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February 10, 2015

Mr. Richard Hyde  
Executive Director  
Texas Commission on Environmental Quality  
P.O. Box 13087, MC 100  
Austin, Texas 78711-3087

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Carter P. Smith  
Executive Director

Re: Application of the Lower Colorado River Authority for Emergency Reduction of Instream Flow Requirements Under Its Water Management Plan For Lakes Buchanan and Travis (Permit 5838)

Dear Mr. Hyde:

Pursuant to the February 9, 2015 notification from the Texas Commission on Environmental Quality ("TCEQ") and pursuant to Texas Water Code §§5.506 and 11.148,<sup>1</sup> the Texas Parks and Wildlife Department ("TPWD") respectfully submits comments on the December 23, 2014 Application of the Lower Colorado River Authority ("LCRA") for Emergency Reduction of Instream Flow Requirements Under Its 2010 Water Management Plan ("WMP") for Lakes Buchanan and Travis ("emergency suspension application"). As the state agency charged with primary responsibility for protecting the fish and wildlife resources of Texas, TPWD seeks to provide the best available data and science regarding Colorado River conditions and the status of the state-threatened Blue Sucker to assist TCEQ's consideration of this matter.<sup>2</sup>

LCRA seeks approval to deviate from WMP instream flow requirements applicable for spring 2015. Specifically, LCRA requests a reduction to 300 cubic feet per second (cfs) of the instream flow requirement to maintain a flow of 500 cfs in the Colorado River between Bastrop and Eagle Lake for a continuous period of not less than six weeks from March through May to protect the state-threatened Blue Sucker (*Cyprinostomus elongatus*).

After careful analysis of recent conditions in the lower Colorado River and available Blue Sucker data, and recognizing the drought's impact on storage in the Highland Lakes, TPWD does not oppose LCRA's emergency request. TPWD's position is narrowly defined and is not intended to endorse the reduced instream flow requirement outside of this particular emergency suspension application. TPWD does appreciate the opportunity to provide relevant

<sup>1</sup> Texas Water Code §5.506(b) states with regard to an emergency or temporary order suspending permit condition relating to beneficial inflows to affected bays and estuaries and instream uses, ". . . The commission shall give the Parks and Wildlife Department an opportunity to submit comments on the proposed action for a period of 72 hours from receipt of the notice and must consider those comments before issuing an order implementing the proposed action." Texas Water Code §11.148(b) contains identical language.

<sup>2</sup> Texas Parks & Wildlife Code §12.0011.

background scientific data and information to assist TCEQ in considering this important matter.

#### **Discussion**

The identical relief from spring 2014 instream flow requirements was sought by LCRA in March 2014; the TCEQ Executive Director granted relief on April 15, 2014, and the Commission affirmed that decision on April 30, 2014. On March 28, 2014, TPWD filed comments responsive to LCRA's request informing TCEQ that TPWD did not object to the proposed relief (Attachment A). TPWD also provided information about actual river habitat conditions and available Blue Sucker data. This letter incorporates by reference TPWD's March 28, 2014 comments since discussion regarding 2010 WMP instream flow requirements and Blue Sucker protection continues to be relevant to TCEQ's consideration of LCRA's current emergency suspension application. Additionally, TPWD acknowledges that drought conditions underlying LCRA's previous emergency request continue to persist in the lower Colorado River Basin.

#### **Context and Comparison of the Proposed 300 cfs Flow Requirement with the Current 500 cfs Flow Requirement**

While TPWD does not oppose LCRA's request to temporarily reduce the seasonal instream flow requirement from 500 cfs to 300 cfs, it is important to note that since the flow requirements for the Blue Sucker are part of a comprehensive instream flow regime, the proposed 300 cfs flow cannot be examined in isolation, nor is it easily comparable to the current 500 cfs requirement. As a result, although a flow of 300 cfs is expected to support at least 86% of the maximum available spawning habitat for the Blue Sucker,<sup>3</sup> the relationship between flows approximating 300 cfs and the expected protection of 86% of Blue Sucker spawning habitat occurs in the context of the comprehensive instream flow regime, rather than the more static instream flow schedule incorporated in the current WMP.<sup>4</sup>

Under the 2010 WMP provisions as applied to 2015 conditions, LCRA is required to maintain a minimum flow of 120 cfs in the Colorado River from Bastrop downstream to Eagle Lake, except for a continuous six week period in March through May when a flow of 500 cfs is required for Blue Sucker spawning and for the benefit of other aquatic species. The expected percentage of protected Blue Sucker spawning habitat at 300 cfs under the current flow

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<sup>3</sup> LCRA Application For Emergency Reduction of Instream Flow Requirements Under Its Water Management Plan For Lakes Buchanan and Travis (Permit 5838), December 23, 2014, Attachment K, Affidavit of Bryan Cook at page 4.

<sup>4</sup> BIO-WEST, Inc. 2008. *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.

scenario is unknown, as there has been no direct determination of the effect on spawning habitat of a 300 cfs flow occurring outside of the context of a full instream flow regime.<sup>4</sup> While TPWD and LCRA generally reach the same conclusions regarding effects of reducing instream flows for spring 2015, TPWD's position is based primarily upon recent river conditions rather than an expectation of a specific amount of protected Blue Sucker spawning habitat.

#### **Recent Lower Colorado River Conditions**

In 2014, the lower Colorado River from Bastrop to Wharton experienced periodic flow pulse events in the midst of extended periods of low flow. These short-lived pulses benefited this area of the river by preventing the re-establishment of once abundant large vegetative mats and by improving water quality and physical conditions. More recent rainfall events and higher flow pulses in late 2014 and the beginning of 2015 most likely provided additional scouring of aquatic vegetation. However, 2014 inflows into the Highland Lakes from streams and tributaries were the second lowest recorded since 1942, the year that Mansfield Dam was completed. While the Austin area had above-average rainfall which improved river flow downstream, the Highland Lakes watershed in the Texas Hill Country experienced below-normal rainfall and remains in serious drought.

#### **Blue Sucker Study Status**

In 2014, TPWD, Texas Tech University, and LCRA initiated a collaborative study in the lower Colorado River on Blue Sucker population dynamics. The goal of the study is to provide information to assess the effects of streamflow on habitat use and reproductive and recruitment success of Blue Sucker. The study will last approximately four years at a cost of almost \$300,000. While it is premature to draw conclusions from the ongoing research, valuable data has been collected, and the study partners are optimistic that the study will refine knowledge of the species and provide the basis for future recommendations as to Blue Sucker instream flow needs. Ongoing and future work in support of the study includes tracking the movement of tagged fish and relating movement to riverine flows and other environmental variables. Fin rays and scales will also be analyzed for growth rates and aging and the size of the Blue Sucker population in the lower Colorado River will be estimated.

Blue Sucker study team biologists conducted initial collection and tagging efforts in mid-December 2014. The study team collected adult Blue Suckers at four locations and juvenile Blue Sucker at two locations. Of particular significance is the collection of juvenile Blue Suckers as these are the first juveniles collected in the lower Colorado River.

Table 1. Blue Suckers tagged on the Lower Colorado River Dec. 15-17, 2014.

Approximate Location	Adult Blue Sucker	Juvenile Blue Sucker
Bastrop	12	0
Smithville	0	0
La Grange	12	1
Columbus	1	0
Altair	10	7
Total	45	8

Overall fish condition observations made during the initial collection and tagging effort revealed that:

- several adult Blue Suckers in the lower river reaches had developed eggs and milt;
- large males displayed breeding tubercles (small horny bumps) on their head and body; and
- large females were gravid.

These observations suggest reproductive development and pre-spawn conditioning were underway in mid-December. However, these conditions give no indication as to future spawning success, growth and development of larval fish into young-of-year class fish. In addition, the observations monitored only Blue Sucker distribution and condition. The WMP spring instream flow requirement from which LCRA is seeking relief provides habitat and spawning cues for species other than Blue Sucker. Benefits to other fish and wildlife species and their habitats in the lower Colorado River extend to the State Fish of Texas, Guadalupe Bass (*Micropterus treculii*). Historic flow conditions in the lower Colorado River supported healthy populations of Guadalupe Bass, contributing to a highly valued sport fishery that produced the current State Record Guadalupe Bass in February 2014.

Between January 17–21, 2015, Texas Tech researchers observed that many of the fish tagged at La Grange and Altair had moved up to eight miles upstream since mid-December. This upstream movement may be an indication that fish are preparing for spawning. Water temperature at these sites approached a maximum of 55° F (13° C). Conversely, tagged Blue Sucker at the most upstream study site (near Bastrop) were found essentially at their original tagging location. Water temperature at Bastrop was 52° F (11° C). Blue Sucker typically spawn when water temperatures increase to 59–64° F (15–18° C). Given the condition and movement of tagged Blue Sucker, river conditions, and recent warm weather, we expect that Blue Sucker will spawn in February in the lower Colorado River and that larval fish will search for food and habitat in the following months.

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While the study will undoubtedly provide valuable information for understanding the reproductive ecology and conservation needs of the Blue Sucker and address critical data gaps, it is not known what cumulative impact multiple, successive years of reduced flows for Blue Sucker spawning will have on available Blue Sucker spawning habitat, reproductive success and recruitment of young-of-year fish into the Blue Sucker population. Collections of juvenile fish are very encouraging and the study team will continue to learn more about this life stage, but it is unknown what conditions preceding and/or following a successful spawning event led to survival and growth into juvenile fish. In addition, it is not yet known if the numbers of juvenile Blue Suckers are adequate to support a healthy and resilient Blue Sucker population in the lower Colorado River.

**Conclusion**

Based upon the best available science, current river conditions, recently collected Blue Sucker data, and the information in the attached March 28, 2014 TPWD comment letter, TPWD does not oppose LCRA's request to reduce flows from 500 cfs to 300 cfs in the Colorado River between Bastrop and Eagle Lake for a continuous period of not less than six weeks from March through May to protect the state-threatened Blue Sucker for the 2015 spawning and recruiting season.

TPWD looks forward to continuing to work with LCRA and others to better understand the conservation needs of the Blue Sucker and to ensure protection of the fish and wildlife resources in the lower Colorado River basin.

Thank you for the opportunity to provide biological input on this important matter. If you should have any questions, please do not hesitate to contact me at (512) 389-4802.

Sincerely,



Carter Smith  
Executive Director

CS:CBB:dh

Attachment

cc: Mr. Phil Wilson, General Manager, LCRA



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March 28, 2014

Mr. Richard Hyde  
Executive Director  
Texas Commission on Environmental Quality  
P.O. Box 13087, MC 100  
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Executive Director

Re: Application of the Lower Colorado River Authority for Emergency Reduction of the Instream Flow Requirements Under its Water Management Plan For Lakes Buchanan and Travis (Permit 5838)

Dear Mr. Hyde:

Pursuant to the March 27, 2014 notification from Texas Commission on Environmental Quality ("TCEQ") and pursuant to Texas Water Code §§5.506 and 11.148<sup>1</sup>, the Texas Parks and Wildlife Department ("TPWD") respectfully submits the following comments on the March 21, 2014 Application of the Lower Colorado River Authority ("LCRA") for Emergency Reduction of Instream Flow Requirements Under Its 2010 Water Management Plan ("WMP") for Lakes Buchanan and Travis ("emergency suspension application").

In the emergency suspension application, LCRA seeks TCEQ Executive Director approval to deviate from conditions of the WMP. Specifically, LCRA requests a reduction to 300 cubic feet per second (cfs) of the WMP instream flow requirement of maintaining a flow of 500 cfs in the Colorado River between Bastrop and Eagle Lake for a continuous period of not less than six weeks from March through May to protect the state-threatened Blue Sucker (*Cypleptus elongatus*).

Please be advised that TPWD does not oppose LCRA's request and recognizes the challenging drought related conditions that continue to plague the Colorado River basin. TPWD does appreciate the opportunity to provide relevant background scientific data and information to assist TCEQ in considering this important matter.

**Introduction and Position**

TPWD is the state agency charged with primary responsibility for protecting the state's fish and wildlife resources.<sup>2</sup> In this regard, TPWD seeks to ensure that the best

<sup>1</sup> Texas Water Code §5.506(b) states with regard to an emergency or temporary order suspending permit condition relating to beneficial inflows to affected bays and estuaries and instream uses, ". . . The commission shall give the Parks and Wildlife Department an opportunity to submit comments on the proposed action for a period of 72 hours from receipt of the notice and must consider those comments before issuing an order implementing the proposed action." Tex. Water Code §11.148(b) contains identical language.

<sup>2</sup> Tex. Parks & Wild. Code §12.0011.

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available data and science regarding Colorado River conditions and the status of the state-threatened Blue Sucker are provided for your consideration.

TPWD understands and appreciates the drought conditions in the Lower Colorado River Basin as described by LCRA in its emergency suspension application. TPWD also recognizes that significant relief for the competing water demands will only be provided by a substantial increase in rainfall. Based upon drought conditions, current and recent Colorado River instream flows and temperatures, and based upon best available science, TPWD does not oppose LCRA's request.

Please know that TPWD has been collaborating with LCRA regarding the conservation needs of the Blue Sucker. To that end, TPWD is preparing to launch a three-year study relating instream flows to Blue Sucker spawning movements, habitat use, and recruitment in the lower Colorado River. This study will help fill in knowledge gaps related to the Blue Sucker and can inform TCEQ, LCRA, and other Colorado River stakeholders in future decisions affecting instream flow needs. LCRA management has represented that LCRA expects to support TPWD's Blue Sucker study by offering assistance with water quality and temperature modeling and will also assist with additional fish tagging during our routine monitoring. Additionally, LCRA is interested in discussing with TPWD opportunities that may exist for LCRA to manage the releases it makes for other downstream customers in a manner that can also provide more environmental flow benefits.

#### **Background of WMP Requirements for Instream Flow and Blue Sucker Protection**

The WMP, which was approved by the TCEQ in January 2010, acts as an extension of LCRA's water rights for the Highland Lakes. The WMP requires LCRA to provide water to meet instream use needs based upon combined lake storage and inflows into the lakes. Under current conditions, the WMP requires the LCRA to ensure that at least 500 cfs is maintained in the Colorado River from Bastrop to Eagle Lake for a continuous period of not less than six weeks between March and May to support Blue Sucker populations. These instream flows may be met by a variety of sources, such as releases for downstream users, return flows, and rainwater runoff. LCRA's obligation to release water from the Highland Lakes pursuant to the WMP is only triggered if the specified instream flows are not met by other combined sources.

The 500 cfs requirement is primarily based upon a study that contained observations of Blue Sucker spawning in the lower Colorado River, as well as the best professional judgment of fisheries biologists familiar with the life history and biological needs of this species (Mosier and Ray 1992). BIO-WEST (2008) developed habitat-flow relationships for spawning Blue Sucker in the

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lower Colorado River confirming that 500 cfs provides substantial, quality spawning habitat.

Blue Sucker, *Cycoreptus elongatus*, is a big river fish that is highly specialized for fast water riverine habitat. In Texas, Blue Sucker occur in the Red River, Sabine, Neches, Colorado, and Rio Grande drainages. Blue Sucker were once abundant, but their range and population size have been reduced and it is listed as a state-threatened species (1977, 31 Texas Administrative Code §65.175). Blue Sucker may live more than 20 years and grow to lengths over 800 mm. In the lower Colorado River, adult Blue Sucker spawn from February – March when water temperature increases to 15-18° C (58-65° F); spawning may begin as early as January and could extend into April depending on climatic conditions. Blue Sucker may make long spawning migrations under high streamflow conditions (BIO-WEST 2008). Spawning occurs in deep, high current velocity rapids and fertilized eggs stick to rocky substrate. Information about larval and juvenile habitat use in the lower Colorado River is lacking and no samples of juvenile Blue Sucker have been reported.

The Mosier and Ray study recommended flow of 500 cfs also provides connectivity between spawning habitats and deeper areas of habitat that are utilized by adult Blue Suckers before and after spawning. The Mosier and Ray study was a stratified approach to the development of flow recommendations designed to protect the diverse native fish community of the Colorado River downstream of the Highland Lakes. In addition to providing for the needs of Blue Sucker, the 500 cfs flow during the spring also supports good water quality, recreation and habitat for other fish and wildlife species. In the absence of higher flows and pulse events, aquatic macrophytes such as hydrilla and water hyacinth can become established throughout the lower portion of the Colorado River.

#### **LCRA Selection of 300 cfs Flow to Protect Blue Sucker**

The 2010 WMP requirements related to the Blue Sucker are intended to provide some protection for seasonal spawning, but they were not designed to provide a full instream flow regime to protect a range of instream needs. It is generally recognized by instream flow scientists that a flow regime using a full range of flow components is needed to maintain fully functioning streams. Variations in the magnitude, frequency, duration, timing, and rate of change of stream flows are all critical components of a natural flow regime (Poff et al., 1997). Variability in stream flow is manifested to stream biota as a change in habitat availability. Consequently, the life histories of stream fishes and other aquatic organisms are adapted to the seasonal and inter-annual variability of low, base, and high flow components. Hydrologic pattern and variability are therefore key determinants of aquatic community structure and stability (Poff and Ward, 1989; Poff et al., 1997; Richter et al., 1996, Dilts, et al., 2005).

As set out in the emergency suspension application, LCRA's request to reduce flows to protect Blue Sucker from 500 cfs to 300 cfs is based in part upon a study conducted by BIO-WEST (2008) that produced recommendations for instream flow regimes in the lower Colorado River. The BIO-WEST study relied in part on modeling of habitat versus flow relationships for habitat guilds and the state-threatened Blue Sucker and was used to formulate environmental flow regimes at several locations. Spring season flows of approximately 300 cfs are one component of a complete environmental flow regime that included a full range of flows to reflect subsistence, base, and high flow pulse conditions as shown in the table below from the Executive Summary of the BIO-WEST report:

**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
<b>AUSTIN REACH</b>												
Subsistence	50	50	50	50	50	50	50	50	50	50	50	50
<b>BASTROP REACH</b>												
Subsistence	200	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
<b>COLUMBUS REACH</b>												
Subsistence	348	375	375	255	425	534	342	190	273	190	202	301
Base-DRY	487	590	525	554	366	967	570	310	405	350	480	464
Base-AVERAGE	828	835	1,020	977	1,310	1,440	895	510	610	741	735	737
<b>WHARTON REACH</b>												
Subsistence	315	303	284	270	304	371	212	167	180	147	173	202
Base-DRY	492	537	531	561	385	964	577	314	410	360	480	470
Base-AVERAGE	838	906	1,036	1,011	1,397	1,512	904	522	617	749	764	746
<b>COLORADO RIVER DOWNSTREAM OF AUSTIN</b>												
<b>PULSE FLOWS</b>												
Base	MAGNITUDE (2,000 to 3,000 cfs); FREQUENCY (4-10 times annually); DURATION (3-5 days)											
High	MAGNITUDE (> 8,000 cfs); FREQUENCY (2 Events in 3 year period); DURATION (2-3 days)											
<b>CHANNEL MAINTENANCE</b>												
	MAGNITUDE (27,000 - 30,000 cfs); FREQUENCY (1 Event in 3 years); DURATION (3 days)											
<b>OVERBANK</b>												
	MAGNITUDE (> 30,000 cfs); FREQUENCY and DURATION (Naturally Driven)											

The 2014 conditions would correspond with the subsistence flow guidelines in the above table. Within the flow regime, the BIO-WEST study calculated that a flow of approximately 300 cfs supports 86% of the maximum available Blue Sucker spawning habitat in the Columbus reach (Table 4.9, BIO-WEST 2008) and over 92% in the Bastrop reach (Table 4.11, BIO-WEST 2008). According to the model, higher flows (such as 500 cfs) would increase the amount of Blue Sucker spawning habitat in the lower Colorado River. Higher flows would also provide additional habitat for adult Blue Suckers and increase connectivity to suitable spawning habitat.

### **Current Lower Colorado River Conditions**

While TPWD does not oppose LCRA's request to temporarily reduce the instream flow requirement from 500 cfs to 300 cfs, it is important to understand that the 300 cfs flow recommendation cannot be examined in isolation, nor is it easily comparable to the current 500 cfs requirement. As shown in the BIO-WEST study, the relationship between flows approximating 300 cfs and the expected protection of 86% of Blue Sucker spawning habitat is supported when those 300 cfs flows occur in combination with the full array of varying flows provided as part of a comprehensive instream flow regime. The BIO-WEST based comprehensive flow regime is not required in the current WMP. If the current 500 cfs flow requirement is reduced to 300 cfs, the 300 cfs flows will occur in the absence of a full, varying instream flow regime. The expected percentage of protected Blue Sucker spawning habitat at 300 cfs is unknown. Except for the six week period of 500 cfs for Blue Sucker spawning, LCRA currently is only required to maintain a minimum flow of 120 cfs in the Colorado River from Bastrop downstream to Eagle Lake. There is no direct comparison of the effect on spawning habitat from a 300 cfs flow occurring without a full instream flow regime to the effect on spawning habitat from a 300 cfs flow occurring within a full instream flow regime. To help address this knowledge gap, an assessment of current and recent river conditions is necessary to evaluate the impact of a 300 cfs flow on Blue Sucker spawning and habitat.

High flow pulse events in fall 2013 scoured the lower Colorado River of large vegetative mats that had accumulated following a prolonged low flow period, improving water quality and physical conditions. Flows of near 300 cfs since the beginning of 2014 have since maintained a water quality suitable for aquatic biota. Recent conditions were appropriate for Blue Sucker to spawn.

TPWD biologists surveyed three sites for Blue Sucker spawning activity and to collected adults to assess gonad condition. Water temperature was nearly 19° C. Eight large, fully tuberculated, and fertile males were collected in a rapid near La Grange, Texas on March 19. One large female that had spent ovaries (i.e., she had likely completed spawning for the season) was collected near Utley on March 20, 2014. No Blue Suckers were collected at Smithville rapids and no active spawning was confirmed at any of the sites. These observations suggest that spawning may be occurring (fertile males) but may be completed for some fish (spent female) which aligns well with spawning conditions reported previously.

The requirement of the WMP for which LCRA is seeking relief relates only to the Blue Sucker. However, it is important to note that releases for the Blue Sucker provide ancillary benefits to other fish and wildlife species and their habitats in the lower Colorado River. This includes the State Fish of Texas, Guadalupe Bass (*Micropterus treculii*). Historic flow conditions in the lower

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Colorado River supported healthy populations of Guadalupe Bass, contributing to a highly valued sport fishery that produced the current State Record Guadalupe Bass in February 2014.

### **New TPWD Study of Blue Sucker Habitat, Spawning, and Recruitment**

TPWD is preparing to initiate a three-year study in the lower Colorado River. The primary objective of this research is to provide information to assess the effects of varied streamflow levels on habitat use and reproductive success of Blue Sucker in the lower Colorado River. Specific study components include a better understanding of the life history strategy, movement and habitat requirements of various life stages, growth rates and aging, population estimates, and reproductive ecology. This study will develop the best available science and fill critical data gaps to inform TCEQ, LCRA, and other Colorado River stakeholders in future decisions affecting water supply needs in the basin. It is expected that LCRA will offer assistance with water quality and temperature modeling and will also assist with additional fish tagging during our routine monitoring.

To support this study and to gain an understanding of current conditions within the basin, field efforts have been initiated recently by TPWD. Longitudinal temperature monitoring along the river will provide diurnal water temperature data. This data can also be incorporated into a dynamic water quality modeling analysis to show water quality changes and trends under various streamflows. Additional Blue Sucker collection efforts surrounding known spawning locations will provide spawning condition and movement pattern information. Larval fish sampling may also indicate reproductive success and recruitment of young-of-year fish.

### **Conclusion**

Based upon the best available science and the current river conditions described above, TPWD does not oppose LCRA's request to reduce flows from 500 cfs to 300 cfs in the Colorado River between Bastrop and Eagle Lake for a continuous period of not less than six weeks from March through May to protect the state-threatened Blue Sucker.

To assist in developing the science needed to better understand the future conservation needs of the Blue Sucker, TPWD is committed to working with LCRA to implement several important actions, including:

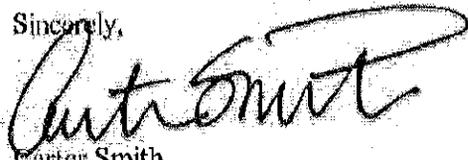
- Commencing required releases as soon as possible (if necessary to maintain 300 cfs at Bastrop to Eagle Lake) to support Blue Sucker spawning and larval development as needed;

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- Filling in key information gaps by investigating flow and temperature conditions that support Blue Sucker life stages; and
- Improving management of Blue Sucker spawning flows based on more complete biological information to allow development of : biologically based triggers based on temperature and spawning condition and refinement of timing, magnitude, and duration of flows to maximize efficiency.

Thank you for the opportunity to provide biological input on this important matter in the Colorado River Basin. Should you have any questions at all, please do not hesitate to contact me at (512) 389-4802.

Sincerely,



Carter Smith  
Executive Director

CS:CBB:dh

cc: Mr. Phil Wilson, General Manager, LCRA  
Ms. Ann Bright  
Ms. Colette Barron-Bradsby

### Citations

- BIO-WEST, Inc. 2008. *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; Round Rock, Texas.
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