricity to customers in Texas. LCRA also provides firm raw water to several industries located downstream.

33. The 2010 WMP requires that firm customers (mainly cities and industries) be curtailed on a pro rata basis and that LCRA cease all releases for interruptible stored water (regardless of the impact on the crops) when a DWDR is declared.

34. If LCRA is required to follow the 2010 WMP and the drought continues, LCRA and its firm customers may need to acquire or develop large quantities of alternative water supplies to meet essential needs of their respective potable water systems. LCRA's firm customers are working on plans to implement curtailment and secure alternative supplies;

however many of LCRA's firm customers do not have any readily available alternative sources of water supply that could substitute for their reliance on the Colorado River, and these projects could take years to develop.

35. If LCRA is required to follow the 2010 WMP and the drought continues, LCRA will almost certainly have to:

    a. Begin releases of interruptible stored water to meet demands in the four irrigation operations for the 2014 crop;

    b. Probably reach the third (and final) criteria for DWDR conditions;

    c. Declare a DWDR;

    d. Cut off stored water for interruptible contracts, thereby ruining the crop already planted; and

    e. Curtail cities' and industries' water use by 20% or more.

36. Curtailments that would occur if combined storage drops substantially will result in reduced water supply to power plants, threatening their ability to generate electricity. Because LCRA's firm water customers would be required to cut back substantially if the drought persists under a DWDR declaration, municipal customers are likely to be forced to institute drought response measures that would include restrictions on indoor water use, resulting in threats to public health and safety.

37. Based on recent lake levels and the forecast, there is a chance of reaching conditions triggering a declaration of a DWDR as soon as May 2014 and greater than a one in two chance by late August.

38. In September 2013 the lakes came within 37,000 acre-feet of reaching the emergency level of 600,000 AF or 30% capacity and there has been very little recovery since then. In May 2012 the lakes refilled to an amount close 1.1 million AF (to 1.033 million AF on May 22, 2012) and yet without any release to Lakeside, Gulf Coast and Pierce Ranch the lakes dropped to the second lowest level on record of 637,000 AF on September 19, 2013, and came very close to falling below emergency levels. An emergency order in place in 2012 prevented such a release.

39. Water savings by Austin of an estimated 86,000 AF over the past two years played a key role in preventing combined storage from reaching the 600,000 AF level in September 2013.

40. The extraordinary magnitude of change in inflows since the drought of record upon which the 2010 WMP is based, in terms of how much lower the inflows have been in recent years, signals the need for great caution to be taken with regard to decisions concerning large releases to interruptible customers because they make it more probable that lake levels will not quickly recover once such releases occur.

41. Currently, LCRA owns four water systems that take raw water from Lakes Buchanan and Travis. LCRA also has 15 firm water customers that actively take raw water for municipal purposes from Lake Travis that are not a part of LCRA's utility facilities. The lowest pumping elevations of the intakes range from 555 feet mean sea level (msl) to 650 feet msl on Lake Travis. On January 9, 2014, the lake level at Travis was 628.45 msl. On February 15, 2014, the lake level at Lake Travis was 627.75 msl.

42. The lowest operating depths of the following raw water intakes owned and operated by LCRA's firm water customers on Lake Travis are as follows:

Brushy Creek Regional Utility Authority (BCRUA) = 620 ft-msl
Cedar Park (regular intake) = 615 ft-msl
Leander (regular intake) = 615 ft-msl
Lago Vista (Intake #1) = 612 ft-msl
Lago Vista (Intake #2) = 600 ft-msl
Jonestown WSC = 600 ft-msl
WCID 17 = 595 ft-msl
Lakeway MUD = 590 ft-msl
Cedar Park and Leander (joint emergency drought intake) = 590 ft-msl

43. In the absence of an emergency order, the raw water intakes owned and operated by LCRA's firm water customers on Lake Travis are projected to become inoperable as early as the following dates:

BCRUA = already inoperable and will remain inoperable
Cedar Park (regular intake) = inoperable by June 2014
Leander (regular intake) = inoperable by June 2014
Lago Vista (Intake #1) = inoperable by July 2014
Lago Vista (Intake #2) = inoperable by August 2014
Jonestown WSC = inoperable by August 2014
WCID 17 = inoperable by October 2014
Lakeway MUD= inoperable by December 2014
Cedar Park and Leander (joint emergency drought intake) = inoperable by December 2014.

44. The Windermere Oaks Water Supply Corporation (WOWSC) uses an intake barge to pump raw water from Lake Travis for its customers under an LCRA firm water contract. Although WOWSC has already modified its intake structure to operate in shallower water, lake level elevations of 618 ft- msl or lower present significant operating challenges. Groundwater is not feasible alternative water supply for WOWSC.

45. As lake levels drop, retail water suppliers are unable to pump water from the lakes. This causes wholesale raw water customers to either move intakes to reach the water, or obtain alternative sources. Smaller systems will likely have to haul water from a water utility with a viable source. If the lake levels drop more quickly than arrangements for alternative intakes or supplies can be implemented, LCRA water systems and its customers' water systems will have difficulty in meeting firm customers' water needs.

46. Low lake levels in Lake Travis have a direct impact on the ability of local emergency services personnel to fight structure fires and wildfires that may occur. In 2011, the Perdernales Fire Department, which serves western Travis County and relies primarily upon water from Lake Travis, was able to draft water from Lake Travis at multiple locations on the lake. As of February 17, 2014, the Fire Department had access to only one reliable water source at the lake. With these limitations, the Fire Department has experienced 45-minte turnaround times for trucks to bring water to a fire, and it has had to stop fighting a fire due lack of water in its trucks or helicopters. These circumstances constitute a current threat to the health and safety of residents served by the Perdernales Fire Department.

47. Combined storage levels are a strong indicator of an imminent threat to the public health and safety. However, given the rapid rise and fall of combined storage levels throughout the historical record, combined storage levels, in and of themselves, are insufficient to determine whether an imminent threat to the public health and safety exists.

Conservation and Drought Contingency Plan

48. LCRA's water conservation plan complies with TCEQ rules. LCRA has required its municipal customers to adopt conservation plans before there was a state requirement.

49. LCRA provides conservation program planning support for its customers. In 2012, LCRA began a rebate program for certain irrigation technologies and a wholesale customer cost-share program focused on conservation. LCRA has supported significant improvements in water use efficiency in rice irrigation systems, including volumetric pricing and canal rehabilitation.

50. LCRA was originally required to develop a Drought Contingency Plan (DCP) as a direct result of the court order adjudicating LCRA's water rights and the Texas Water Commission 1989 WMP Order.

51. When TCEQ adopted the Chapter 288 rules for DCPs, LCRA adopted separate stand alone DCPs relating to irrigation, municipal, and industrial operations that more specifically addressed the requirements of the Chapter 288 rules. LCRA incorporated all of the same triggers and criteria from the WMP into its Chapter 288 DCP. These DCPs were incorporated into Chapter 4 of the WMP.

52. LCRA adopted water use reduction targets including the following: water use reduction goals for firm water supply customers of 5 percent by asking firm customers to implement their voluntary water use reduction measures when the combined storage of Lakes Buchanan and Travis is less than 1.4 million AF; ten to twenty percent reduction goals by asking firm customers to implement their own mandatory water use reduction measures when combined storage levels fall below 900,000 AF; and a mandatory pro rata curtailment of firm water supplies for customers of 20 percent or more will be implemented when combined storage levels fall below 600,000 AF and other criteria are met for a drought more severe than the Drought of Record.

53. In August, 2011, LCRA called on its firm water customers to voluntarily implement mandatory water use restrictions under their DCPs to reduce water use by 10 to 20 percent.

54. LCRA has adopted additional changes to LCRA's raw water contract rules that include the procedures for implementing a pro rata curtailment of firm water customers. The rules also provide a surcharge to be set by the LCRA Board for unauthorized use of water (taking more water than authorized under a mandated curtailment of firm water supplies) and clarifying the drought contingency requirements related to golf course irrigation and recreational use.

55. LCRA's WMP requires LCRA to develop a stored water curtailment plan to be approved by the LCRA Board and TCEQ in response to combined storage dropping below 900,000 AF. TCEQ approved that plan for LCRA's firm customers in December of 2011.

56. LCRA has fully implemented its DCP. It requires all of its customers that currently divert and purchase water from LCRA to have a DCP. Most of these firm customers have stayed in some form of mandatory water restrictions, significantly limiting landscape irrigation. LCRA's industrial customers have worked to reduce non-essential water uses. Also, LCRA has had several meetings with firm customers in preparation for pro rata curtailment.

57. The LCRA Board approved a no more than once per week watering restriction that would take effect in March 2014 if combined storage is below 1.1 million AF and interruptible stored water to the Gulf Coast and Lakeside irrigation divisions and Pierce Ranch has been cut off. LCRA has not requested TCEQ approval of this action and this order does not address such action.

58. Just in the past 2 years Austin's conservation and drought measures have resulted in an estimated 86,000 AF savings. Austin hired outside consultants and participated in a rigorous process with LCRA to determine its annual conservation savings in preparation for possible pro-rata curtailment. This resulted in an estimated savings of 26,000 AF a year from conservation measures in place (52,000 in two years). In addition Austin has calculated its savings achieved from imposing drought measures for more than two years which includes a one-day a week watering schedule. This is estimated at 17,000 AF per year (34,000 AF in two years).

59. There has been a drop from Austin's highest recent year of 190 GPCD, in 2006, to the most recent year of 136 GPCD due to its conservation and drought measures.

60. Because the planning, permitting, and construction for developing large new water supplies for Austin and other large municipal areas is necessarily on a decades-long timeframe, a severe shortage in or total depletion of the already diminished supply within a few years due to an imminent release of interruptible stored water under LCRA's 2010 WMP is an imminent threat to public health and safety.

61. Health and safety consequences from supply shortages can start to be experienced long before a municipal water supply is totally depleted.

62. Water restrictions result in a drop in overall usage, which in turn impacts the amount of flow in the entire Austin Water Utility (AWU) system. The AWU system has more than 3,700 miles of water pipes and 39 storage tanks, which are designed to handle peak demands and fire flows. As flow decreases, AWU system's ability to handle peak demands and fire flows may be affected, which is an imminent threat to public health and safety.

63. Once combined storage levels have reached a point that will require Austin and other LCRA firm water customers, as a practical measure, to impose water rationing, then individual households will start to make choices in how to use that rationed amount of water. Over a vast population, some of those choices can be poor choices with regard to sanitation practices (for example deferring for too long certain sanitary uses of water) that can negatively impact public health and safety despite a utility's effort to educate its customers on safe practices.

64. Outdoor watering in a drought is critical to preserving trees and tree canopy important to human health in an urban environment, preventing home foundations from cracking, and avoiding negative health effects from landscaping dying off.

Alternatives

65. LCRA has evaluated many alternatives to address the emergency conditions that the drought presents. Alternatives explored include: Utilizing water from LCRA's other lakes, aggressive conservation, securing the Garwood right for purposes other than agriculture, interbasin transfers, and trucking in water from other sources. LCRA has evaluated many other alternatives to address the emergency conditions that the drought presents.

66. None of the alternatives LCRA has identified would avert the projected water supply shortage because most of the supplies identified would produce insufficient or uncertain quantities of supply, would create other operational issues for customers, may involve a lengthy permitting process (if not implemented on an emergency basis), or would take years to develop. None of the alternatives identified are feasible or practicable alternatives to the emergency authorization.

67. Amending downstream run of the river rights to allow diversion for new uses and at new locations would provide some supply, but the use of these rights alone is not – by itself – a feasible and practicable alternative to the emergency relief related to the 2010 WMP. All of the rights would require amendments to add diversion points, additional places of use, and possible storage. Also, the downstream run-of-river water rights are highly variable in terms of availability and quantity, and do not provide by themselves a sufficient quantity of water to eliminate the need for the emergency relief from the 2010 WMP as requested herein.

68. In 2012, LCRA supplied about 4,000 AF to firm customers downstream of Austin under temporary permits that would otherwise have been released from Lakes Buchanan and Travis. In 2013, LCRA supplied about 1,000 AF to such customers under such

temporary permits. While this was beneficial, temporary permits are not sufficient replacement for water lost if releases are required.

69. A twenty percent reduction in water use by firm customers will require difficult measures. There may be dramatic reductions in outdoor water use. However, none of these measures will occur quickly enough to help lake levels. Some LCRA customers, such as Austin, have achieved water savings through reductions in water use. Most industrial customers would have to implement the full twenty percent reduction more immediately and this likely means a curtailment in annual production.

70. LCRA is pursuing a formal amendment to its 2010 WMP but that process will not be completed in time to address LCRA's requested relief. LCRA filed an application to amend its 2010 WMP on March 12, 2012. TCEQ prepared a draft permit for LCRA comment on October 12, 2012. Notice of the application was sent to all water right holders in the Colorado River Basin and published in local newspapers in April, 2013. May 28, 2013, was the last date to request a public meeting or a contested case hearing, or comment on the application. On June 3, 2013, the ED advised LCRA that he would not be forwarding the application to the Commission at this time, and that his staff would be conducting further review on the application.

71. There is no feasible practicable alternative for Austin on short order to replace its water supply should it be depleted in a few years to the point of drastic shortages by large interruptible water releases during a period of record low inflows. Although Austin has made very earnest efforts to identify alternative water supplies, a replacement water supply for 1 million people cannot be identified and developed in a few years. Austin has identified only very small amounts of water that may be able to be purchased for exorbitantly expensive prices. The small amounts do not sufficiently address the health and safety risks and the exorbitant prices do not make these practicable alternatives.

72. An interruptible stored water curtailment trigger should be set to avert, rather than create, conditions that could require declaration of a DWDR.

73. LCRA staff performed analyses to determine whether lesser amounts of combined stored water than 100,000 AF could be supplied to Gulf Coast, Lakeside, and Pierce Ranch at lower combined storage trigger levels. The results showed that these alternatives were not practicable because the small amount of water that could be made available would result in significant losses and difficulties maintaining the canal water levels for the movement of water.

Relief Requested

74. LCRA's requested curtailment approach for 2014 is more restrictive than the curtailment triggers in emergency orders issued by the Commission in 2012 and 2013. The 850,000 AF trigger in effect in 2012 and 2013 was based on avoiding the potential for dropping below 600,000 AF during the first crop of the season. Under LCRA's current approach, before the releases for interruptible water users are made, LCRA requests a combined storage trigger increase to a level that puts off the possibility of storage falling below 600,000 AF until spring of 2015.

75. LCRA has determined that if the combined storage is less than 1.1 million AF, providing even some stored water releases to Gulf Coast, Lakeside, and Pierce Ranch operations amplifies the risk of a DWDR declaration before spring 2015.

76. LCRA requests TCEQ to issue an emergency order to deviate from the 2010 WMP as it pertains to the determination of interruptible supply for 2014 and instead provide interruptible stored water based on the combined storage of Lakes Buchanan and Travis on March 1, 2014 at 11:59 p.m. as follows:

    a. Provide no interruptible stored water to customers within the LCRA Gulf Coast and Lakeside Divisions and Pierce Ranch if combined storage is below 1.1 million AF;

    b. Provide up to 100,000 AF of interruptible stored water for diversion by customers within LCRA's Gulf Coast and Lakeside Divisions and Pierce Ranch if combined storage is at or above 1.1 million AF but below 1.2 million AF;

    c. Provide up to 124,000 AF of interruptible stored water for diversion by customers within LCRA's Gulf Coast and Lakeside Divisions and Pierce Ranch if combined storage is at or above 1.2 million AF, but below 1.3 million AF;

    d. Provide up to 148,000 AF of interruptible stored water for diversion by customers within LCRA's Gulf Coast and Lakeside Divisions and Pierce Ranch if combined storage is at or above 1.3 million AF but below 1.4 million AF; and

    e. Provide up to 172,000 AF of interruptible stored water for diversion by customers within LCRA's Gulf Coast and Lakeside Divisions and Pierce Ranch if combined storage is at or above 1.4 million AF.

77. LCRA will also provide interruptible stored water to the Garwood Irrigation Division and Pierce Ranch, to the extent required by their contracts.

Notice to the Governor

78. Notice regarding the ED's consideration of this emergency order was provided to the Governor of Texas by letter dated January 23, 2014.

Procedure

79. On January 23, 2014, LCRA filed with the ED a supplement to its request for an emergency order.

80. On January 27, 2014, the ED considered LCRA's December 10, 2013 request and January 23, 2014 Supplement and issued an order granting an emergency authorization to the LCRA to amend its WMP, Permit No. 5838, pursuant to section 11.139 of the Texas Water Code.

81. The January 27, 2014 ED's Emergency Order included notice that the Commission would hold a hearing on February 12, 2014, to affirm, modify, or overturn the Order.

82. On January 24, 2014, the Chief Clerk of the Commission mailed notice of the Commission's February 12, 2014 hearing as required by law. The mailed notice stated: "Under 30 Tex. Admin. Code § 295.174, there is no right to a contested case hearing on this emergency order."

83. On February 10, 2014, LCRA submitted a second supplement to its request for emergency authorization.

84. On February 12, 2014, the Commission convened a public hearing on this matter, Chairman Shaw presiding. Commissioner Baker participated. Commissioner Covar recused himself. ALJ Newchurch was present throughout the public hearing, at the Commission's request.

85. The Commission and ALJ Newchurch heard over four hours of unsworn public comments about the Executive Director's Emergency Order. At the end of the public comment, the Commission discussed the matter with ALJ Newchurch and offered their preliminary view on the matter. The Commission then voted to refer the matter to SOAH for an evidentiary hearing to convene immediately. They also instructed ALJ Newchurch to submit a PFD to the Commission no later than February 21, 2014. The Commission stated that consideration of the PFD would be on its February 26, 2014 agenda.

86. ALJs Newchurch and Vickery reconvened the hearing on February 12, 2014. They admitted parties and other procedural matters were considered.

87. The following are parties in this case:

PARTY	REPRESENTATIVE
Lower Colorado River Authority (LCRA)	Lyn Clancy & Greg Graml
Executive Director (ED) of the TCEQ	Robin Smith
Office of Public Interest Counsel (OPIC)	Blas Coy & Vic McWherter
City of Austin	Ross Crow & Mary K. Sahs
Colorado Water Issues Committee (CWIC)	Carolyn Ahrens & Michael J. Booth
Central Texas Water Coalition (CTWC)	Cynthia C. Smiley, Shana Horton, & Frank Cooley
Highland Lakes Firm Water Customer Cooperative (Highland)	Patricia Carls & Carla Connolly
Texas Parks & Wildlife Department (TPWD)	Collette Baron Bradsby & James B. Murphy
National Wildlife Federation (NWF)	Myron Hess
Lehner/Lewis Interests & Garwood Irrigation (Garwood)	Molly Cagle & Samia Rogers
Clive Runnells d/b/a AP Ranch (AP Ranch)	Charles W. Irvine & Mary Carter

88. LCRA paid the cost of transcribing the hearing and expediting delivery of the transcript, and has not asked for any part of that cost to be allocated among the other parties.

II. CONCLUSIONS OF LAW

1. The ED may issue an emergency order under Texas Water Code § 11.139 to amend a permit or certificate of adjudication for 120 days after notice to the Governor if the ED finds that emergency conditions exist which present an imminent threat to the public health and safety which requires immediate action before the Commission can take action and there are no feasible practicable alternatives to the emergency authorization.

2. The Commission may issue an emergency order under Texas Water Code § 11.139 to amend a permit or certificate of adjudication for 120 days after notice to the Governor if the Commission finds that emergency conditions exist which present an imminent threat to the public health and safety and which override the necessity to comply with established statutory procedures and there are no feasible practicable alternatives to the emergency authorization.

3. LCRA is obligated under a 1988 court order and Certificates of Adjudication Nos. 14-5478 and 14-5482 to meet the demands of its firm, non-interruptible water supply customers 100% of the time without shortage through a repeat of the conditions in the Drought of Record.

4. The Findings of Fact show that the requirements of Texas Water Code § 11.139 have been met. Following the 2010 Water Management Plan with the ongoing drought and its effect on the water supply constitute an emergency that presents an imminent threat to the public health and safety. There are no practicable alternatives to this action.

5. The ED had the authority to issue the Emergency Order.

6. The Commission must consider whether to affirm, modify, or set aside an emergency order issued by the ED under Section 11.139 of the Texas Water Code no later than 20 days after the ED issues the order.

7. LCRA has the burden of proving that an emergency order should be granted.

8. The Commission in issuing an emergency order under Texas Water Code § 11.139 must ensure that the relief granted is adequate and tailored to address the imminent threat to public health and safety.

9. LCRA's application for an emergency order should be granted in part and the ED's Emergency Order should be affirmed in part and modified in part as set out below.

10. LCRA should pay the full cost of transcribing the hearing in this case.

11. By entering this order, the Commission is not construing in any way either the 1987 Agreement or the 1998 Purchase Agreement between LCRA and Garwood Irrigation Company. Nothing in this Order shall be considered or construed in any way to support one construction or another of the 1987 Agreement and the 1998 Purchase Agreement between LCRA and Garwood Irrigation Company.

III. EXPLANATION OF CHANGES

1. As directed by the Commission at its February 26, 2014 agenda, the Office of the General Counsel has made the necessary revisions to the ALJs' Proposed Order to effectuate the Commission's decision. Specifically, Findings of Fact, Conclusions of Law, and Ordering Provisions have been renumbered to reflect the Commission's revisions to the ALJs' Proposed Order. Thus, references in this section to Findings of Fact, Conclusions of Law, and Ordering Provisions refer to the provisions as renumbered by the Office of the General Counsel, except with respect to stricken provisions. In instances where this section references stricken provisions, the original numbering of the provisions by the ALJs in their Proposed Order is utilized.

2. On February 26, 2014, the ALJs distributed a letter with the ALJs' recommendations with respect to the parties' exceptions to their proposal for decision. In their presentation, the ALJs explained that these recommended revisions to their Proposed Order were supported by the evidence in the record. Accordingly, the Commission made the following revisions to the ALJs' proposed order: 1) Finding of Fact No. 3 is revised, as requested in the ED's exceptions; 2) Findings of Fact Nos. 8, 17, 29, 39, 43, 51, and 57, are revised, as requested in LCRA's exceptions; 3) Findings of Fact Nos. 44 and 46 are added as new Findings of Fact, as requested in CTWC's exceptions; and 4) original Finding of Fact No. 2a was relocated as Ordering Provision No. 6a, now renumbered as Ordering Provision No.7.

3. During the Agenda meeting, the Commission discussed that given the current conditions, the current lake levels, the forecasted weather, and the limited time between the agenda meeting and the March 1, 2014 trigger date that there is no need to establish a specific combined storage level as a trigger for this emergency order. The Commission also indicated that they must take only the action necessary to address the imminent threat to public health and safety. Therefore, the Commission decided to remove references to trigger levels from the ALJs' proposed order. Accordingly, the Commission struck Findings of Fact Nos. 30a, 30b, 30c, 30f, 30g, 31c, 45a, 49, 49a, and 49b, and struck the last sentence of Finding of Fact No. 38.

4. The Commission made several revisions to provide increased clarity to the ALJs' proposed order and to remove redundant provisions. Therefore, the Commission in its motion, struck Findings of Fact Nos. 41a, 42f, 42g and Ordering Provision No. 8; and revised Findings of Fact Nos. 7, 17, and 22. Additionally, Ordering Provision No. 3 was revised to reflect that the emergency order is final and effective on the date of issuance, pursuant to Texas Government Code § 2001.144(a)(3). Finally, the Commission revised Finding of Fact No. 78 to include the specific date on which notice was provided to the Governor of Texas.

5. In response to the exception filed by CWIC, the Commission struck the last part of the last sentence of Finding of Fact No. 17. Specifically, the Commission struck the words, "...in contravention of the 1988 Order and Certificates of Adjudication Nos. 14-5478 and 14-5482" as unnecessary to its decision to address the imminent threat to public health and safety in this matter.

6. The Commission stated in their deliberation that an automatic renewal is not appropriate in this emergency order given the variability of the specific facts and circumstances relating to the imminent threat to public health and safety in this matter. For this reason, the Commission added Finding of Fact No. 47, which reads, "Combined storage levels are a strong indicator of an imminent threat to the public health and safety. However, given the rapid rise and fall of combined storage levels throughout the historical record, combined storage levels, in and of themselves, are insufficient to determine whether an imminent threat to the public health and safety exists." In addition, the Commission added new Conclusion of Law No. 8, which reads, "The Commission in issuing an order under Texas Water Code § 11.139 must ensure that the relief granted is adequate and tailored to address the imminent threat to public health and safety."

7. Based on the Commission determination that all requirements of Texas Water Code § 11.139 have been met, and the Commissions' determination to remove references in the ALJs' proposed order to trigger levels, the Commission revised Ordering Provision No. 1 to read, "LCRA's 2010 WMP is amended to alleviate LCRA from any obligation to provide interruptible stored water to customers within LCRA's Gulf Coast and Lakeside Divisions and Pierce Ranch for the duration of this emergency order."

NOW, THEREFORE, BE IT ORDERED BY THE COMMISSION OF THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY THAT:

1. LCRA's 2010 WMP is amended to alleviate LCRA from any obligation to provide interruptible stored water to customers within LCRA's Gulf Coast and Lakeside Divisions and Pierce Ranch for the duration of this emergency order.

2. LCRA may provide interruptible stored water to the Garwood Irrigation Division and Pierce Ranch, to the extent required by their contracts.

3. Pursuant to Texas Government Code § 2001.144(a)(3), this emergency order is final and effective on the date of issuance.

4. This emergency order terminates on May 26, 2014. However, this emergency order may be renewed once for no more than 60 days.

5. This emergency order only addresses the specific relief requested from LCRA and is not meant as precedent for amendments to LCRA's WMP or future emergency relief.

6. If any provision, sentence, clause, or phrase of this emergency order is for any reason held to be invalid, the invalidity of any portion shall not affect the validity of the remaining portions of this emergency order.

7. This emergency order does not alter LCRA's obligations to provide water specifically for instream flow or freshwater inflow purposes pursuant to the 2010 WMP.

8. LCRA shall pay the full cost of transcribing the hearing in this case.

9. All other motions, requests for entry of specific Findings of Fact or Conclusions of Law, and any other requests for general or specific relief not expressly granted herein, are hereby denied for want of merit.

10. The Chief Clerk of the Texas Commission on Environmental Quality shall forward a copy of this Order to the parties.

Issue Date: FEB 27 2014

TEXAS COMMISSION ON
ENVIRONMENTAL QUALITY

Bryan W. Shaw

Bryan W. Shaw, Ph.D., P.E. Chairman

OFFICE OF THE GOVERNOR

RICK PERRY
GOVERNOR

March 14, 2014

FILED IN THE OFFICE OF THE
SECRETARY OF STATE
11:00 AM O'CLOCK

MAR 14 2014

NANDITA BERRY
Secretary of State

The Honorable Nandita Berry
Secretary of State
State Capitol Room 1E.8
Austin, Texas 78701

Dear Madam Secretary:

Pursuant to his powers as Governor of the State of Texas, Rick Perry has issued the following proclamation:

> A proclamation renewing the certification that exceptional drought conditions pose a threat of imminent disaster in a specified number of counties in the State of Texas.

The original proclamation is attached to this letter of transmittal.

Respectfully submitted,

Dede Keith

Dede Keith
Deputy Director
Constituent Communication Division
Office of the Governor

DK/gsd

Attachment

Attachment I
Governor's Proclamation
(3-14-14)

PROCLAMATION

BY THE

Governor of the State of Texas

TO ALL TO WHOM THESE PRESENTS SHALL COME:

I, RICK PERRY, Governor of the State of Texas, issued an Emergency Disaster Proclamation on July 5, 2011, certifying that exceptional drought conditions posed a threat of imminent disaster in specified counties in Texas.

WHEREAS, significantly low rainfall has resulted in declining reservoir and aquifer levels, threatening water supplies and delivery systems in many parts of the state; and

WHEREAS, prolonged dry conditions continue to increase the threat of wildfire across many portions of the state; and

WHEREAS, these drought conditions have reached historic levels and continue to pose an imminent threat to public health, property and the economy; and

WHEREAS, this state of disaster includes the counties of Archer, Armstrong, Bailey, Bandera, Baylor, Bell, Bexar, Blanco, Bosque, Brazoria, Briscoe, Brown, Burnet, Carson, Castro, Childress, Clay, Cochran, Coke, Coleman, Collin, Collingsworth, Colorado, Comal, Comanche, Concho, Coryell, Cottle, Crosby, Dallam, Dallas, Dawson, Deaf Smith, Delta, Denton, Dickens, Dimmit, Donley, Eastland, Edwards, Ellis, Erath, Fannin, Fisher, Floyd, Foard, Fort Bend, Frio, Gaines, Garza, Gillespie, Gray, Grayson, Hale, Hall, Hamilton, Hansford, Hardeman, Hartley, Haskell, Hemphill, Hidalgo, Hill, Hockley, Hood, Hopkins, Hudspeth, Hunt, Hutchinson, Irion, Jack, Johnson, Jones, Kaufman, Kendall, Kent, Kerr, Kimble, King, Knox, La Salle, Lamar, Lamb, Lampasas, Lipscomb, Llano, Lubbock, Lynn, Mason, Matagorda, McCulloch, McLennan, Medina, Menard, Mills, Mitchell, Montague, Moore, Motley, Navarro, Nolan, Ochiltree, Oldham, Palo Pinto, Parker, Parmer, Potter, Randall, Real, Red River, Roberts, Rockwall, Runnels, San Saba, Schleicher, Scurry, Shackelford, Sherman, Somervell, Stephens, Sterling, Stonewall, Sutton, Swisher, Tarrant, Taylor, Terrell, Terry, Throckmorton, Tom Green, Travis, Uvalde, Val Verde, Wharton, Wheeler, Wichita, Wilbarger, Willacy, Williamson, Wise, Yoakum, Young and Zavala.

THEREFORE, in accordance with the authority vested in me by Section 418.014 of the Texas Government Code, I do hereby renew the disaster proclamation and direct that all necessary measures, both public and private as authorized under Section 418.017 of the code, be implemented to meet that threat.

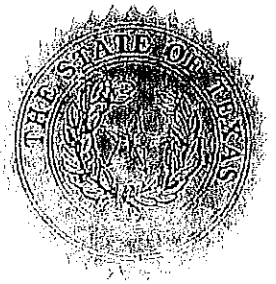
As provided in Section 418.016 of the code, all rules and regulations that may inhibit or prevent prompt response to this threat are suspended for the duration of the state of disaster.

In accordance with the statutory requirements, copies of this proclamation shall be filed with the applicable authorities.

IN TESTIMONY WHEREOF, I have hereunto signed my name and have officially caused the Seal of State to be affixed at my office in

FILED IN THE OFFICE OF THE SECRETARY OF STATE
11:00 AM O'CLOCK
MAR 14 2014

the City of Austin, Texas, this the 14th day of March, 2014.



RICK PERRY
RICK PERRY
Governor of Texas

ATTESTED BY:

NANDITA BERRY
NANDITA BERRY
Secretary of State

FILED IN THE OFFICE OF THE
SECRETARY OF STATE
11:00 AM O'CLOCK
MAR 14 2014

APPLICATION OF THE LOWER COLORADO RIVER AUTHORITY FOR EMERGENCY AUTHORIZATION	§ § § §	**BEFORE THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY**

AFFIDAVIT OF BRYAN COOK

THE STATE OF TEXAS	§
	§
COUNTY OF TRAVIS	§

Before me, the undersigned authority, personally appeared Bryan Cook, a person known by me to be competent and qualified in all respects to make this affidavit, who being by me first duly sworn, deposed as follows:

1. I am over 21 years of age, of sound mind, and have never been convicted of a felony or crime of moral turpitude. I am fully competent and qualified in all respects to make this affidavit.

2. The facts stated in this affidavit are within my personal knowledge and are true and correct.

3. I, Bryan Cook, am an individual residing in Austin, Texas.

4. I have a Bachelor of Science in Resource and Environmental Studies and a Masters of Science in Aquatic Biology, both from Southwest Texas State University. I have a Masters of Public Affairs from the University of Texas at Austin, LBJ School of Public Affairs. A true and correct copy of my resume, detailing my prior work history and education, is attached hereto under Tab 1.

5. I have worked for the Lower Colorado River Authority (LCRA) for 16 years. For the last 16 years, I have worked with the LCRA's water quality and water supply planning business. My current title is Water Quality Supervisor.

6. I served as Vice Chair of the Colorado-Lavaca Basin and Bay Expert Science Team, which established environmental flow recommendations for streams in the Colorado and Lavaca River and Matagorda and Lavaca Bay

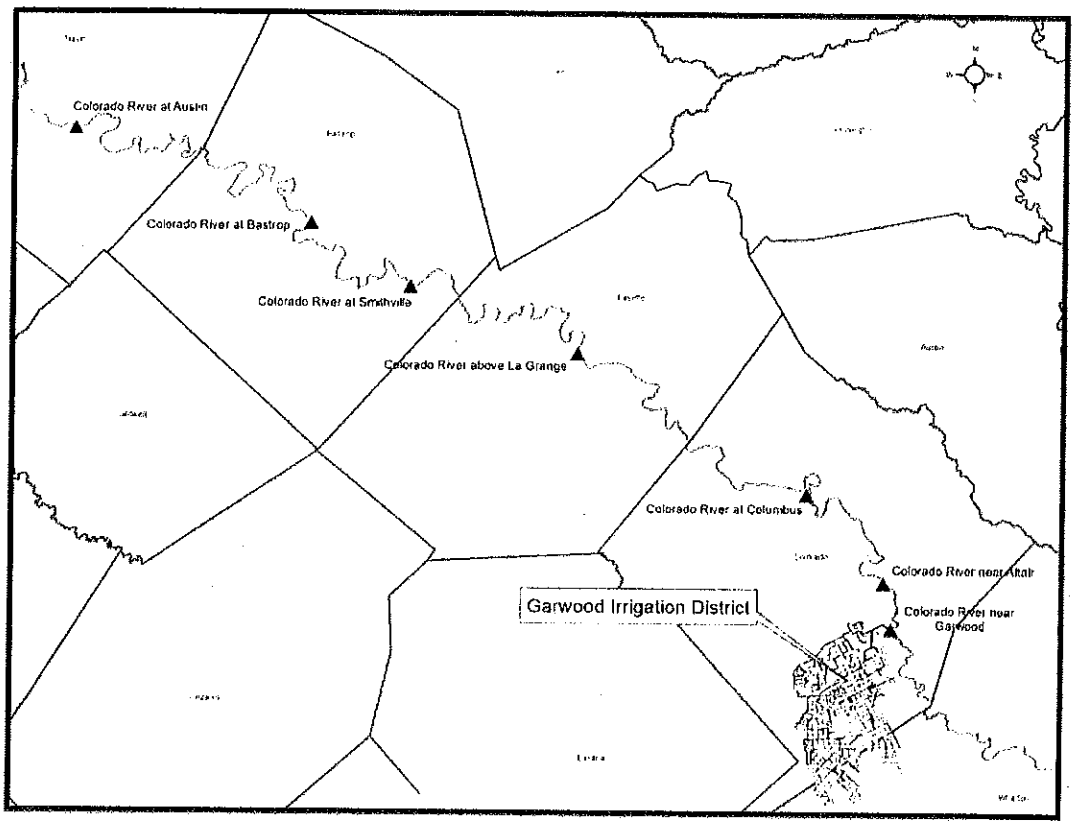
7. As part of my duties at the LCRA, I regularly monitor and assess water quality data for the lower Colorado River basin. I have been directly involved in overseeing various studies of the aquatic habitat and water quality of the lower Colorado River and Matagorda Bay. My opinion is based on this review and my experience in the field. It is my opinion that:

    a. The lower 290 miles of the Colorado River below Austin flows through the East Central Texas Plains, Blackland Prairies, and Western Gulf Coast Plains

ecoregions. The river basin transitions from the rocky Hill County to deep clay soils, cutting through geologically distinct zones that create distinct physical habitat characteristics. Instream flow in the lower Colorado River is a master variable that directly and indirectly influences habitat, biology, and water quality.

b. The Blue Sucker (Cycleptus elongatus) is a state-listed threatened species in Texas and is a species of concern throughout its range due to its unique biological characteristics. Blue Suckers are long-lived (up to 20 years), depend on specific habitat related to high flow, and have low recruitment of young into the population. This combination of factors makes them particularly sensitive to alterations to the flow regime. The Blue Sucker is uniquely adapted to life in swift currents. (It is elongated and tubular in shape and has large pectoral fins which facilitate movement in swift currents.) Adults utilize high velocity flow areas over hard substrate such as bedrock outcrop, boulders, and cobble riffles. These habitat types are present between Bastrop and Eagle Lake (downstream of the Colorado River at Columbus gage). *See* Figure 1.

Figure 1. Colorado River below Austin



c. Blue Suckers are known to undertake long spawning migrations, often covering hundreds of miles. Radio-tagged fish in the lower Colorado River which had traveled from La Grange, Smithville, and Bastrop were

located in a spawning aggregation with about 50 other Blue Sucker just below Longhorn Dam in 2005. After spawning, the fish returned to their 'home' area. Two male Blue Suckers tagged at Altair migrated to Onion Creek and Utley, but did not return to the 'home' area. In other years, fish were observed to not make long spawning runs, opting to spawn near the 'home' areas, when flow and water temperature conditions were suitable. (*See* Tab 2, Blue Sucker Life History Studies Summary Report, BIO-WEST, Inc., Oct. 2007 pp 3-3 through 3-8, 4-1, hereinafter "2007 Blue Sucker Summary Report.")

d. LCRA has conducted instream flows studies evaluating the habitat of the Blue Sucker and the impact of streamflows on water quality. The most recent study was performed as part of the LCRA-SAWS Water Project. The study followed the principles of the Texas Instream Flow Program, recommended several levels of instream flow and was also the basis for the Senate Bill 3 Environmental Flow Standards for the lower Colorado River. This study used the latest data and science to assess the relationship between various factors and Blue Sucker habitat. (*See* Tab 3, *excerpts from* Lower Colorado River, Texas Instream Flow Guidelines, BIO-WEST, Inc., March 2008, hereinafter "2008 Instream Flow Guidelines Report.") Those factors included habitat suitability criteria (depth, velocity, substrate) and data recorded during observations of spawning fish such as depth, velocity, substrate, and temperature. The computer models and data analysis in the study were used to develop instream inflow criteria for the Colorado River. Prior to this study, LCRA conducted a study in conjunction with the Texas Parks and Wildlife Department (TPWD) in 1992. (*See* Tab 4, *excerpts from* Instream Flows for the Colorado River, Mosier and Ray, June 1992, hereinafter "1992 Instream Flow Study.") This study established critical and target instream flow criteria for several locations in the lower Colorado River. The study also recommended a release of 500 cubic (cfs) for a continuous six week period in March, April and May to provide spawning habitat for Blue Sucker (until addition study was conducted to refine the criteria). The 2010 WMP[1] uses the critical instream flow criteria (including the 500 cfs release) from the 1992 study.

e. The recent studies affirmed that instream flows were important to the maintenance of adequate spawning habitat for the Blue Sucker. The "subsistence" criteria in the 2008 Instream Flow Guidelines Report are analogous to LCRA's "critical" flow requirements in the current WMP. The new criteria are reflected in the Texas Commission on Environmental Quality's environmental flow standards for new permits in the lower Colorado River basin. 30 Tex. Admin Code ch. 298, subch. D. Table 1, below, summarizes both sets of criteria.

[1] Although called the 2010 WMP, the proposed amendments were filed with TCEQ in 2003, *before* the study underlying 2008 Instream Flow Guidelines Report was completed.

Table 1. Instream Flow Criteria

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Subsistence Flows (New Study)												
Bastrop	208	274	274	184	275	202	137	123	123	127	180	186
Columbus	340	375	375	299	425	534	342	190	279	190	202	301
Wharton	315	303	204	270	304	371	212	107	188	147	173	202
Critical Flows (current WMP)												
Bastrop to Eagle Lake	120	120	500 for 6 weeks; 120 for remainder			120	120	120	120	120	120	120

f. As shown in the table, the subsistence criteria during the March-May timeframe are lower than the 500 cfs critical flow requirement.

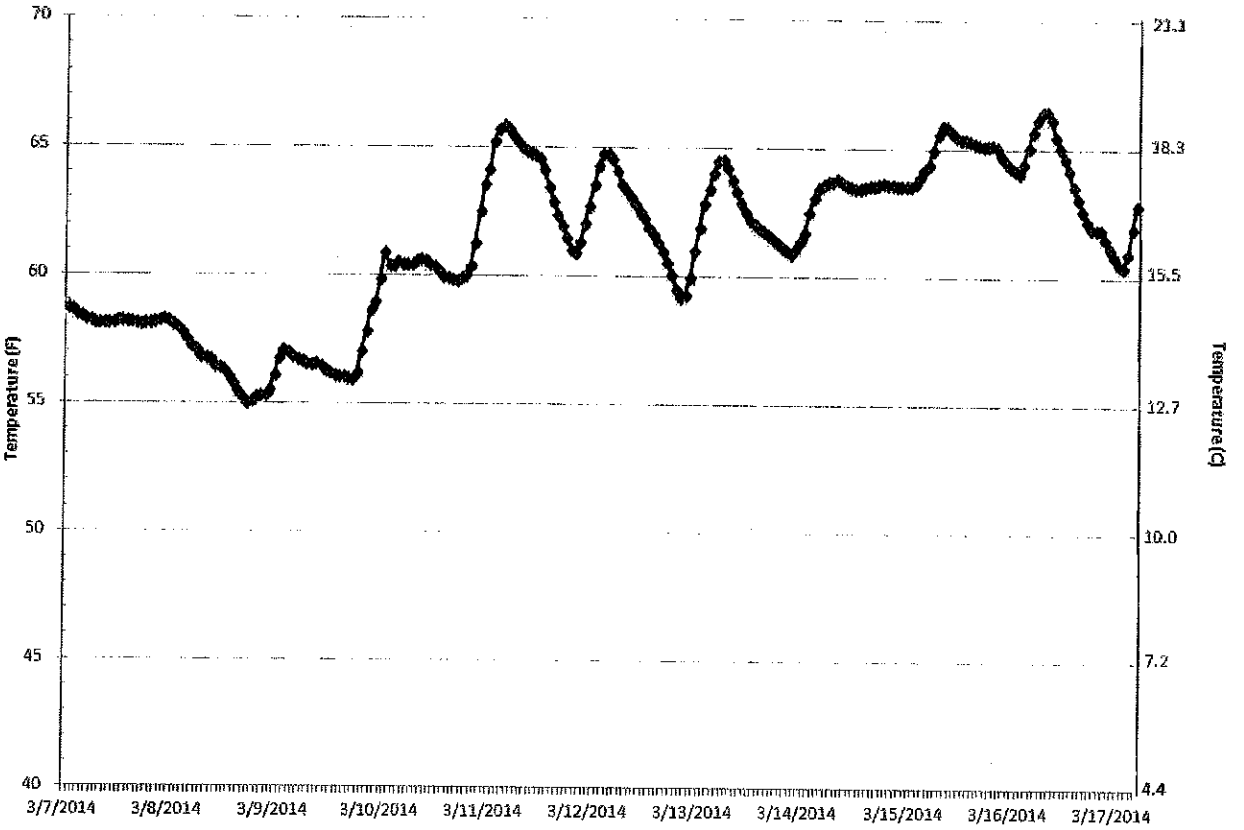
g. A flow of 500 cfs supports between 93 and 100 percent of the maximum available spawning habitat for the Blue Sucker. A flow of 300 cfs (which is generally consistent with the new criteria in the table above) would support at least 86% of the maximum available spawning habitat for the Blue Sucker. (*See* Tab 3, 2008 Instream Flow Guidelines Report, p. 79 Table 4.9.)

h. The flow conditions in the lower Colorado River in February and March 2014 to date (which have been close to or exceeded 300 cfs for the entire period—*see* Affidavit of Ryan Rowney) are supportive of significant spawning habitat for the Blue Sucker.

i. Spawning of the Blue Sucker has been observed in February and March. (*See* Tab 4, 1992 Instream Flow Study, p. 38-39; and Tab 2, 2007 Blue Sucker Summary Report at 3-3 through 3-8.)

j. LCRA collected water temperature data for the period from March 7 to March 17, 2014. (*See* Figure 2.) The recorded water temperatures were consistent with temperatures recorded in prior monitoring in February and March in which spawning of the Blue Sucker was observed. (*See* Tab 2, 2007 Blue Sucker Summary Report at 3-3 through 3-8.)

Figure 2. Water Temperature in Bastrop Reach (Utley, TX)



k. LCRA routinely performs water quality monitoring of the lower Colorado River. Tables 2, 3 and 4 present water quality data collected since 2000 when flows were below 350 cfs. Water quality standards are consistently met (with few exceptions) when flow is at or near 300 cfs.

Table 2. Water Quality Data for Webberville Reach, 1428

Date	Flow	Temp	DO	pH	Chloride	Sulfate	E coli	TDS
Standard		***95***	***6***	***6.5 - 9***	***100***	***100***	***126***	***500***
2/2/2000	324	12.99	9.63	7.43	66	64	20	352
12/10/2001	302	14.59	9.86	7.68	30	35	1110	249
12/5/2005	294	14.7	9.75	7.98	59	46	35	343
2/1/2006	331	15.86	8.65	7.71	57	49	13	322
12/4/2006	260	12.7	9.3	7.9	56	48	75	335
12/2/2008	210	13	9.6	7.9	67	54	30	361
2/3/2009	193	13	12.9	8	72	60	23	372
12/7/2010	335	12.9	9.9	8	50	46	44	334
6/5/2012	347	31.1	8.6	8.4	69	89	32	399

10/4/2012	302	24.6	8.4	8.1	57	50	25	326
12/3/2012	233	21.2	6.2	7.8	80	68	9	420
2/11/2013	203	17.8	7.4	7.6	87	77	43	428
4/8/2013	335	21.9	5.8	7.7	67	69	91	387
10/8/2013	340	24.9	9.5	8	58	60	34	333

Table 3. Water Quality Data for Bastrop Reach, 1434

Date	Flow	Temp	DO	pH	Chloride	Sulfate	E coli	TDS
Standard		***95***	***6***	***6.5 - 9***	***100***	***100***	***126***	***500***
2/2/2000	324	10.19	13.18	8.44	54	55	10	311
12/10/2001	302	13.99	10	7.73	24	34	2380	227
12/5/2005	294	13.32	10.69	8.23	52	46	29	339
2/1/2006	331	15.11	9.26	7.89	51	45	37	286
12/4/2006	260	10.7	10.3	8	46	43	16	273
12/2/2008	210	11.9	10.8	8.1	67	55	8	359
2/3/2009	193	11	12.5	8.6	70	60	8	366
12/7/2010	335	11.8	11.3	8.6	51	47	7	338
6/5/2012	347	31.7	10.9	8.9	70	95	26	404
10/4/2012	302	23.8	7.8	8.1	40	39	100	255
12/3/2012	233	20.4	9.2	8.3	77	69	19	413
2/11/2013	203	17.5	9.2	8.2	86	80	34	430
4/8/2013	335	21	7	8	50	53	70	315
10/8/2013	340	25	10.4	8.2	61	66	27	349

Table 4. Water Quality Data for Columbus Reach, 1402

Date	Flow	Temp	DO	pH	Chloride	Sulfate	E coli	TDS
Standard		***95***	***5***	***6.5 - 9***	***100***	***100***	***126***	***500***
12/3/2008	266	14.7	9.4	8.1	59.8	54.5	66	311
2/4/2009	254	12	10.4	8.5	61.9	55.1	2	366
12/8/2010	334	11.9	10.8	8.5	49.7	49.3	66	346
12/6/2011	332	11.8	9.7	8	67.3	77.5	240	387
8/8/2012	137	31.3	5.9	8.8	50.7	56.2	17	302
12/4/2012	242	21.2	8	8.5	68.9	60.4	1000	363
2/12/2013	242	16.5	11.7	8.4	73.8	74.1	15	399
8/7/2013	340	31.6	8.5	9	56.3	44	26	304
10/8/2013	343	23.8	9.3	8.2	26.8	31.1	49	211
12/10/2013	246	9.19	11.65	8.02	48.4	68	37.3	372
2/11/2014	314	9.43	12.18	9.02	70.3	88.8	29.8	421

"In my opinion, maintaining flows at 300 cfs maintains an acceptable balance between protecting environmental flow needs for the Blue Sucker and other firm water needs because there should not be a significant impact on the Blue Sucker or water quality."

Further affiant sayeth not.

Bryan Cook

BRYAN COOK, AFFIANT

SWORN TO AND SUBSCRIBED before me on the 20th day of March, 2014.

TABETHA JASKE
Notary Public, State of Texas
My Commission Expires
January 11, 2018

Tabetha Jaske

Notary Public in and for the State of Texas

My Commission Expires: 1-11-2018

Aquatic Scientist *II* Sep. 2000 -Jan. 2005

- Expanded the long-term fixed station water quality monitoring program in Matagorda Bay.
- Developed statistical relationships between freshwater inflows, salinity, and species abundance in Matagorda Bay.
- Participated and provided recommendations for environmental flows in LCRA's Water Management Plan process.
- Designed and implemented intensive chemical, biological, and habitat monitoring program targeting watersheds throughout the Lower Colorado River basin.
- Prepared final reports and presented data at statewide conferences and to the general public.

Watershed Protection Coordinator II *Aug. 1999 - Sep. 2000*

- Designed and implemented water quality monitoring programs to assess stormwater treatment ponds.
- Conducted stormwater monitoring, analyzed runoff data and evaluated success of best management practices for federal Clean Water Act 319 Grants.
- Performed chemical and biological assessments throughout the lower Colorado River basin supporting the Texas Clean Rivers Program.

Environmental Coordinator I Jan. 1998 - Aug. 1999

- Conducted stormwater monitoring to support federal Clean Water Act 319 grants.
- Analyzed water quality samples to determine runoff quality from innovative best management practices.
- Prepared quarterly progress reports for grants.
- Assisted with routine water quality monitoring and data analysis.

SOUTHWEST TEXAS STATE UNIVERSITY, SAN MARCOS, TEXAS Jan. 1997 - Dec. 1997
Zoology Teaching Assistant

- Taught principals of taxonomy, anatomy, and physiology to underclassmen.
- Prepared lesson plans and administered examinations.

CITY OF AUSTIN, ENVIRONMENTAL SERVICES, AUSTIN, TEXAS Feb. 1994 - Jan. 1997
Professional Intern

- Prepared technical reports to staff and supervisors summarizing development trends and applicable ordinances.
- Researched developments over environmentally sensitive zones.
- Performed on-site inspections of land development projects.

SKILL SUMMARY

- Monitoring and analysis of estuarine and freshwater ecosystems
- Ability to communicate with technical and non-technical audiences
- Quantitative and multivariate analysis of chemical and biological data
- Managing water quality grants
- Operations of water quality, flow, and biological monitoring equipment
- Knowledge of State water quality standards

Tab 1

Bryan P. Cook

Lower Colorado River Authority
P. O. Box 220
Austin, TX 78767-0220

EDUCATION

Master of Public Affairs, December 2004
LBJ School of Public Affairs
The University of Texas at Austin
Professional Report: "Freshwater Inflows To Matagorda Bay"

Master of Science, May 1998
Aquatic Biology
Southwest Texas State Univ.
Thesis: "Seasonal and Longitudinal Variation in Nitrate and Chlorophyll *a* in a Central Texas Reservoir"

Bachelor of Science, December 1995
Major: Resource and Environmental Studies, Minor: Biology
Southwest Texas State Univ.

SUMMARY

Sixteen years experience in collection and analysis of water quality and biological data, evaluation and development of riverine and estuarine environmental flow recommendations, with past five years overseeing these activities as a supervisor. Excellent writing and public speaking skills. Experience as liaison in technical and public stakeholder processes, as primary internal expert for environmental flows and water quality processes within the Colorado River system, and as expert witness in legal and regulatory proceedings. Success with funding and project management of water quality grants. Exceptional skills in operation of water quality data sondes, flow meters, boat operation, and biological collection devices in estuarine and freshwater ecosystems.

PROFESSIONAL EXPERIENCE

LOWER COLORADO RIVER AUTHORITY, AUSTIN, TEXAS — Jan. 1998 - PRESENT

Water Quality Supervisor — *Jan. 2009 – Present*

- Conduct and review complex biological and water quality evaluations, including estimating water needs for the environment and environmental impacts of water supply strategies.
- Supervise, coordinate, and direct activities of staff related to the Clean Rivers Program
- Manage the Clean Rivers Program grant and other team grants
- Review and comment on state water quality permit applications filed in the Colorado River Basin
- Represent LCRA with water quality related stakeholder groups
- Provide written expert testimony in support of LCRA's position in legal proceedings.

Senior Aquatic Scientist — Jan. 2005 – Jan 2009

- Conduct and review complex biological and water quality evaluations, including estimating water needs for the environment and environmental impacts of water supply strategies.
- Prepare reports and provide recommendations for solutions to water supply and management issues.
- Interpret results from water quality and water quantity models simulating all aspects (physical, chemical, and biological) of the Colorado River system- including watersheds, tributaries, rivers, reservoirs, and estuary systems.
- Convey information to internal and external customers and provide expertise to upper management regarding statewide water policy issues and Lower Colorado River Authority (LCRA) operations.
- Serve as the primary internal expert and liaison with state resource agencies for environmental flows and water quality processes within the lower Colorado River Basin.
- Provide written expert testimony in support of LCRA's position in legal proceedings.
- Manage federal Clean Water Act 319 grant contracts.
- Selected and graduated from Leadership LCRA 2006, a year long leadership development program.

Tab 2

Blue Sucker Life History Studies Summary Report

Colorado River Flow Relationships to Aquatic Habitat and State Threatened Species: Blue Sucker

Prepared for

Lower Colorado River Authority

and San Antonio Water System

Prepared by

BIO-WEST, Inc.
1812 Central Commerce Court
Round Rock, TX 78664-8546

OCTOBER 2007

Water Project

LCRA ENERGY • WATER • COMMUNITY SERVICES

San Antonio Water System

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Acronyms and Abbreviations

CFS	Cubic Feet Per Second
DO	Dissolved Oxygen
GPS	Global Positioning System
HSC	Habitat Suitability Criteria
LCRA	Lower Colorado River Authority
LSWP	LCRA-SAWS Water Project
SAWS	San Antonio Water System
TCEQ	Texas Commission on Environmental Quality
TPWD	Texas Parks and Wildlife Department
USGS	United States Geological Survey
WUA	Weighted Usable Area

1.0 INTRODUCTION

The blue sucker (*Cycleptus elongatus*) is a wide-ranging catostomid fish native to large rivers in the Mississippi River Basin and large Western Gulf Slope drainages of Louisiana and Texas. It has been documented from northern Wisconsin, central Montana, and Pennsylvania southwest to central Texas. A sister species, the southeastern blue sucker (*Cycleptus meridionalis*), has recently been recognized from Gulf Slope drainages east of the Mississippi in Alabama, Mississippi, and Louisiana (Burr and Mayden 1999). In addition, recent genetic analyses has suggested that populations in the Rio Grande drainage of Texas, New Mexico, and Mexico are divergent from other *C. elongatus* populations, and a formal species description is currently being conducted for this species (Bessert 2006).

Blue suckers are a rather large long-lived fish that obtain total lengths over 800 mm (32 inches) and weights over 4,000 g (8.8 lbs.). Southeastern blue suckers are thought to live up to 33 years based on opercular bone aging (Peterson et al. 1999), and have been known to migrate large distances upstream during annual spring spawning migrations (Mettee et al. 2003, Peterson et al. 2000). Blue suckers inhabit relatively deep, high-velocity rapids over firm substrates such as cobble and bedrock and feed on aquatic invertebrates – mainly Trichopteran and Dipteran larvae (Rupprecht and Jahn 1980, Moss et al. 1983). Although they were once an important part of commercial catches from the Mississippi River, abundance of blue suckers has declined in many areas due to reservoir construction which blocks migration routes and limits availability of high-velocity rapids habitats (Rupprecht and Jahn 1980, Mettee et al. 2003). Due to such impacts, the population status of blue suckers is somewhat questionable and they are considered threatened or endangered throughout much of their range (Peterson et al. 2000).

In Texas, blue suckers exhibit a rather sparse and disjunctive distribution. Disregarding the recently recognized Rio Grande species, specimens have been confirmed from the Colorado River in central Texas, and the Sabine and Neches Rivers in the eastern part of the state. However, several large rivers located in between those mentioned lack confirmed reports of blue suckers (Burr and Mayden 1999). The disjunctive distribution of blue suckers within the state and the lack of data on confirmed populations have led to its listing as a threatened species by the state of Texas.

Given the limited information on blue sucker populations in Texas and the potential for impacts to the lower Colorado River blue sucker population as a result of the LSWP, an effort was made to gather data on movement, migration, habitat use, and general life history of blue suckers within the lower Colorado River. This report provides a summary of all activities associated with this task, and a discussion of subsequent results.

2.0 MOVEMENT AND MIGRATION

2.1 Tagging

Thirty blue suckers (486-705 mm TL) were collected by boat electrofishing from five pre-selected riffle locations within the lower Colorado River. Riffle locations were selected because previous sampling by LCRA biologists and others had identified blue suckers in these areas. Thirteen blue suckers were collected and implanted with radio transmitters at a riffle site near Altair (Colorado County), four at a site near Columbus (Colorado County), six at a site near LaGrange (Fayette County), two at a site near Smithville (Bastrop County), and five at a site near Bastrop (Bastrop County) (Figure 2.1).

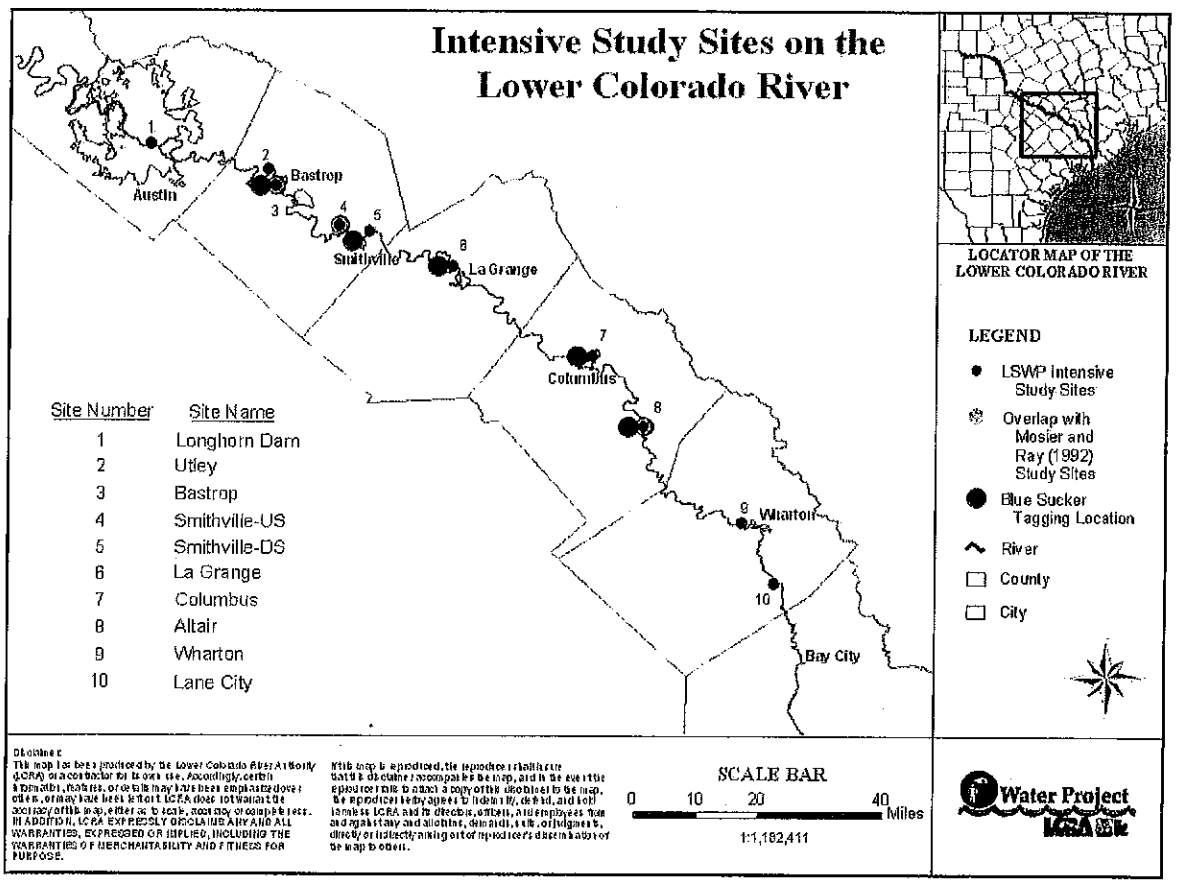


Figure 2.1 – Map showing tagging locations of blue suckers in the Colorado River, Texas.

Once captured, fish were held in a flow-through holding tank set in the river until time of surgery. Total length (mm) and weight (g) of each fish was measured, and the abdominal area was gently squeezed in an attempt to expel milt or eggs and thus determine sex of the fish (Table 2.1, Figure 2.2). Individuals which did not readily expel gametes, and for which gonads were not obvious during surgery, were recorded as sex unknown.

Table 2.1 - Date, location, length, weight, sex, and tag frequency of 30 blue suckers implanted with radio transmitters in the lower Colorado River, Texas.

Location[1]	GPS Coord.[2]	Date	Total Length (mm)	Weight (g)	Sex	Frequency
Columbus	14 R 737896 3289952	10/19/2004	642	2722	F	149.320
Columbus	14 R 737896 3289952	10/19/2004	486	680	U	149.340
Columbus	14 R 737896 3289952	10/19/2004	535	1134	U	149.360
Columbus	14 R 737896 3289952	10/19/2004	524	1134	U	149.380
Altair	14 R 751808 3272345	10/20/2004	556	3175	U	149.400
Altair	14 R 751808 3272345	10/20/2004	555	1588	M	149.420
Altair	14 R 751808 3272345	10/20/2004	705	4536	F	149.440
Altair	14 R 751808 3272345	10/20/2004	521	1134	U	149.460
Altair	14 R 751808 3272345	10/20/2004	596	1814	M	149.480
Altair	14 R 751808 3272345	10/20/2004	655	2722	M	149.500
Altair	14 R 751808 3272345	10/20/2004	584	2041	U	149.520
Altair	14 R 751808 3272345	10/20/2004	667	3175	M	149.540
Altair	14 R 751808 3272345	10/20/2004	605	2495	F	149.560
Altair	14 R 751808 3272345	10/20/2004	686	4082	F	149.580
Altair	14 R 751808 3272345	10/20/2004	558	2268	M	149.600
Altair	14 R 751808 3272345	10/20/2004	665	2948	M	149.620
Altair	14 R 751808 3272345	10/20/2004	596	2495	M	149.640
La Grange	14 R 702322 3314482	10/21/2004	610	2722	M	149.660
La Grange	14 R 702322 3314482	10/21/2004	601	2041	M	149.680
La Grange	14 R 702322 3314482	10/21/2004	665	3402	M	149.700
La Grange	14 R 702322 3314482	10/21/2004	685	4082	F	149.720
La Grange	14 R 702322 3314482	10/21/2004	668	3629	F	149.740
La Grange	14 R 702322 3314482	10/21/2004	651	2948	M	149.760
Smithville	14 R 677445 3321657	10/22/2004	670	3175	M	149.780
Smithville	14 R 677445 3321657	10/22/2004	621	2268	M	149.800
Bastrop	14 R 656632 3336236	10/27/2004	693	3856	F	149.820
Bastrop	14 R 656632 3336236	10/27/2004	646	2722	M	149.840
Bastrop	14 R 656632 3336236	10/27/2004	676	3175	M	149.860
Bastrop	14 R 656632 3336236	10/27/2004	600	2381	M	149.880
Bastrop	14 R 656632 3336236	10/27/2004	607	2268	M	150.180

[1]All fish captured in the Colorado River, Texas.

[2]All GPS Coordinates in UTM Nad 83.

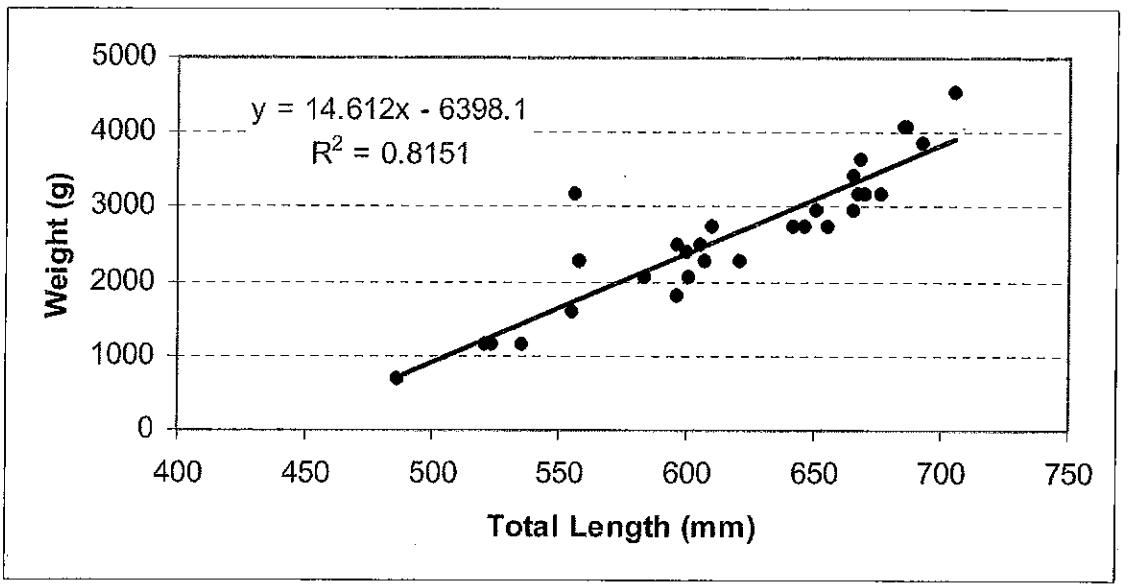
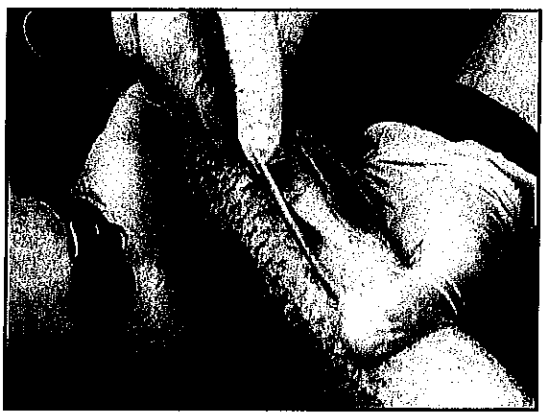
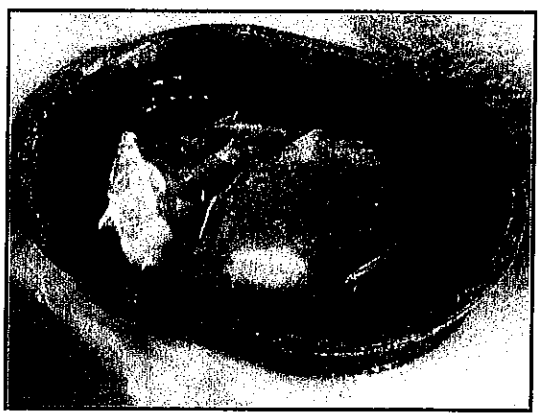


Figure 2.2 - Length-weight relationship for 30 blue suckers collected from the lower Colorado River, Texas.

Immediately before surgery, each fish was placed into a 100 quart ice chest containing a mixture of river water and clove oil as an anesthetic. Once fish became docile and lost equilibrium, a sharp scalpel was used to make a small 2-cm incision immediately behind the left pelvic fin. A 16-gram radio transmitter (LOTEK model #MBFT_3A, frequency range: 149.320-150.180) was then placed inside the peritoneal cavity of the fish, and the incision was closed with surgical sutures leaving the antennae exposed. Scissors were then used to remove a small clip from the anal fin of each fish for later genetic analysis (see section 3.4). A small Floy anchor tag was inserted near the dorsal fin of each fish to aid in identification. After surgery, iodine was used to disinfect surgical wounds, and fish were placed into a separate flow-through recovery tank in the river. Once fish had fully recovered (at least 45 minutes in recovery tank) they were released back into the river near the site of capture.

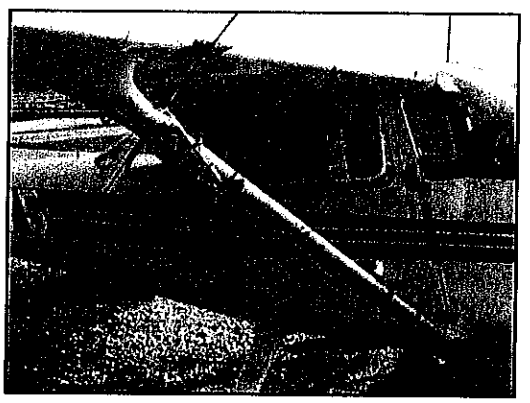




2.2 Tracking

Movement of tagged fish was monitored from time of release through 2007 by frequent mobile tracking excursions using an SRX_400 Telemetry Receiver (Lotek Wireless, Inc.) and an H-antenna. This receiver emits an audible signal of varying intensity to indicate proximity to the transmitter frequency being scanned. Most tracking was conducted by boat, with one person driving and one person operating the telemetry receiver and antennae. Once a signal was detected, an effort was made to get as close as possible to examine specific habitat use of tagged fish (see section 3.0). A strong audible signal at a low gain setting indicated close proximity to the tag. A GPS waypoint was then taken at the exact location of strongest signal strength using a handheld GPS unit (Garmin GPSMap 60CSx), and notes on date, time, general location, habitat, and confidence in location were recorded.

Mobile tracking was also conducted by fixed-wing aircraft on several occasions. When tracking by aircraft, the H-antennae was securely fastened to the wing of a small plane and the cord was run inside the cockpit to a person monitoring the receiver. To reduce the effects of engine noise on detection of audible signals, headphones were worn during aircraft tracking excursions. An experienced pilot then flew as low as possible along the river corridor. Although tracking by aircraft did not allow for specific microhabitat measurements, it was a more time efficient method to cover large expanses of river and provide general locations of tagged fish.



In addition to mobile tracking excursions, a fixed station receiver was established just upstream of the Altair tagging location at the LCRA's Eagle Lake Pumping Facility. A continuously monitoring telemetry receiver connected to two stationary antennas, one facing the river on each end of the facility, allowed detection of any tagged fish that passed by this facility. Data from this receiver was then downloaded to a laptop computer every 3-4 months.

2.2.1 2005

Tracking efforts from release (October 2004) through December 2005 resulted in 255 observations of tagged blue sucker locations. Results demonstrate that in spring 2005, several tagged fish made large upstream spawning migrations. In fact, 77% of fish considered alive at the end of the year had moved more than 1.2 miles from their initial tagging locations. Seven fish traveled over 100 miles upstream during spring 2005 (Table 2.2). The longest migration documented was a male blue sucker (149.640) that moved approximately 167 miles from the Altair riffle complex to the mouth of Onion Creek. As discussed in section 3.2, three fish that made large upstream migrations led the study team to a spawning aggregation of approximately 50 blue suckers congregated just downstream of Longhorn dam, which blocks further upstream migration.

Table 2.2 - Longest distances moved by radio-tagged blue suckers in 2005.

Tag #	Tagging Site	Sex	Distance Traveled (miles)	Farthest Upstream Point
149.640	Altair	male	167	Onion Creek
149.380*	Columbus	n/a	148	Low-Head Decker Lake Diversion Dam
149.420	Altair	male	139	Utley Site
149.660*	La Grange	male	115	Longhorn Dam
149.480	Altair	male	108	2.0 Miles Upstream of Upstream Smithville Site
149.600	Altair	male	106	Upstream Smithville Site
149.400	Altair	male	105	Upstream Smithville Site
149.720*	La Grange	female	87	Between Webberville and Utley
149.800*	Smithville	male	82	Longhorn Dam
149.860*	Bastrop	male	56	Longhorn Dam

* denotes fish that returned to their home riffles

Interestingly, the majority of these fish (65%) returned to within 0.6 miles of their initial tagging location during late spring and early summer 2005. For example, fish 149.380 traveled 148 miles upstream from the Columbus riffle to the Decker Lake Diversion Dam in early March, and then returned to the Columbus riffle by August. As a result of upstream spawning migrations and subsequent return trips downstream, several tagged fish moved 200-300 miles during the course of the year.

Differences in movement patterns were observed between male and female blue suckers. Of the male blue suckers tagged, 87% moved more than 1.2 miles during 2005, whereas only 50% of females migrated. Of the females that migrated, 100% returned to their home riffle by the end of the summer; however, only 57% of males returned.

Results suggest that males may be more mobile than females; however, more data are needed to confirm this observation.

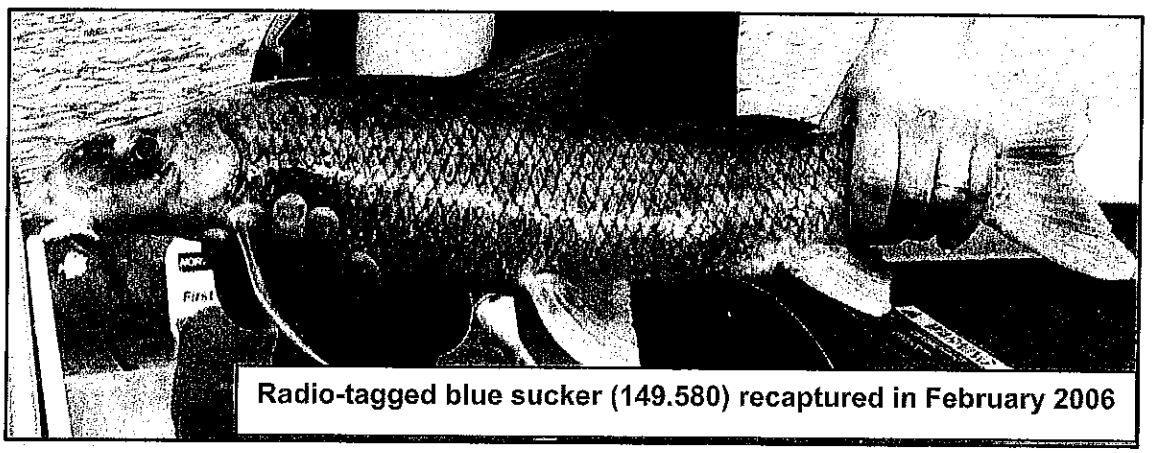
During tracking activities in 2005, three tags were recovered from the river bottom. Two of these tags never exhibited any substantial movement; however, one tag (149.480) made a large upstream migration from its tagging site near Altair to Smithville in May, and was then recovered near La Grange in October 2005. In addition, four other tags had not moved in several return visits and were thought to be dead or shed as of December 2005. One tag (149.540) was not relocated during 2005. Despite this, 15 months after tagging 22 of 30 (73%) tags were still considered to be in live fish at the beginning of 2006.

2.2.2 2006

Tracking efforts from January to December 2006 resulted in 69 observations of tagged blue sucker locations. Movement patterns in 2006 were substantially different from those observed in 2005. Of the 15 live fish located in spring 2006, no large upstream migrations were observed. The largest upstream movement documented was fish 149.420 which was located approximately 1.9 miles upstream from its previous location. Nine fish which made upstream migrations in spring 2005 showed little to no upstream movement in spring 2006. Four fish which had stayed near their home riffles in spring 2005 did the same in 2006. Fish 149.800 moved several miles downstream in spring 2006.

Most movement documented the previous year corresponded to upstream spawning migrations in early spring, and resulting return trips in late spring and summer. Since no large upstream migrations were observed in spring 2006, tagged blue suckers moved very little over the course of the year. Over the entire year, only three fish moved distances of greater than 10 miles, all in a downstream direction.

One tagged fish (149.580) was recaptured at the Altair riffle with the help of LCRA biologists and electrofishing equipment in February 2006 (16 months after tagging). The fish was in good health, and the surgery wound had healed well. The small Floy tag placed near the fish's dorsal fin during surgery was no longer present. This fish was subsequently released unharmed, and was relocated several times after being recaptured.



Radio-tagged blue sucker (149.580) recaptured in February 2006

Four more tags were recovered in 2006, bringing the total number of recovered tags to seven. Additionally, five tags were considered to be dead or shed by the end of the year because they had not moved in several return visits. Tag 149.540 had still not been located since release. The remaining 17 tags were still considered to be in live fish at the beginning of 2007.

2.2.3 2007

Tracking efforts in 2007 resulted in 12 observations of tagged blue sucker locations. As expected, decreasing battery power in tags and increasing mortality/shedding rates negatively influenced tracking success. Additionally, extremely high flows prevented tracking during early summer 2007.

Again, no large migrations were observed in 2007. Five tagged fish thought to be alive were relocated in spring 2007 in or near their home riffle. Three of these fish had exhibited upstream migrations in 2005, whereas two of them had not moved substantial distances from their home riffle during the course of the study.

The final tracking session was conducted in August 2007. Although tracking success was low due to tag failure/shedding and higher than normal flows, several tags were located which were thought to be in live fish. Again, most fish moved little from their home riffles during the course of 2007.

2.2.4 Movement Summary

Twenty-nine tags were relocated at least twice since release in October 2004. One tag (149.540) was never relocated and is thought to have malfunctioned. From the remaining 29 tags there were 337 total observations over a 34 month period (Table 2.3). Several tags were located over 10 times during the course of the study. Although several tags were eventually shed (seven were recovered), this is to be expected given the high-velocity rocky habitats occupied by blue suckers. Recovered tags often exhibited twisted and mangled antennas, suggesting that they had perhaps become tangled in the substrate and thus pulled from the fish's body. Despite the number of shed tags, overall tag retention was good and tracking data provided extremely valuable information on movement of blue suckers in the lower Colorado River.

Table 2.3 - Number of relocations and final status of each radio-tagged blue sucker.

Tagging Location	Frequency	Sex	Number of Observations	Final Status
Columbus	149.320	F	10	Dead or shed
Columbus	149.340	U	11	Tag recovered
Columbus	149.360	U	7	Dead or shed
Columbus	149.380	U	12	Alive
Altair	149.400	U	8	Dead or shed
Altair	149.420	M	9	Unknown
Altair	149.440	F	22	Alive
Altair	149.460	U	8	Dead or shed
Altair	149.480	M	6	Tag recovered
Altair	149.500	M	2	Dead or shed
Altair	149.520	U	8	Tag recovered
Altair	149.540	M	0	Unknown
Altair	149.560	F	9	Unknown
Altair	149.580	F	20	Alive
Altair	149.600	M	10	Unknown
Altair	149.620	M	18	Alive
Altair	149.640	M	11	Dead or shed
La Grange	149.660	M	11	Tag recovered
La Grange	149.680	M	9	Tag recovered
La Grange	149.700	M	12	Tag recovered
La Grange	149.720	F	15	Alive
La Grange	149.740	F	16	Unknown
La Grange	149.760	M	12	Alive
Smithville	149.780	M	14	Alive
Smithville	149.800	M	13	Alive
Bastrop	149.820	F	15	Tag recovered
Bastrop	149.840	M	8	Unknown
Bastrop	149.860	M	17	Alive
Bastrop	149.880	M	10	Unknown
Bastrop	150.180	M	14	Alive

In summary, movement patterns of tagged blue suckers differed substantially between years. During the first year of tracking (2005) most tagged fish made large upstream spawning migrations in early spring and the majority returned downstream by the end of summer. However, in the following two years (2006 and 2007) no large spawning migrations were observed. For example, Figure 2.3 demonstrates movement of fish 149.720 throughout the study period.

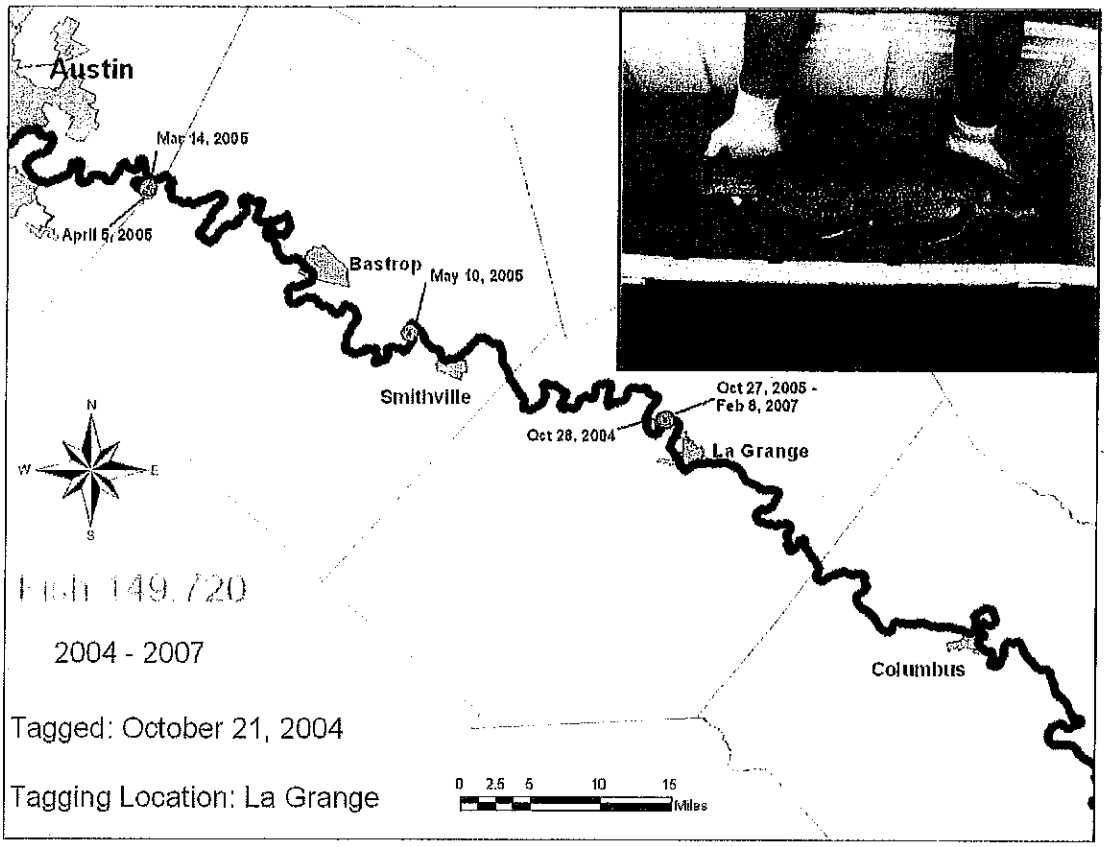


Figure 2.3 – Movement of fish 149.720 in the lower Colorado River, Texas.

Differences in movement patterns of tagged blue suckers among years were most likely a result of significantly different flows during spawning periods (Table 2.4). Large precipitation events in late winter and early spring 2005 led to consistently high flows throughout this period, whereas drier conditions in 2006 resulted in much lower flows. In 2007, flows were low throughout much of the early spring (i.e., February), but were punctuated by high flow events in January and March.

Table 2.4 - Average monthly discharge at Austin, Bastrop, and Columbus for January through April 2005-2007.

USGS Stream Gage	Average Monthly Discharge (cfs)			
	January	February	March	April
Winter/Spring 2005				
Austin (08158000)	2,154	2,274	5,719	2,183
Bastrop (08159200)	2,400	2,759	6,740	2,874
Columbus (08161000)	3,063	4,614	7,367	3,179
Winter/Spring 2006				
Austin (08158000)	188	209	456	965
Bastrop (08159200)	350	374	711	1,267
Columbus (08161000)	369	416	663	1,134
Winter/Spring 2007				
Austin (08158000)	431	214	354	354
Bastrop (08159200)	2,212	423	1,636	849
Columbus (08161000)	3,498	519	3,309	1,806

3.0 HABITAT USE AND LIFE HISTORY

Tracking data not only provided information on movement and migration of blue suckers, but also allowed the study team to monitor habitat use of tagged blue suckers. This data is summarized in section 3.1. Tagged blue suckers also led the study team to numerous spawning aggregations during the course of the study. A summary of spawning observations from these areas is provided in section 3.2. To provide further information on life history, the project team sampled extensively for larval and juvenile blue suckers. A summary of activities and subsequent results associated with this task are provided in section 3.3.

3.1 Adult Habitat Use

When tracking was conducted by boat, an effort was made to get as close as possible to examine specific habitat use of tagged fish. This was usually done by wading into the area with the receiver and antenna in hand until the strongest signal strength was observed. Often, as the study team would close in on a tagged fish, signal strengths would suddenly become weaker as the fish moved away from the area. Once the best estimate of a fish's initial location was obtained, a GPS point was taken, and habitat measurements were collected. Depth, velocity, and dominate substrate were recorded. Water depth (ft) and velocity (ft/s) were measured using a Marsh-McBirney Flowmate Model 2000 portable flowmeter and incremental wading rod at five points representing the center and the corners of a hypothetical square encompassing the tagged fish's initial location. Dominant substrate was classified at each point as silt, sand, gravel, cobble, boulder, or bedrock following the standard Wentworth scale based on particle size. Occasionally, water depth and velocity were too high to allow for specific habitat measurements.

Habitat data (depth, velocity, and dominate substrate) collected in the immediate area of blue suckers located during tracking activities demonstrates that adult blue suckers occupy relatively deep, high-velocity habitats similar to those reported in the literature. Depths ranged from 1.4 - 8.0 feet (average = 3.4), and velocities ranged from 0.2 - 4.8 feet/second (average = 2.4). Substrates in areas where blue suckers were present were most commonly bedrock (41%), gravel (33%), and cobble (16%), and occasionally boulder (9%) and sand (2%) (Figure 3.1).

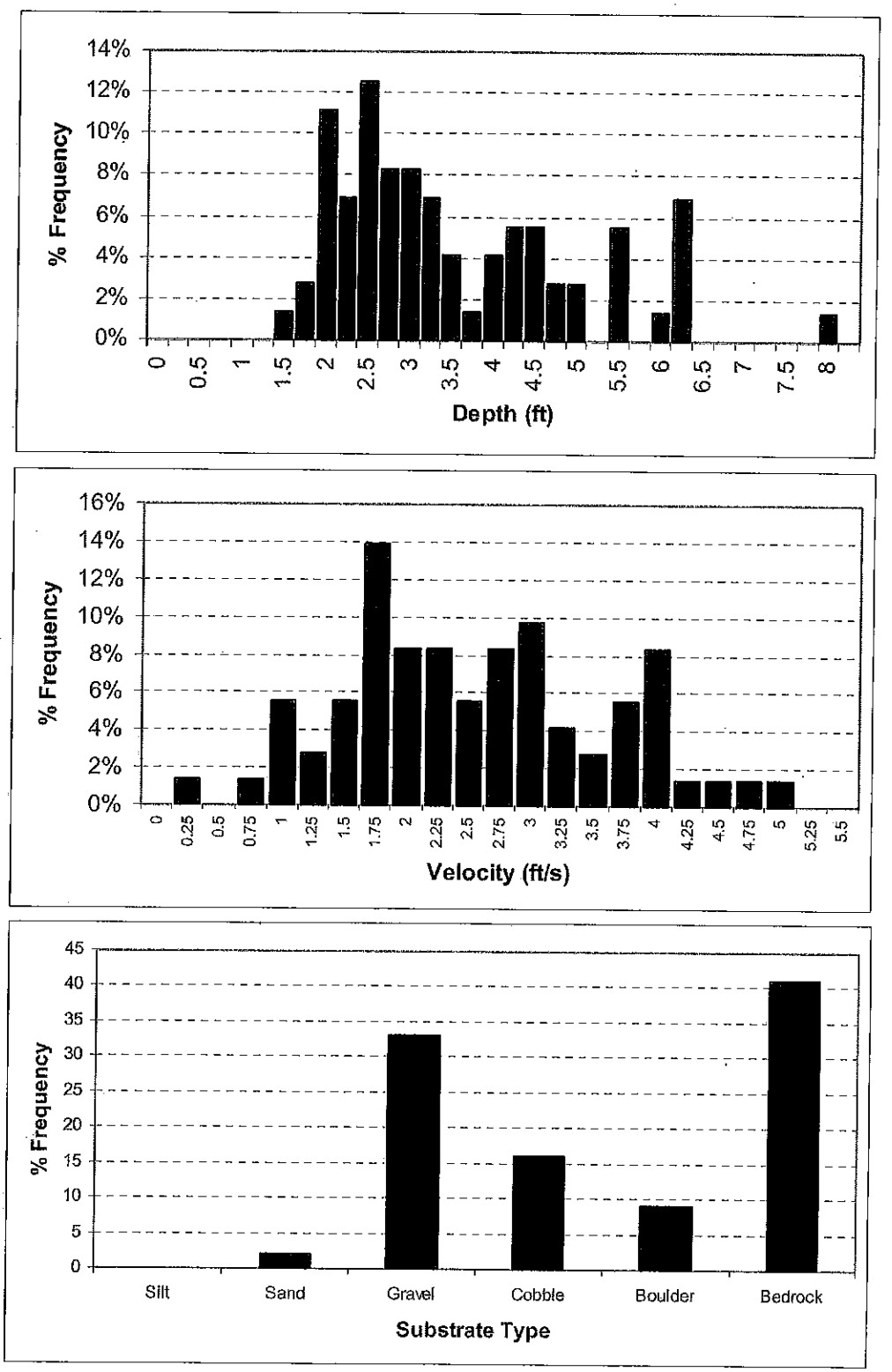


Figure 3.1 – Distributions of depth (ft), velocity (ft/s), and dominant substrate in locations of tagged blue suckers.

3.2 Spawning Observations

Several blue sucker spawning sites were identified by the project team over the course of the study. Detailed depth, velocity, and substrate measurements were taken at each site. The following is a description of study sites identified each year, and a summary of overall results.

3.2.1 2005

On March 13, 2005 three tagged blue suckers (149.660, 149.800, and 149.860) led the study team to a spawning aggregation of 40-50 adult blue suckers immediately below Longhorn Dam. Coincidentally, this occurred on a day in which water was being held in Town Lake for a regatta race and the 7,000+cfs that had been occurring in the river downstream was reduced to <1,000 cfs for about a six hour period. The three tagged blue suckers (originally tagged in three different riffle complexes) had moved between 55 and 115 river miles to this area just below Longhorn Dam. Spawning behavior was first discovered at 1:30 pm and continued until a large amount of water was released at 5:20 pm (when the race was over) at which time the flows became too high to observe fish. The USGS gage indicated that discharge was between 770 cfs and 910 cfs during this time period. Water temperature was approximately 16 °C. Spawning behavior exhibited by this congregation of blue suckers included vigorous splashing and the dorsal region of the fish breaching the water surface in several areas. Pictures and video were recorded to document the spawning behavior.

As discharge below Longhorn Dam was >7,000 cfs during the entire following week, the project team had to wait until the following weekend when regatta races again allowed for brief but significant reductions in flow at the spawning location. The spawning habitat was thus revisited on Saturday, March 19, 2005 to evaluate if spawning behavior of blue suckers was still taking place. On this date, only 10 to 15 adult blue suckers remained in the area (including one radio-tagged fish), and the project team did not observe any spawning activity. Detailed velocity, depth, and substrate measurements were collected because flows (780 cfs to 975 cfs) were similar to that of the previous week when spawning activity was evident. Pictures and underwater video of blue suckers were again collected to document the observations. The underwater footage taken on March 19, 2005 included numerous close (<2 ft. distance) observations of adult fish, which were very docile and not readily disturbed by the observer and underwater video camera. Evidence of cleared areas of substrate was also documented with video and still images. The spawning area contained large boulders, cobble, and bedrock substrates. Depth measurements in the specific areas of spawning were fairly shallow (0.5 - 2.5 ft.), and velocities low (0.3 - 1.8 ft/s) compared to data recorded from radio-tagged adults collected during other times of the year. Included were several deeper holes (2.5-3.0 ft) that were absent of the filamentous algae growing in the shallower areas.

3.2.2 2006

Discharge during late winter and early spring of 2006 was much lower than in 2005 (see Table 2.4), and thus presented the study team with much more favorable conditions for spawning observations. Previous observations of spawning blue suckers on the

Colorado River by the study team and others had been made in early March. Therefore, in early February 2006 the project team initiated tracking efforts to determine the current location of all radio-tagged fish in the river, with the additional goal of documenting any potential spawning aggregations. These efforts led to documentation of three blue sucker spawning sites as described below.

The first spawning site was located on February 8, 2006, when the project team tracked a radio-tagged blue sucker (149.620) to a small aggregation (≥ 5 individuals) of adult blue suckers within the Altair riffle complex. Although the water was too turbid to accurately assess exact behaviors, the fish were congregated in a confined area (≈ 5 m x 10 m) of decreased velocity immediately below a ledge in the middle of the riffle with high-velocity chutes on both sides. The substrate in the area was dominated by bedrock, but also contained small amounts of gravel and cobble. Water temperature at the time was 15 °C. Upon closer examination hundreds of milky white eggs (≈ 2–4 mm diameter) were found attached to the underside of large cobble–sized rocks in the area. Depths in the area ranged from 1.0-2.0 feet, and mean velocity ranged from 0.3-2.7 ft/s.

Altair spawning site

On February 9, 2006, another aggregation of approximately 20 adult blue suckers was documented while searching for radio-tagged fish at the La Grange riffle. The fish were tightly congregated in a relatively small, high-velocity area near the head of the riffle with a mixed substrate of bedrock, gravel, and cobble. Depths in the area ranged from 1.5-2.3 feet, and mean velocities ranged from 0.6-3.3 ft/s. Water temperature at the time was 16 °C. Again, hundreds of milky-white eggs, identical to those collected at Altair, were found on the substrate in the area near the aggregation and immediately downstream. The project team collected several of these eggs for verification, and several minutes of underwater video were taken in an attempt to capture spawning behavior. Although no spawning was actually witnessed, the project team observed the aggregation for approximately one hour in which time most of the fish moved little from their initial location. Similar to the spawning aggregation documented in 2005, fish were fairly docile and were not readily disturbed by the observers.

Spawning site at La Grange

Blue sucker eggs

The third confirmed spawning location of 2006 was documented at a riffle complex within the Utley intensive model site on February 14. Although no fish were observed at this location, eggs identical to those found at Altair and La Grange were collected from the substrate along a fast, shallow, cobble riffle near the upstream end of the site. Several eggs were collected for verification, and habitat measurements were taken in the area of egg deposition. Eggs were scattered over a relatively broad area in depths ranging from 0.7-1.1 feet, and velocities of 0.6-1.1 ft/s. Immediately downstream of the egg deposition site, depths increased to approximately 4 feet. The water temperature at the time was 12 °C.

Eggs collected by the study team at La Grange and Utley were brought back to the BIO-WEST laboratory for verification. Visual examination of these eggs corresponded well with descriptions in the literature. Eggs collected at Utley were sent to Mike Bessert at the University of Nebraska for official verification. Mr. Bessert's PhD project describes population genetics of the blue sucker complex. Using both microsatellite and mitochondrial DNA markers, he confirmed that the eggs were in fact blue sucker embryos.

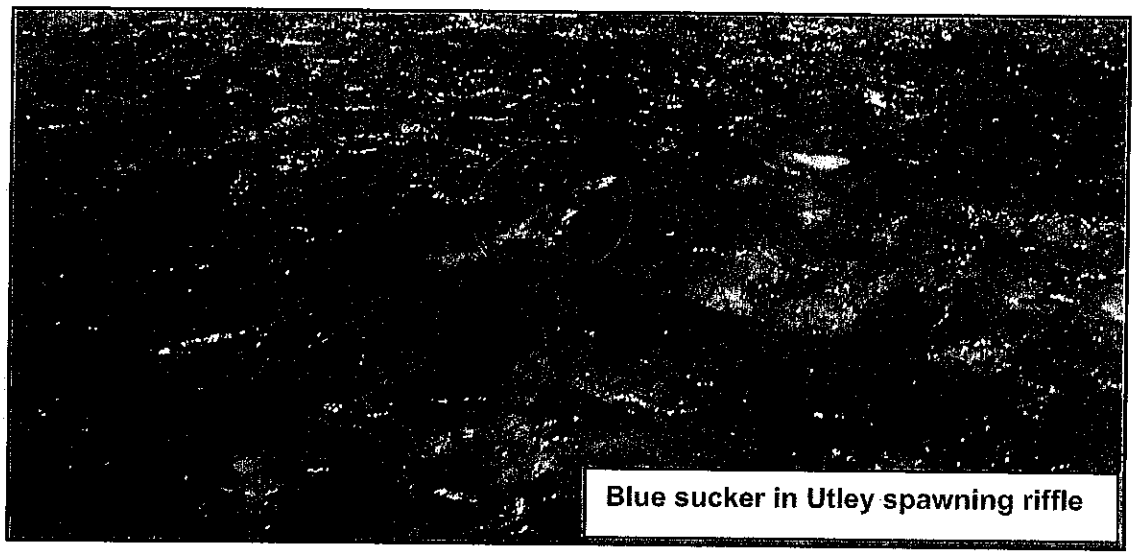
3.2.3 2007

Again in 2007, the study team initiated tracking efforts in early February with the goal of documenting spawning aggregations. Efforts in 2007 identified five spawning areas. Spawning was documented at the three previously discovered sites in the river near Altair, La Grange, and Utley, as well as a new site near Smithville. Additionally, reports from a local fisherman led to documentation of a spawning site in Onion Creek just upstream of its confluence with the Colorado River. The details of each spawning aggregation are documented below.

On February 7, 2007 the study team documented spawning blue suckers at the Utley riffle (in the same location as eggs were found in 2006). Approximately 50 adult blue suckers were congregated in a shallow riffle area over small to large cobble. Fish were seen forming tight congregations and vigorously rolling over, around, and between one another. This was often accompanied by splashing from the dorsal or caudal fin of the fish breaching the waters surface. Eggs similar to the ones found the previous year were discovered attached to cobble-sized stones immediately downstream of the observed

spawning congregations. Depths in the area ranged between 0.9 and 1.3 feet, and velocities ranged from 2.1 to 3.1 feet/second. Water temperature at the time was 15 °C.

In an effort to confirm if blue sucker eggs were hatching, drift nets were placed below the spawning site at Utley five days after spawning activity was observed. Several newly hatched larval fish were collected in the drift nets immediately below the spawning site over the next few days. Section 3.3 provides a more detailed description of methods and results associated with larval sampling efforts.



Blue sucker in Utley spawning riffle

On the morning of February 8, 2007 the study team located a new spawning area at a riffle just downstream of the boat ramp in Smithville. Although only 4 adult blue suckers were witnessed at the time, eggs were abundant in the area. The area of egg deposition consisted of a fast shallow riffle over gravel, cobble, and bedrock substrates. Depths in the area ranged from 0.7 to 1.3 feet, and velocities ranged from 0.4 to 4.4 feet per second. Water temperature at the time was 15 °C.

Later that day a spawning aggregation was documented at the previously discovered spawning site near La Grange. Approximately 100 adult blue suckers were observed exhibiting spawning behavior over fast bedrock chutes, and eggs were collected in the immediate area. Depths ranged from 1.4 to 2.6 feet, and velocities ranged from 2.3 to 5.1 feet per second. Water temperature at the La Grange riffle was 15 °C.

The following day (February 9, 2007) blue sucker eggs were discovered at the previously identified spawning area near Altair. Although no spawning fish were witnessed in this location, habitat measurements were taken around the egg deposition site. Depths ranged from 0.9 to 2.4 feet, and velocities ranged from 0.4 to 4.8 feet per second over a gravel and bedrock substrate.

Information provided by a local fisherman led to discovery of another spawning location near the mouth of Onion Creek on February 22, 2007. A local fisherman reported to the study team that he had witnessed 30-100 blue suckers engaged in spawning activity at a small riffle approximately 200 yards upstream of the mouth of Onion Creek on February 20, 2007. Two days later when the project team visited the location, blue sucker eggs were found on the substrate. Although no blue suckers were witnessed by the study team, measurements were taken in the area of egg deposition since flows in the creek had changed little over the previous two days. Depths in the area ranged from 0.6 to 1.9 feet, and velocities ranged from 0.8 to 3.8 feet per second. Eggs were deposited over clay bedrock and gravel, and the water temperature in the area was 15 °C.

Onion Creek

Later the same day the study team encountered another congregation of spawning blue suckers while tracking at Smithville. Approximately 50 to 60 feet (within the same riffle complex) from the original egg deposition site identified a few days earlier was a large congregation of 20-30 adult blue suckers (including tagged fish 149.780). Again, spawning behavior was witnessed and eggs were collected from the substrate. Depths ranged from 1.0-1.6 feet, and velocities ranged from 1.9-6.0 feet per second. Substrate in the area consisted of gravel, cobble, and bedrock. Water temperature at the time was 18 °C.

3.2.4 Spawning Summary

Over the course of the study the project team identified seven different spawning areas either by witnessing spawning activity or by collection of blue sucker eggs. At three of these sites spawning was documented in 2006 and 2007. Table 3.1 provides a brief summary of spawning observations made throughout the study period.

Table 3.1 - Summary of blue sucker spawning observations by the study team on the lower Colorado River from 2005-2007.

	2005	2006	2007
Time	March	February	February
Location	Below Longhorn Dam	Utley Bastrop La Grange Altair	Onion Creek Utley Smithville La Grange Altair
Observations	Spawning Activity 3 tagged fish from 3 different riffles traveled 56 to 115 miles	Spawning Activity Eggs found	Spawning Activity Eggs Found Larval Fish Collected

Habitat data collected at blue sucker spawning sites differed slightly between years (Figure 3.2). However, as more data were collected and more spawning sites were identified under various flow conditions (1 site in 2005, 3 sites in 2006, 5 sites in 2007) the project team achieved a more accurate assessment of spawning blue sucker habitat. Overall, results demonstrate that spawning habitat is considerably shallower but fairly similar in velocity to common adult habitats (Figure 3.3). Depths at spawning sites averaged 1.4 feet (range: 0.6-2.6), and velocities averaged 2.5 ft/s (range: 0.3-6.0). In addition, spawning substrates differed slightly from those used during other times of the year, and consisted mainly of cobble (38%), followed by bedrock (37%), and gravel (25%). Water temperatures observed during spawning surveys ranged from 12-18 °C; however, water temperatures were close to 15 °C when most actual spawning behavior was observed.

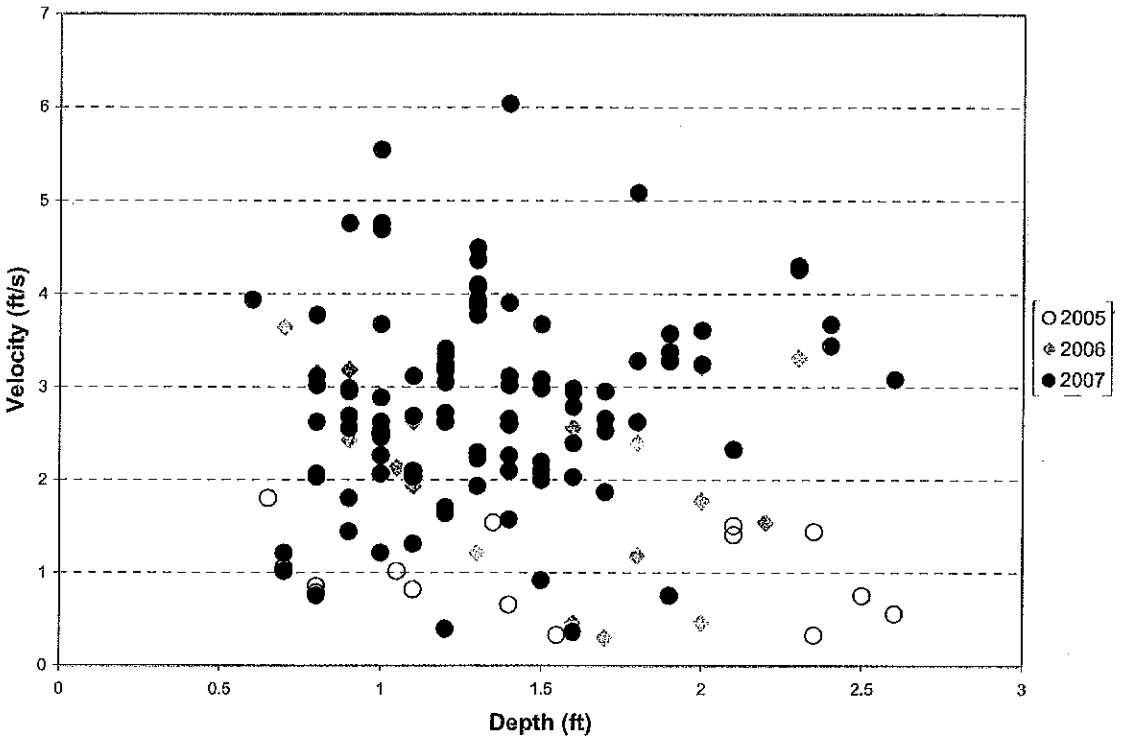


Figure 3.2 – Scatterplot of depths and velocities recorded at sites of blue sucker spawning activity in the lower Colorado River during 2005, 2006, and 2007.

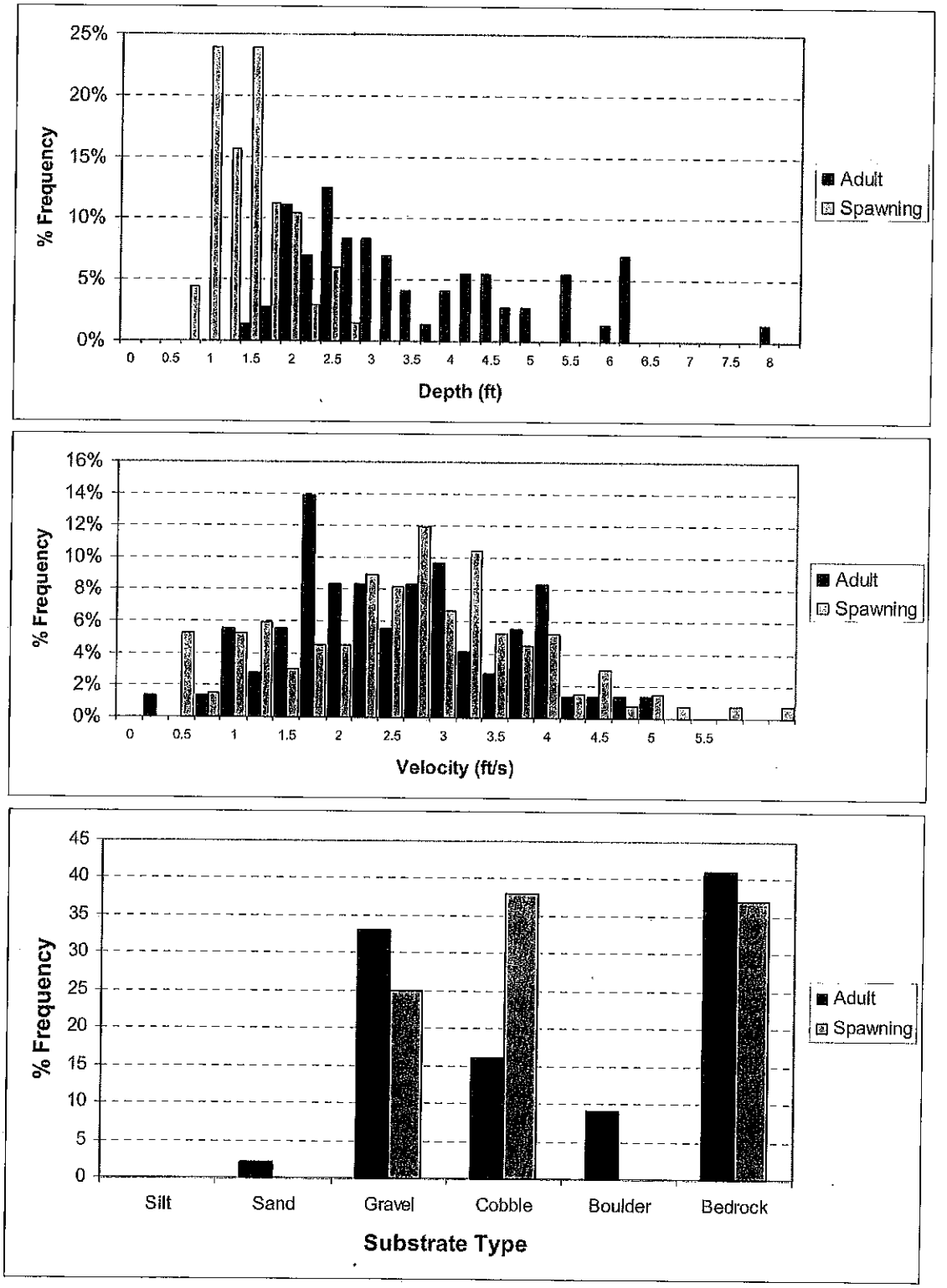


Figure 3.3 – Depth, velocity, and substrate used by spawning blue suckers in early spring (blue) and by adult blue suckers the remainder of the year (black).

3.3 Larval/Juvenile Observations

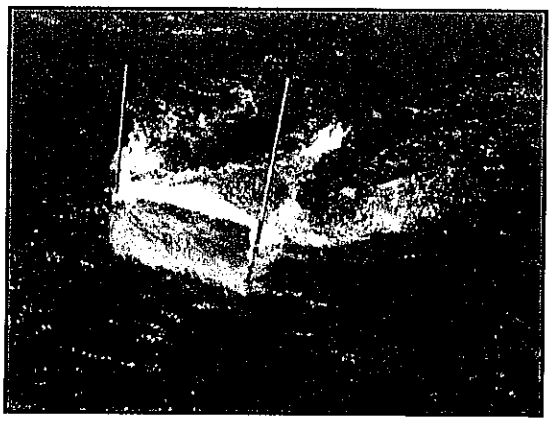
Little information is available regarding the early life history of blue suckers because of the scarcity of larval and juvenile blue suckers collected by researchers (Morey and Berry 2003). Although a few recent studies have predictably documented larval blue suckers in near-channel backwaters (Fisher and Willis 2000, Adams et al. 2006), most studies conducted on the species have yielded few, if any, juveniles. Inability to capture juvenile blue suckers has often been attributed to the behavior and habitat affinities of the species which make sampling difficult and inefficient (Morey and Berry 2003). Unfortunately, collections from the Colorado River exhibit the same trend as previous studies and are dominated by large individuals. This section provides a summary of the activities and results associated with larval and juvenile blue sucker sampling.

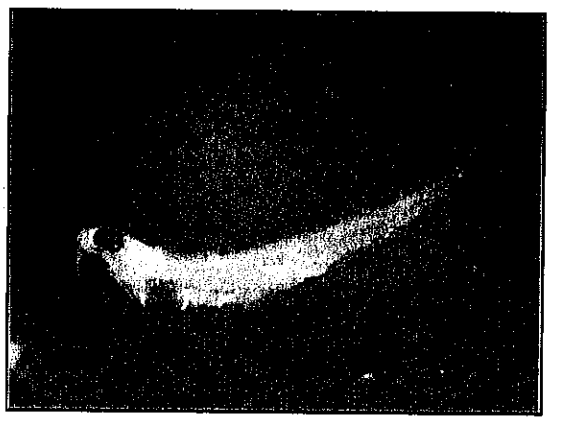
Extensive efforts by the project team aimed specifically at collection of larval and/or juvenile blue suckers began in spring 2005. After documentation of the spawning aggregation below Longhorn Dam in early March 2005 (see section 3.2) flows in the river were extremely high (>5,000 cfs) for several weeks. Sampling for juvenile blue suckers was initiated as soon as flows receded to levels amenable for sampling. In the late spring and summer of 2005 nine sampling trips were dedicated specifically to capturing juvenile blue suckers (Table 3.2). Despite extensive sampling using a variety of techniques, no juvenile blue suckers were captured in 2005.

Larval/juvenile sampling was reinitiated shortly after spawning was documented in early spring 2006. Flows during spring 2006 were much lower than the previous year and allowed for larval sampling shortly after spawning was observed. Beginning on March 9, the project team began sampling with standard larval fish techniques such as small-mesh larval seines and light traps. Initially sampling was focused near and downstream of known egg deposition sites; however, eventually a wide variety of habitats were sampled throughout the river. Given the fast initial growth rates of blue suckers (Moss et al. 1983), efforts switched to sampling for juvenile blue suckers in summer 2006. From July through November 2006 a variety of techniques (e.g., seines, boat electrofishing, barge electrofishing, Fyke nets) were used in multiple locations in an attempt to capture juvenile blue suckers (Table 3.2). Unfortunately, no juvenile blue suckers were captured in 2006.

The project team continued larval/juvenile sampling in spring 2007. Identification of blue sucker eggs in 2006 and 2007 provided confirmation that spawning was occurring in the lower Colorado River. Therefore, early efforts in 2007 focused on using fine-mesh, stationary, drift nets set immediately downstream of known egg deposition sites to determine if eggs were hatching. Spawning blue suckers were documented at Utley on February 7, 2007 (see section 3.2), and given that blue sucker eggs hatch approximately 6 days following fertilization (Semmens 1985), drift nets were placed immediately below the Utley spawning site on February 12, 2007. These nets were then checked once a day for the following three days and all contents were removed and brought back to the BIO-WEST laboratory for further examination. Examination of drift net contents led to identification of several small larval fish approximately 10 mm or less total length, as well as a number of blue sucker eggs which had been dislodged from the rocks upstream. All eggs were placed in an aquarium with river water, and observed for

hatching. One larval fish was collected from the aquarium and combined with the other larval fish collected in drift nets. Visual identification was difficult because of the size and condition of the fish collected; however, given that they were collected immediately downstream of a riffle where blue sucker spawning was observed and eggs were confirmed only a few days earlier, the study team is confident that they represent larval blue suckers. Although an attempt was made to confirm this with molecular techniques, DNA extractions from the larvae were unsuccessful.





Now confident that spawning was occurring and fish were hatching, efforts to document juvenile blue suckers continued in April 2007. On April 3-5, 2007, sampling was conducted using seines, experimental gill nets, and a backpack electrofisher near the spawning site in Onion Creek, and near Webberville, La Grange, and Altair. At each site, three experimental gill nets were set out overnight, and one day was spent sampling with seines and the backpack electrofisher. Following the April sampling event, high flows prevented juvenile sampling in late spring and early summer 2007. The next sampling trip was conducted on September 28, 2007 using boat and barge electrofishing techniques. Despite considerable effort, no juvenile blue suckers were observed.

In addition to efforts directed specifically at capturing juvenile blue suckers, the project team has conducted considerable larval/juvenile sampling while on the river for telemetry tracking activities. The team has also spent extensive time on the river collecting fish during habitat guild sampling (over 8,000 fish collected) and biological validation sampling (≈5,000 fish collected) related to the habitat modeling portion of this project. Through these efforts, the project team has gained extensive knowledge of habitat preferences for the entire lower Colorado River fish assemblage, including other Catostomid species (i.e., river carpsucker, smallmouth buffalo, and gray redhorse). The team has also collected and observed numerous adult blue suckers and has gained extensive insight into their habitat preferences. Unfortunately, lack of juvenile blue suckers in Colorado River collections has not allowed for quantification of their habitat affinities, and prompts concern regarding recruitment success of the species.

Table 3.2 - Dates, locations, and techniques used during larval/juvenile blue sucker sampling trips on the lower Colorado River, Texas between May 2005 and Oct. 2007.

Date	Location/Reach	Techniques Used
May 18, 2005	Webberville	Seines, Backpack electrofisher
May 19, 2005	Longhorn Dam	Seines, Backpack electrofisher
July 28, 2005	Smithville	Seines, Backpack electrofisher, Otter trawl
August 1, 2005	Webberville to Utley	Seines, Boat electrofisher
August 2, 2005	Downstream of Columbus	Seines, Otter trawl
August 3, 2005	Columbus	Seines, Otter trawl
August 4, 2005	La Grange	Seines, Boat electrofisher, Snorkeling
August 23, 2005	Utley to Bastrop	Seines
August 24, 2005	Downstream of Altair	Seines
March 9, 2006	La Grange	Seines, Boat electrofisher, Barge electrofisher
March 22, 2006	Utley	Seines, Light traps
March 31, 2006	Bastrop	Seines
April 4, 2006	Altair	Seines
April 5, 2006	Columbus	Seines
July 31, 2006	Utley to Bastrop	Seines, Boat electrofisher, Barge electrofisher
August 1, 2006	Upstream of Smithville	Seines, Boat electrofisher, Barge electrofisher
September 27, 2006	Altair	Seines, Fyke net, Cast net
September 28, 2006	Columbus	Seines, Fyke net, Cast net
November 29, 2006	Altair	Seines, Fyke net, Boat electrofisher, Barge electrofisher
April 3, 2007	Onion Creek to Webberville	Seines, Gill nets, Backpack electrofisher
April 4, 2007	La Grange	Seines, Gill nets, Backpack electrofisher
April 5, 2007	Altair	Seines, Gill nets, Backpack electrofisher
September 28, 2007	Webberville	Boat electrofisher, Barge electrofisher
October 1, 2007		Seines, Gill nets, Hoop nets, Boat electrofisher, Barge electrofisher

3.4 Genetics

Genetic samples were taken in the form of fin clips from the blue suckers caught during the tagging collection effort in the fall of 2004. A 1-3 cm^2 section of the soft tissue of the anal fin was taken from each fish after surgery was performed, and subsequently placed into a vial containing 95% ethanol for preservation. Fin clips were collected from all tagged fish at each site where sampling of blue suckers occurred (Altair, Bastrop, Columbus, La Grange, and Smithville). Upon completion of the tagging portion of the study, all genetic samples were sent to Mike Bessert at the University of Nebraska for analysis, where he was working on his PhD project assessing population genetics of blue suckers.

Throughout the study, the project team has stayed in contact with Dr. Bessert, who has now completed his dissertation. His molecular analyses suggest that the Rio Grande blue sucker population is genetically divergent, should be recognized as a separate species (a formal species description is currently being written), and is in need of special conservation concern. Based on his results he speculates that blue suckers, range-wide, are not terribly threatened. However, in addition to the Rio Grande species some local blue sucker populations are of concern--mainly those which are isolated by dams or occurring in disjunct drainages such as the Sabine River and Colorado River in Texas.

The major concern for the Colorado River population is reduced allelic richness. Allelic richness is a measure of genetic diversity, and scores from the Colorado River (4.521) are the lowest out of 27 drainages examined (range-wide mean = 6.870). Reduced genetic diversity could signify some type of recent founding event or population bottleneck. However, a more detailed analysis of the Colorado River population is needed to gain insight into the causes of this apparent reduced diversity.

4.0 SUMMARY

Radio-telemetry data indicate that spawning migration of blue suckers in the lower Colorado River is strongly tied to discharge, and is likely initiated by high flows. During high flows in early spring 2005, most tagged blue suckers made large upstream spawning migrations. However, during lower flows in spring 2006 and most of spring 2007 no spawning migrations were observed. Differences in migration patterns and discharge between years proffer one of two possible conclusions. Lower flows observed in spring 2006 and most of spring 2007 could have physically limited the normal spawning migrations of blue suckers due to the low water levels. Alternatively, higher discharge in spring 2005 could have resulted in inundation of normal spawning areas throughout the river, and thus forced a mass upstream migration to search for more suitable spawning habitat. Given that spawning was observed in several locations throughout the river in 2006 and 2007, and that high pulse events in 2007 should have allowed for migrations yet none were observed, the second alternative seems more feasible. However, even if large migrations only occur during high flow years when normal spawning areas are inundated, their importance to the population should not be overlooked. During years of lower flow blue suckers in the lower Colorado River evidently move little from their "home" riffle, and likely spawn with other members of the same riffle sub-population. Therefore, high flow years may serve as important dispersal mechanisms needed to stimulate gene flow between distant sub-populations from various riffle complexes. This is especially important given the reduced genetic diversity suggested by Dr. Bessert's molecular analyses.

Spawning activity of blue suckers in the lower Colorado River takes place at water temperatures similar to those reported elsewhere (12-18°C). However, as expected, spawning seems to take place earlier in the Colorado River than in more northern latitudes. Blue suckers spawn in late April and May at temperatures of 13-23°C in Kansas, Missouri, and the upper Mississippi River (Rupprecht and Jahn 1980, Moss et al. 1983, Vokoun et al. 2003). Mettee et al. (2003) noted peak spawning activity for southeastern blue suckers in the Alabama River was in late March at temperatures of 15-17°C, which corresponds well with other reports from the same region (Semmens 1985, Peterson et al. 1999). We documented spawning activity of blue suckers in central Texas in early February through early March depending mainly on water temperature. For example, spawning activity witnessed February 7-9, 2007 (water temp. ≈ 15°C) was followed by a severe cold front that dropped daytime high air temperatures from near 70°F to near 40°F for 3-4 days. During this period, water temperature dropped several degrees, and spawning activity ceased. However, after several days of warm weather and a subsequent increase in water temperature spawning was again witnessed on February 22, 2007 (18°C).

Although spawning was documented on several occasions, eggs were confirmed in 2006, and hatching was observed in 2007, no juvenile blue suckers were collected during the study. Previous researchers in other systems have had similar difficulty in collecting juvenile blue suckers due to the habitat affinities of the species (Morey and Berry 2003). Regardless, lack of juveniles in recent collections elicits concern regarding recruitment success of this state-threatened species in the lower Colorado River.

Habitat data collected during blue sucker telemetry efforts was used to create habitat suitability criteria (HSC) for use in the aquatic habitat modeling portion of the study. Development of HSC allowed the project team to model changes in habitat in relation to discharge for both spawning blue suckers and non-spawning adults. In addition, HSC were developed for five other habitat guilds consisting of up to eight species each (BIO-WEST 2007). Developing a flow regime that provides some habitat for each guild throughout the year promotes a healthy and diverse fish assemblage. As for blue suckers, specific habitat affinities demonstrate that maintenance of at least some deep, high-velocity rapids throughout the year is important for their continued success. However, perhaps even more important, especially given recruitment concerns expressed above, is maintenance of adequate amounts of spawning habitat in early spring months.

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Tab 3

Lower Colorado River, Texas Instream Flow Guidelines

Colorado River Flow Relationships to Aquatic Habitat and State Threatened Species: Blue Sucker

Prepared for

Lower Colorado River Authority

and San Antonio Water System

Prepared by

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March 31, 2008

Water Project

LCRA ENERGY • WATER • COMMUNITY SERVICES

San Antonio Water System

EXECUTIVE SUMMARY

The lower Colorado River downstream of Austin has been impacted by human activity for more than 100 years and there are currently diversions, return flows, low water dams, agriculture up to the banks, and other structural and non-structural modifications. Nevertheless, the river continues to support a diverse aquatic and riparian environment. This environment relies on the quality, quantity, and timing of water moving through the lower Colorado River basin. A major alteration to the natural flow regime of the lower Colorado River occurred with the completion of Buchanan and Mansfield Dams (1937 and 1940, respectively). The LCRA-SAWS Water Project (LSWP) also has the potential to alter characteristics of the flow regime, and thus, the Colorado River Flow Relationships to Aquatic Habitat and State Threatened Species: Blue Sucker Study was conducted. This study was developed to assess potential impacts or benefits resulting from the LSWP and address the environmental principles applied to the project.

Two of the environmental principles incorporated into the LSWP contract relate directly to the lower Colorado River aquatic and riparian environment. They specify that before LSWP implementation, studies must show that the project (1) "protects and benefits the lower Colorado River watershed and the Lower Colorado River Authority (LCRA) Service Area, including municipal, industrial, agricultural, recreational, and environmental interests"; and (2) "provides for instream flows no less protective than those included in the LCRA Water Management Plan (WMP) for the Lower Colorado River Basin, as approved by the Texas Commission on Environmental Quality." Additionally, the Texas Instream Flow Program (TIFP) has a legislative mandate (Senate Bill 2) to identify instream flow conditions that support a "sound ecological environment", which is described as "...a functioning ecosystem characterized by intact, natural processes, resilience, and a balanced, integrated, and adaptive community of organisms comparable to that of the natural habitat of a region." (TIFP Draft 2006). The respective resource agencies participating in the TIFP have participated in this study since its inception.

Streamflow acts as a "master" variable that directly and indirectly influences the full range of riverine resources and functions, including hydrology and hydraulics, biology (aquatic and riparian), geomorphology, and water quality. Intensive biological and physical data collection activities associated with these key study components were completed in 2004-2007. A detailed description of these activities can be found in BIO-WEST 2004, 2005, 2006, 2007. Chapter 2 provides an overview of each river study component while Chapters 3 and 4 document how study results were used to develop instream flow guidelines for the lower Colorado River.

In order to meet the environmental principles set forth for the LSWP and remain consistent with the TIFP objectives to conserve biodiversity and maintain biological integrity, the project team followed the recommendations of the NRC (2005) which has subsequently been endorsed by the TIFP (TIFP Draft 2006). The integration process involves four components of the hydrologic regime: subsistence flows, base flows, high flow pulses, and overbank flows. Hydraulic and habitat modeling, sediment transport analysis, and water quality modeling were used to support the development of

subsistence and base flow guidelines. Pulse, channel maintenance and overbanking flow recommendations were based on sediment transport analysis conducted during this study and a hydrologic analysis of existing and pre-1940 flow regimes.

To establish instream flow guidelines, physical habitat times series were computed based on two flow scenarios. These included the existing condition (1975 to 2004) and pre-1940 (from 1898 at Austin and from 1916 at Columbus through 1939). The existing flow scenario was included in the habitat time series analysis because 1) the field data (physical and biological) used for the hydraulic and habitat models, sediment transport analysis, and baseline riparian conditions were all collected under the existing flow regime, and 2) the present day geomorphic conditions, riparian zone, water chemistry, aquatic habitat, and biological resources have all been imprinted by the existing flow regime. Additionally, the water quality and biological data collected by LCRA over the past decade reflect good water quality and diverse biological communities. Therefore, an examination of the existing flow regime was deemed necessary to evaluate the potential for maintaining similar conditions. The pre-1940 "natural" flow scenario was included to be consistent with the guidance of the TIFP and Natural Flow paradigm. Even though the data collected for this study was done under the existing flow regime, using natural flow conditions as a reference for comparison often provides insight into the ecological variability of riverine systems.

An evaluation of the hydrology, habitat time series modeling results, sediment transport analyses, and water quality results indicated that the pre-1940 flow regime is different from the existing flow regime. A detailed description of these differences is provided in Section 4.2.3. The TIFP (TIFP Draft 2006) proposes, "The goal of ensuring a 'sound ecological environment' has been equated to maintaining the ecological integrity and conserving the biological diversity of riverine ecosystems. In order to meet these goals, the Agencies recognize the importance of maintaining the natural habitat diversity, hydrologic character, and water quality of river systems." For the ecological advantages discussed in Section 4.2.3 and to be consistent with the goals of the TIFP, the pre-1940 time period was selected to be used for the development of instream flow guidelines. Hardy et al. (2006) states, "Utilizing the characteristics of the natural flow regime as a "template" is widely accepted and applied at the international level ...."

Instream flow recommendations for five categories (subsistence, base, pulse, channel maintenance, and overbank flows) specific to the LSWP are recommended for the lower Colorado River (Table ES.1). The subsistence flow recommendations represent minimum conditions at which water quality is maintained at acceptable levels and aquatic habitats are expected to resemble those found during extreme conditions in a more natural setting. The base flow recommendations provide a range of suitable conditions with the goal of maintaining year to year variability and the ecological functions associated with this level of variability. Pulse flows provide a myriad of ecological functions including but not limited to nutrient and organic matter exchange, limited channel maintenance, flushing, vegetation scouring, and seed dispersal. Channel maintenance flows provide for the maintenance of channel capacity, while also flushing accumulated fine sediments from important gravel bar and riffle habitats, and scouring accumulated sediments from pool habitats. Overbank flows inundate low floodplain areas adjacent to the river providing for lateral floodplain and riparian

connectivity, floodplain maintenance and nutrient deposition, and recruitment of organic material and woody debris.

Table ES.1. Instream Flow Guidelines for the lower Colorado River specific to the LSWP.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
AUSTIN REACH												
Subsistence	50	50	50	50	50	50	50	50	50	50	50	50
BASTROP REACH												
Subsistence	208	274	274	184	275	202	137	123	123	127	180	186
Base-DRY	313	317	274	287	579	418	347	194	236	245	283	311
Base-AVERAGE	433	497	497	635	824	733	610	381	423	433	424	450
COLUMBUS REACH												
Subsistence	340	375	375	299	425	534	342	190	279	190	202	301
Base-DRY	487	590	525	554	966	967	570	310	405	356	480	464
Base-AVERAGE	828	895	1,020	977	1,316	1,440	895	516	610	741	755	737
WHARTON REACH												
Subsistence	315	303	204	270	304	371	212	107	188	147	173	202
Base-DRY	492	597	531	561	985	984	577	314	410	360	486	470
Base-AVERAGE	838	906	1,036	1,011	1,397	1,512	906	522	617	749	764	746

COLORADO RIVER DOWNSTREAM OF AUSTIN	
PULSE FLOWS	
Base	MAGNITUDE (2,000 to 3,000 cfs); FREQUENCY (8–10 times annually); DURATION (3–5 days)
High	MAGNITUDE (@ 8,000 cfs); FREQUENCY (2 Events in 3 year period); DURATION (2–3 days)
CHANNEL MAINTENANCE	MAGNITUDE (27,000 - 30,000 cfs); FREQUENCY (1 Event in 3 years); DURATION (3 days)
OVERBANK	MAGNITUDE (> 30,000 cfs); FREQUENCY and DURATION (Naturally Driven)

As discussed in Chapter 4, the Austin Reach has a subsistence flow recommendation whereas the Bastrop, Columbus, and Wharton reaches have proposed monthly regimes for subsistence and two levels of base flow. Pulse flows, channel maintenance flows and overbanking flows are currently the same amongst reaches.

The LSWP instream flow recommendations represent an ecologically balanced approach that takes into account hydrology, biology, geomorphology, and water quality with the goal of supporting a sound ecological environment in the lower Colorado River. The project team concurs with the TIFP and acknowledges that a critical component of all recommendations for this project is a long-term monitoring program to evaluate the effectiveness of the LSWP instream flow guidelines. In conjunction with long-term monitoring, adaptive management will be a vital component to assist in ensuring the success of the environmental principles associated with the LSWP and goals of the TIFP.

Table 4.9. Percent of maximum available habitat per month per reach for LSWP Subsistence Flow recommendations.

BASTROP REACH

Month	SUBSISTENCE Discharge (cfs)	Percent of Maximum Available Habitat: Rapid - Adult Blue Sucker	Spawning Blue Sucker	Deep Pools	Deep Run	Pools/Edges/ Backwaters	Shallow Runs	Riffles
January	**208**	16%	84%	60%	84%	91%	99%	89%
February	**274**	25%	91%	64%	88%	88%	100%	94%
March	**274**	25%	91%	64%	88%	88%	100%	94%
April	**184**	13%	82%	58%	83%	92%	99%	87%
May	**275**	26%	91%	64%	88%	88%	100%	94%
June	**202**	16%	N/A	59%	84%	91%	99%	88%
July	**137**	7%	N/A	55%	81%	94%	98%	83%
August	**123**	5%	N/A	54%	80%	95%	98%	81%
September	**123**	5%	N/A	54%	80%	95%	98%	81%
October	**127**	5%	N/A	54%	80%	94%	98%	82%
November	**180**	13%	N/A	58%	83%	92%	99%	86%
December	**186**	13%	N/A	58%	83%	92%	99%	87%
Annual Average		14%	88%	59%	83%	92%	99%	87%

COLUMBUS REACH

Month	SUBSISTENCE Discharge (cfs)	Percent of Maximum Available Habitat: Rapid - Adult Blue Sucker	Spawning Blue Sucker	Deep Pools	Deep Run	Pools/Edges/ Backwaters	Shallow Runs	Riffles
January	**340**	16%	88%	58%	89%	94%	99%	97%
February	**375**	19%	90%	59%	90%	93%	99%	98%
March	**375**	19%	90%	59%	90%	93%	99%	98%
April	**299**	12%	86%	56%	88%	95%	100%	96%
May	**425**	24%	93%	61%	91%	92%	98%	99%
June	**534**	33%	N/A	64%	93%	88%	96%	100%
July	**342**	16%	N/A	58%	89%	94%	99%	97%
August	**190**	5%	N/A	51%	82%	97%	99%	88%
September	**279**	10%	N/A	55%	87%	95%	100%	95%
October	**190**	5%	N/A	51%	82%	97%	99%	88%
November	**202**	5%	N/A	52%	83%	96%	99%	89%
December	**301**	12%	N/A	56%	88%	95%	100%	96%
Annual Average		14%	89%	57%	87%	94%	99%	95%

WHARTON REACH

Month	SUBSISTENCE Discharge (cfs)	Percent of Maximum Available Habitat: Rapid - Adult Blue Sucker	Spawning Blue Sucker	Deep Pools	Deep Run	Pools/Edges/ Backwaters	Shallow Runs	Riffles
January	**315**	N/A	N/A	40%	79%	91%	100%	96%
February	**303**	N/A	N/A	39%	78%	92%	100%	96%
March	**204**	N/A	N/A	34%	73%	96%	99%	88%
April	**270**	N/A	N/A	37%	77%	93%	100%	94%
May	**304**	N/A	N/A	39%	78%	92%	100%	96%
June	**371**	N/A	N/A	42%	80%	89%	99%	97%
July	**212**	N/A	N/A	35%	73%	96%	99%	89%
August	**107**	N/A	N/A	29%	66%	99%	97%	77%
September	**188**	N/A	N/A	34%	72%	97%	99%	87%
October	**147**	N/A	N/A	32%	70%	98%	98%	83%
November	**173**	N/A	N/A	33%	71%	97%	99%	86%
December	**202**	N/A	N/A	34%	73%	96%	99%	88%
Annual Average		N/A	N/A	36%	74%	95%	99%	90%

Tab 4

THE POWER TO MAKE A DIFFERENCE.

Instream Flows for the Lower Colorado River

Reconciling Traditional Beneficial Uses With
the Ecological Requirements of the
Native Aquatic Community

Lower Colorado River Authority

FINAL REPORT

June 1992

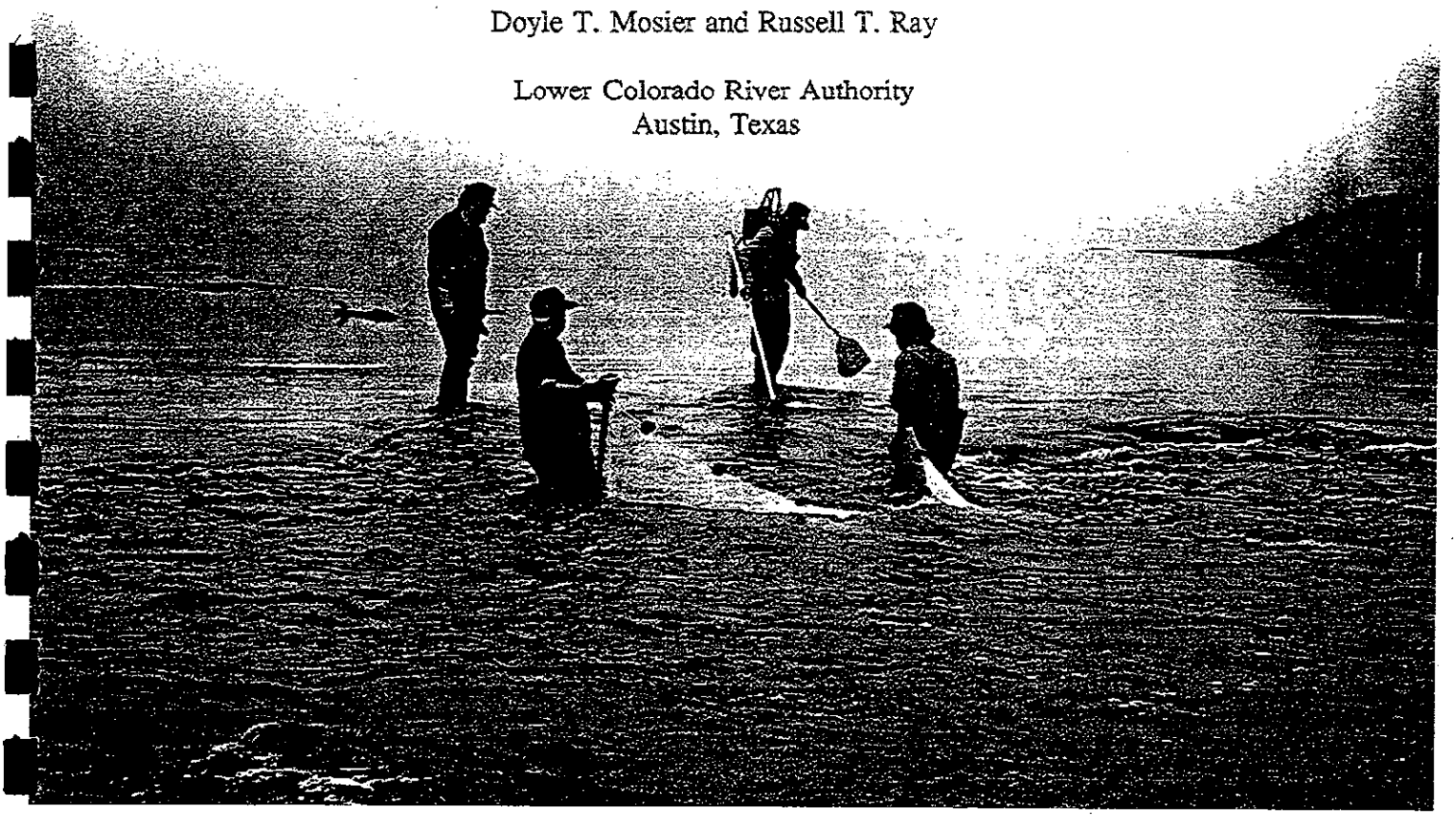
Instream Flows for the Lower Colorado River:

Reconciling Traditional Beneficial Uses With
the Ecological Requirements of the
Native Aquatic Community

Prepared by:

Doyle T. Mosier and Russell T. Ray

Lower Colorado River Authority
Austin, Texas



LOWER COLORADO RIVER AUTHORITY
INSTREAM FLOW STUDY

EXECUTIVE SUMMARY

The impact of reservoir construction and subsequent management strategies for economically beneficial uses on the native aquatic communities of impacted streams is increasingly becoming an area of concern for natural resource managers. Reservoirs built for flood control, hydropower and water supply are operated in such a manner as to alter the natural flow regimes of the impounded stream. Consequently, these activities may have a substantial impact on the structure of the natural community assemblages of rivers and streams.

As mandated in the 1988 adjudication of the Lower Colorado River Authority's (LCRA) water rights in the lower segment of the Colorado River, the LCRA and the Texas Parks and Wildlife Department (TPWD) performed a cooperative study to investigate the instream flow needs of the fish community native to the Colorado River downstream of Austin. This study provides the basis for a series of flow recommendations designed to mitigate the impacts of LCRA's water management strategies on the aquatic community of the Colorado River.

The following schedule of flows takes into consideration the water quality and physical habitat requirements of the fish community native to the Colorado River.

Subsistence and critical flows: Since all City of Austin wastewater plants discharge into the Colorado River downstream of Highway 183, return flows of treated effluent bypass the Austin gage, effectively dewatering parts of the river immediately downstream of Longhorn Dam when no releases are being made from the dam. Flows of less than ten cfs have been common at this gage during the non-irrigation season although flows are substantially higher immediately downstream. Although this segment does not have the capacity to support a balanced, natural community due to its proximity to the dam, a minimum flow should be maintained in this reach. A review of historical flow records indicate that flows seldom fell below 50 cfs during dry periods before impoundment by the Highland Lakes. It is recommended that a flow of at least **46 cfs** be maintained at the Austin gage at all times. This is the 7Q10 (the seven-day average low flow expected to occur every ten years) for the Austin gage based on the period of record prior to impoundment by the Highland Lakes (1898 to 1940). Maintenance of low flows at the Austin gage will require the City of Austin to alter operational procedures at Longhorn Dam to avoid pulsed discharges from the dam's automatic gates.

A mean daily discharge of greater than **120 cubic feet per second** as measured

at the Bastrop Gage should be maintained at all times except March, April, and May (critical flow months) in order to provide adequate water quality conditions in the Colorado River. This is a minimum flow based on the Texas Water Commission's standard of a daily average of greater than five milligrams per liter dissolved oxygen and meets the criteria for the high quality aquatic habitat designation in segment 1402 and 1428. Model simulations indicate that this discharge will provide a minimum daily average of greater than six mg/l dissolved oxygen throughout most of segment 1428. This recommendation is based on the assumption that the City of Austin will maintain an effluent quality at or above current levels and amend their TWC permits to require that they meet those standards in the future. Minimum flow recommendations should be considered subject to revision as predictive capabilities are improved.

The seasonally adjusted target flow recommendations given below are largely adequate to meet the critical flow requirements for the target species during the spawning season. However, until more information on the flow requirements of the Blue Sucker (*Cycleptus elongatus*) during critical periods are available, it is recommended that flow be maintained at or above **500 cfs** at Bastrop for a continuous period of not less than six weeks during the months of March, April, and May. Further studies on the life history of the Blue Sucker in the Colorado River are needed.

Subsistence and critical flows are classified as a non-interruptible demand on water resources and instream flows should be maintained at or above these levels at all times.

Target flows: A schedule of flows that provides an optimal range of habitat complexity to support a well balanced, native aquatic community was determined for each study reach. These flow regimes are considered an optimal range and should be maintained whenever water resources are adequate but should be classified as an interruptible demand subject to curtailment when water resources become limited during drought periods. Since native fish species are adapted to normal seasonal variations in flow regimes, target flows were adjusted monthly to emulate the annual cycle. It is interesting to note that the composite optimal flows are roughly equivalent to the historic median flows prior to impoundment. The following recommended target flows are based on the Bastrop study reach since this segment contains suitable habitat for the Blue Sucker (*Cycleptus elongatus*), listed as a threatened (protected nongame) species by the Texas Parks and Wildlife Department. Since diversions for irrigation have the potential to reduce flows significantly in the lower reaches, flows should be monitored at Eagle Lake and Egypt to assure that target flows for those reaches are also met (Attached Table).

Maintenance flows: Periodic spates of high flows are needed to prevent siltation and dense macrophyte growth. It is presumed that these flows would be provided by natural rainfall events but may occasionally require dam releases in excess of generation capacity for short periods. Frequency and duration of maintenance flows will be determined by examination of historical data on flow regimes and macrophyte growth patterns. Macrophyte studies are in progress.

These recommendations represent a balanced approach to instream flow requirements that take into account both natural flow regimes and water quality conditions needed to support a healthy, diverse native fish community downstream of Austin and should provide a strong technical foundation for the development of instream flow policy for the Lower Colorado River.

Schedule of Recommended Flows for the Colorado River Downstream of Austin:

Month	Subsistence/Critical Flows (cfs)		Target Flows (cfs)		
	Austin	Bastrop	Bastrop	Eagle Lake	Egypt
January	46	120	370	300	240
February	46	120	430	340	280
March	46	500	560	500[a]	360
April	46	500	600	500[a]	390
May	46	500	1030	820	670
June	46	120	830	660	540
July	46	120	370	300	240
August	46	120	240	200	160
September	46	120	400	320	260
October	46	120	470	380	310
November	46	120	370	290	240
December	46	120	340	270	220

[a] Since target flow at Eagle Lake (based on overall community habitat availability) were insufficient to meet Blue Sucker (*Cycleptus elongatus*) spawning requirements during March and April, target flows were superseded by critical flow recommendations for this reach.

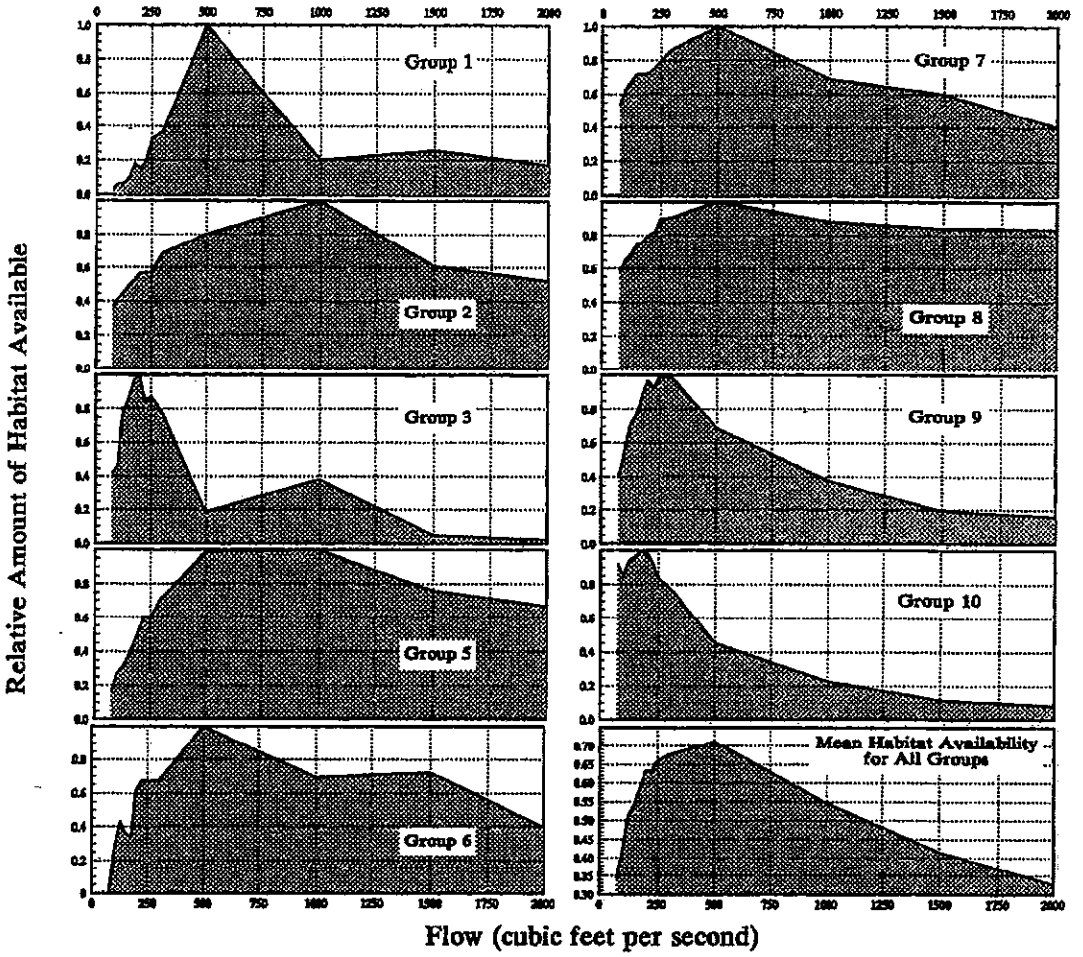


Figure 16. Relative habitat availability for fundamental habitat groups at Bastrop.

Smithville: The Smithville study reach contained habitat for all functional guilds except sandy runs (Group 4, spawning *Macrhybopsis aestivalis*) and adult blue suckers (Group 6). Habitat availability was more consistent over a wider range of flows for most guilds (Figure 17). Target flows were not dominated by requirements for a specific fundamental group.

Several *Cycleptus elongatus* were observed spawning in this study reach at the head of the rock outcrop that forms a section control (XSEC 7889) on March 9, 1989 at a flow of 225 cfs. Spawning occurred over a large cobble/boulder bottom contiguous to a bedrock outcrop in one foot of water at a velocity of 1.6 feet per second. The eggs appeared to be broadcast and drifted into the riffle immediately downstream of the spawning site.

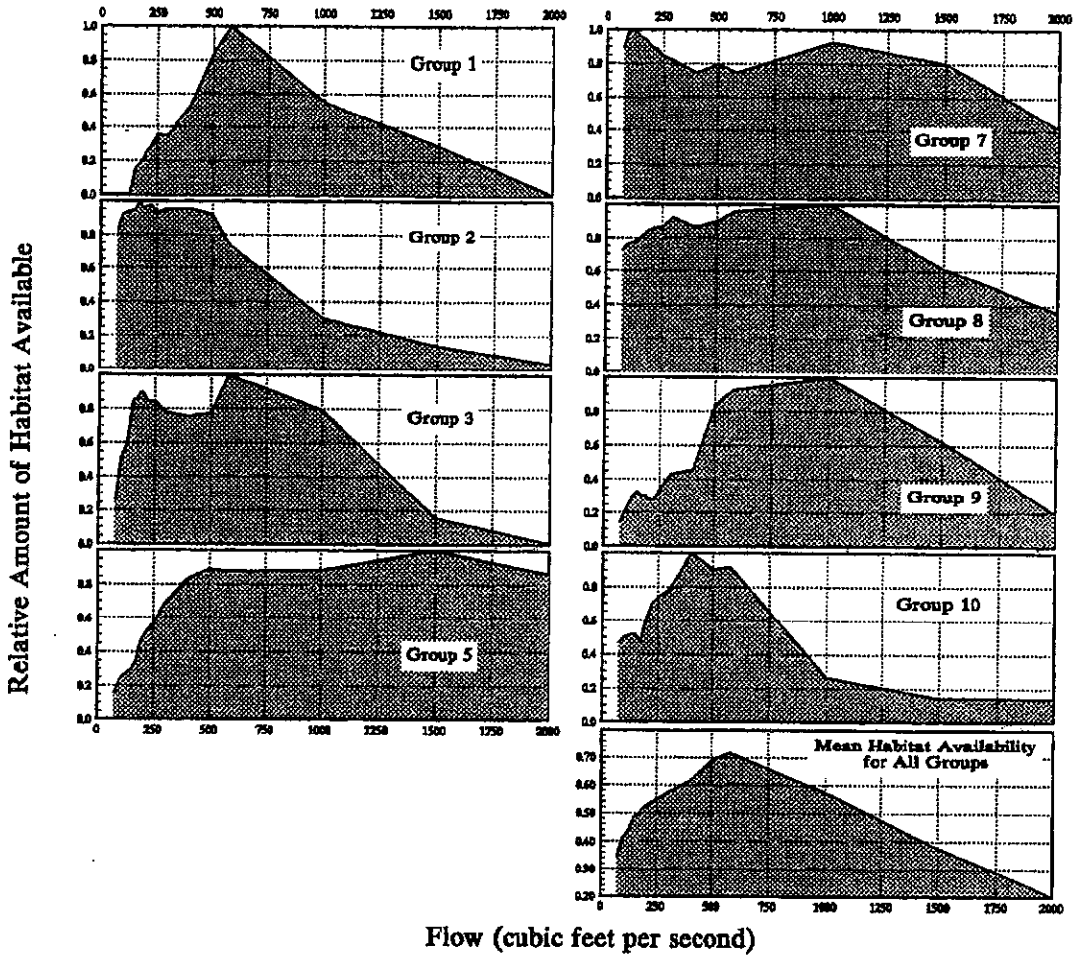


Figure 17. Relative habitat availability for fundamental habitat groups represented at Smithville.

Eagle Lake: One of the most extensive rock outcrops between Austin and the Gulf of Mexico is located in this study reach and appears to provide significant spawning habitat for the blue sucker. In February 1990, numerous tuberculate *Cycleptus elongatus* males in spawning condition were observed in the rapids and gravid females were collected in the pools immediately downstream. Since no females were observed in the rapids and no spent females were collected during this time, it is assumed that spawning had not commenced. Target flow to maintain community diversity at Eagle Lake was 400 cfs (Figure 18).

Egypt: The Egypt study reach lacked suitable habitat for *Cycleptus elongatus* adults but all other habitat groups were represented (Figure 19). This segment was the only one that included significant habitat for *Macrhybopsis aestivalis* spawning. A decrease in target flow (325 cfs) was for Eagle Lake due to differences in physical habitat availability.

APPLICATION OF THE LOWER COLORADO RIVER AUTHORITY FOR EMERGENCY AUTHORIZATION	§ § § §	**BEFORE THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY**

AFFIDAVIT OF NORA MULLARKEY MILLER

THE STATE OF TEXAS	§
	§
COUNTY OF TRAVIS	§

Before me, the undersigned authority, personally appeared Nora Mullarkey Miller, a person known by me to be competent and qualified in all respects to make this affidavit, who being by me first duly sworn, deposed as follows:

1. I am over 21 years of age, of sound mind, and have never been convicted of a felony or crime of moral turpitude. I am fully competent and qualified in all respects to make this affidavit.

2. The facts stated in this affidavit are within my personal knowledge and are true and correct.

3. I, Nora Mullarkey Miller, am an individual residing in Austin, Texas.

4. I have a Bachelor of Arts degree in Sociology from the University of Texas at Austin and a Master of Public Health degree from the University of Texas Health Science Center in Houston.

5. I have worked for the Lower Colorado River Authority (LCRA) for over 26 years. My current title is Water Conservation Supervisor. My experience is further detailed in the attached resume, attached under Tab 1.

6. As part of my duties at the LCRA, I am responsible for helping to prepare and implement LCRA water conservation plans and drought contingency plans.

7. I have had experience implementing mandatory water restrictions for the City of Austin, as well as for the LCRA water utilities.

8. The Drought Contingency Plan (DCP) for LCRA's firm water customers establishes what measures the LCRA will take during times of drought. (The DCP is included in Chapter 4 of LCRA's Water Management Plan. *See* 2010 Water Management Plan at 4-32.) Those measures are as follows: 1) when combined storage in lakes Travis and Buchanan is at or below 1.4 million acre-feet, LCRA encourages all of its customers to implement voluntary water conservation measures; 2) when combined storage in lakes Travis and Buchanan is at or below 900,000 acre-feet of water, LCRA asks its firm water customers to implement mandatory water restrictions, with a goal of decreasing water use by 10-20%; and 3) when

combined storage in lakes Travis and Buchanan reach 600,000 acre-feet of water, and upon a declaration of a Drought Worse than Drought of Record (DWDR) by the LCRA Board of Directors, LCRA will implement pro rata curtailment of its firm customers' water use, with a goal of reducing water use by 20% initially. If combined storage continues to drop below 600,000 acre-feet, the Board may implement further mandatory reductions. LCRA's rules provide for a temporary variance from these requirements only in the limited circumstance where a customer can demonstrate that the public health, welfare or safety is threatened. (*See* LCRA Water Contract Rules, Article 11, rule 11.14 available at: http://www.lcra.org/water/water-supply/water-supply-contracts/Documents/water_Water_Sale_Contract_Administrative.pdf.)

9. Further, in November 2013, the LCRA Board of Directors temporarily amended the firm customer Drought Contingency Plan to require that firm customers limit outdoor landscape irrigation to no more than once per week if on March 1, 2014 the combined storage in lakes Buchanan and Travis is below 1.1 million acre-feet and if interruptible stored water supply to customers in LCRA's Gulf Coast and Lakeside divisions and Pierce Ranch is cut off. This drought response measure will not require that customers achieve a specific percentage savings. As of March 1, 2014, the combined storage was below 1.1 million acre-feet and interruptible stored water supply to customers in LCRA's Gulf Coast and Lakeside divisions and Pierce Ranch wa cut off. As a result, the no more than once per week landcscape irrigation restriction is in effect.

10. To conserve water, LCRA has engaged in extensive water conservation efforts since 1989. Attached under Tab 2 is LCRA's Ongoing Water Conservation Initiatives and Drought Response Efforts Report, which provides more details about LCRA's water conservation and drought contingency planning and response efforts. Additional information can also be found in the 2009 LCRA Raw Water Conservation Plan, which is available electronically on LCRA's website at: http://www.lcra.org/water/save-water/Documents/2009_LCRA_Water_Conservation.pdf.

11. All of LCRA's firm customers that currently divert and purchase water from LCRA are required to have a drought contingency plan. As of March 2014, 100% of those customers (other than those with "temporary" contracts of up to three years and up to 10 acre-feet per year) have plans on file. LCRA has implemented a separate drought contingency plan for its domestic use and irrigation customers which fall under the temporary contract category. (*See* http://www.lcra.org/water/water-supply/water-supply-contracts/Documents/DU-Temp-DCP-with-Amendment.pdf.) Further, LCRA has a drought contingency plan that applies to its irrigation operations. (*See* 2010 WMP pp. 4-23 to 4-31.)

12. On August 23, 2011, combined storage in lakes Travis and Buchanan dropped below 900,000 acre-feet. LCRA has asked firm customers to implement their mandatory drought measures with a goal of reducing water use by 10-20%, as required by LCRA's DCP. The response of these customers is summarized under Tab 2, attached to my affidavit.

13. In the summer of 2008, the City of Austin, the LCRA West Travis County System, and Travis County Water Control and Improvement District No. 17 began requiring their retail customers to limit outdoor watering to twice a week. The City of Austin moved to require

limits on landscape watering to once per week during the fall of 2009, when LCRA asked customers to implement mandatory water restrictions as a result of reaching the 900,000 acre-feet combined storage trigger. Once the 2009 drought eased, the City of Austin decided to move back to the required twice weekly limit on landscape irrigation, but continued this on a year-round basis. In September of 2011, the City of Austin once again implemented the limitation on landscape irrigation to once per week for its retail customers due to hitting the 900,000 acre-feet combined storage trigger. Except for about a six week period in the summer of 2012, City of Austin customers have stayed in once a week restrictions for the past two years. Other major municipal customers are also currently in once per week watering restrictions. Together with the City of Austin, these customers represent nearly 95% of the population that receive raw water from the LCRA.

14. If a Drought Worse than Drought of Record is declared, LCRA's 2010 Water Management Plan provides that the firm customers' supply be curtailed on a pro rata basis, consistent with state law. In December 2010, LCRA obtained approval from the Texas Commission of Environmental Quality of its Water Curtailment Plan for Firm Customers. As of March 1, 2014, LCRA has pending or final pro rata plans for all of its firm water customers who are actively diverting water. LCRA is continuing to work with some of these customers to finalize the plans.

15. In evaluating potential water savings from drought response measures, I have reviewed a 2009 study by the Texas Water Development Board, "Drought Management in the Texas Regional and State Water Process." (Available at: http://www.twdb.state.tx.us/publications/reports/contracted_reports/doc/0804830819_DroughtMgmt.pdf.) The report estimates that implementation of the drought of record stage in the drought contingency plans of all municipal providers across Texas would reduce annual water demands by between 15 and 20 percent (based on information in the drought plans). According to the TWDB study, the measures required to achieve this level of savings would have some onerous effects on customers and would affect customers' quality of life and local economic conditions. The study team stated that some of the goals listed in the water suppliers' drought contingency plans were unrealistic and most were untested. For most providers in Texas who have implemented their drought contingency plans, there is limited or no data available regarding actual water savings during drought conditions.

16. In 2011 and 2013, LCRA conducted benchmarking research throughout the United States as well as Australia, to assess the effectiveness of drought response measures. The water providers interviewed stated that water savings between 15 to 40 percent were realized from implementation of mandatory drought restrictions. The timeframe for savings varied from six months to three years for wholesale providers and less for smaller, mainly retail providers. For some water suppliers such as the City of Atlanta, East Bay Municipal Utility District, and North Texas Municipal Water District water savings were below 15 percent for the first year of implementation. Atlanta had an initial reduction of 10 percent during the first year of drought restrictions but was able to receive an additional 14 percent when the state of Georgia declared a statewide drought emergency. A 40 percent savings was achieved in Australia after an extended period and included a ban on outdoor watering. Information obtained during the benchmarking effort can be found under Tab 3 and Tab 4.

17. Some LCRA customers have reported their estimated savings from drought restrictions imposed over the past two years. Those customers implementing the once per week limit on landscape irrigation are estimating savings of 15% or greater on an annual basis. This savings estimate is consistent with calculations performed by LCRA using 2007-08 winter water use compared with 2008 summer water use to develop a proxy of how much water might be used outdoors. Many municipal customers DCPs eliminate all outdoor spray irrigation under pro rata curtailment. Assuming winter use represents only indoor use for municipal customers, eliminating all outdoor water use might save somewhere between 15% to 25% on an annual basis. Completely eliminating outdoor water use is expected to create significant financial hardship for the landscape and irrigation community.

18. LCRA's TCEQ-approved Water Curtailment Plan for Firm Customers considers the extent to which customers have already implemented conservation and drought contingency measures in determining their effective required pro rata curtailment. Many of LCRA's customers sought and obtained modifications to their required curtailment based on a variety of factors, including conservation savings. In addition, some of the customers, including the City of Austin, have already implemented drought response measures that may bring them close to meeting the initial required reduction. However if water supplies continue to decline, the LCRA Board could adopt more stringent water reductions, thus requiring customers to implement additional measures.

19. LCRA continues to work with its firm customers in preparation for the possible implementation of pro rata curtailment.

Further affiant sayeth not.

Nora Mullarkey Miller
NORA MULLARKEY MILLER, AFFIANT

SWORN TO AND SUBSCRIBED before me on the 20th day of March, 2014.

TABETHA JASKE
Notary Public, State of Texas
My Commission Expires
January 11, 2018

Tabetha Jaske
Notary Public in and for the State of Texas

My Commission Expires: 1-11-2018

Tab 1

Nora Mullarkey Resume

Nora Mullarkey has 30 years of experience in water conservation. She began her work as a conservation coordinator at the City of Austin, where she oversaw water conservation plumbing retrofit programs and evaluated programs for water savings and cost effectiveness. For the past 26 years, Nora has been with the Lower Colorado River Authority (LCRA), and currently manages its water conservation program. In this capacity, Nora oversees the planning and implementation of conservation programs for LCRA firm and interruptible raw water customers, and provides planning and policy oversight on conservation issues affecting the LCRA and its customers. During this historic drought, Nora has managed the pro rata curtailment process for firm water in anticipation of reaching a drought worse than the drought of record.

While at the LCRA, Nora has also been responsible for environmental education programs and special community events such as volunteer water quality monitoring, household hazardous waste collections and river and lake cleanups. Before joining the LCRA, Nora worked as a water conservation specialist for the City of Austin and as a socioeconomic and land use specialist for Espey, Huston and Associates.

Nora is or has been involved in the following local, state and national water conservation professional activities:

- TCEQ Irrigation Advisory Council member
- TWDB Water Conservation Advisory Council, alternate
- Texas AWWA Water Conservation and Reuse Division Past Chair and current Water Conservation Subcommittee Chair
- Texas Legislative Task Force on Rainwater Harvesting member
- American Rainwater Catchment Systems Association Board member
- City of Austin Citizen's Water Conservation Advisory Committee

Nora received a Bachelor of Arts degree in Sociology and a Master of Public Health degree- both from the University of Texas.

Tab 2
Lower Colorado River Authority
On-going Water Conservation Initiatives and Drought Response Efforts Report

LCRA Water Conservation Overview

LCRA believes that water conservation will benefit its customers and is necessary for the long-term quality and sustainability of the lower Colorado River basin's water supply. LCRA has coordinated, and will continue to coordinate, with its customers and the public to implement innovative, effective and cost-efficient water conservation practices. LCRA has focused its conservation efforts on reducing the water used for irrigated agriculture, providing public awareness through outreach and education, and providing technical assistance and incentives to wholesale customers.

Municipal customers in the lower Colorado River basin also have been leaders in water conservation. As LCRA's largest municipal customer serving more than 80 percent of the population in the basin, the City of Austin has maintained one of the most comprehensive water conservation programs in the state for more than two decades. Austin's conservation efforts combine incentive programs with customer education, conservation ordinances and rules. In recent years, additional municipal customers in the LCRA basin such as Travis County Water Control and Improvement District (WCID) No. 17 have implemented irrigation evaluation programs and other water conservation efforts to effectively lower water use in their service areas.

Ongoing LCRA Water Conservation Efforts

Agricultural water conservation strategies

As the largest user of water from the lower Colorado River system, irrigated agriculture has provided one the best opportunities for LCRA to reduce the overall water demand through conservation programs. Beginning in 1986, LCRA initiated a major program to increase irrigation water use efficiency in rice irrigation systems. Between 1989 and 1997, the introduction of volumetric pricing and canal rehabilitation are estimated to have saved approximately 13 percent or about 41,500 acre-feet annually, of the projected water use that would have occurred without conservation practices in place.

House Bill 1437, passed by the Texas Legislature in 1999, authorizes LCRA to provide funds for the development of water resources or other water-use strategies to replace or offset up to 25,000 acre-feet per year of surface water transferrable to Williamson County. Guided by the HB 1437 implementation plan, a grant program was initiated in 2006 to help finance agricultural water conservation strategies both for structural improvements within LCRA irrigation divisions and for grants to agriculture producers. One of the main priorities on the list of conservation strategies to implement has been precision laser land leveling. Over the past five years, LCRA has provided up to 30 percent of the costs to the farmers for the implementation of this conservation measure on nearly 27,500 acres of land, with an estimated water savings of 7,760 acre-ft/yr.

In 2009, LCRA completed a short-term strategy report update, which recommended two major capital projects in the irrigation divisions in addition to continuation of the precision land leveling program. These projects are: 1) implementing volumetric measurement in the Garwood Irrigation Division, and 2) retrofitting and automating in-canal gate structures in the LCRA Irrigation Divisions. In late 2009, LCRA began implementation of a $1 million Garwood volumetric measurement project. Through this project, over 400 standardized water delivery and flow management structures were installed in the Garwood canal system, and 85 miles of canal laterals have been cleaned or rehabilitated. In addition, 139 miles of existing canals formerly managed by land owners are now managed by LCRA. Installation of 36 walk bridges and measurement piers at every delivery structure allow staff to collect accurate daily water measurements. Volumetric pricing was implemented for the first time in the 2012 irrigation season after two test seasons of daily water measurement throughout the Garwood canal system. A $100,000 grant was secured from TWDB in 2009 to assist with the Garwood measurement project.

In 2010, LCRA received a nationally competitive grant from the U.S. Bureau of Reclamation (USBR) to fund $257,000 or almost half of the Gulf Coast Gate Rehabilitation and Control project. This project replaced and automated eleven canal check structure sites (22 gates) within the eastern canal system of the Gulf Coast Irrigation Division. The grant funds allowed LCRA to pursue the installation of a supervisory control and data acquisition (SCADA) system to remotely monitor and control canal water levels at the gates. Three spill monitoring sites will also be monitored to quantify water loss from the canal system. The project construction, SCADA software interface, and radio communications testing have been completed and the new gates are ready to be fully utilized in the next irrigation season. In June 2013, TWDB awarded LCRA $101,700 to assist with additional gate structures in the Gulf Coast Irrigation Division. Combined, these measures are projected to meeting LCRA's 2009 water conservation plan goal to save an estimated 10,000 acre feet per year by 2014.

Municipal and Industrial Water Conservation Strategies

As a major water rights holder, the Lower Colorado River Authority (LCRA) is required to develop and implement a water conservation plan. In 1989, prior to the Texas Administrative Code, Chapter 288 rules, LCRA developed Rules for Water Conservation and Drought Contingency and required all new firm water customers applying for a new or modified water supply contract to develop plans in accordance with these rules.
As a wholesale provider of water, LCRA must work through its wholesale customers to save water at the end-user level. LCRA offers a variety of strategies to save water such as incentive programs through which LCRA partners with its customers to offer water-saving fixtures such as high-efficiency toilets or other technologies; requirements that new or updated contracts include conservation best management practices; and an expansion of LCRA's education outreach efforts to provide useful information to consumers.

LCRA is currently in its fifth fiscal year of implementing its current 2009 water

conservation plan. In the fall of 2009, LCRA modified its water conservation rules to require all customers have water conservation coordinators and provide annual plan implementation reports to LCRA. A Conservation Coordinator Committee now works in concert with LCRA to implement programs.

In 2010, LCRA began a residential indoor plumbing fixture replacement program where it provides free toilet vouchers and showerheads. LCRA wholesale customers are responsible for administering the program on a local level. Eleven wholesale customers have distributed 4,100 toilets and 2,290 showerheads since 2010.

Also in 2010, LCRA began offering water efficiency audits to commercial, institutional and industrial (CII) water users that directly or indirectly receive water from LCRA. Since then, 32 business and school water audits have been completed within the service area of six retail customers. In 2012, LCRA began a CII rebate program to offer incentives to replace commercial equipment up to a fixed dollar amount or cost per acre-foot saved, based on recommendations from water audits. Nine schools have participated in the rebate program, saving an estimated 24 acre-feet of water annually.

LCRA also began providing irrigation evaluation training to the staff of LCRA's wholesale customers. As a result, nine of LCRA's wholesale customers completed approximately 550 residential and 40 commercial irrigation evaluations between 2010 and 2012. In the summer of 2012, LCRA began offering evaluations directly to domestic users who have contracts with LCRA to use water from the Highland Lakes. Beginning this fiscal year, irrigation technology rebates are also available to wholesale customer end-users and domestic users if recommended as part of an irrigation evaluation. The rebates can be used for soil moisture sensors, rain sensors, pressure-regulating spray heads and other water saving irrigation technology. LCRA began offering the rebates in the summer of 2012, and three wholesale customers plan to offer them to their customers this year.

LCRA began a wholesale customer cost-share program in the spring of 2012. LCRA will pay up to $151 per acre-foot saved, assuming a 10-year project life, or 50 percent of the cost, whichever is less. So far, two customers have received cost-share funding; one for a project to replace a potable water line with a reclaimed water line to irrigate a park, and another to decrease utility water loss. The combined savings for these two projects is estimated at 67 acre-feet annually.

LCRA power plants have been implementing water conservation measures as well, as outlined in LCRA's 2009 Raw Water Conservation Plan. At the Fayette Power Plant, stormwater from the coal pile runoff pond is now being reused as cooling water instead of being discharged, and a project to convert from a wet to a dry ash handling system resulted in the closure of a 32- acre ash storage pond. Leak repair work is being completed with more efficiency, outdoor irrigation is done only as needed, and old plumbing fixtures have been upgraded at the Ferguson Power Plant. Combined, these measures have resulted in an estimated 270 acre-feet per year of water savings.

Finally, LCRA has been educating customers in its service area about water conservation through its public awareness efforts. Monthly conservation articles with supporting how-to videos are made available through LCRA WaterSmart Web site. In addition, the LCRA conservation team regularly staffs events and gives presentations with water conservation tips and other information throughout LCRA's service area.

Since 2009, these water conservation programs have conserved an estimated 2,700 acre-feet of water per year (450 million gallons per year). The savings is a combination of customer programs implemented directly with LCRA and programs customers implemented on their own, such as implementing TCEQ landscape irrigation standards, adopting mandatory water use restrictions, and LCRA power plant reuse and conservation projects.

LCRA administers an annual progress report survey to its customers and uses the Alliance for Water Efficiency water savings tracking tool to determine the progress of the conservation programs.

LCRA staff are currently updating LCRA's Water Conservation Plan, which is due for submittal to TCEQ on May 1, 2014.

Drought Response Efforts

As a wholesale water supplier, LCRA requires all of its firm municipal, industrial and irrigation water customers to prepare and submit drought contingency plans. The drought contingency plans are designed to reduce water demands through supply and demand management measures as a result of water supply conditions. Since it began requiring drought plans as part of its contract rules, LCRA has provided technical assistance and other relevant information to its wholesale customers during the planning process. In November 2010, LCRA staff began actively working with customers to update their drought contingency plans to be consistent with the LCRA drought plan. As of December 2013, 100 percent of customers who are actively diverting water have plans on file with LCRA.

Some measures thought of as drought response measures have the potential to become permanent water demand management measures. Four wholesale customers – Travis County WCID #17, Lakeway Municipal Utility District, West Travis County Public Utility Authority, and the City of Pflugerville – have adopted permanent landscape water restrictions from May through September each year. Their end users must follow a mandatory water schedule that limits outdoor landscape irrigation to no more than twice weekly and are prohibited from irrigating between the hours of 10 a.m. and 7 p.m. except with a hand-held hose. The City of Austin implemented a mandatory schedule in 2008 that corresponds to the same landscape restrictions, but is in effect year-round.

LCRA Drought Response—Customer Communications and Support

LCRA strives to maintain open lines of communication with all of its water customers. During the 2009 drought, LCRA hosted several work sessions with its firm water customers, particularly in the fall and winter of 2009 and in January 2010. The goals of the work sessions were for customers to share information on their mandatory drought response efforts and learn from each others' experiences and challenges, and for LCRA staff to introduce pro rata curtailment. Customers provided feedback on proposed pro rata curtailment rules, some of which were incorporated into the final pro rata contract rules.

As drought conditions worsened in 2011, LCRA focused on providing up-to-date, clear information to its customers and assistance with drought restriction implementation through sharing of resources and technical information. LCRA has held four customer meetings with its customers since July of 2011 to keep them updated regarding drought conditions.

July 2011 meeting
This meeting between LCRA and water customers focused on the seriousness of drought conditions, importance of water conservation, and timeframe for potential mandatory water restrictions. LCRA staff met with more than 60 people who represent many of LCRA's municipal and industrial raw water customers. Presentations included updates on the ongoing drought conditions throughout the lower Colorado River watershed, water storage projections, water conservation, and measures that LCRA has taken and will take under its state-approved plan if drought conditions worsen. LCRA informed its customers of what actions will occur when water storage levels fall below set triggers, including reducing releases for environmental needs, cutting back water for agricultural customers, and working with its wholesale municipal and industrial customers to implement mandatory water-use restrictions.

October 2011 meeting
The primary purpose of this meeting was to prepare customers for the possibility of pro rata curtailment in 2012. LCRA shared information on the current drought and water supply, explained the history and reasons for pro rata curtailment, and reviewed the process and procedures for implementing pro rata curtailment, and. Customers had the opportunity to express their challenges and issues with implementing pro rata curtailment.

January 2012 meeting
Almost 90 customers attended this customer meeting and were updated on a number of issues, including the drought, the weather outlook, the Water Management Plan and a new conservation incentive program. Those that attended also took part in a roundtable discussion on topics including: 1) the need to coordinate drought messages; 2) the importance of conservation education; 3) the challenges of enforcing drought measures;

and 4) the benefits and challenges of having a uniform watering schedule throughout the region.

August 2012 meeting
The drought was again on the agenda for this customer meeting. LCRA staff provided an update on the current drought and water supply situation, gave an update on the pro rata curtailment plan review process, and gathered customer feedback on the pro rata curtailment process. Over sixty customers attended this meeting.

Meetings in 2013
LCRA has held firm customer meetings on May 2, June 28, August 29 and November 15 of this year. The May meeting focused on customer curtailment plans and the possibility of mandatory pro rata curtailment later this year. At the June meeting, LCRA and its customers shared and discussed lessons learned from drought response benchmarking, approaches taken by various LCRA customers to implement drought response measures, and the additional steps that may be taken if pro rata is triggered and conditions continue to worsen. The August meeting continued the discussion of pro rata curtailment, including clarification that customers could modify current pro rata plans on file to add demand growth in 2012. Finally, at the November meeting, the 2014 emergency relief proposal as well as proposed changes to LCRA drought contingency plan rules for customers were discussed.

Meetings in 2014
A firm water customer meeting was held on January 31. The meeting included continuing discussions of the water supply outlook and drought response measures. Customers were also told that they would be receiving notice soon to update their pro rata baseline to include 2013 growth. Other topics included a discussion on the update of the LCRA water conservation plan and possible rate increases.

Other communication efforts
Combined storage of lakes Travis and Buchanan, two reservoirs constructed to store water supply, reached the milestone storage volume trigger of 900,000 acre-feet on August 24, 2011 under LCRA's Water Management Plan. As a result, the following day LCRA called on its wholesale firm water customers to implement mandatory water use restrictions under their individual drought contingency plans to reduce their water use by 10 to 20 percent. Information was sent out via a direct e-mail newsletter to customers, and certified letters. LCRA created a section titled "Water Use Restrictions" on the LCRA Web site that provides links to individual customers' water restrictions, including restrictions for LCRA water utility customers.

LCRA sent out a notice to customers on April 26, 2012 stating that while the combined storage levels had risen to over 1.0 million acre-feet, LCRA was requesting that customers continue implementing mandatory water restrictions until the combined storage increased to at least 1.1 million acre feet. When the combined storage dropped once more to less than 900,000 acre-feet on September 3, 2012, LCRA sent out a reminder to customers to implement mandatory restrictions. LCRA continues to update

the Water Use Restrictions page on the LCRA web site. The page shows which customers are in various stages of restrictions.

Customer drought response efforts

In September of 2011, 21 LCRA municipal customers and LCRA's retail water utilities began implementing mandatory water restrictions. Currently, all major municipal water customers are in mandatory restrictions, and in February 2014, customers representing nearly 95% of the total population served by the LCRA were limiting outdoor water use with a hose-end sprinkler or automatic system, not including drip irrigation, to no more than once per week. Other non-essential uses have also been curtailed. Major customers in once per week watering drought restrictions include Austin, Cedar Park, Pflugerville, Travis County WCID 17, Lakeway MUD and the West Travis County Public Utility Authority. Except for about a six week period in 2012, the City of Austin has been under once per week water restrictions since the fall of 2011. Most of the other municipal customers have been under mandatory restrictions of at least no more than twice per week watering since that time as well.

Many irrigation and recreation customers also informed LCRA of the water reduction measures they implemented to cut back their water use by 10 to 20 percent. Most golf courses reduced their overall water budget, while others scaled back on ornamental beds, area of irrigated roughs (areas not essential to the playability of a course), or other high water using areas.

LCRA industrial customers, who consist of power plants and a few large industries along the Gulf Coast, cut back on non-essential water uses, such as outdoor watering. However, these cutbacks likely have resulted in a very minimal savings. Any further cutbacks for industrial customers could result in a decrease in production.

Firm water customers were notified in February of the LCRA Board resolution that required a limit on ornamental landscape spray irrigation to once per week, beginning March 1, 2014. Customers must notify LCRA that they are implementing this restriction if they are not already implementing a once a week watering schedule. The deadline for notifying LCRA is March 31.

Pro rata curtailment preparation

The LCRA Water Management Plan requires LCRA to begin working with customers to develop pro rata curtailment plans once the 900,000 acre-feet combined storage trigger has been reached. As stated earlier, a customer meeting was held in October 2011 to begin this process and provide the customers with an opportunity to ask questions.

Customers were sent letters with their proposed water allotment, assuming a 20% curtailment, and given a deadline of February 15, 2012 to submit their plans. Those that did not submit plans by that time were automatically assigned a 20% pro rata allotment.

LCRA water conservation staff met with customers in person as well over the phone, and also responded to hundreds of emails to answer questions and assist customers in the development of their plans. Eighty-four customers submitted plans and 54 of those customers requested modifications. Customers were allowed to modify their water demand baseline for conservation, reuse, growth, outage, and alternative water supply. The last of the customer plans was accepted in July, 2012. As a result of modifications to the reference year baseline water use, the effective savings under pro rata curtailment would be 8%, with a range from 0% to 20%, depending on the customer. However, if water supplies continue to decline, the LCRA Board could adopt more stringent water reductions.

LCRA met with its firm water customers in May, June, August and November of 2013, and January of 2014 in further preparation for the possibility of the implementation of pro rata curtailment as discussed above.

Tab 3

Benchmarking Research on Drought Restrictions implemented in other Communities (Compiled in 2011)

	Atlanta, Georgia	Georgia (state-wide)	Aurora Water, Colorado	Denver Water, Colorado	Corpus Christi, Texas	North Texas Municipal Water District, Texas	East Bay MUD, California
Timeframe drought response measures implemented	2006-2009	9/1/2007 -2009	2002-2003	2002-2003	1984-1986, 1996, 2001	2005 -2006	1977, Late 1990s, Summer 2008-2009
Water Savings							
Percent Reduction Goal (overall)	10%	10%	Undefined ("as much as possible")	30% by Stage 3 (10%-20% previous stages)	Current goals (1%-5%-10%-15%) 1996 plan (10-5-10%) for stages 1-3	5%	15% Overall (Mandatory savings goals varied depending on customer class)
Percent Reduction Achieved (overall)	14-24% (water use remains at 17% below pre-drought)	~10%	32%	29%	30% (off of peak summer usage in 1980s) 11% savings in 1996 (although the goal at that time was 25%)	10-15%	12%
Tracking Water Savings	Monthly comparison to pre-drought for savings	Reports required of water providers	Monthly comparison to pre-drought for savings	Annual comparison to pre-drought for savings	Monthly	Monthly tracking of water use & reduction goal was emailed out to all member cities	Savings triggers were based off of expected production for that timeframe
Drought Response Measures							
Mandatory Watering Schedule	No Outdoor Watering (with exceptions)	No Outdoor Watering (with exceptions)	Twice weekly, no more than 15 minutes per zone	Twice weekly	Once every 5-day or 14-day schedule (depending on stage)	Varied depending on Member City	Recommended Schedule (no more than 3 days/week)
New Landscapes	Allowed if installed by professional & green industry certification received	Allowed (green industry represents significant jobs and impact on the economy)	Not allowed	Allowed (soil restrictions added)	Allowed, landscape plan must be submitted in advance	Member Cities Allowed	Allowed (New connections limited sod & required efficient irrigation systems)
Restrictions on Golf Courses	Tees and Greens exempt	Stage 4 – greens only (95% curtailment)	No more than twice weekly watering allowed	Difficulty with compliance	Time of day and day of the week restrictions	Tees and Greens exempt	30% Reduction Goal

	Atlanta, Georgia	Georgia (state-wide)	Aurora Water, Colorado	Denver Water, Colorado	Corpus Christi, Texas	North Texas Municipal Water District, Texas	East Bay MUD, California
Restrictions on Industrial Customers	10% reduction goal included industrial (large success from customers such as Delta Airlines, Georgia Aquarium)	10% reduction goal included industrial	Outdoor water use restrictions (Surcharges likely prompted conservation)	Surcharges & aggressive attempts to get reductions (plus rebates) led to process improvements for customers including Pepsi & Frito Lay	Surcharges for industrial customers if use is in excess of baseline minus a pre-defined percentage reduction goal	Only on outdoor water use	Industrial 5% Reduction Goal
Enforcement							
Enforcement Actions (for violations)	Fines (surcharges) on water bills	NA	Fines (surcharges) on water bills	Fines (surcharges) on water bills and flow restrictors	Citations	NA	EBMUD investigates customers who have not saved and installed flow restrictors
Surcharges as a Result of Excess Use	No	NA	Surcharges were added to bills (30% reduction applied to outdoor historical use)	Surcharges were added to bills for Denver retail (flat gallon amount applied)	Surcharges added to bills (for residential, commercial, industrial customers)	Some member cities added surcharges to bills	Drought rate structure took effect in 2008
Additional Staff Needed	5 inspectors plus hotline staff added	NA	Aurora: 8 hotline and 15 patrol staff added	Denver added ~10 staff for enforcement	Staff were pulled from other areas and deputized by the court	Many member cities added staff for enforcement	Staff shifted responsibilities to add enforcement
Public Information							
Marketing Campaign	Relied heavily on free media and state-wide campaign	Georgia "Water Smart Campaign: Save Water, Save Time, Save Money"	"Use Only What You Need" Regional Campaign	"It's a Drought…Do Something!" Campaign	"Have You Saved Water Today?" and "If We All Save a Little, We Save A Lot"	"Water IQ: Know Your Water Campaign"	"Save Water. Beat the Drought. This is a job for everyone: be a water saving hero" (Bay Area Water Savings Partnership)
Stakeholder meetings	Yes	Yes	Yes	Golf Course associations, etc.	Yes	Water IQ helped facilitate & organize	Yes

	Atlanta, Georgia	Georgia (state-wide)	Aurora Water, Colorado	Denver Water, Colorado	Corpus Christi, Texas	North Texas Municipal Water District, Texas	East Bay MUD, California
Customer Council/ Advisory Group	Yes	No response	12-person Customer Advisory formed during drought (appointments by City Council)	Customer Advisory Council in place since 1970s	Water Use Allocation Committee formed (of Council/ Mayoral appointees) to assist with industrial reduction	NTMWD held monthly meetings with member cities to provide drought updates and exchange of information	
Technical Presentations given to End-use Customers	Top 50 Customer Workshop held to help encourage water use reduction for these high water use customers	Throughout the state, particularly with industrial customers	Yes	Yes	Yes	NTMWD gave presentations throughout member cities' service areas	Speakers Bureau available

Benchmarking Conclusions

Drought conditions and the implementation of mandatory, rather than voluntary, drought response measures can result in water savings. The water providers interviewed stated that water savings between 10 to 30 percent were realized once mandatory drought restrictions were put in place. All programs were supported by large-scale public awareness efforts, and most water suppliers implemented a surcharge system in addition to outdoor restrictions to help achieve water savings.

Aurora Water Supply, Denver Water Supply, East Bay Municipal Utility District (EBMUD), Corpus Christi and a number of member cities served by North Texas Municipal Water District (NTMWD)implemented a water use allocation system that charged customers for additional water use above and beyond a specified amount. EBMUD allocated a monthly water use amount based on historical use minus the percent reduction goal; for residential, the goal was 19 percent. Residential customers using less than 100 gallons per capita per day were not penalized for their low-water use habits and were exempt from the drought charges.

All water providers interviewed stated that water savings had a significant impact on revenue in the short term. In addition to water savings achieved during the time of drought restrictions, a "drought-shadow" effect also occurred for nearly all of the water providers, where water use remained low after restrictions were lifted. Nearly all the water providers interviewed stated that some level of water use reduction remained after the drought as a result of changed behaviors, new programs implemented, and greater public awareness. For EBMUD, water use restrictions were lifted in late 1977 after a multi-year drought; however, water use levels by the mid-1980s had not returned to pre-drought levels despite a steadily growing population.

A number of the water suppliers interviewed provided water directly to industrial customers. For these large industrial customers, limitations on outdoor water use alone could not achieve the water savings goals set by the water suppliers. In addition, the possibility of surcharges forced some industrial customers to threaten relocation. By offering technical expertise and significant rebates for water saving initiatives, Denver and Atlanta were able to partner with their industrial customers such as Pepsi, Frito Lay, Xcel Energy, the Georgia Aquarium, and others to evaluate the way they used water and help the customers put in place process changes that often resulted in substantial water savings with no negative impact to production.

Individual Water Providers' Drought Response Overview

Corpus Christi, Texas

Corpus Christi implemented drought response measures in 1984-1986, in 1996, and again in 2001. In 1986, as a result of the multi-year drought where the City was faced with less than a one-year water supply, the water supplier developed its first drought contingency

plan. The plan currently includes four stages that correspond to the percentage of combined reservoir levels. The following triggers and drought response measures are included in the latest version of the drought plan:

- 50% capacity triggers City-wide voluntary water conservation (1% reduction goal)
  - ✓ Municipal operations on mandatory conservation
- 40% capacity triggers community-wide mandatory conservation (5% reduction goal)
  - ✓ No lawn or vegetation watering between 10 am to 6 pm
  - ✓ Large parcels of land must obtain approval for watering plan
  - ✓ Commercial nurseries must use hand-held, drip or sprinkler system to irrigate stock
  - ✓ Use of wastewater effluent permitted; sign must be posted on property
- 30% capacity triggers the five-day outdoor watering schedule (10% reduction goal)
  - ✓ Irrigation of golf courses permitted at a minimum rate
  - ✓ Suspend targeted inflows when reservoir below 30% of capacity
  - ✓ Violations punishable by $500 per day
- 20% capacity triggers the monthly residential household water allocation (15% reduction goal)
  - ✓ Each household is allotted 6,000 gallons/month (unless a customer can verify that she or he has more than 2 people living there). Water use in excess of this amount is charged at an aggressive increasing rate per 1,000 gallons (with additional use being charged $5-$8-$13-$40 per each 1,000 gallons above the customers' water use allotment).

In Corpus Christi, a multi-stage conservation program was imposed during the 1984 drought to extend dwindling supplies. Water use restrictions were first implemented during the summer of 1984 and remained in effect through the rest of 1984 and into 1985. During this time, three separate stages, or conditions, of water use restrictions were implemented: (1) condition 1 called for voluntary limitations on outdoor water use; (2) condition 2 restrictions put mandatory limits on allowable watering hours and limited watering to a designated day, once every ten days; and, (3) condition 3 restrictions implemented water rationing on a monthly basis; also, during 1984, under condition 3 a total ban on outdoor water use was implemented.

Corpus Christi Drought Trigger	Date Initiated	Effect on Water Use
Voluntary Conservation (Stage 1)	May 17, 1984	Little to no effect
Mandatory Conservation (Stage 2)	July 1, 1984	28.6 MGD daily reduction
Mandatory Water Rationing (Stage 3)	August 25, 1984	25.4 MGD daily reduction
Some Condition 3 Restrictions Lifted	October 30, 1984	----
Mandatory Water Rationing Lifted	September 24, 1984	----
Return to Condition 2 Restrictions	January 22, 1985	----

When mandatory drought restrictions were implemented in 1984 and 1985, the restrictions reduced water use in Corpus by approximately 30 percent of peak summer usage, according to a study by David Maidment and D.T. Shaw. The study's analysis also showed there to be an average reduction of 27.2 MGD during the period of July through November 1984. Lastly, the analysis showed that the voluntary restrictions, implemented during the early stages of the drought, had little effect in the city.

More than 40 percent of the annual water use in the City of Corpus Christi is for industrial purposes. City staff has worked closely in the past with the large industrial customers to help them determine ways to reduce their water use and a number of industrial representatives are included on the City's Water Resources Advisory Committee. Industrial customers have made significant strides in reducing their water use—with some refineries averaging 50 gallons of water use per barrel of crude oil refined compared to refineries in California who use from 90-100 gallons of water per barrel on average.

During times of serious drought, the City creates a Water Use Allocation and Review Committee, comprised of mayoral and city council appointees who are charged with the task of granting variances and evaluating industrial, commercial, and institutional (ICI) water needs, among other tasks. Similar to residential customers, the ICI customers are limited to water use allocations when the combined reservoir storage drops to 20 percent or below. The committee helps to determine those allocations and reviews variances to the allocation amounts. New services are also prohibited during this stage, unless approved by the Allocation and Review Committee.

Lastly, to help set an example during drought times, the City developed a water diverter to be used in the field during line flushing to divert water to landscaped areas rather than run it down the storm drains.

City of Atlanta, Georgia

The City of Atlanta implemented drought response measures in 2006. The state of Georgia implemented its drought response plan, finally declaring a Stage IV Drought Emergency in September 2007. The City of Atlanta restrictions mirrored the state restrictions, with the greatest emphasis on outdoor water use reduction.

Stage IV of the Georgia Drought Emergency Plan called for a ban on most outdoor watering with a few exceptions. According to City of Atlanta staff, there was some reluctance on the part of the state to declare a Stage IV Drought Emergency until absolutely and completely necessary, due to the projected impact on the landscaping industry, which is estimated to employ more than 75,000 Georgians.

Stage IV set a statewide goal of 10 percent reduction in overall water use by water providers. Savings amounts varied between regions, with nearly 15 percent monthly savings for northern Georgia. For the City of Atlanta, although the drought restrictions

were officially lifted in January 2009, the current water use remains below 17 percent of 2006 use—which savings are thought to be a result of awareness, an increase in alternative water use, conservation initiatives, and the downturn in the economy.

The City of Atlanta brought together its top 100 largest customers, a group that included hotels, hospitals, office complexes, a federal prison, Pepsi bottling company, airline corporate headquarters and others, for a workshop on the potential impact of the drought measures and ways to reduce water use. Nearly 90 percent of the customers attended the meeting where case studies and other information were presented. The state also offered support by performing audits on large Industrial Commercial and Institutional (ICI) customers. According to the City of Atlanta, all of its high water use customers saved water.

New landscape installations were allowed under the restrictions; however, a partnership was formed with the Metro Atlanta Lawn and Turf Association (MALTA) to help increase water use efficiency for new landscape installations. In order to be issued the variance by the City of Atlanta to water outdoors, a landscaper had to first take a course on proper watering and design administered by MALTA.

Denver Water, Colorado

Denver's Drought Response Plan called for percentage reductions based on reservoir levels; however, it quickly found itself in a drought worse than the drought of record in 2002 after significant snowfall reductions. Denver Water's Board of Directors changed Denver's Drought Response Plan regularly as the drought became more severe—as a planning document, it had never been implemented and so much of what came up, according to staff, was unexpected and unplanned.

The public awareness campaign, "It's a Drought. Do Something!" used humor to help increase awareness of the drought. Advertisements included sayings like "no need to wash your clothes, just don't wear any" or "don't wash your dishes, just get a dog." Denver Water staff stated that while funny and entertaining, there might not have been enough of an emphasis on the importance of saving water and other messages that needed to be communicated during the drought.

A lot of the challenges faced by Denver Water included managing public expectations. Significant backlash was received from the public concerning what was perceived to be a lack of planning on Denver Water's part that resulted in the implementation of restrictions. Some neighboring communities who relied on groundwater supplies were not as heavily impacted during the 2002-2003 drought, adding to the lack of public understanding about water resource planning and availability. Other challenges included budget reductions as a result of the drought having an impact on CIP funding.

Aurora Water Supply, Colorado

Aurora Water Supply provides water to a primarily residential community. With the first in time, first in right priority water right system in Colorado, Aurora's water supply reservoirs were nearly 26 percent full as a result of severely reduced snowfall from 2002-

2004. Mandatory restrictions were put in place with a no more than twice weekly watering schedule and limits on the times that individual irrigation zones could run (no more than 15 minutes per zone). The installation of new landscaping was not allowed, which resulted in significant push-back from home builders and the landscaping industry. Other drought restriction requirements included restrictions on car washes that mandated recycling or ceasing operation, prohibiting the use of all fountains (unless supporting aquatic habitat), and limiting golf courses and parks to the mandatory watering schedule. While some of these measures were not thought to achieve significant water savings, the issue of public perception was linked to the individual measures and provided as the reason for implementation.

As a result of the drought, long-term changes to outdoor landscape codes for new development were put in place such as minimum soil requirements, limitations on turf grass, and an efficient irrigation system design requirement.

East Bay Municipal Utility District

Rebates, incentives, and regulations have been a part of East Bay Municipal Utility District's (EBMUD) conservation program for years to help encourage efficient water use practices. EBMUD has put in place mandatory drought response measures a number of times since the 1970s. In August 2008, EBMUD declared a severe water shortage emergency as a result of consecutive dry years. The District implemented drought response measures designed to achieve an overall water savings goal of 15 percent.

A number of water efficiency measures were required of customers during this time including a provision on prohibiting water waste (allowing water to run off a property), and requiring shut-off nozzles on all hoses. The main focus of the drought response measures in 2008, however, was a water use customer allocation. Baseline water use for customers was calculated using monthly billing information from the previous three years. Customer allocations were then calculated according to the percentage reduction goals included in Table 2. Surcharges for water use in excess of the allocated amounts were charged at an increasing rate for single family residential customers and a flat rate for all others. Customers using less than 100 GPCD were not penalized for their low-water use habits and were exempt from the drought charges.

EBMUD Customers' Water Use Reduction Goals

Customer Group	**Water Use Reduction Goal**
Single Family Residential	19%
Multi-family Residential	11%
Irrigation	30%
Commercial	12%
Institutional	9%
Industrial	5%
Overall Goal	**15%**

In addition to the surcharges, flow restrictors were used for customers who were found to be wasting water. A regional public awareness campaign also complimented these measures. The implementation of drought response and conservation measures were estimated to reduce water use by 12 percent or nearly 26,000 acre-feet of water.

North Texas Municipal Water District

The North Texas Municipal Water District (NTMWD) implemented drought restrictions in 2005. Stage 1 voluntary restrictions began in October 2005 and the stages implemented increased in severity until mandatory restrictions were lifted in 2007. Stage 3, the first stage that required mandatory measures, set a 5 percent overall reduction goal for its member cities. Savings numbers were tracked on a monthly basis—with NTMWD setting the 5% goal off of previous water use prior to the drought. Water use by the member cities was e-mailed to the cities every month along with information on what was being saved and whether or not the savings exceeded or fell short of the 5 percent savings goal.

Member cities implemented various drought contingency measures, including mandatory watering schedules with time of day and day of the week water restrictions, limitations on ornamental fountains, prohibiting car washes without shut-off nozzles, and adding surcharges to water bills if water use exceeded a pre-determined amount. The watering schedule varied between the member cities depending on their specific system needs—for instance, the City of Frisco implemented a restriction on outdoor water use between 5am and 8am due to capacity and pumping issues when indoor use was at its highest, while others promoted a schedule that allowed watering on your trash day to make it easy for customers to remember. Nearly all the member cities' schedules did not allow outdoor watering to occur between the hours of 10 am and 6 pm, which consistency aided regional messaging efforts.

A representative from NTMWD stated that the system was able to shave off approximately 200 MGD during the summer when drought restrictions were in place. Overall, water savings were an average of 10-15 percent. Moreover, some level of water savings has continued despite restrictions being lifted. The NTMWD representative said this is thought to be in part due to increased awareness in addition to member cities implementing conservation incentive programs and keeping the watering schedule in place on a permanent basis.

NTMWD played an active role in helping its customers with their drought response efforts. Staff served as a technical resource, and they made themselves available to give presentations and other talks throughout the member cities' service areas. In addition, NTMWD brought together its member cities on a monthly basis to give them an update on the drought situation, Water IQ efforts, the likelihood of advancing to the next drought emergency stage, and to provide a forum for members to voice questions and concerns. Member cities were made aware of the change in drought stages (from Stage I to Stage II to Stage III) 30 days in advance of it being declared.

Stakeholder meetings were held with the help of Enviromedia, who assisted in advanced outreach to stakeholder groups, securing locations, and coordinating the meetings for groups of irrigators, landscapers, pool maintenance specialists and others. Member cities were always informed in advance of any presentation, speaking event, or stakeholder meeting if it was to be held in their service area.

After the drought ended, NTMWD revised its model drought contingency plan to reduce the number of voluntary stages to one rather than two and to add a restriction on cool season rye grass.

Tab 4

Benchmarking Research on Mandatory Drought Restrictions implemented in other Communities (Compiled in 2013)

	Barton Springs Edwards Aquifer Authority	San Antonio Water System	Melbourne Water, Australia	Seqwater, Queensland, Australia	Metropolitan Water District, CA	Sonoma County Water Authority, CA	Southern Nevada Water Authority, NV
Timeframe drought response measures implemented	2011-2012	2012-2013	Nov 2002-Feb 2005 and Sept 2006- Nov 2012	2005-2009	July 2009- June 2010	2009	2002-2003, 8 of last 11 years dry
Type of Water Use Provider	Wholesale and Retail	Mostly retail, some wholesale ~1.6 million end users	Wholesale to 3 large municipal retailers ~4 million end-users	Wholesale- State Govt owned entity responsible for managing regional water supply	Wholesale only, 26 member cities/districts, 19 million end-users	Wholesale only to 9 retail cities/districts 600,000 end-users	Wholesale only to 7 member cities/districts ~2 million end-users
Water Savings							
Percent Reduction Goal (overall)	20% - 6 months 30% - 4 months	26-36% (varies based on aquifer level)	18% Stage 4 (outdoor water bans) 25% over ~10 years by 2015	Targets in per capita use instead of % reduction	15% wholesale 10% retail	25%	Mandatory 10% first year
Percent Reduction Achieved (overall)	10-38% monthly	25% off permitted volume, required reduction 22%, normal year use 80-85% of permit	44% since 1997	41-43% achieved by 2009	15%	25%	16% first year, 34% by 2011
Baseline used to cut back from	Permitted volume	Permitted volume	None specified- recent use, changed over time	2004-2005 (pre-restriction average rainfall year)	Past three years of pre-drought water sales (2004-2006)	2004 baseline (state mandate)	N/A
Driver of Water Use Reduction Efforts	Edwards Aquifer Authority mandated reduction permitted volume	Edwards Aquifer Authority mandated reduction permitted volume	Yearly supply available, State regulatory entity required specific mandatory retail restrictions	State Govt required mandatory specific water use restriction measures	Yearly April 1st Board declaration of available water supply/need for allocation	State regulatory entity mandated cutback of 25%	Supply allocation capped at 300,000 acft
Timeframe reduction goal achieved	2 months for 20% 1 months for 30%	Ongoing, met target aquifer levels	Target 155 goal lcd (41 gpcd) achieved in 1 yr (7% decrease)	3 years	One year	6 months	One year

	Barton Springs Edwards Aquifer Authority	San Antonio Water System	Melbourne Water, Australia	Seqwater, Queensland, Australia	Metropolitan Water District, CA	Sonoma County Water Authority, CA	Southern Nevada Water Authority, NV
Tracking Water Savings	Monthly tracking of goals, high level management meetings if goal exceeded	Weekly meetings/internal projection updates	Responsibility on retail side, yearly outlook issued forecasting supply capacity zone and action plan	Weekly, retail customers supplied water use weekly,	Monthly reports given to each member agency during allocation, Local ordinance database compiled	Collected reports from retailers bi-weekly, Monthly tracking of water use & reduction goal	No formal process
Modification credits	N/A	N/A	Time/volume offsets w/ water use plan for some large community use like sports fields, one/one w/ industries	N/A	Conservation (only equipment change outs), Reuse, Growth, Local supply	No	N/A
Before/after per capita use, residual effect of drought		N/A- complicated by merger with Bexar Met	423 lcd in 1990s (112 gpcd) to 240 lcd (63 gpcd) in 2010	475 lcd in 2004 (126 gpcd), 225 lcd (59 gpcd) in 2008	1990- 205 gpcd 2008-185 gpcd	2007- 139 avg gpcd 2012- 119 avg gpcd (high 160 gpcd)	2002- 314 gpcd 2013- 219 gpcd
Drought Response Measures							
Mandatory Watering Schedule	20% 5 day schedule 7pm-10am 30%- hand-hold only irrigation	Once every other week in Stage 3 (640 msl), Stage 2 once weekly w/ restricted hours (650 msl)	Critical (Stage 4) bans outdoor water use except for food gardens w/ water use plan	Stage 4- outdoor bucket watering only, 4 hrs, 3x/wk, Stage 5, gardens only, Stage 6, gardens, 3 hrs, 1x/week	None mandated at wholesale level, request 1 day/wk reduction	Varied depending on Member City	Recommended Schedule (no more than 3 days/week)
New Landscapes	30%- all outdoor use except with hand held hose banned	Max 10,000 sq ft irrigated area, 4 in soil, Variance permitted Stage 2- for 5 wks Stage 3- less than 50% turf	Not allowed	Stages 4-6- hand held only 1 hr/day for 2 wks	No restrictions at wholesale level	Member Cities decide	New homes turf not allowed in front yards

	Barton Springs Edwards Aquifer Authority	San Antonio Water System	Melbourne Water, Australia	Seqwater, Queensland, Australia	Metropolitan Water District, CA	Sonoma County Water Authority, CA	Southern Nevada Water Authority, NV
Restrictions on Commercial Outdoor Irrigation		Golf courses- Stage 2- 20% less than ET rates or <= 1.6x base usage, Stage 3, 30% less than ET rates or <=1.4x base usage	Same as residential, exemptions for public gardens or sports fields at discretion of retail provider	25% reduction in water use from baseline, potable water not allowed for parks in later restriction levels	No restrictions at wholesale level	50% reduction required on all commercial irrigation by 2014	Water budgets imposed for golf courses- 10% reduction goal 1st year
Enforcement							
Enforcement Actions (for violations)	$250-$500/day, 2x during critical stage (30%), board order/hearing, ultimately law suit	Strict, consistent enforcement, off-duty police officer patrol all hours, 75-200 citations per month year round	Retail only: Fines, daily penalties, disconnection, imprisonment	$150K wholesale non-compliance, Retail level fines ranged from $90-$200	Fines (surcharges) <10% over – 2-3x base rate >10% over – 4-5x base rate	Enforced by state water resources control board	Fines for commercial users for exceeding budget, individual retail agency fine structures
Allotment	20%- max use/mo 12,000 gal/conn 30%- max use/mo 9,000 gal/conn		N/A		Level 2 of 10 levels Regional shortage 10%, wholesale <=15%		No formal allotment process at wholesale level
Surcharges as a Result of Excess Use	Has not been needed, high level meetings effective deterrent	In the plan, not implemented since 1996	N/A	Surcharges added to bills	Surcharges added to bills	Member cities discretion	No formal surcharge process at wholesale level
Additional Staff Needed	No additional staff, enforcement mostly rests on retailers to achieve reduction	NA	Not at wholesale level	Not substantial, but some at wholesale level due to formation of new regulatory entity	No, staff resources reallocated to drought activities	Member cities discretion	N/A

	Barton Springs Edwards Aquifer Authority	San Antonio Water System	Melbourne Water, Australia	Seqwater, Queensland, Australia	Metropolitan Water District, CA	Sonoma County Water Authority, CA	Southern Nevada Water Authority, NV
Public Information							
Public Awareness outreach	Supplied retailers with flags, road signs (and require use in DCP), car magnets, bill inserts, relatively small service area	Media partnership critical (weather people, local news), scorecard for media	Weekly reports to mass media, Newspaper, radio, TV, billboards etc, public forum & surveys, phone hotline, social media, website		Bill boards, radio, local news spots, partnership campaigns w/ member agencies	High profile regional water awareness campaign	Contact public information division for more info
Communication efforts/ challenges	Streamlined messaging, repeatable messaging	Messaging confusion w/ Edwards Aquifer Authority, Ongoing, high level of awareness		Consistent messaging over a broad area initially a challenge	Participation in rebate programs increased to 3x more than budgeted	Working through state mandated commercial use reduction	
Lessons Learned	Ask for evidence of letters sent to violators, ask for list of top users		Rapid Climate Shift created uncharted territory. Need flexibility of stages within state mandated DCP	Critical need for consistency, community must be engaged & understand severity of situation to achieve targets	Have a robust appeals process that is defined well, plan ahead for refinement process after drought ends	Effectively engaged landscape community through landscaper training, landscape water advisory group	Avoid outright bans that affect economic interests- can still achieve target water savings. Public perception about small volume but highly visible water uses matters.

2013 Benchmarking Conclusions

Drought conditions and the implementation of mandatory drought response measures during severe droughts can result in substantial water savings. The water providers interviewed stated that water savings between 15 to 40 percent were realized from implementation of mandatory drought restrictions. The timeframe for savings varied from six months to three years for wholesale providers and less for smaller, mainly retail providers. However, several wholesale water providers did not have the actual percent reduction achieved, just that the goals were met. The driving force behind the mandated water use reductions was either imposed by a regulatory authority or self-driven due to a water shortage or system constraint. The baseline water use varied from a permitted annual water volume, to a recent period of use where weather conditions were average and mandatory restrictions were not in place.

Most programs required a specific percent reduction goal and gave retail providers the latitude to determine specific drought response measures. The exception was in Australia, where template retail drought plans were mandated by the state, in some cases with minimal options. A few wholesale providers had different goals by customer class, with a per capita use goal for the municipal sector.

All wholesale programs included three key components: large-scale public awareness efforts, significant effort to partner with customers; and supported the compilation and sharing of information regionally. Regional awareness campaigns were a cornerstone of successful plan implementation for most water providers surveyed, and for all with service over a large geographic area. Those campaigns helped achieve water savings faster as drought conditions worsened, provided consistent messaging, and drove increased participation in conservation programs. Most water suppliers implemented a surcharge system in addition to outdoor restrictions to help achieve water savings.

Lessons learned from the implementation of mandatory drought response measures to achieve significant water use reduction included having consistent regional messaging, using a variety of approaches to achieve desired water use reductions, using outright bans on specific types of water use as a last resort, partnering closely with retail customers, and assisting with information sharing among customers. Most wholesale water providers interviewed did not significantly increase staff but reallocated staff time and other resources to fund awareness campaigns.

In addition to water savings achieved during the time of drought restrictions, a "drought-shadow" effect also occurred for nearly all of the water providers, where water use remained low after restrictions were lifted. Nearly all the water providers interviewed stated that some level of water use reduction remained after the drought as a result of changed behaviors, new programs implemented, and greater public awareness.

Allocation systems were not utilized by many of the wholesale providers interviewed, although Metropolitan Water District of Southern California (MWD) required its

wholesale customers to cut back purchases from a growth-adjusted pre-drought baseline. Metropolitan's Water Supply Allocation Plan formula, which accounted for local alternative supplies and included credits for conservation and reuse. MWD went through an extensive revision process of its allocation plan after the first time it was fully implemented in 2009-2010. One of the changes was to allow for a minimum per capital threshold of 100 total gpcd and 55 indoor gpcd to address significant variation in per capita use among its customers.

CERTIFICATE

STATE OF TEXAS §
§
COUNTY OF TRAVIS §

I, John W. Rubottom, hereby certify that I am the General Counsel and Assistant Secretary of the Board of Directors of the Lower Colorado River Authority (LCRA), a conservation and reclamation district, duly organized and existing under and by virtue of the public laws of the State of Texas.

I further certify that the Board of Directors of LCRA, on November 19, 2013, in a meeting posted properly in accordance with the Texas Open Meetings Act and with a quorum present and voting, by a vote of 8 to 7, adopted a resolution captioned "Resolution of the Board of Directors of the Lower Colorado River Authority Regarding Drought Management Actions in Response to Current Drought Conditions."

I further certify that a true and correct copy of the aforesaid Resolution is attached hereto. Such Resolution has not been modified, amended or repealed and remains in full force and effect as of this date.

TO CERTIFY WHICH, witness my hand and official seal this the 3rd day of December 2013.

John W. Rubottom, General Counsel
and Assistant Secretary of the
LCRA Board of Directors

Board approved Nov. 19, 2013

Resolution of the Board of Directors of the Lower Colorado River Authority Regarding Drought Management Actions in Response to Current Drought Conditions

Whereas, the Colorado River basin is experiencing a serious drought that has, at times, been more intense than the worst recorded drought this region has experienced, the Drought of Record that occurred from 1947 to 1957; and

Whereas, 2011, 2012 and 2013 have produced record low inflows to the Highland Lakes; and

Whereas, LCRA has sought and obtained emergency drought relief from the Texas Commission on Environmental Quality (TCEQ) to reduce demands for interruptible stored water for agricultural purposes in 2012 and 2013 that have reduced demands on lakes Buchanan and Travis; and

Whereas, combined storage in lakes Buchanan and Travis on Nov. 18, 2013, was 727,914 acre-feet, or 36 percent full; and

Whereas, the TCEQ has previously found that the conditions presented by the current drought pose an imminent threat to human health and safety because of the potential impacts on LCRA's firm customers, who face mandatory curtailment if storage in the lakes continue to drop; and

Whereas, recent heavy rains in the region have failed to replenish LCRA's water supply reservoirs, with most of the inflows entering the watercourse downstream of Lake Travis; and

Whereas, the contributing watershed to the Highland Lakes is included in the Governor's emergency disaster proclamation related to drought; and

Whereas, LCRA's Board of Directors understands the economic distress caused by this drought to farmers in the lower Basin and throughout the state; and

Whereas, LCRA's Board of Directors also understands the economic distress caused by this drought to firm customers and the region around the Highland Lakes; and

Whereas, current analysis indicates the possibility of combined storage dropping to 600,000 acre-feet and triggering the LCRA Board to declare a Drought Worse than Drought of Record as early as spring 2014; and

Whereas, absent emergency relief from the 2010 Water Management Plan, LCRA would be obligated to release significant amounts of interruptible stored water in 2014, even if combined storage on the evaluation date were just above 600,000 acre-feet; and

Whereas, many LCRA firm municipal water customers have implemented restrictions on landscape irrigation water use to once-per-week or twice-per-week or taken other measures to reduce nonessential water use; and

Whereas, LCRA's Board of Directors wants to take all necessary and prudent steps to manage the region's water supply to meet the essential needs of the communities and industries through this severe drought; and

Whereas, LCRA's Board of Directors has previously authorized staff to seek temporary amendments to downstream water rights to allow for their use in meeting firm customer demands at additional diversion points in 2014; and

Whereas, additional drought management measures must be pursued to address the drought in a responsible and measured way; and

Whereas, LCRA experts have analyzed numerous comparisons of current conditions and historical droughts and have recommended a comprehensive set of drought management actions needed to respond adequately to the continued and unprecedented drought conditions; and

Whereas, LCRA's Board of Directors believes that the severe drought conditions necessitate drought response measures related to LCRA's interruptible agricultural customers and firm water customers.

THEREFORE, BE IT RESOLVED that the LCRA Board of Directors hereby takes the following actions:

1. The General Manager or her designee is authorized to prepare and file an application to seek emergency relief from TCEQ under Texas Water Code § 11.139, and any other applicable law, to allow LCRA to deviate from the 2010 Water Management Plan as it pertains to the determination of interruptible supply for 2014 as follows:

    a. Provide interruptible stored water for first crop in 2014 based upon the combined storage of lakes Buchanan and Travis on March 1, 2014 at 11:59 p.m. as follows:

        i. Provide no interruptible stored water to customers within the LCRA Gulf Coast and Lakeside Divisions and Pierce Ranch if combined storage is below 1.1 million acre-feet;
        ii. Provide up to 100,000 acre-feet of interruptible stored water for diversion by customers within LCRA's Gulf Coast and Lakeside Divisions and Pierce Ranch if combined storage is at or above 1.1 million acre-feet but below 1.2 million acre-feet;
        iii. Provide up to 124,000 acre-feet of interruptible stored water for diversion by customers within LCRA's Gulf Coast and Lakeside

Divisions and Pierce Ranch if combined storage is at or above 1.2 million acre-feet but below 1.3 million acre-feet;

iv. Provide up to 148,000 acre-feet of interruptible stored water for diversion by customers within LCRA's Gulf Coast and Lakeside Divisions and Pierce Ranch if combined storage is at or above 1.3 million acre-feet but below 1.4 million acre-feet;

v. Provide up to 172,000 acre-feet of interruptible stored water for diversion by customers within LCRA's Gulf Coast and Lakeside Divisions and Pierce Ranch if combined storage is at or above 1.4 million acre-feet;

b. Provide interruptible stored water to the Garwood irrigation division and Pierce Ranch, to the extent required by their contracts.

2. The LCRA Drought Contingency Plan is temporarily amended to provide for additional regulation of water use by firm water customers as follows:

If combined storage of lakes Buchanan and Travis is below 1.1 million acre-feet on March 1, 2014 and TCEQ has issued an order that results in the cutoff of interruptible stored water supply to the Gulf Coast, Lakeside and Pierce Ranch irrigation operations, the following measures shall take effect until such time as either combined storage increases to1.1 million acre-feet or above or interruptible stored water is supplied to any customers in the Gulf Coast, Lakeside or Pierce Ranch irrigation operations:

a. Firm customers shall adopt and implement watering restrictions that limit the irrigation of ornamental landscaped areas (such as lawns) with hose-end sprinklers or automatic irrigation systems other than drip irrigation to no more than once per week.

b. Municipal wholesale water customers shall provide LCRA with an order, ordinance, or resolution to demonstrate adequate enforcement provisions related to the restrictions.

c. Failure to comply with the watering restrictions will subject the customer to the following penalties to be determined by the LCRA Board of Directors:

i. First documented violation: Written notice of violation;
ii. Second documented violation: Penalty of up to $2,000;
iii. Third and subsequent violation: Penalty of up to $10,000;
iv. Each day in which the violation is observed is considered a separate violation.

Approved this 19th day of November 2013

CERTIFICATE

STATE OF TEXAS §
§
COUNTY OF TRAVIS §

I, John W. Rubottom, hereby certify that I am the General Counsel and Assistant Secretary of the Board of Directors of the Lower Colorado River Authority (LCRA), a conservation and reclamation district, duly organized and existing under and by virtue of the public laws of the State of Texas.

I further certify that the Board of Directors of LCRA, on March 19, 2014, in a meeting posted properly in accordance with the Texas Open Meetings Act and with a quorum present and voting, authorized the general manager or his designee to pursue emergency authorization under Texas Water Code § 11.148, or any other applicable legal authority, for a reduction in the minimum critical instream flow required for the blue sucker fish from 500 cfs to 300 cfs under LCRA's 2010 Water Management Plan for a six-week period to end no later than May 31, 2014, and to take any other actions necessary to implement such authorization, all as recommended by LCRA staff, described in LCRA Board Agenda Item 17 – Emergency Relief Related to Instream Flows for Blue Sucker.

I further certify that a true and correct copy of LCRA Board Agenda Item 17 is attached hereto.

TO CERTIFY WHICH, witness my hand and official seal this the 19th day of March, 2014.

John W. Rubottom, General Counsel
and Assistant Secretary of the
LCRA Board of Directors

Attachment M
Certification of Board Action;
Agenda Item 17 (3-19-14)

FOR ACTION

17. Emergency Relief Related to Instream Flows for Blue Sucker

Proposed Motion

Authorize the general manager or his designee to pursue emergency authorization under Texas Water Code § 11.148, or any other applicable legal authority, for a reduction in the minimum critical instream flow required for the blue sucker fish from 500 cfs to 300 cfs under LCRA's 2010 Water Management Plan for a six-week period to end no later than May 31, 2014, and to take any other actions necessary to implement such authorization.

Board Consideration

LCRA Board Policy 102 - Authority and Responsibilities requires Board approval for all decisions in which Board policy or direction has not been clearly established. Board action is required to seek emergency relief from the Texas Commission on Environmental Quality (TCEQ) regarding this matter.

Budget Status and Fiscal Impact

Approval of these actions has no impact on the FY 2014 budget.

Summary

Pursuant to LCRA's state-approved and required 2010 Water Management Plan (2010 WMP), which dictates LCRA's operation of lakes Buchanan and Travis, LCRA must provide water from these lakes to help maintain critical instream flows in the lower Colorado River downstream of Austin. In general, LCRA's environmental flow obligations contained in the WMP reflect a balance between the competing needs of water within the basin and do not ensure or require LCRA to satisfy all environmental flow needs without regard to other needs for water. Similar to how LCRA provides water for interruptible agricultural uses, LCRA's commitment to provide water for environmental needs under the WMP is generally tied to the amount of water LCRA has in storage on Jan. 1 each year. Thus, LCRA's environmental flow obligations are curtailed to some extent in drier years and higher in years when storage is higher. LCRA's contract rules also provide for a curtailment of LCRA's firm water obligation for environmental flow needs at the same time as firm customers are curtailed in response to a Board declaration of a Drought Worse than Drought of Record.

Although LCRA obtained emergency relief from TCEQ in February 2014 to address releases of interruptible stored water for agricultural uses, LCRA has not sought changes to its obligations to release stored water for environmental flows under the 2010 WMP. In 2014, LCRA is obligated under the 2010 WMP to maintain certain critical instream flows (i.e. flow in the Colorado River) and to help meet the critical freshwater inflow needs of Matagorda Bay.

Of particular relevance for this agenda item, LCRA is obligated to provide sufficient flows in the lower river to maintain an instream flow level of 500 cubic feet per second (cfs) from Bastrop to Eagle Lake during a six-week period between March and May. This higher level of flow in the spring provides between 93 percent and 100 percent of the maximum available spawning habitat for the state-threatened blue sucker fish. More recent studies concerning the blue sucker conducted by LCRA as part of the LCRA-SAWS water project suggest that an

instream flow of 300 cfs over this time period will support at least 86 percent of the maximum available spawning habitat for the blue sucker. This lower level of instream flow is generally consistent with recent environmental flow standards adopted by TCEQ that apply to new water rights during severe conditions.

The 2010 WMP requires LCRA to release storable inflows and previously stored water to maintain certain minimum instream flows in the lower river. (This differs from LCRA's obligation related to freshwater inflows to Matagorda Bay, which is limited by the monthly storable inflows to the Highland Lakes.) Typically, LCRA tries to take advantage of the natural flow in the river and water released for downstream customers so it can minimize the amount of water that needs to be released from the Highland Lakes to meet the 500 cfs requirement for the blue sucker. During wet years, LCRA can meet this requirement without releasing water from the Highland Lakes. During very dry years, LCRA could release as much as 25,000 to 30,000 acre-feet over the six weeks to meet this requirement. A reduction in the instream flow requirement for blue sucker habitat from 500 to 300 cfs has the potential to save as much as 17,000 acre-feet in lakes Buchanan and Travis.

Presenter(s)

Karen Bondy
Executive Manager, Water Resources

LCRA BOARD POLICY

102 - AUTHORITY AND RESPONSIBILITIES

December 14, 2011

102.10 PURPOSE

This policy defines the relationship between the Board of Directors and the management of LCRA through the description of responsibilities and expectations and through the establishment of guidelines for the delegation of certain powers and duties.

102.20 POLICY

102.201 Responsibilities of the Board of Directors. The Board of Directors (Board) will establish the overall goals and objectives of LCRA, review them on an ongoing basis and adopt Board policies setting forth desired direction of management actions to attain such goals and objectives. The Board will approve an annual business plan that provides funding for the realization of those goals and objectives.

The Board will consider and establish policies in the public interest. The Board will faithfully discharge its public trust by conducting its affairs in a highly moral, ethical and sound business manner. Board members, collectively and severally, will not direct the policies and actions of LCRA from perspectives of private gain or personal advantage.

102.202 Delegations to the General Manager. The Board of Directors delegates to the general manager all general powers and duties in the LCRA enabling legislation, other applicable law, LCRA Bylaws and Board Policies necessary to accomplish LCRA's purpose, plans and objectives as approved by the Board, except for those specifically reserved for the Board by provisions of the LCRA enabling legislation, Bylaws, Bond Resolutions and other Board policies. Notable exceptions include:

A. Authorization to borrow money or approve bond resolutions.

B. Approval of agreements related to joint ownership of generating facilities.

C. Setting rates charged for water, power and other services.

D. Approval of sale of any real property.

E. Approval of contracts and purchase orders for consultant services in accordance with related Board policies.

F. Approval of contracts and purchase orders for the acquisition of materials, supplies, equipment, and related services, in accordance with related Board policies (except that the general manager is delegated the authority to approve contracts for capacity and/or energy purchases to replace capacity, for emergency conditions, and for economic advantage related to LCRA electric system operations, provided that any such off-system purchase must be for a term of less than one year).

G. Regardless of delegated authority in this or any other LCRA Board policy, Board approval is required for all decisions where Board policy or direction has not been clearly established.

The Board will articulate clear and coherent goals and statements of its expectations through its policies and plans.

102.203 Responsibilities of the General Manager. The general manager, as the chief executive officer of LCRA, is responsible for carrying out the business and activities of LCRA according to state law, the LCRA Bylaws, and Board policy.

The general manager may delegate in writing any general powers, duties and related authorities, as deemed appropriate, to officers and management staff members.

The general manager is responsible for bringing policy matters to the attention of the Board when its current policies give inadequate direction to LCRA operations or leave LCRA at a disadvantage because of changing conditions. The general manager will provide thorough, well-organized information to the Board in a timely manner. Communications to the Board will be made forthrightly and with candor in the evaluation of the conduct of business and operations of LCRA.

102.30 PROCEDURES

102.301 Goals and Priorities. As provided in the bylaws, the general manager each year will present to the Board objectives, goals and priorities for its consideration. These goals will clearly establish the Board's direction in key areas of LCRA affairs.

102.302 Annual Budget. The general manager will present to the Board an annual Business Plan that will include operating and capital budgets to carry out the Board's goals and priorities. The Business Plan will include projections of LCRA's overall financial performance and capital financing plans, and describe the projects, programs and the associated revenues and expenditures for the next fiscal year.

Adoption of the Business Plan authorizes the general manager to complete work plans and make associated expenditures within budgets as provided for in accordance with Board policies. The general manager will provide quarterly updates that include indicators of performance toward key goals, actual revenues and expenditures compared to budget, future financial performance projections and status of major capital projects. The resolution adopting the budget will establish

the amount that may not be exceeded without Board approval and the guidelines for approving amendments, reallocations or adjustments to the capital and operating budgets.

102.303 Sunset Review of Regulatory Programs. The general manager will review the effectiveness of, and need for, each major regulatory program of LCRA at least once every six years. These programs shall include, but not be limited to, the Highland Lakes Watershed Ordinance, the Highland Lakes Marina Ordinance, the On-Site Sewerage Facilities Rules, the Litter and Illegal Dumping Abatement Ordinance, and the LCRA Land and Water Use Regulations. The general manager shall recommend to the Board whether to abolish, continue or modify each such program.

102.40 AUTHORITY

LCRA enabling legislation, Chapter 8503, Special District Local Laws Code
LCRA Bylaws, Sections 3.02, 6.01, 6.02

EFFECTIVE: December 1984. Amended Dec. 14, 1989; Oct. 25, 1991; Sept. 22, 1994; Dec. 15, 1999; March 22, 2000; July 1, 2002; Nov 19, 2003; and Dec. 14, 2011.

LCRA EMPLOYEE POLICY MANUAL: 100 GENERAL AND ADMINISTRATIVE			
Policy 106: Delegation of Authority			
Approval Date	November 2010	Owner	General Manager
Effective Date	July 1, 2011	Policy Owner Review	Annual
Revision Dates	Nov. 18, 2011 Jan. 30, 2014	Next Executive Team or Designee Review	2017

Purpose
This policy ensures compliance with matters specifically reserved by the Board of Directors and identifies matters either reserved to or delegated by the general manager.

Policy
No employee of LCRA is authorized to take any action reserved to the Board of Directors under Board Policy 102. All other general powers and duties in the LCRA Enabling Act, bylaws, Board policies, and other applicable law necessary to accomplish LCRA's purpose, plans, and objectives are the responsibility of the general manager and those persons to whom the general manager specifically delegates such authority.

106.1 Authority Reserved to General Manager
Authority for the following matters is reserved to the general manager unless specifically delegated to an executive manager/officer or other LCRA employee by separate documented authorization from the general manager:

- Taking a position on matters that significantly affect relations with public or private entities outside of LCRA
- Employing outside legal counsel, in consultation with the general counsel
- Filing, dismissing, or settling a lawsuit, in consultation with the general counsel
- Taking a formal position in the name of LCRA with regard to federal, state, or local legislation consistent with Board Policy 104
- Filing non-routine pleadings before any state or federal administrative agency
- Acquiring interests in real property. However, documents of conveyance or acquisition may be executed by managers or their designees after the transaction or project involving acquisition has been approved by the Board of Directors.

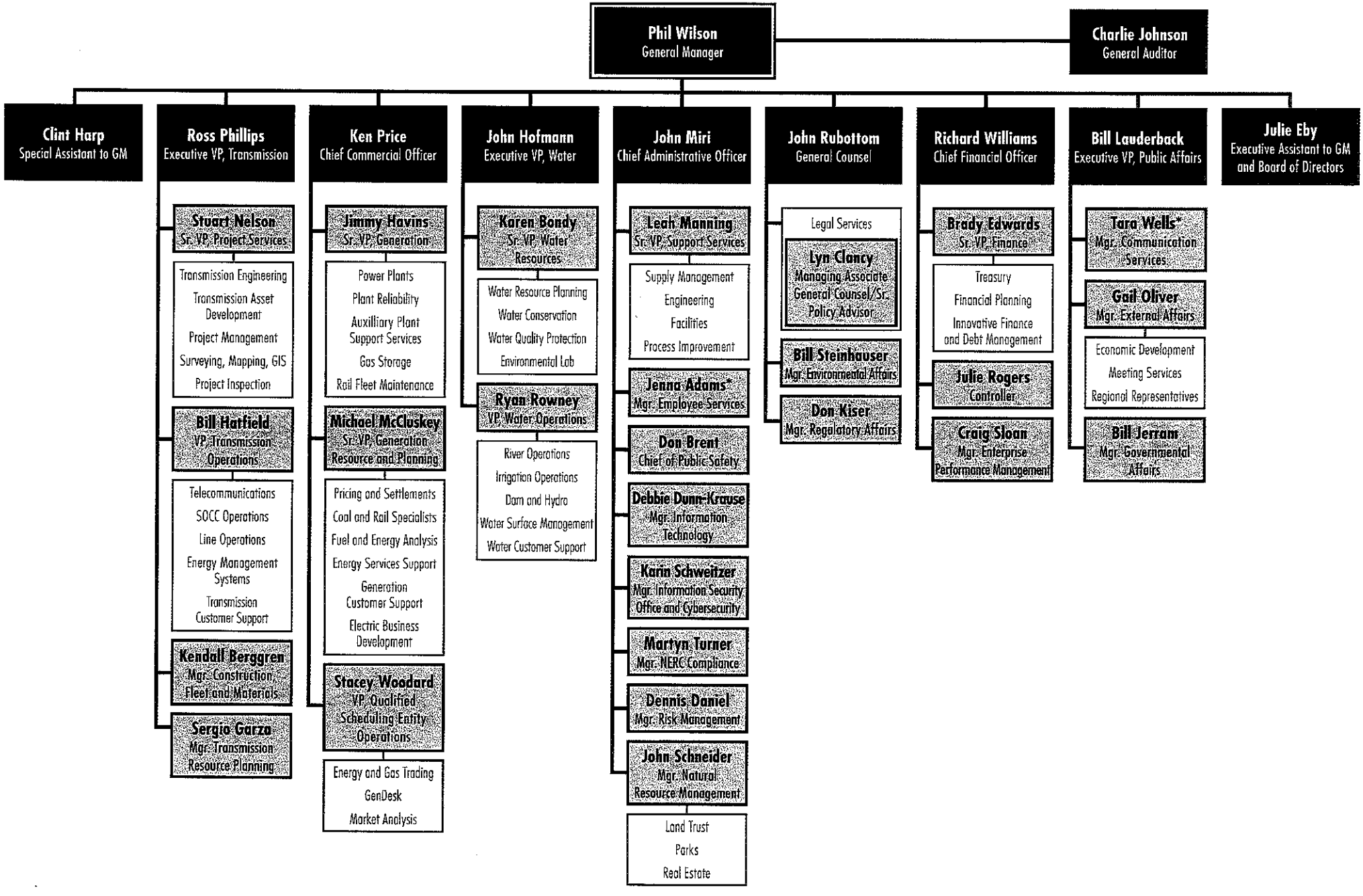
106.2 General Delegation of Authority by General Manager
The general manager delegates to the executive managers/officers any and all powers and duties necessary to manage their respective departments and service areas, except for those matters reserved to the Board of Directors or general manager as specified in this policy and Board Policy 102. Executive managers/officers are further authorized to delegate authority to their respective department managers and staff. Except in cases of unanticipated short-term absences and emergencies, all delegations must be authorized by another policy, or be documented and consistent with this and other policies, including but not limited to policies related to employment, contract administration, and supply management.

106.3 Exception for Unanticipated Short-Term Absence or Emergency
Temporary delegations by the general manager or executive managers/officers, or re-delegations necessitated by short-term absence in the event of an emergency, should be in writing when possible but may be made verbally. For purposes of this exception, an emergency is a condition or circumstance that poses an imminent threat to power generation, transmission, or distribution; environmental quality; flood control; water operations; employee or public safety; or that could result in an immediate, significant financial, or operational loss or damage to property.

See also:
EPM Policy 107: Contract Management
EPM Policy 108: Supply Management
EPM 106R1: Expense Approval Authority
Board Policy 104 - LCRA Board Position on Legislation

LCRA Organizational Overview

Effective March 17, 2014



*Interim manager

LCRA
ENERGY • WATER • COMMUNITY SERVICES