Petition
to timely adopt and implement Desired Future Conditions for the Colorado Alluvial Aquifer during the current Groundwater Management Area 12 review and adoption period ending January 2027.

Proposed Desired Future Condition and Monitoring Network for the Colorado Alluvial Aquifer in Bastrop County, Texas, to sustain the Colorado River during a repeat of the Drought of Record.

by

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VOLUME I

Policy & Technical Justifications

ACKNOWLEDGEMENT: Environmental Stewardship wishes to acknowledge the contributions of George Rice and Eric Allmon in the preparation of this proposal and petition. The views expressed in this document are those of Environmental Stewardship, informed by the best available science and Texas Water Code.

George Rice, an independent contractor, has served as expert witness and resource consultant to Environmental Stewardship since 2013. Applying his professional skills using the best available science, George has used the groundwater availability model for GMA-12 and other tools to evaluate and report on the potential impacts of groundwater pumping on surface waters in Lost Pines Groundwater Conservation District and GMA-12. As the model has evolved over the past several years, he has evaluated the changes in how the model and its revisions handle and predict impacts on surface waters and the aquifers. In doing so, he has kept our understanding and assertions within the bounds of what the science and the models are able to predict. Based on his work with the models, George has guided and strengthened our understanding of groundwater and surface water interactions, and how those interactions are predicted to impact the Colorado River, its tributaries, the underlying aquifers, the landowners, and communities that depend upon these water resources in Central Texas. We are grateful for his unwavering dedication to truth and knowledge, and pleased to share his work with Lost Pines GCD and GMA-12.

Eric Allmon, Perales Allmon & Ice P.C., has served as counsel to Environmental Stewardship since 2011. Eric has led our attempts over the years to bring attention to, and seek compliance with, the statutory requirements of the Texas Water Code as they apply to the protection and conservation of surface and groundwaters as they naturally interact throughout the Texas Colorado River basin, and the rights of affected persons. He was our counsel in bringing an appeal of the first GMA-12 Desired Future Conditions in 2012, an affected persons appeal in the End Op contested case as it was taken to Bastrop District Court and beyond, and has guided our many interactions with Lost Pines GCD regarding permits, and GMA-12 regarding desired future conditions. Eric has helped us understand and maneuver the legal intricacies of water law in Texas. His grasp of the laws, how they are, their proper application, and how Texas Supreme Court decisions have shaped the statutes and findings of the courts, are reflected in the work that we have done, and what Environmental Stewardship has accomplished over these years. We are grateful for his persistence in seeking environmental sustainability, and are pleased to share his insights with Lost Pines GCD and GMA-12.

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Colorado Alluvial Aquifer

Proposed Desired Future Condition and Monitoring Network for the Colorado Alluvial Aquifer in Bastrop County, Texas, to sustain the Colorado River during a repeat of the Drought of Record.

ABSTRACT: A desired future condition (DFC) is proposed for the Colorado Alluvium Aquifer in Bastrop County, Texas. The aquifers in Bastrop County are under the jurisdiction of the Lost Pines Groundwater Conservation District. Policy and technical justifications are given for the proposed desired future condition. Technical support is provided by original work by Environmental Stewardship's resource consultant George Rice using the GMA-12 groundwater availability model and other published studies. Where appropriate, and as required by the Texas Water Code, factors for considerations in establishing desired future conditions are discussed. A work plan is included to guide development of the final DFC and implementation monitoring network. All original reports by the resource consultant are included in the appendices.

Key Words: desired future conditions, Colorado River, Colorado Alluvium Aquifer, Carrizo-Wilcox Aquifer, water monitoring network, surface water-groundwater interaction, Lost Pines Groundwater Conservation District, Environmental Stewardship.

1. INTRODUCTION

Environmental Stewardship (ES) has advocated for desired future conditions (DFCs) that are protective of surface water to be developed since the initial Groundwater Management Area 12 Joint-Planning cycle in 2008. During the third cycle, ES proposed several scenarios to the GMA-12 representatives and received feedback that was constructive in developing the DFCs being proposed for the Colorado Alluvium Aquifer in this document. Desired Future Conditions for the Colorado Alluvial Aquifer (Colorado River Alluvium) are proposed that utilize existing stream gauges (river and tributary) along with alluvial wells as the means to quantitatively measure compliance with the proposed DFCs.

The methodology proposed for use in monitoring the DFCs was developed and tested as a part of the Lower Colorado River Authority - San Antonio Water Systems (LCRA-SAWS or LSWP) project between 2002 and 2011. The LSWP Groundwater for Agriculture Team installed a shallow water monitoring system on the Colorado River in Wharton and Matagorda Counties, Texas, to monitor the gain/loss relationship between the surface water (river) and groundwater to measure the impact of agricultural groundwater pumping on the Colorado River. The reports and experience from this project can inform the development and implementation of the DFCs being proposed. Key scientists from this original work are currently involved with GMA-12.

The use of a groundwater availability model (GAM) is not necessary to monitor and comply with the proposed DFCs. Even so, the ability to model the system and predict the impacts of groundwater pumping on the Colorado River and its tributaries in the Bastrop reach of the river will be beneficial. Using the updated GMA-12 GAM (2020) and the recently adopted 2022 DFCs (S-19) the model runs were conducted to test the extent to which the model can be used to predict impacts, identify limitations, and suggest modifications. Additional field data will help

refine and verify the accuracy of the predictions. The DFC field data that will be collected while monitoring the surface water-groundwater relationship may also be used to inform the model. Finally, the recent surface water-groundwater impact pilot study conducted by LCRA for the TWDB in response to Senate Bill 3 work plan studies will be useful in designing and implementing a monitoring network in the Bastrop reach (RWH&A, 2021).

This document, including the appendices, is organized to respond to the factors that are stipulated in the statutes to be addressed in the explanatory report. These issues are addressed and presented for consideration by Lost Pines GCD and GMA-12.

Environmental Stewardship's interest is to have DFCs adopted for the Colorado River Alluvial Aquifer in the Bastrop reach and to have an ongoing monitoring program implemented to ensure that the surface water and groundwater interests of the communities and environment of Bastrop and Lee Counties are protected.

2. PROPOSED DESIRED FUTURE CONDITION FOR THE COLORADO ALLUVIAL AQUIFER.

Environmental Stewardship is requesting that a desired future condition be established for the Colorado Alluvial Aquifer with the following objective:

> To maintain the saturated depth of the Colorado Alluvial Aquifer at a minimum of [to be determined] feet above the most recent drought of record "DOR" [1] low-flow water level in the Colorado River to maintain a relationship between the river and the alluvium that is adequate to support a *sound ecological environment* during a repeat of the most recent DOR in the Bastrop reach of the river and protect surface water rights throughout the basin.

Since establishing a final DFC will be an iterative process over several years as field data are collected as described in the implementation work plan (Appendix 2), an "interim" DFC based on comparison of water levels in the river and alluvium is proposed to maintain the current gaining relationship between the water level in the river and the current water level in the alluvial aquifer.

The minimum head for the aquifer vs. low-flow level in the river should be determined per the work plan at several gauges along the Bastrop reach. As a starting point, a two (2) ft minimum is estimated from Figure 1 to be approximately 314 ft MSL for the alluvium vs 312 ft MSL for the river at the Bastrop gauge. Additional field data will better inform this estimate.

A minimal operating field monitoring network between river gauges and wells in the Colorado Alluvial Aquifer can be used to establish an interim desired future condition for the aquifer based on water levels alone. Hydraulic conductivity measurements, when available, will enable estimates of groundwater discharge to the river using the empirical gauged water levels.

Low-flow levels in the Colorado River experienced during the most recent drought of record can be used to establish the interim DFC limit and to set trigger points that can guide actions to

[1] The U.S. Drought Monitor started in 2000. Since 2000, the longest duration of drought (D1–D4) in Texas lasted 271 weeks beginning on May 4, 2010, and ending on July 7, 2015. The most intense period of drought occurred the week of October 4, 2011, where D4 affected 87.99% of Texas land. https://www.drought.gov/states/texas#historical-conditions

meet the planning goal of the DFC, including, as necessary, pumping curtailment. Table 1 is a summary of the low-flow data for the Colorado River at the Bastrop gauge during the recent DOR and the TCEQ Subsistence flow standards for each month of each season (TCEQ, 2012).

Once a fully operational network is in place, and water level and hydraulic conductivity data are available, a DFC based on discharge of groundwater to the river can be established that is adequate to support a sound ecological environment during a repeat of the most recent DOR.

TABLE 1. Monthly Low-flow levels for the Colorado River at Bastrop for DOR.

Monthly Low-Flows for Drought of Record 2010-15 by Season*
USGS 08159200 Colorado Rv at Bastrop

	Winter (cfs)			Spring (cfs)				Summer (cfs)		Fall (cfs)			
Year	December	January	February	March	April	May	June	July	August	September	October	November	Year Low
2010		347	594	471	961	977	1130	906	772	695	342	332	332
2010-11	337	342	388	308	627	1010	1440	922	985	751	196	243	196
2011-12	212	243	352	332	507	**303**	**261**	**200**	200	261	176	**184**	184
2012-13	**196**	**225**	**200**	**208**	279	443	327	388	204	**126**	299	425	**126**
2013-14	370	356	276	249	**208**	336	351	226	**190**	271	**165**	194	165
2014-15	285	285	346	341	341	308	765	324	262	200	219	562	200
Month Low	196	225	200	208	208	303	261	200	190	**126**	165	184	
Subsistence**	186	208	274	274	184	275	202	137	123	123	127	180	

* Seasons are as described for Colorado River Environmental Flow Standards: TCEQ, Chapter 36, Subchapter D, Section 298.305 Definitions

** Susbsistance flow standard for the Colorado River at the Bastrop Gauge. Texas Commission on Environmental Quality Chapter 298 - Environmental Flow Standards for Surface Water SUBCHAPTER D: COLORADO AND LAVACA RIVERS, AND MATAGORDA AND LAVACA BAYS §§298.300, 298.305, 298.310, 298.315, 298.320, 298.325, 298.330, 298.335, 298.340 Effective August 30, 2012

Figure 1 contrasts the predicted water levels in the Colorado Alluvial Aquifer for the years 2010 and 2070 in relationship to the GAM water levels in the Colorado River in the Bastrop reach of the river[2]. The GAM predicts that water levels in the alluvium will decline but are higher than the river. The effect of this (not shown in Figure 1) is that groundwater discharge to the river will decline.

[2] The water levels in the Colorado River are constant throughout the GAM simulation. They do not change from 2010 to 2070. As field data becomes available, water levels in the alluvium should be compared to low-flow water levels in the river during the recent drought of record at each station where historical data are available.

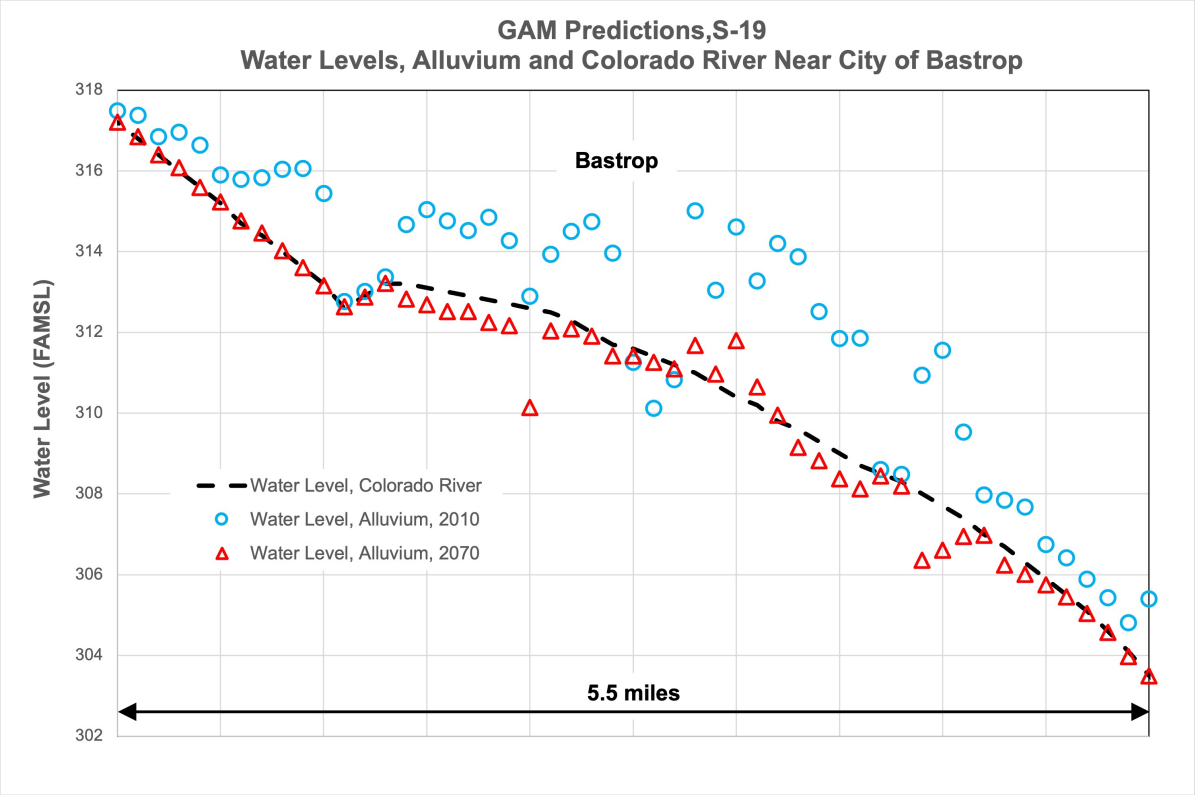

Figure 1. 2010 and 2070 Water Levels in Colorado Alluvial Aquifer vs. Colorado River.

2.1 Water level based Desired Future Condition (DFC)

Establishing a defensible DFC using measurable conditions such as described herein is equivalent to the established practice of setting a DFC for an aquifer based on drawdown of the aquifer due to pumping. In this way, the groundwater availability model (GAM) is only needed to evaluate scenarios based on the physical conditions of the alluvial aquifer *desired* or *anticipated* in the future.

The ability to measure parameters that quantitatively describe the aquifer and river stages has long been recognized as a key element to manage water resources. The ability to link these parameters to better understand and quantify the relationships between these resources has been demonstrated both in the lower Colorado Basin (See Section 2.2) and in a recent pilot project in the Bastrop reach (RWH&A, 2021). Most of the river gauges, and some of the aquifer wells, are already available, can be identified, can be re-activated, or can be installed. Technology to gather and store data electronically is practiced by both the local river authority and the District. The mathematical equations that are needed to calculate anticipated impacts have been developed. As such, all the key elements to establish a monitoring network are accessible.

The demonstrated methodology can be used to compare water levels in the river to water levels in the surrounding alluvial aquifer to determine if the relationship of the river to the alluvial aquifer is resilient enough to support a sound ecological environment in the Bastrop reach of the

river.[3] The environmental flow criteria to provide a sound ecological environment have been established for the Bastrop reach of the river[4]. As such the primary scientific information that is needed to establish a defensible and enforceable desired future condition is already available.

This concept was introduced to the GMA-12 representatives. (Environmental Stewardship, April 20, 2021). The primary reason for reluctance was the amount of data available. While Environmental Stewardship maintains that adequate data was available at that time, efforts to gather further data will enable adoption of such a DFC in the current (4th) round of review.

2.2 River Gauge and Alluvium Well Monitoring System

The Lower Colorado River Authority-San Antonio Water System Water (LCRA-SAWS) Project in the lower Colorado River Basin at Wharton and Bay City included gain/loss studies using stream gauges and nearby alluvial water wells as described above. Two reports are available that describe the shallow monitoring well installation (USR and Baer Engineering, 2006) and a final monitoring data report (USR and Baer Engineering, 2007-08). These two reports will be instructive to the design, installation and monitoring of the Colorado Alluvium Aquifer in Bastrop County, Texas.

The Monitoring Data Report from April 2006 to December 2007 for the LSWP Shallow Wells Installed in Wharton and Matagorda Counties, Texas, cited above provides detailed information regarding installation, operation, and the results of the monitoring project (See Appendix 4).[5] That data reflected the direct relationship between water levels in the Alluvium and the Colorado River, as well as the ability to quantify that relationship.

2.3 Other Considerations; Special Management Zone

2.3.1. Special Management Zone (See also Section 5.3.3)

The Colorado Alluvial Aquifer (CAA) and the shallow flow zones[6], are distinct features throughout the District in that they are the only zones where groundwater and surface waters are directly exchanged between the aquifers and the rivers and streams of the District. The geologic strata associated with these geographically unconfined areas are functionally different from the strata of the other aquifers, and have a functional condition of use – directly exchanging water with surface waters -- that is unique to these zones in the District.

Authority to create special management zones comes from Water Code Section 36.116(d).

[3] The monitoring methods may use those in section 4.1 of Steve Young's 2017 report to the Colorado Lavaca Basin and Bay Area Stakeholder Committee (CL-BBASC) (See References)

[4] Chapter 298 - Environmental Flow Standards for Surface Water, SUBCHAPTER D: COLORADO AND LAVACA RIVERS, AND MATAGORDA AND LAVACA BAYS §§298.300, 298.305, 298.310, 298.315, 298.320, 298.325, 298.330, 298.335, 298.340 Effective August 30, 2012

[5] See Appendix 1, at Section 5.4.3., Environmental Flows.

[6] Shallow flow zones are collectively represented by Layer 2 in the GAM. See Young et. al. 2017 for description of shallow aquifers and their relationship to surface water interactions.

2.4 Proposed Surface Water Monitoring Network Configuration

Several monitoring stations should be located close to existing river/stream gauges for several reasons[7]. In addition to the reasons given in the referenced publication, the location of a few reference monitoring stations near existing river gauges for which historical data are available provide context for the adopted DFC levels. The DFCs proposed are intended to provide resilience through a DOR. River gauge data for the most recent DOR and, where possible, the DOR of the 1950's, provide the desired information to make such a determination. For example, the data provided in Table 1 provide a context for selecting a low-flow level for the DFCs that relate to both the low-flow levels during the 2010-15 DOR and the environmental flow standards set for the river at the Bastrop gauge.

Each station should consist of a monitoring well into the Colorado Alluvial Aquifer outfitted with automated data collection and transmitting equipment to provide depth and physical/chemical properties on a regular basis that are collected at a central location.

The data from each station can be used to compare the water level in the alluvial aquifer with the level in the river or stream as measured by the existing river/stream gauge to determine a gaining/losing relationship. That is, higher water levels (actually, higher differences in water levels between the alluvium and the river) result in greater flows between the alluvium and the river.

Measuring hydraulic conductivity of the alluvium at each of the monitoring stations and other locations will enable quantitative estimates of discharge rates. Having empirical data on hydraulic conductivity can also be used to improve the predictive ability of the model. Water quality (physical/chemical) data will help characterize the approximate ratio of river/stream water as compared to the alluvial aquifer water that may contain groundwater coming from communicating major and minor aquifers in the region.

Well monitoring sites should be located near the following existing USGS gauges:

There are several gauge locations available in the Bastrop reach of the Colorado River (CR). A minimum of three gauges should be selected and three monitoring wells located and outfitted.[8]

Gauge Location	Selection Preference
CR at Utley	Preferred river site
CR at Bastrop	Preferred river site
CR near Upton	Optional river site
CR at Smithville	Preferred river site
Wilbarger Creek near Utley	Optional stream site
Big Sandy Creek near Bastrop	Optional stream site
Cedar Creek south of Bastrop	Optional stream site

[7] See Young et. al. (2017), Table 7-1: Factors considered in identifying locations to investigate the dynamics of water transfer between the Colorado River and the Colorado River alluvium including bank storage. Location near a river gauge was ranked very high importance since a river gauge is essential for surface water-groundwater interaction studies, are very expensive to install, and suitable location sites are limited.

[8] Low-flow data are not currently available online via USGS or the LCRA Hydromet for the following gauge locations: Colorado River at Utley and Webberville, Wilbarger Creek and perhaps other.

2.5 Include DFC and monitoring work plan in Lost Pines' Management Plan.

Lost Pines GCD is on track to review and revise its management plan this year to include changes in the adopted 2022 DFCs. As a part of the revision, it would be appropriate to include plans to remedy or mitigate the potential impacts of groundwater pumping within the district, and outside the district, on surface waters within the district such as the Colorado River and its tributaries.

Lost Pines GCD has requested input from Environmental Stewardship regarding the goal, objectives and performance standards that might be included in its management plan.

Proposed District specific goal for the Management Plan:

> **Goal:** Address surface water and groundwater interactions in the Colorado Alluvial Aquifer to enable management of the impact of groundwater pumping on the Colorado River and its tributaries, to maintain a relationship between the river and the alluvium that is adequate to support a *sound ecological environment* during a repeat of the most recent DOR in the Bastrop reach of the river and protect surface water rights throughout the basin and protect property rights.
>
> **Objective:** To better understand how, and to what extent, local aquifers contribute to streamflows under wet, dry, and drought conditions. Determine what level of contribution sustains a sound ecological environment and protect property rights through extraordinary drought conditions.
>
> **Performance standard:** Perform studies to determine the current relationship between the river, alluvial aquifer, and the major and minor aquifers. Determine under what conditions the aquifers are contributing to a sound ecological environment, what conditions could cause the river to reverse its historical gaining condition and start contributing water to the aquifers on a continuous basis, and determine what conditions cause a shift in equilibrium.[9]
>
> **Performance standard:** Install a surface water and groundwater network of wells and gauges to collect groundwater elevations and basic water chemistry data from alluvial water wells that are directly comparable to water stage and chemistry data from established river gauges. Compare the data from the alluvial well network to the data being collected on major and minor aquifer wells through the Monitoring Well Program.
>
> **Performance standard**: Set DFC to maintain a gaining relationship between the river and the alluvial aquifer and sustain a sound ecological environment in the river during a repeat of the most recent DOR.
>
> **Performance standard:** Track and map the exempt water users in the District to determine reliance on the alluvial aquifer (this might be a performance standard under Drought goal whereby the District determines how many exempt water wells might be impacted by declining stream.)

[2] Water budget analysis, as described by Hutchison 2021, will be useful in describing and understanding these conditions.

> **Performance standard:** Monitor water quality in alluvium water wells to determine if industrial and municipal activities upstream and in Bastrop County are degrading water quality.
>
> NOTE: water chemistry and water quality are differentiated here with water chemistry associated with characterizing a water source, i.e. Simsboro vs. river. Water quality is associated with detecting pollution and pollutants.

Environmental Stewardship is submitting this proposal to establish a desired future condition on the Colorado Alluvial Aquifer (Colorado River Alluvium) and to monitor the surface water-groundwater relationship to facilitate the work of the District to establish a plan to manage, and potentially mitigate, the risks that have been identified. By including a plan related to the protection of surface waters and the river in the management plan, the District will take an important step in recognizing its duty and responsibility to conjunctively manage water resources and to conserve and protect those resources for the benefit of the citizens of Bastrop and Lee Counties, and Texas.

3. POLICY JUSTIFICATION

It is responsible policy to evaluate the impacts of groundwater pumping on surface waters like the Colorado River and its tributaries using both the groundwater and surface water availability models (GAMs and WAMs), consider the advice of expert witnesses and administrative law judges, consider decisions of the Lost Pines Board of Directors on related matters, and take appropriate actions to remedy or mitigate the situation before damage occurs.

Authority for groundwater conservation districts to take such actions are provided for in the Conservation Amendments to the Texas Constitution and the Texas Water Code[10]. This authority is not limited to protecting aquifers where commercial (non-exempt) development has occurred, but extends to conserving and protecting the water resources of the state (both surface and groundwater) and property rights of both exempt and non-exempt wells and property ownership associated with such development.

Both groundwater and surface water technical analysis predict potentially unreasonable impacts to the Colorado River and its tributaries due to the amount of groundwater production adopted in the 2022 DFCs (GAM run S-19) (See Appendix 1, Sections 5.4.1, 5.4.2, 5.7, and Appendix 3). A responsible means of remedying this situation would be to reduce adopted DFCs to a level that is sustainable and does not unreasonably damage the river and other surface water resources. However, such an approach was rejected by GMA-12 in the adoption of the 2022 DFCs.

[10] Tex. Water Code § 36.108(d)(3) requiring that in developing a DFC, hydrological conditions, including "average *annual recharge, inflows, and discharge*" be considered, (d)(4) requiring that in developing a DFC "other environmental impacts, including impacts on spring flow and other interactions between groundwater and surface water;" be considered, Tex. Water Code §36.0015 (Purpose), *"[C]onsistent with the objectives of Section 59, Article XVI, Texas Constitution*, groundwater conservation districts may be created as provided by this chapter," Texas Constitution Article XVI, Section 59, providing that:

> The conservation and development of all of the natural resources of this State, . . . including . . . the waters of its rivers and streams . . . and the preservation and conservation of all such natural resources of the State are each and all hereby declared public rights and duties[.]

An expert on surface water-groundwater interaction and groundwater management opined after evaluating GAM runs for pumping scenarios in Lost Pines GCD in Bastrop County,

Quoting Dr. Hutchison (2019):

> "From a regional groundwater perspective, the [new] model does show a reduction in groundwater discharge to surface water under the base case in Bastrop County, and shows that [a] scenario that adds [...] pumping would eventually result in a condition where surface water in Bastrop County would recharge the groundwater system".
>
> "it is unreasonable to summarily dismiss the potential for impacts [on surface waters]."

Analysis of the impact of reducing water in the Colorado River due to groundwater pumping was evaluated using the surface water availability model (WAM) are described in Appendix 1, Section 5.7.2, and in Appendix 3. The removal of 25,000 and 40,000 acre-feet per year impacted about 11,000 water rights involving an average of about 7,000 - 10,000 acre-feet per year per water right. Overall natural flow at Bastrop was reduce by about 16,000 - 21,500 acre-feet per year. Freshwater flow to Matagorda Bay was reduced by a similar amount. This is a direct impact on the environment and property rights that have not typically been considered when adopting DFCs but are statutorily relevant to a consideration of DFCs.

Based on the above expert opinion and analysis, and the technical justifications, the only responsible policy is to take remedial action by establishing a desired future condition that protects the Colorado River by protecting the relationship between the river and the alluvium to ensure that the discharge of groundwater is adequate to support a *sound ecological environment*, and *surface water rights* by setting trigger points for taking actions to better understand and predict impacts, and being prepared to take further actions should conditions require. The proposed remedial action is to establish a desired future condition (DFC) on the Colorado Alluvium Aquifer with the intent to maintain a resilient gaining relationship for the river that is adequate to support an ecologically sound environment, protection of property rights of domestic and commercial wells operating in the alluvium, and protection of impacted surface water rights.

4. TECHNICAL JUSTIFICATION

Several technical methods were used to evaluate the impact of groundwater pumping on surface waters, including the Colorado River and its tributaries. The GMA-12 Groundwater availability model (GAM 2020) was used in developing such technical information as: water budgets to predict the impact of pumping on the outflow of groundwater to surface waters, drawdown in aquifers, induced leakage between aquifers, and induced flows to/from other districts, and to evaluate direct impact on the Colorado Alluvial Aquifer.

Additionally, a surface water availability model (WAM) was used to predict the impact of removing groundwater baseflows from surface water flows in the Colorado River in relationship to predicted (modelled) pumping. These impacts were measured in terms of changes in established environmental flows under wet, dry and drought conditions at several gauge stations in the lower Colorado River basin.

Finally, original technical evaluation of existing field studies and datum were done by the author to better quantify the amount of groundwater discharge that has historically been contributed by the Carrizo-Wilcox aquifer group to Colorado River baseflow. (See Appendix 1, Section 5.0.)

Taken together, these models indicate that a Colorado River Alluvium DFC is needed to address potential unreasonable impacts to the environment and property rights.

Groundwater Availability Analysis (GAM):

When the impact of groundwater pumping was evaluated using the groundwater availability model (GAM), the historical trend toward a decreased outflow of groundwater is predicted to continue to decrease flow in the river. In other words, under the various pumping scenarios evaluated, such as the adopted 2022 DFCs (S-19), the Colorado River is predicted to contribute "captured" water[11] to the aquifers because of the increase in groundwater pumping.

Though a gain/loss relationship has been used to denote a significant and unreasonable impact on the river in establishing a DFC for the alluvium that is adequate to support a sound ecological environment during a repeat of the recent DOR, it is important to recognize that when the "losing stream" status is reached, the resiliency of the river has already been compromised and damaged.

Lost Pines GCD Board voted to adopt a "conservation standard" that reduced pumping and reduce impacts on the river as represented by GAM Run S-20. Though this was rejected by GMA-12, once the 10% variance is applied to reduce the amount of pumping adopted in S-19, the result will be a 54% reduction in pumping from the originally proposed DFC and a 31% reduction in drawdown from the originally proposed DFC[12]. This action is a significant shift that helps protect the river and its tributaries in Lost Pines GCD. Though this is a significant reduction in the amount of pumping anticipated, and a similar reduction in drawdown, it is not protective of the Colorado River or exempt domestic wells because *both scenarios* come perilously close to the same unreasonable results, 1) damage to the resiliency of the river and its ability to support a *sound ecological environment,* and 2) an eventual reverse in the gain/loss relationship.

Since additional field data would improve these predictions and enable refinement of a DFC that protects outflows to the river at an ecologically acceptable level, a monitoring plan should be developed and implemented.

Surface Water Availability Analysis (WAM):

Surface water availability analysis (WAM) -- used by TCEQ and others to evaluate the impact of surface water removal in granting surface water rights -- also predicted that the impact of removing the amount of groundwater from surface water availability would cause unreasonable impacts on the environment and on water use allocations to surface water permit holders (water rights). See Appendices 3 and 11.

Surface water availability analysis also indicates that water in the Colorado River at Bastrop and below has, for all intents and purposes, been fully appropriated, *i.e.,* no more water remains

[11] Hutchison's September 1, 2021, recent presentation to TAGD

[12] Environmental Stewardship, Success Reining In DFCs, https://www.environmental-stewardship.org/2021/11/24/success-reigning-in-proposed-dfcs/

available for future appropriation as a water right. As a result, any reductions in flows negatively impact existing water rights holders. Groundwater pumping appears to create a gradual reduction of reliable streamflow over a relatively long period of time.

Environmental flow standards are not being met at recommended frequencies, and additional groundwater pumping will likely result in further reduction in these attainment frequencies.

In summary, the effect of the proposed groundwater pumping on surface water resources is unreasonable because it increases the shortfalls in meeting environmental flow targets. Since the flows in the river are already often below levels needed to maintain the ecological health of the river, any additional pumping that causes further instream flow reduction is unreasonable.

Percent of groundwater produced coming from surface water

To aid in developing a basis for a conservation standard that considers sustainable pumping without causing damage to surface waters, Rice used Run S-19 to develop water budgets that were used to compare the change in surface water captured as a percent of total groundwater production. Use of these analytical tools to describe conditions in the aquifers and how they relate to surface water are described by Hutchison (Hutchison, September 1, 2021).

In the Lost Pines GCD, the increased outflow was due to increased pumping and to an increase in the amount of groundwater flowing into neighboring counties. In GMA 12, almost all the increased outflow was due to increased pumping. For both areas, the largest source of water for the increased outflow was a reduction in the amount of groundwater discharged to streams. For the Lost Pines GCD, the reduction in discharge to streams accounted for 52% of the increased outflow. For GMA 12, the reduction in discharge to streams accounted for 64% of the increased outflow. Details of the water budgets for Lost Pines GCD and GMA 12 are presented in Appendix 7, Parts 1 and 2 respectively.

In the Lost Pines GCD, direct groundwater discharges to streams decreased by approximately 52,000 AFY. In GMA-12, the decrease was about 210,000 AFY.

In addition to the direct impacts on streams, there are indirect impacts. The indirect impact of groundwater pumping on streams includes the reduction of outflows to drains (primarily springs), and any reduction in recharge to streams that are caused by captured (induced) recharge to aquifers that would otherwise flow to streams. Recharge from precipitation is naturally distributed between streams (surface water) and groundwater aquifers. When the aquifers are "full", as they have historically been, they reject recharge[13], and the recharge goes

[13] Dutton, Alan R., Bob Harden, Jean-Philippe Nicot, and David O'Rourke. February 2003. GROUNDWATER AVAILABILITY MODEL FOR THE CENTRAL PART OF THE CARRIZO-WILCOX AQUIFER IN TEXAS, Page 81 - Rejected recharge is the concept that much of the water that reaches the water table as recharge in the unconfined part of the aquifer does not travel downdip into the confined part of the aquifer. Rejected recharge leaves the unconfined part of the aquifer by discharge to seeps and springs in valleys, discharge to rivers and streams, and evapotranspiration in river bottomland areas. Rejected recharge generally does not include withdrawal of groundwater by wells in the unconfined aquifer. The water that cycles through the unconfined aquifer, therefore, is not available for withdrawal by wells in the confined part of the aquifer. Captured recharge is the concept that drawdown of water levels in the confined part of the aquifer increases the gradient in hydraulic head and draws more groundwater from the unconfined to confined parts of the aquifer. In addition, drawdown of water levels in the unconfined aquifer, owing to pumping of wells in either the unconfined or confined parts of the aquifer, results in a decrease in the discharge of groundwater to rivers and streams and may reduce actual evapotranspiration. Groundwater that is "captured" by the confined aquifer reflects a change in the water budget of the aquifer.

to streams. As the aquifers are pumped and are less than 100% full, recharge to the aquifers is induced (captured), and less recharge from precipitation goes to streams.

The indirect impact of groundwater pumping, as described above, can also be seen in the water budgets in Appendix 7. In Lost Pines GCD the reduction in outflows to drains and increased recharge to aquifers was about 17% (about 17,000 AFY) between Period 1 (2001-2010) and Period 2 (2061-2070). In GMA-12 the reduction in outflows to drains and increased recharge to aquifers was about 18% (about 52,000 AFY) between the two periods.

Overall, in Lost Pines the net impact on streams was a decrease of about 69% (about 69,000 AFY), and for GMA-12 the net decrease was about 82% (about 262,000 AFY).

5.0 FACTORS CONSIDERED FOR DESIRED FUTURE - See Appendix 1 for details of the following topics considered:

5.1 Aquifer Uses and Conditions
5.2 Water Supply Needs and Water Management Strategies
5.3 Hydrological Conditions
5.4 Environmental Factors
5.5 Subsidence
5.6 Socioeconomic
5.7 Private Property Rights
5.8 Feasibility of Achieving Desired Future Conditions
5.9 Any Other Relevant Information

6.0 OTHER DESIRED CONDITIONS CONSIDERED

Environmental Stewardship (March 18, 2021) proposed a scenario to GMA-12 for establishing DFCs for the Colorado River that used the updated GAM to set and enforce DFCs. After discussion and feedback from the representatives, it was the opinion of the GMA-12 representatives that before they would consider a DFC based on the GAM field data would be needed to better quantitative inform predictions to be enforceable. The activities recommended herein would remedy such concerns.

ES made numerous presentations to GMA-12 over the 5-year review cycle that demonstrated the potential impacts of various GAM scenarios being considered for DFCs on the Colorado River where the GAMs predicted a reversal in gain/loss relationship during the planning horizon.

7.0 RECOMMENDATIONS AND COMMENTS RECEIVED

Carlos Rubenstein - Policy considerations

William R. Hutchison - Technical considerations

8.0 SUMMARY

Groundwater and surface water naturally interact in river basins where shallow groundwater formations are in contact with the river directly and through alluvial aquifers that follow the course of the river and its tributaries. Analysis of the interaction between the Colorado River, the Colorado Alluvial Aquifer, and the major and minor aquifers indicate that there is a potential for unreasonable impacts on the river and its tributaries and private property rights due to groundwater pumping.

Desired future conditions for the aquifers are the State's preferred method of managing aquifers to protect surface waters and property rights. Desired future conditions and a monitoring network are proposed to avoid or mitigate the potential impacts of groundwater pumping on the Colorado River and to protect the property rights of domestic and commercial well owners.

Policy and technical justifications for the proposed DFC and monitoring network are provided along with the technical analysis that support the need to implement the Lost Pines GCD management plan.

9.0 IMPLEMENTATION WORK PLAN - See Appendix 2

Sections 2 of this document provides a basis and template for developing a desired future condition (DFC) for the Colorado Alluvial Aquifer in Bastrop County, Texas. The information provided forms the foundation for the requested DFC and describes the methodology to collect and analyze data in order to fully develop the details of the DFC. The implementation of the DFC will, of necessity, take place over a period of several years as a surface water-groundwater monitoring network is developed, data are collected, and analyses are made to inform interim and final decisions. The Implementation Plan (Appendix 2) provides more details regarding how this process might proceed once protection of the river and property rights are included in the Lost Pines GCD Management Plan.

10.0 REFERENCES

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Hutchison, William J. July 25, 2019. Expert Report for the General Manager of the Lost Pines Groundwater Conservation District. Dr. Hutchison is currently an expert witness for the State of Texas in Texas vs. Mexico and Colorado in the United States Supreme Court on these same groundwater pumping impacts on surface water related to the Rio Grande River in New Mexico. Among his many other credentials, he is a consultant for our neighboring GMA-11, and Dr. Hutchison has also been a consultant for Lost Pines on these same matters pertaining to the potential impacts of groundwater pumping on surface waters, including the Colorado River in Bastrop County, Texas.

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Jaclyn Wise

From: Gary Westbrook
Sent: Thursday, November 20, 2025 9:38 AM
To: Jaclyn Wise
Subject: FW: ES Encourages GMA-12 to re-adopt the current DFCs
Attachments: 2022.9.16_ColoradoAlluviumDFC_PetitionFINAL.pdf

For GMA 12

Sincerely,
Gary Westbrook
General Manager
Post Oak Savannah GCD
Office: 512-455-9900 Cell: 979-571-5761
Fax: 512-455-9909 Website: www.posgcd.org

From: Steve Box <[redacted]>
Date: Thursday, November 20, 2025 at 7:28 AM
To: "David M. Bailey" <info@mideasttexasgcd.com>, Alan Day <aday@brazosvalleygcd.org>, Elvis Hernandez <elvis@lostpineswater.org>, "David A. Van Dresar" <info@fayettecountygroundwater.com>, Gary Westbrook <Gwestbrook@posgcd.org>
Cc: Michele Gangnes <[redacted]>, Andrew Wier <[redacted]>, Linda Curtis <[redacted]>, George Rice [redacted]>, Harold Connett <[redacted]>, Michael MacLeod <[redacted]>
Subject: ES Encourages GMA-12 to re-adopt the current DFCs

GMA-12 Representatives:

Environmental Stewardship (ES) urges that the Desired Future Conditions for the GMA-12 aquifers be maintained at the current levels of drawdown as modeled in run PS4-2.

As you know, ES has advocated that the impacts of groundwater withdrawals on the Colorado River running through Bastrop and Fayette County be considered in managing the aquifers in the management area. Modeling has forecasted that pumping of groundwater from the aquifers of the region — primarily from the Simsboro formation of the Wilcox Group — will cause the historical contribution of groundwater to the river to decline and eventually to reverse. The timing and impact on the river are directly dependent on the amount of pumping allowed by the desired future conditions (DFC) adopted by the groundwater conservation districts.

Such a reversal would mean that the historic relationship between the river and the aquifers that causes the river to be a “gaining stream” will cause the river to become a “losing stream” where surface water is contributed to the aquifers. Such a reversal has the potential of devastating effects on both the ecology of the river and the quality of the groundwater being supplied as drinking water in Central Texas. This is especially important in Bastrop County where the Carrizo-Wilcox aquifer group intersects the Colorado River and outcrop in the Wilbarger Bend reach between Austin and the city of Bastrop.

Monitoring of water quality in the Colorado River in the Austin-Bastrop-Smithville reach of the river — Segments 1428 and 1434 — conducted by Environmental Stewardship have documented that these segments are contaminated with high levels of per- and polyfluoroalkyl substances (PFAS) that are toxic to aquatic life and humans. Fortunately, most of the tributaries and groundwater wells in the watershed are not currently contaminated with PFAS or other substances that are found in the river.

From other studies done by LCRA it has been shown that the high levels of inflow of groundwater making the river a gaining stream may be the primary factor protecting the groundwater from becoming contaminated by the river during high flow events. The LCRA study found that river water does not enter into the river alluviaum and thence into the confined aquifers during high flow events. As such, it is hypothesized that the pressure of the outflow from the aquifers is adequate to isolate the aquifers from contamination by river water. Were this relationship to reverse as predicted, the high volume of pumping of the Simsboro aquifer — which outcrops at Wilbarger Bend — would allow river water to be drawn into the aquifers thus contaminating the drinking water that is drawn from municipal and water supply company wells within a few miles of the river.

For these reasons, Environmental Stewardship has petitioned Lost Pines GCD to establish a DFC for the Colorado Alluvial Aquifer (see attached original submission that was re-submitted in 2025) or designate the aquifer as a management zone to protect the relationship between the river and the aquifers. Likewise, it would be a necessary for limitations to be placed on the DFCs for the other aquifers.

As such, we urge that the current DFCs be re-adopted during this planning cycle in order to provide more time to adequately monitor and better understand the implications of over-pumping on the ecology of the river and the quality of the groundwater being withdrawn for use as drinking water.

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BRINGING SCIENCE TO DECISION-MAKING