Candidate Conservation Agreement with Assurances for the Texas Pimpleback (*Cyclonaias petrina*), Texas Fawnsfoot (*Truncilla macrodon*), Texas Fatmucket (*Lampsilis bracteata*) and Balcones Spike (*Fusconaia iheringi)* in the Lower Colorado River Basin below O.H. Ivie Reservoir

Developed cooperatively by:

U.S. Fish and Wildlife Service – Southwest Region

and

Lower Colorado River Authority (LCRA)

and

LCRA Transmission Services Corporation (LCRA TSC)

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LIST OF ACRONYMS

CCAA	Candidate Conservation Agreement with Assurances
CRP	Clean Rivers Program
ERCOT	Electric Reliability Council of Texas
ESA	Endangered Species Act
FOIA	Freedom of Information Act
GIS	Geographic Information System
HCP	Habitat Conservation Plan
HLWO	LCRA's Highland Lakes Watershed Ordinance
ITP	Incidental Take Permit
LCRA	Lower Colorado River Authority
LCRA TSC	LCRA Transmission Services Corporation
OSSF	On-site sewage facility
TCEQ	Texas Commission on Environmental Quality
TPWD	Texas Parks and Wildlife Department
NRCS	Natural Resources Conservation Service
PUC	Public Utility Commission of Texas
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
WMP	LCRA Water Management Plan

GLOSSARY OF TERMS

Term	Definition
Annual Report	A report of CCAA activities provided to the USFWS annually by March 1; the report covers the period between January 1 and December 31 of the prior year
Avoidance and Minimization Measure	A measure that reduces the amount of (or completely avoids) incidental take of a Covered Species
°C	Abbreviation for degrees Celsius
CCAA Term	The duration of the CCAA; 20 years from the date of CCAA issuance
Changed Circumstances	Defined by regulations at 50 C.F.R. §17.3 as "changes in circumstances affecting a species or geographic area covered by a conservation plan or agreement that can reasonably be anticipated by plan or agreement developers and the Service [USFWS] and that can be planned for (e.g., the listing of new species, or a fire or other natural catastrophic event in areas prone to such events)"
Conservation Measure	A measure intended to protect suitable habitat from identified threats, provide opportunities for expanding such habitat, and provide refugia for the species
Conservation Strategy	The voluntary Conservation Measures and Avoidance and Minimization Measures described in this CCAA
Conservation Zone	A portion of the Covered Area that represents similar conditions with respect to the presence or absence of Suitable Habitat and occurrence and abundance of one or more Covered Species
Covered Activity(ies)	An activity that, when performed in accordance with this CCAA, may result in authorized incidental take of the Covered Species
Covered Species	Collectively, the set of species addressed by this CCAA
Covered Area	The geographic area where LCRA and LCRA TSC will implement this CCAA and where incidental take may be authorized when performing Covered Activities
Critical Habitat	As defined in Section 3(5)(A) of the ESA
Suitable Occupied Habitat	River reaches with Suitable Habitat for a Covered Species that has documented presence of at least one of the four Covered Species
Suitable Habitat	Areas that possess the elements of habitat for a Covered Species
Unforeseen Circumstances	Unforeseen Circumstances are changes in circumstances affecting a species or geographic area covered by an HCP or agreement that could not reasonably have been anticipated by the ITP applicant and the USFWS at the time of the HCP or agreement's development, and that result in a substantial and adverse change in the status of any Covered Species (50 C.F.R. §17.3)
Zone	Conservation Zone

1 INTRODUCTION

1.1 Purpose and Benefits

On Aug. 26, 2021, the U.S. Fish and Wildlife Service (USFWS) proposed to list the Texas pimpleback (*Cyclonaias petrina*, formerly classified as *Quadrula petrina*), Texas fatmucket (*Lampsilis bracteata*), and false spike (*Fusconaia mitchelli*) as endangered under the Endangered Species Act of 1973 (ESA), as amended. The Texas fawnsfoot (*Truncilla macrodon*) was proposed for listing as threatened [86 Fed. Reg. 47,916 (Aug. 26, 2021)]. Genetic research by Smith et al. (2020) found that the false spike should be separated into two species, with the populations found in the Colorado River basin reclassified as Balcones spike (*Fusconaia iheringii*). USFWS simultaneously proposed to designate critical habitat for these freshwater mussel species, including significant portions of the Colorado River and its tributaries (86 Fed. Reg. at. 47,948-70).

This agreement between USFWS and the applicants, the Lower Colorado River Authority (LCRA) and LCRA Transmission Services Corporation (LCRA TSC), is a Candidate Conservation Agreement with Assurances (CCAA) for the Texas pimpleback, Texas fawnsfoot, Texas fatmucket, and Balcones spike (collectively, “Covered Species”) and part of LCRA’s and LCRA TSC’s application to the USFWS for an Enhancement of Survivial Permit (Permit) under section 10(a)(1)(A) of the ESA, as amended (16 U.S.C. 1531 et seq.). A CCAA is a voluntary agreement whereby property owners (including state, tribal, non-federal publicly owned, or privately owned property) agree to manage their property, or a portion thereof, to remove or reduce threats to Covered Species and provide a net conservation benefit to affected Covered Species (50 C.F.R. 17.22(d)). As non-federal owners of real property, including without limitation rights of way and water rights in the lower Colorado River basin, LCRA and LCRA TSC each have sufficient rights and authority to implement their respective obligations under this CCAA. The term of this CCAA is 20 years.

This CCAA is intended, designed, and reasonably expected to achieve a net conservation benefit for the Covered Species over the 20-year term of this CCAA. The CCAA includes a Conservation Strategy (Section 7) specifically designed to maintain

and/or increase resiliency, redundancy, and representation for the Covered Species by providing opportunities for population increases, improving species habitat, reducing severity and extent of water quality and flow-related impacts to existing populations, and removing or minimizing other threats to the Covered Species. Using Adaptive Management principles, USFWS, LCRA, and LCRA TSC can agree to modify the Conservation Strategy included in this CCAA.

USFWS may consider the existence and implementation of the CCAA in making its final decision regarding designation of critical habitat for the Covered Species and may preclude the need to designate critical habitat for one or more of the Covered Species either entirely or within specific geographic areas (86 Fed. Reg. 47,972).

The Permit would authorize take of the Covered Species, should they become listed as "endangered" or "threatened" under the ESA during the term of this CCAA. When performed in compliance with the terms and conditions of the Permit and this CCAA, the Permit would authorize take resulting from certain activities ("Covered Activities," *infra* Section 11) undertaken by LCRA or LCRA TSC within the boundaries of LCRA's Water Service Area (the "Covered Area," *see* Section 6, *infra*). So long as LCRA and LCRA TSC comply with the terms of this CCAA, additional actions above and beyond those contained in the CCAA will not be required. Furthermore, additional land, water, or resource use limitations will not be imposed upon LCRA or LCRA TSC should the Covered Species become listed in the future. While the CCAA provides conservation benefits to many aquatic species within the Covered Area, only the Covered Species will be included in the Permit.

1.2 Species Status Assessment

The USFWS Species Status Assessment Report for the Central Texas Mussels (SSA Report) was finalized in 2019. The SSA Report assessed the then-current condition of known populations of the Central Texas mussels, including the Covered Species[1] and ranked each population as Healthy, Moderately Healthy, Unhealthy, or

[1] Subsequently, Smith et al. (2020) distinguished mussel populations formerly believed to be

Functionally Extirpated (USFWS 2019).

For Texas pimpleback, three populations were ranked as Unhealthy (Concho,[2] San Saba and Llano rivers) and two populations were ranked as Moderately Healthy (middle Colorado River/San Saba and lower Colorado River). Within the Covered Area, the goals of this CCAA for the Texas pimpleback include improving the health of the populations on the San Saba and Llano Rivers to Moderately Healthy and to Healthy for the populations on the middle Colorado River/San Saba River and the Lower Colorado River.

The SSA report similarly assessed the then-current condition of known populations of Texas fawnsfoot. The population on the lower end of the San Saba River was categorized as Unhealthy and the population in the lower Colorado River was ranked as Moderately Healthy. A goal of this CCAA is to improve the overall condition of the San Saba River population of Texas fawnsfoot to Moderately Healthy and to improve the overall condition of the lower Colorado River population of the Texas fawnsfoot to Healthy.

Two Texas fatmucket populations were identified as Moderately Healthy (San Saba and Llano rivers), two populations were ranked as Unhealthy (Elm Creek[3] and Pedernales River), and one population was ranked as Functionally Extirpated (Onion Creek). Within the Covered Area, the goals of this CCAA for the Texas fatmucket include improving the health of the population on the Pedernales River to Moderately Healthy and helping restore a functioning population in Onion Creek.

Within the Colorado River basin, the SSA identified two known populations of Balcones spike (identified as false spike in the SSA), located in the lower San Saba River and the Llano River near Ranch Road 1871 southwest of Mason, Texas. Both populations were ranked as Unhealthy, primarily because few individuals were found

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false spike (*F. mitchelli*) within the Colorado River basin to instead be Balcones spike (*F. iheringi*) based upon genetic analysis. Therefore, in anticipation that the Balcones spike will be separately listed as threatened or endangered, LCRA and LCRA TSC are seeking coverage for Balcones spike in this CCAA.

2 The Concho River is outside of the Covered Area. See Section 6.

3 Elm Creek is outside of the Covered Area. See Section 6.

during population surveys and because data collected showed little evidence that reproduction was occurring. One goal of this CCAA is to improve the Balcones spike population in these locations to an overall Moderately Healthy condition, where Balcones spike can be found in approximately half of all appropriate habitats with more than 25 individuals detected in each survey, and where about half of the sites have evidence of reproduction.

2 AUTHORITY

Sections 2, 7, and 10 of the ESA of 1973, as amended, 16 U.S.C. §§ 1531, 1536, 1539, and the Fish and Wildlife Coordination Act, allow USFWS to execute this CCAA and associated permit. This CCAA was prepared in accordance with the USFWS's Candidate Conservation Agreement with Assurances Policy ("CCAA Policy") (81 Fed. Reg. 95164), and related regulations (50 C.F.R. §§ 17.22(d), 17.32(d)), both of which became effective on March 21, 2017 (82 Fed. Reg. 8501, 8540). Section 10(a)(1)(A) of the ESA authorizes the issuance of permits to "enhance the survival" of a listed species for acts that would otherwise be prohibited by Section 9 if such acts are expected to enhance the propagation or survival of the affected species. However, such permits issued for candidate or other non-listed species do not become effective unless and until those species are listed as "threatened" or "endangered" under the ESA. Consistent with the CCAA Policy, Part 1, and Section 6 of the ESA, this CCAA has been developed in coordination and cooperation with TPWD and any affected tribes.

3 COVERED SPECIES

The species covered by this CCAA are the Texas pimpleback (*Cylconaias petrina*), Texas fawnsfoot (*Truncilla macrodon*), Texas fatmucket (*Lampsilis bracteata*), and Balcones spike (*Fusconaia iheringi*).

3.1 Texas Pimpleback

The Texas pimpleback is a freshwater mussel that is endemic only to the Colorado River basin of Texas (Johnson et al. 2018). Originally petitioned as *Quadrula petrina*, this species was subsequently reassigned to the genus *Cyclonaias* (Randklev et al. 2017).

The Texas pimpleback grows to approximately 103 mm in length and has a subquadrate to suboval shell with moderate inflation. It typically has yellow, tan, brown, black, or a combination of those colors on its outer shell and occasionally has green rays or concentric blotches. The internal nacre color is white with some iridescence in the posterior region of the shell (Howells 2014). It is often confused with *Cyclonaias pustulosa* (formerly known as smooth pimpleback *Cyclonaias houstonensis*), which can be found cohabitating with Texas pimpleback in the Colorado River basin.

Once thought to occur throughout the Colorado River and its major tributaries, remaining populations of Texas pimpleback have been documented in the lower Concho River, upper San Saba River, lower San Saba River/middle Colorado River, Llano River and lower Colorado River. Of these five known populations, the most robust and resilient population occurs in the lower San Saba River and middle Colorado River; however, this population is seen as only Moderately Healthy (USFWS 2019). Survey efforts of this population since 2012 have documented 247 live individuals from a series of run-riffle-pool habitats east of the city of San Saba (Sowards et al. 2013), 481 individuals from CR 340 and CR 126 crossings in the San Saba River (Tsakiris and Randklev 2014), 15 individual Texas pimpleback from CR 340 crossing on the San Saba River in 2017 (USFWS 2019), five individuals found in the San Saba River near the city of San Saba (USFWS 2019), 97 live individuals from six sites in the middle Colorado River (Bonner et al. 2018), and 42 Texas pimpleback from the lower San Saba River near the confluence with the Colorado River. In addition, a mark-recapture site established by Bonner et al. (2018) reported finding 394 Texas pimpleback mussels in the middle Colorado River near the city of San Saba. This mark-recapture project was initiated with funding from the Texas Comptroller of Public Accounts.

Texas pimpleback can be found in medium to large rivers of the Colorado River basin. They prefer substrate types with mud, sand or gravel and can sometimes be found in cracks in the bedrock of rivers (Howells 2014). Texas pimpleback have a strong association with riffles compared with other native Colorado River mussels (Bonner et al. 2018), but also can be found in run mesohabitats (Randklev et al. 2017). In the lower Colorado River near Altair, Texas, Bonner et al. (2018) reported Texas pimpleback to be closely associated with water depths between 0.6 and 0.9 meters (m),

and with mean column velocities below 0.2 meters/second (m/s). In a simulated field-dewatering trial, Bonner et al. (2018) found that the Texas pimpleback is better at avoiding dessication than two other Central Texas mussels. By exhibiting considerable horizontal movement, Texas pimpleback could survive for approximately 32 days (LT50) with a dewatering rate of 0.044 meters per day (m/d) (albeit during cooler winter months), making it somewhat more resilient to dewatering during low-flow events, at least under milder temperature conditions (Bonner et al. 2018). However, thermal limits can vary at different times of the year (Martin 2016) and across populations for freshwater mussels (Khan 2018).

All native freshwater mussels rely upon host fish during a specific part of their life cycle called the glochidial stage. Gravid female mussels lure host fish toward their shells and then release fertilized eggs (glochidia) that then attach to the gills and/or fins of the fish. The glochidia eventually fall off into the sediment as fully developed juveniles (Barnhardt et al. 2008; Fritts et al. 2012). Texas pimpleback can use at least three species of host fish – channel catfish (*Ictalurus punctatus*), flathead catfish (*Pylodictus olivarus*) and tadpole madtom (*Notorus gyrinus*) (Howells 2014; Dudding et al. 2019). Like other species in the tribe Quadrulini, Texas pimpleback tend to exhibit short-term brooding, which means they release their glochidia soon after the larvae reach maturity (Barnhart et al. 2008).

3.2 Texas Fawnsfoot

The Texas fawnsfoot is a freshwater mussel found in the Brazos, Trinity, and Colorado River basins of Central Texas (Strecker 1931; Lea 1859; Howells et al. 1996; Howells 2014; Randklev et al. 2017; Inoue et al. 2018).

Shells are typically small (60 mm or less in length), elongate oval and compressed (Howells et al. 1996; Howells 2014). The beak is above the hinge line with sculpture described as three to six single looped concentric ridges, though one to two heavier ridges may be present (Howells et al. 1996; Howells 2014). The periostracum is typically light yellow or brown with green rays (Howells et al. 1996; Howells 2014). Like other *Truncilla* species, Texas fawnsfoot often will have green rays broken into chevron-like patterns (Howells et al. 1996; Howells 2014). In the shell interior, the nacre is white,

pseudocardinal teeth are compressed, and lateral teeth are thin (Howells et al. 1996; Howells 2014).

Within the Colorado River basin, historical records indicate the Texas fawnsfoot inhabited a large portion of the watershed from the North Concho River in Sterling County all the way to the main stem of the Colorado River in Wharton County. They also were documented throughout the Concho, San Saba and Llano rivers, as well as Onion Creek (Howells 2010).

Survey records in the Colorado River basin as of May 2022 indicate the Texas fawnsfoot inhabit the lower Colorado River in Fayette, Colorado, Wharton, and Matagorda counties, as well as the San Saba River in San Saba County (USFWS 2019; LCRA 2022 *in draft*). The population of Texas fawnsfoot in the lower Colorado River is considered Moderately Healthy, which means the habitat is relatively healthy and stable and survey efforts have found individuals in approximately 50% of all available habitats during reasonable surveying efforts. The San Saba population is considered Unhealthy, meaning that few individuals have been found in areas of Suitable Habitat during reasonable survey efforts (USFWS 2019).

Habitat use of Texas fawnsfoot appears to be variable with individuals found in a variety of habitat types. They are most often found in higher order streams and rivers and prefer mud, sand and gravel substrates (Howells 2014). Adults are often found in bank habitats but also can be found in backwater, riffle, point bar, run edge, and pool edge habitats with low to moderate velocities (Randklev et al. 2017). In the lower Colorado River, Texas fawnsfoot were most commonly found in run edge habitats and habitat suitability was reported to be highest at water depths of 0.6 to 0.9 m with mean column velocities below 0.5 m/s (Bonner et al. 2018).

Little is known regarding the life history requirements of Texas fawnsfoot (Howells 2014). They are presumed to have a similar reproductive cycle to other *Truncilla* species, which are long-term brooders that parasitize solely on freshwater drum (*Aplodinotus grunniens*) to complete their life cycle (Howells 2014; Barnhart et al. 2008).

Molecular evidence indicates genetic isolation among drainages and the existence of three separate evolutionarily significant units, which supports that Texas

fawnsfoot in the Colorado River basin should be considered a separate conservation unit from the Brazos and Trinity river basins (Inoue et al. 2018). Maintaining representation of Texas fawnsfoot across the three river basins is important for ensuring long-term viability of the species (USFWS 2019).

3.3 Texas Fatmucket

The Texas fatmucket is a freshwater mussel that was originally described as the species *Unio bracteatus* by A.A. Gould in 1855 from the "Llanos River." Texas fatmucket is a small to medium-sized freshwater mussel that typically does not grow over 100 mm shell length. The species exhibits sexual dimorphism, but both males and females typically exhibit yellow-green-tan coloration with dark rays that broaden near the margin. The shell shape is elliptical to subrhomboidal (Howells et al. 1996; Howells 2014).

The recognized scientific name of *Lampsilis bracteata* was solidified by Strecker (1931) who noted the species was "characteristic of the Guadalupe and Colorado River systems." However, Inoue et al. (2020) found that Texas fatmucket in the Guadalupe River basin are more closely related to *L. hydiana* than to *L. bracteata*, and are likely a new species. Hence, the newly recognized Guadalupe fatmucket (*L. Bergmanni*) found in the Guadalupe River system is now considered distinct from the Texas fatmucket found only in the Colorado River basin of Texas.

As of May 2022, the species is known to have only five populations in the following waterways: lower Elm Creek (Runnels County), upper/middle San Saba River, Llano River, Pedernales River, and lower Onion Creek (USFWS 2019). Historically, the species is presumed to have lived exclusively in the upper and middle portions of the Colorado River basin throughout the Edwards Plateau ecoregion (Howells 2014).

The species prefers stable substrates of mud, sand, and gravel bottoms and is sometimes found in bedrock fissures or in between the roots of riparian plants and aquatic vegetation (Howells 2014). Like the other Central Texas mussels, Texas fatmucket requires flowing water of rivers and streams. The species has been described as being vulnerable to extreme low flows and is oftentimes associated with spring outflows.

Texas fatmucket are known to have host fish in the family Centrarchidae (sunfishes), which include bluegill (*Lepomis macrochirus*), green sunfish (*Lepomis cyanellus*), Guadalupe bass (*Micropterus treculii*), and largemouth bass (*Micropterus salmoides*) (Seagroves et al. 2019; Howells 1997; Johnson et al. 2012; Bonner et al. 2018).

The species uses a bait-like lure to attract predatory fish that attack and rupture the marsupium, which then expels glochidia that attach to the fish. These species are long-term brooders.

3.4 Balcones Spike

The Balcones spike is a freshwater mussel species endemic to the Colorado and Brazos river basins of Central Texas. The Balcones spike is a medium-sized species typically observed at lengths ranging from 50 mm to 75 mm (Howells et al. 1996; Randklev et al. 2013; Randklev et al. 2017) with a maximum shell length at least 96 mm (Smith et al. 2020). Shell shape varies from elongate-oval to sub-rhomboidal (Howells 2014). The beak is slightly elevated above the hinge ligament and typically sculptured with multiple strong w-shaped or double-looped bars (Howells et al. 1996; Howells 2014). The shell exterior is often sculptured centrally with pustules and grooves, though absence of disc sculpture is common (Howells et al. 1996; Howells 2014). The posterior ridge is broadly rounded and the posterior field may have corrugations (Howells 2014). Shell nacre is white, with heavy pseudocardinal teeth and light lateral teeth (Howells et al. 1996; Howells 2014).

Historically, the Balcones spike was considered synonymous with the false spike but was split following genetic research from mussels collected from the Brazos, Colorado and Guadalupe river drainages (Smith et al. 2020). The Balcones spike is now believed to occur exclusively in the Brazos and Colorado river basins (Smith et al. 2020). The biological information about Balcones spike that follows is based upon literature regarding false spike in the Colorado River basin that was published prior to this genetic distinction being made.

The Balcones spike is most frequently associated with fluvial habitats (Howells 2014), and is most commonly observed in riffles and runs with sporadic observations in

other habitats (Randklev et al. 2013; Mabe and Kennedy 2014; Tsakiris and Randklev 2016, Randklev et al. 2017). In the Colorado River basin, the Balcones spike has two known populations – one population unit in the lower San Saba River and the other in the Llano River. Available data as of May 2022 suggests these two populations are very small and isolated. Overall, USFWS considers the Balcones spike as Unhealthy within these two populations in the Colorado River basin (USFWS 2019).

Like other native freshwater unionids, Balcones spike parasitize on host fish during the glochidial stage, receiving nutrition and transport from the host until dropping off as fully developed juveniles (Barnhart et al. 2008; Fritts et al. 2012). Like most *Fusconaia* species, the Balcones spike is a short-term brooder. The gravid females release their glochidia via little packets of mucilage and glochidia (referred to as conglutinate packets) that float out from their shells during a brief period following glochidia maturation to attract host fish (Dudding et al. 2019). False spike in the lower Guadalupe River have been found gravid from February to June (Dudding et al. 2019), but it is unknown if Balcones spike in the San Saba and Llano rivers exhibit the same timing. Confirmed hosts include blacktail shiner *Cyprinella venusta* and red shiner *Cyprinella lutrensis* (Dudding et al. 2019).

Limited information is available on physiological responses and tolerance limits of Balcones spike to variations in water quality. A study by Bonner et al. (2018) for false spike in the lower Guadalupe River estimated optimal temperatures for organism growth of 28°C, and the divide between sublethal and lethal thermal stress was estimated at 31°C. An additional study from the lower Guadalupe River tested upper thermal tolerances of false spike, estimating the LT_{05} (i.e., temperature when 5% of the test individuals died) at about 31°C, and the LT_{50} (i.e., temperature when 50% of the test individuals died) at approximately 33°C (Khan et al. 2019). Similar studies have not been conducted on Balcones spike from the Colorado River basin.

4 THREATS

In the Species Status Assessment for Central Texas Mussels (SSA), the USFWS has identified the threats to the Covered Species as including: (1) altered hydrology, i.e. water quantity; (2) changes in water quality, including those related to water

temperature, chemical contaminants, and runoff and erosion of fine sediments; (3) barriers to dispersal; (4) invasive species; (5) predation; and (6) collection. All of these threats contribute to the degradation, loss, and fragmentation of habitat for the Covered Species to varying degrees. A copy of the SSA can be obtained from the USFWS's Environmental Conservation Online System (ECOS) at: https://ecos.fws.gov/ecp/report/ssa. Below is a detailed description of impacts that these threats may have on the Covered Species.

The degradation, loss, and fragmentation of freshwater mussel habitat can be caused by a variety of factors at multiple scales (Drew et al. 2018; Atkinson et al. 2012). Water quality and quantity are key factors influencing mussel habitat health, as described in Sections 4.1 and 4.2.1. As discussed in Section 4.2.3, riparian and upland land management influence the erosion potential within a watershed and, therefore, the amount of sedimentation that can impact in-stream habitats. Fragmentation can occur as mussel populations become separated by dams or expanses of poor habitat, as described in Section 4.3. Such fragmentation can restrict gene flow and result in genetic isolation of previously connected populations.

Predation, exotic species, and overuse through collection or research are also critical threats to the species, as described in Sections 4.4 through 4.6.

4.1 Water Quantity

The Colorado River has a long history with droughts and floods (Williams 2016), and the Central Texas mussels have survived and evolved to withstand both water quantity extremes throughout the millennia. However, a steady increase in human population growth within the watershed of the Colorado River has resulted in an increased human demand for water resources. Increased use of both surface water and groundwater and reservoir construction have helped satisfy this demand but also have contributed to alterations in the natural flow regimes of watercourses in different parts of the Colorado River basin. Release of water through hydroelectric power generation typically occurs at each of the Highland Lakes dams when water is released for other purposes, such as downstream demands or for instream flow needs (LCRA 2020, § 2.5).

Manmade alterations to the river needed for water management may, at times, change the magnitude, timing, frequency, and duration of flows in the river (Poff et al. 1997). In some locations, flow alterations also may affect (both positively and negatively) the timing and availability of flow for freshwater mussels and other aquatic organisms. The operation of pumps to divert water from the river can disturb substrates near intake facilities that could include mussel habitat. While floods and other natural alterations in flows may result in localized mortality of mussels, such events also may provide long-term ecosystem services and functions (Sotola et al. 2021).

Large on-channel reservoirs typically result in changes to the natural hydrology, which include: decreases in peak discharges, increases in minimum flows, increases in base flow levels, and alterations to the timing of low- and high-flow events (Zhang and Wurbs 2018; Graf 2006; Kondolf and Batalla 2005; Wellmeyer et al. 2005). As of 2019, the Colorado River basin contains 31 reservoirs with storage capacities of 5,000 acre-feet or greater (Texas Water Development Board [TWDB] 2019), 10 of which are on the main stem of the Colorado River. LCRA owns or operates eight of these reservoirs, six of which are on the main stem, with the other two located on tributaries to the Colorado River downstream of Austin. These eight reservoirs were all constructed prior to 1978 and provide important flood control, water supply, and hydroelectric generation functions. LCRA has constructed an off-channel reservoir – Arbuckle Reservoir – in Wharton County. The operation of this reservoir is not expected to significantly affect river flows or water levels downstream. Below Austin, there are no major dams on the Colorado River. A small low-head dam creates a pumping pool to support LCRA's water supply operations near Lane City. In addition, LCRA operates a saltwater barrier weir dam at Bay City.

As in other areas, post-reservoir hydrology data from the lower Colorado River basin indicate increased base flows, reductions in the duration of extreme low-flow events, and reductions in the overall magnitude of high-flow pulses (BIO-WEST 2008). In some cases, these conditions can positively impact mussel communities by preventing desiccation during drought conditions and preventing displacement during extreme high-flow events. At the same time, higher water velocities associated with increased base flows can potentially displace settling juveniles before they can burrow

down and become established in the sediment (Layzer and Madison 1995). In some rivers, altered hydrology has been shown to lead to changes in bedload movement and sediment scour, displacing juvenile mussels (Layzer et al. 1993). Reservoir releases have been shown in other systems to alter basic water chemistry, such as temperature, which also may limit mussel reproduction (Layzer et al. 1993). Additionally, deviations in the timing of high and low flows may affect whether the required host fish species are present during mussel reproductive seasons (Freeman and Marcinek 2006; Gido et al. 2010).

In the Colorado River basin, there has not been thorough documentation of how flows and channelization compared before and after reservoir construction of the Highland Lakes. In-channel modification can alter flow regimes and, thus, patterns of sediment deposition and scour (Petts 1980; Ligon et al. 1995; Baxter 1997). Poff et al. (1997) discussed how elevated base flows from dam releases can cause bed scour, which channelizes the river and decreases habitat diversity. Channelization also can lower the base level of a river and initiate upstream erosion (i.e., head-cutting) (Shields et al. 2000).

The San Saba, Llano, and Pedernales rivers are tributaries to the Colorado River and the Highland Lakes within the Covered Area. While these rivers and their tributaries do not have any major reservoirs that control the flow of water, water flows are affected by diversions by third parties pursuant to state-issued senior water rights, largely for agricutlural and municipal purposes. Moreover, these streams are subject to highly variable flows and have a history of drought and flood cycles (Larkin and Bomar 1983; Heitmuller 2011; Wierman et al. 2017; Khan et al. 2019; Mitchell et al. 2019).

4.2 Water Quality

Freshwater mussels are sensitive to water quality degradation due to higher water temperatures, contaminants, or runoff and erosion. Suitable Habitat for freshwater mussels must maintain adequate and sustained dissolved oxygen levels and water temperature ranges. Water quality degradation due to contamination with certain pollutants can impact the life cycles and overall health of freshwater mussels. In

addition, an increase in fine sediments in the water column due to erosion can have a negative impact on mussel survivability and health.

Every two years, TCEQ compares all available quality-assured water quality data in Texas to the Texas Surface Water Quality Standards and publishes the results in the Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d) (Integrated Report). The 2020 Integrated Report identified 21 impaired river segments in the Colorado River basin (TCEQ 2020b). Of these, there are only two river segments within the San Saba and Concho rivers that are identified as impaired that also have known populations of the Covered Species. TCEQ Segment 1416 of the San Saba River does not support contact recreation based on *E.coli* data collected near the town of San Saba; however, all aquatic life use criteria are being met based upon routine monitoring data collected by LCRA (LCRA 2020). TCEQ Segment 1421 on the Concho River (downstream of San Angelo) is impaired for low dissolved oxygen. The dissolved oxygen deficiency is attributable to low flows through the many impoundments from the O.C. Fisher Dam to the Bell Street Dam in San Angelo (LCRA 2017). However, since the implementation of the Concho River Watermaster program in 2005, trends for dissolved oxygen in this section of the river have improved (LCRA 2017).

4.2.1 Water Temperature

Low-flow conditions can contribute to higher water temperatures and other water quality related stressors to mussels. Research by Khan et al. (2020) on adult thermal tolerance limits for several native mussel species [including false spike, which is closely related to Balcones spike (Smith et al. 2020)] concluded that the average median lethal temperature (LT50) in 96-hour adult tests was 36.4 °C and ranged from 33.7 to 37.5 °C. In contrast, research on sublethal temperatures for glochidia concluded that the average median lethal temperature (LT50) among the glochidia of several native freshwater mussel species during 24-hour tests was 32.4 °C (Khan et al. 2019). Thus, thermal tolerances appear to differ among species for both glochidia and adults, with glochidia being more temperature sensitive than adults. Timing of thermal stressors also is an important factor for how temperature can impact mussel populations. While higher temperatures during the summer months often naturally correspond with lower flows, controlled releases from upstream reservoirs often mitigate these conditions, particularly

in the lower Colorado River below Austin (Sections 5.2 and 7.3.2.1). Thermal stress can redirect energy that normally would be used for growth and reproduction to basic survival (Portner 2001), which may result in decreased fecundity and fitness of mussel populations (Petes et al. 2007). Texas fawnsfoot and Texas fatmucket are both long-term brooders that likely brood larvae through the winter months and release glochidia in the spring (Barnhart et al. 2008). Texas pimpleback spawning is believed to peak in April and again in November (Mussels of Texas 2021). The Balcones spike likely spawns during late winter and broods during the spring and early summer based upon knowledge of closely related false spike (Dudding et al. 2020). The timing of spawning during late winter and brooding during spring and early summer is likely one of the adaptations these species have made to respond to severe conditions, as recognized by the USFWS in its proposed listing (Fish and Wildlife Service 2021), which helps ensure mussel reproduction is completed before optimal water temperatures are exceeded for not only glochidia and juveniles but also for adults. A reproductive window during these times of the year also may minimize impacts to energy allocation for juveniles and adults during summer and late autumn when their resources are needed for growth and maintenance (Haag 2012).

In Section 7.3.2, as a part of the discussion on conservation measures that LCRA and LCRA TSC are committing to implement that address water quality threats, information is provided on historic water temperatures at key locations in waterways near known occupied habitat of the Covered Species, as well as best available science on reproductive timing and thermal tolerance research for each of the Covered Species.

4.2.2 Chemical Contaminants

Several water quality contaminants can impact mussel health and survivability, including ammonia, chlorine, heavy metals, dissolved salts, and organic contaminants such as pesticides and herbicides (Cope et al. 2008). Exposure to elevated levels of ammonia can have lethal and sublethal effects on juvenile mussels and has been implicated as one of the main contributors to the overall decline of mussels throughout North America (Strayer et al. 2004; Newton and Bartsch 2007; EPA 2013). This observed sensitivity to ammonia caused the United States Environmental Protection Agency (USEPA) (2013) to consider the physiological tolerances of mussels when

recommending aquatic life criteria for acute (one-hour average: 17 mg TAN/L) and chronic (30-day rolling average: 1.9 mg TAN/L) exposure to ammonia. In addition to surface runoff, treated effluent discharged from wastewater treatment plants to the river may result in elevated nutrient loading to rivers and lakes. Elevated levels of ammonia and nitrate directly downstream of a wastewater treatment plant in the Grand River, Ontario, Canada, have been associated with the extirpation of mussel populations in large sections downstream of the treatment plant (Gillis et al. 2017). Total ammonia concentrations below 0.7 mg/L (pH of 8) can be considered a safe range for all mussel life stages according to some researchers (Augsperger et al. 2003); however, more research would be needed to know the specific ranges required for protection of the Covered Species.

In some river systems, hydrology can have a direct impact on water quality. Anthropogenic activities that alter flow regimes and landscapes also may exacerbate natural fluctuations in water quality, which can thereby influence survival, growth, and reproduction of freshwater mussels (Strayer 2008). During times of low or no flow, water surface temperatures typically increase while dissolved oxygen levels usually decrease, which can lead to mussel mortality (Gagnon et al. 2004; Golladay et al. 2004; Haag and Warren 2008). In addition, Aldridge and McIvor (2003) have shown that gravid female mussels are more prone to aborting their glochidia prematurely during drought conditions due to high temperatures and stress, thereby limiting reproductive success and recruitment.

In a laboratory setting, a subset of Central Texas mussel species exhibited behavioral responses when exposed to increasing salinity concentrations, resulting in partial valve closure at 2.0 ppt and complete valve closure at 4.0 ppt. These behavioral responses can have negative impacts on how the mussels filter water, breathe and reproduce if exposure to salinity levels higher than 2.0 ppt is long-term (Bonner et al. 2018).

4.2.3 Runoff and Erosion of Fine Sediments

The landscape within a watershed has a strong influence on channel morphology and hydrodynamics of lotic systems (Brim-Box and Mossa 1999; Newton et al. 2008). Alterations to the landscape (e.g., urbanization, agriculture) have been shown to

increase runoff and erosion, which are major contributors to excess fine sediment inputs in river systems (Brim-Box and Mossa 1999). Sedimentation has been shown to negatively impact unionids. A literature review by Goldsmith et al. (2021) found that increases in suspended solids could decrease food availability, physically interfere with filter feeding and breathing, and, by proxy of impacts to host fish, cause cascading effects to mussel early life stages. Sedimentation also can impact the ecological integrity of streams, including changes in stream geomorphology, water quality, and reductions in substrate complexity (Poff et al. 1997; Brim-Box and Mossa 1999).

4.3 Barriers to Dispersal

Dispersal is dependent on movement of host fish and serves several important functions such as connecting subpopulations within the occupied range of a species or allowing a species to move into formerly uninhabited areas (Strayer 2008). Degradation and loss of habitat due to anthropogenic actions may lead to large sections of unsuitable mussel habitat, thus reducing dispersal success (Strayer 2008). In particular, many dams or low-water road crossings, as well as hydroelectric turbines, can prevent host fish movement (Watters 1996; Newton et al. 2008; Rytwinski et al. 2017). Barriers to dispersal pose a threat to the Covered Species and may prevent intrapopulation connectivity and range expansion.

4.4 Invasive Species

The zebra mussel (*Dreissena polymorpha*) has been introduced to every Central Texas river basin (TPWD 2022). In the Colorado River basin, zebra mussels were first discovered in 2017 in Lake Travis and have since spread to all of the Highland Lakes reservoirs, as well as the Colorado River downstream of Austin (TPWD 2022). Dreissenid mussels can cause major abiotic alterations in freshwater ecosystems and have had large impacts on aquatic organisms such as freshwater mussels (Baker and Levinton 2003; Burlakova et al. 2014). Zebra mussels compete for space and food with native mussels and also have been found aggregated on the posterior end of mussels, preventing the ability of the native mussel to filter, leading to mortality (Nichols and Wolcox 1997; Baker and Levinton 2003). Typically, dreissenid mussels densely colonize

lakes and reservoirs, and are not currently considered a major threat to riverine systems (Karatayev et al. 2017).

4.5 Predation

Freshwater mussels provide a food source for a variety of organisms, including raccoons, muskrats, otters, and bottom-feeding fish such as carp (*Carpio* spp.). In addition, there are a variety of infectious diseases and parasites that have the potential to decrease the fitness of freshwater mussels, including trematodes (Tsakiris et al. 2016; Seagroves et al. 2019), mites, and *Conchophthirus* spp. and viruses (Grizzle and Brunner 2009). In the San Saba River, Tsakiris et al. (2016) documented that male Texas pimpleback mussels parasitized by trematodes were devoid of gametogenic tissues, making them incapable of reproduction. Mitchell and Schwalb (2021) found trematode infestations in the Texas fatmucket and Texas pimpleback within the San Saba River and Llano River populations. TPWD is funding a trematode prevalence study to better understand impacts caused by trematodes to freshwater mussels in Texas.

4.6 Collection

Commercial harvest of native mussels was common in Texas during the 20th century (Howells et al. 1996; Haag 2012). Harvest is now prohibited in some areas identified as mussel sanctuaries, as explained below, and minimal commercial harvest occurs in Texas (Howells 2014). In the Colorado River basin, four waterway segments have been designated as mussel sanctuaries (31 Tex. Admin. Code § 57.157). These include portions of Live Oak Creek, the Concho River, the San Saba River, and Elm Creek. Mussel sanctuaries protect populations of both rare and commercially valuable species from harvest. Designation of the sanctuaries is based on the most current scientific survey data available about the occurrence of mussel populations (TPWD 2021b).

Recreational anglers sometimes use the soft tissues of mussels as bait. Although the exact level of harvest for bait is unknown (Howells 2014), it is expected to be minimal. The collection of mussels for scientific studies also has been suggested as

contributing to the threat of freshwater mussels in Texas (USFWS 2019).

5 LOWER COLORADO RIVER AUTHORITY AND LCRA TSC BACKGROUND

LCRA and LCRA TSC are related, but separate, entities. LCRA is a political subivision of the State of Texas and LCRA TSC is a nonprofit corporation. With regard to this CCAA, LCRA is primarily concerned with the conservation and management of surface water resources, power generation, and recreation and land management within the lower Colorado River basin, whereas LCRA TSC is primarily devoted to electric power transmission facilities and services within the lower Colorado River basin and beyond. For the purposes of this CCAA, both entities are submitting a joint application for a single Enhancement of Survival Permit with two permittees. More background regarding both LCRA and LCRA TSC follows.

5.1 Lower Colorado River Authority

LCRA was created in 1934 as a conservation and reclamation district with a statutory authority covering 10 counties encompassing the lower Colorado River, including Bastrop, Blanco, Burnet, Colorado, Fayette, Llano, Matagorda, San Saba, Travis, and Wharton counties (Act of Nov. 10, 1934, 43rd Leg., 4th C.S.). LCRA provides a number of services, including managing water supplies, managing floods along the Highland Lakes, producing and delivering power, providing parks and recreation areas, and supporting community development. Between 1935 and 1951, LCRA built six dams along the Colorado River above Austin, including Tom Miller Dam, which is owned by the city of Austin (Adams 1990; Banks and Babcock 1988). These dams help manage the river in floods and provide a reliable supply of water by forming the chain called the Highland Lakes (LCRA 2021a). With the exception of two reservoirs LCRA owns and operates on downstream tributaries for purposes of power plant cooling, LCRA does not own or operate any other water infrastructure on any of these tributaries or on the main stem of the Colorado River upstream of Lake Buchanan or on other tributaries or river segments that contribute flow to the Highland Lakes or the Colorado River within LCRA's broader service area.

In addition to its water-related responsibilities, LCRA also supplies wholesale

electricity throughout Central Texas to several electric cooperatives and cities. LCRA operates fossil-fueled power plants in Bastrop, Fayette, and Llano counties, in addition to its six hydroelectric facilities on the Colorado River (LCRA 2021b; Tex. Spec. Dist. Code § 8503.004(t)). LCRA also has diversified its energy sources to include wind and solar power (LCRA 2021c). LCRA operates more than 25 parks and recreational facilities along the Colorado River, at the Highland Lakes, and at downstream lakes with power plants (LCRA 2021d) (Figure 1). Consistent with its statutory authority to aid in the prevention of soil erosion within the watershed, LCRA manages approximately 23,000 acres of lands (not subject to inundation) in a manner that conserves soil and water to enhance habitat for native terrestrial and aquatic species and also actively encourages land conservation by others within the watershed. (Tex. Spec. Dist. Code § 8503.004(e)).

Figure 1. LCRA Parks in the Colorado River Basin.

Over time, the Texas Legislature has expanded LCRA's responsibilities and authority. In 1971, LCRA was granted limited authority over pollution control of ground and surface waters and water quality monitoring within its 10-county statutory service area (Tex. Spec. Dist. Code § 8503.004(q)). Since 1988, LCRA has sponsored the Colorado River Watch Network, a volunteer-based environmental education and data collection program along the Colorado River and its tributaries (LCRA 2021e). More than 500 volunteers have taken part in the program. Under the Clean Rivers Act of 1991, LCRA conducts a comprehensive assessment of the basin's water quality in partnership with the TCEQ and the Upper Colorado River Authority. LCRA has served as the lead organization in the Colorado River basin for the Clean Rivers Program since the program's inception in 1991. In 2021, with passage of Senate Bill 632, the Legislature granted LCRA authority to provide certain fiber capacity and facilities for the purpose of facilitating broadband service connectivity (Act of April 30, 2021, 87th Leg., R.S.; Tex. Spec. Dist. Code § 8503.032.). LCRA also works with local communities to attract new businesses and to help existing businesses expand. Between 1990 and 1995, LCRA helped add more than $23 million in capital investment in and around Central Texas (Williams and McCann 2012). Like many other river authorities, LCRA receives no state tax money and cannot levy taxes. LCRA operates on revenues from wholesale electricity and water sales and other services.

5.2 LCRA's Management of the Colorado River for Water Supply and Environmental Flows

LCRA has state-issued water rights to manage water from lakes Buchanan and Travis and other Colorado River flows below Austin. A summary of the state-issued water rights owned or operated by LCRA is included as Appendix A. LCRA supplies water from its two water supply reservoirs, Lake Buchanan and Lake Travis, as well as several other "run-of-river" water rights that allow diversion of water from the river below Austin. Cities, businesses, industries, agriculture, and the environment all rely on the water that LCRA manages.

When LCRA's water rights for lakes Buchanan and Travis went through the state-required adjudication process in the 1980s, LCRA was granted the right to use up to 1.5 million acre-feet of water per year from lakes Buchanan and Travis, subject to a

number of special conditions and restrictions. Most importantly, the court required LCRA to develop a reservoir operations plan, now known as the Water Management Plan ("LCRA's WMP"), demonstrating how LCRA would meets its various water supply commitments. The court further required LCRA to assume certain obligations to provide water for environmental flow needs.[4] To meet the court's mandate, LCRA's WMP addresses the manner in which it delivers water to both "firm" and "interruptible" customers while also providing water to help meet environmental flow needs for the lower Colorado River (LCRA 2020, p. ES-1). Consistent with state water rights permitting requirements, LCRA's WMP is developed using water availability models that assume a repeat of the available and highly variable hydrologic conditions. LCRA's WMP was first approved in 1989 and has been and will continue to be regularly amended to incorporate updated hydrology (such as that which may result from climate change), water demands, and new scientific information related to environmental flow needs.[5] LCRA's WMP, and each amendment thereto, undergoes a significant public input process and, ultimately, requires review and approval of the TCEQ in accordance with state law governing amendments of water rights.

Not only is LCRA's WMP regularly amended to adapt to changed conditions, LCRA's WMP includes adaptive management components that allow LCRA to respond to real-time conditions. The most recent amendment to LCRA's WMP, approved by the TCEQ in 2020 ("2020 WMP"), uses flow conditions reflective of the hydrologic record from 1940-2016 and establishes operational criteria that ensure LCRA can deliver water to firm customers (mainly cities and industries) in a repeat of the droughts of the 1940s to '50s and 2000s to 2010s, including 2011,which was the worst single-year drought on record (LCRA 2020, p. ES-3). LCRA provides water on an "interruptible" basis for agricultural purposes within portions of Colorado, Wharton, and Matagorda counties (LCRA 2020, p. ES-4). The 2020 WMP allows LCRA to respond to real-time hydrologic conditions by curtailing or even cutting off interruptible supply during droughts or other

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4 1989 WMP Order, Findings of Fact # 22 and 34.

5 See, e.g., LCRA 2020, Appendix C, available at https://www.lcra.org/download/appendix-c-priororders-wmp-curtailmentplan-feb2020/?wpdmdl=11926.

shortages (LCRA 2020, § 4.3). LCRA is required to implement such curtailments or cutoffs to maintain a minimum of 600,000 acre-feet of water stored in lakes Buchanan and Travis through a repeat of historic droughts. This minimum storage provides a safety factor to address other hydrologic conditions, such as those that might result from unanticipated increases in water demands or from climate change (which could be more severe than the conditions experienced over the historic record) (LCRA 2020, p. ES-6).

In general, the amount of and manner in which LCRA is required to provide water for environmental flow purposes under LCRA's WMP varies based on season and real-time hydrologic conditions, such as the amount of water stored in lakes Buchanan and Travis at particular times throughout the year. LCRA has dedicated a portion of its firm supply (33,440 acre-feet per year) specifically for environmental flow needs (LCRA 2020, p. ES-7). In addition, LCRA provides water for instream flow needs on an interruptible basis under special conditions set forth in LCRA's WMP (LCRA 2020, p. ES-5; §§ 4.3-4.4). In general, LCRA makes water available for higher levels of instream flows when the overall hydrologic conditions include higher lake levels and higher inflows to the lakes, with the criteria scaled back during drier hydrologic conditions. More details about how the 2020 WMP provides instream flows that are protective of the Covered Species are discussed in Section 7.3.1, *infra*. Diversions of water under LCRA's Garwood water right at locations upstream of the original Garwood agricultural operations (in Garwood, Texas) are also subject to special instream flow protections.

Since the mid-1980s, LCRA has partnered with the state's resource agencies [TCEQ, TPWD, and the Texas Water Development Board (TWDB)], completing some of the first instream flow and freshwater inflow needs studies in Texas. The results of these studies formed the basis for specific amendments to the environmental flow conditions in LCRA's WMP in 1991, 1992, 1999, and 2010.[6] In addition, LCRA commissioned new studies on instream flows and freshwater inflows in the mid-2000s that led to specific amendments to the environmental flow conditions in LCRA's WMP in

[6] Copies of the prior orders approving WMP amendments are available at https://www.lcra.org/download/appendix-c-priororders-wmp-curtailmentplan-feb2020/?wpdmdl=11926.

2015 and which served as the foundation of TCEQ's environmental flow standards for the lower Colorado River below Austin and Matagorda Bay. The information included in these studies reflect the most current and best available information regarding the environmental flow needs of the lower Colorado River basin below Austin to Matagorda Bay. The 2020 WMP relies on these studies and TCEQ's standards to craft criteria that control LCRA's water operations under various hydrologic conditions in a manner that supports the ecological health of the lower river and bay while meeting its customers' water supply needs.

5.3 LCRA Transmission Services Corporation

LCRA Transmission Services Corporation (LCRA TSC) is a nonprofit corporation conducting electric transmission operations within Texas. As of May 2022, LCRA TSC owns or operates more than 5,500 circuit miles of electric transmission lines and maintains or operates equipment at about 430 electric substations across the state. LCRA TSC's transmission lines and substations help provide reliable electric transmission service to Texas power generators and are an integral part of the overall power system for residential, business, commercial, and industrial power customers across Texas. As with other electric transmission systems in Texas, the Public Utility Commission of Texas (PUC) regulates the activities of LCRA TSC, and LCRA TSC coordinates its operations with the Electric Reliability Council of Texas (ERCOT). ERCOT manages the power grid that serves most of the state. LCRA TSC monitors the projected growth in demand for electricity and works with its transmission customers and regulatory agencies to ensure that its facilities, including new transmission lines and new substations, meet federal and state requirements for providing reliable electric transmission service.

The overwhelming majority of LCRA TSC activities take place in areas that have no potential for impact to the Covered Species. LCRA TSC has facilities within easements (including a 200-foot buffer on either side of the waterway), comprised of

10.4 acres within areas of Suitable Occupied Habitat[7] (i.e., Zone A, *see infra* Section 6.1) and 86.6 acres within Suitable Habitat[8] (i.e., Zone B, *see infra* Section 6.2).

LCRA TSC has a long history of ensuring that its activities are implemented in a manner that avoids or minimizes impacts to other threatened and endangered species consistent with the requirements of the ESA. Indeed, in October 2019, LCRA TSC secured approval from USFWS for an Incidental Take Permit and Habitat Conservation Plan ("LCRA TSC Systemwide HCP") that provides ESA coverage for LCRA TSC activities for 23 threatened or endangered species in 241 Texas counties. Further, in many cases, LCRA TSC's activities are covered by other HCPs, such as its own Competitive Renewable Energy Zone Transmission Line HCP (ITP No. TE-46542A), the Four Utilities HCP (ITP No. TE-78366-0), the Balcones Canyonlands Conservation Plan (BCCP) (ITP No. TE-788841), the Williamson County Regional HCP, and the Southern Edwards Plateau HCP. At this time, none of these HCPs provide coverage for the Covered Species that are the subject of this CCAA.

6 COVERED AREA AND CONSERVATION ZONES

The Covered Area, as shown by the gray area depicted on the map in Figure 2, includes the portion of the Colorado River basin that contributes inflow to the Colorado River downstream of the junction of McCullough, Brown, and Coleman counties and areas within LCRA's Water Service Area, except those portions of Williamson and Lampasas counties outside of the Colorado River basin. It also includes those portions of LCRA's Water Service Area within Colorado, Wharton, and Matagorda counties that are located outside of the Colorado River basin.[9] For purposes of this CCAA, the

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[7] This includes 20 transmission lines (most or all of which completely span the waterway and riparian area), 3 substations, 1 transmission structure, 5 crossings, and 2 gates.

[8] This includes 65 transmission lines (most of which completely span the waterway and riparian area), 32 transmission structures, 62 crossings, and 26 gates.

[9] LCRA TSC understands that its activities may have potential to impact freshwater mussels in areas outside the proposed Covered Area and for new construction within the Covered Area. In addition to the coverage sought in this CCAA for maintenance and operation of existing facilities within the Covered Area, LCRA TSC may seek coverage under the

Covered Area is divided into Conservation Zones. These Conservation Zones are generally based on differences in known occurrence and abundance of Covered Species as of May 2022 and allow for the prioritization of specific measures in different zones, as discussed below in Section 6. The Conservation Zones are discussed below and also depicted in Figure 2.

Endangered Species Act for its other activities through Section 7 consultation, where appropriate, or may in the future seek to amend LCRA TSC's Systemwide HCP/ITP to include coverage for freshwater mussels.

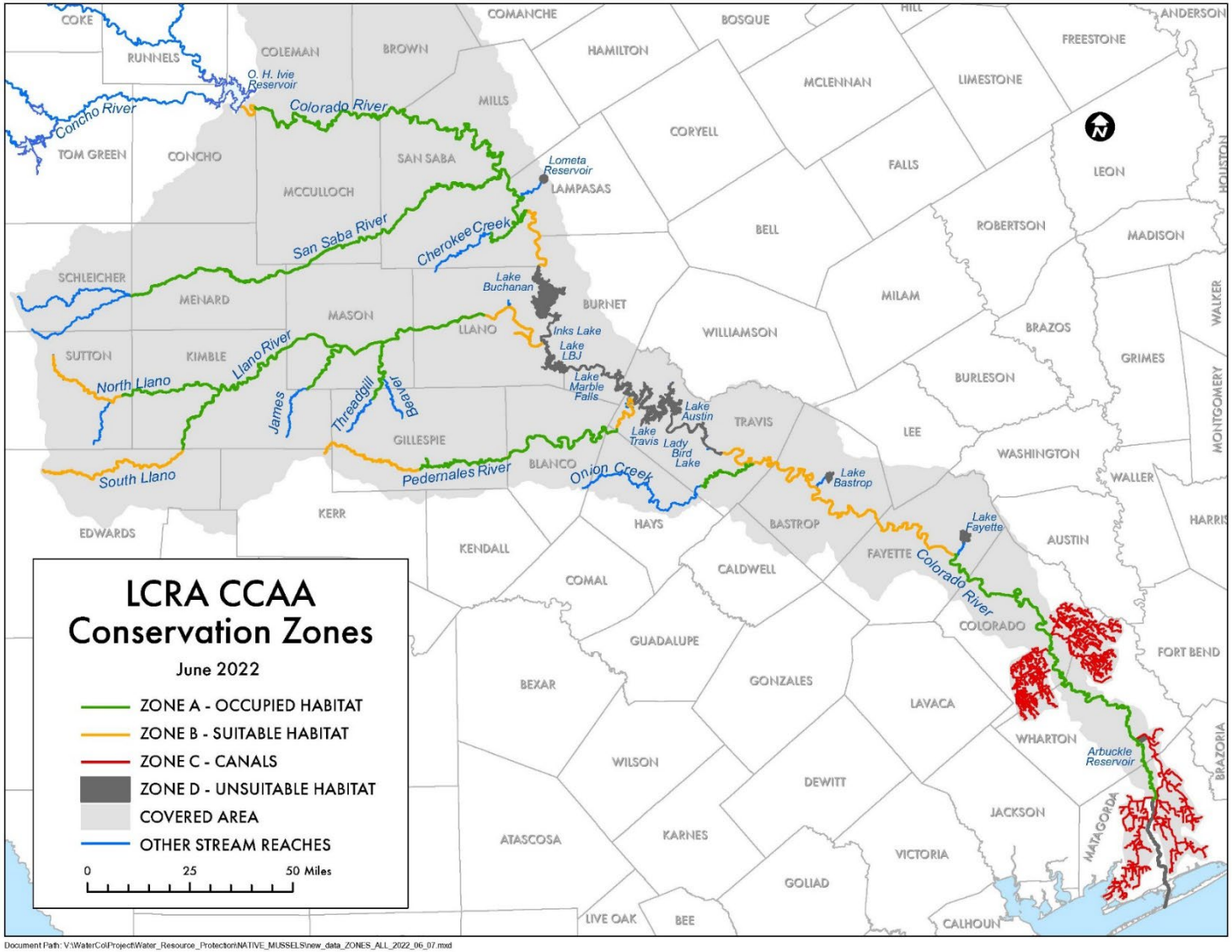

Figure 2. LCRA's and LCRA TSC's CCAA Covered Area and Conservation Zones.

6.1 Zone A – Suitable Occupied Habitat

Zone A is generally comprised of 740 stream miles[10] of Suitable Occupied Habitat, which is comprised of river reaches with Suitable Habitat that has documented presence of at least one of the four Covered Species (Figure 3). Generally, Zone A includes those portions of the Colorado River and its tributaries within the Covered Area identified as "current distribution" in the USFWS Central Texas Mussels Species Status Assessment (USFWS 2019, Chapter 5) and a few segments identified by USFWS as Proposed Critical Habitat for each of the four Covered Species. Zone A also generally includes those portions of the watershed within the Covered Area that drain into the river segments or tributaries containing occupied habitat.

[10] Estimates of stream miles within each Conservation Zone or subzone were developed with the assistance of LCRA's Geographic Information System (GIS) expert, using data from the Proposed Rule for the Central Texas Mussels (86 Fed. Reg. 47,916), LCRA survey data, and the National Hydrography Dataset. Zone A (occupied habitat) estimates differ from the total river miles referenced by the USFWS in its proposal for critical habitat within the Colorado River basin in part because Zone A includes small segments of occupied habitat that were not included in the proposed critical habitat, and portions of proposed critical habitat are within the Colorado River basin but outside of the Covered Area.

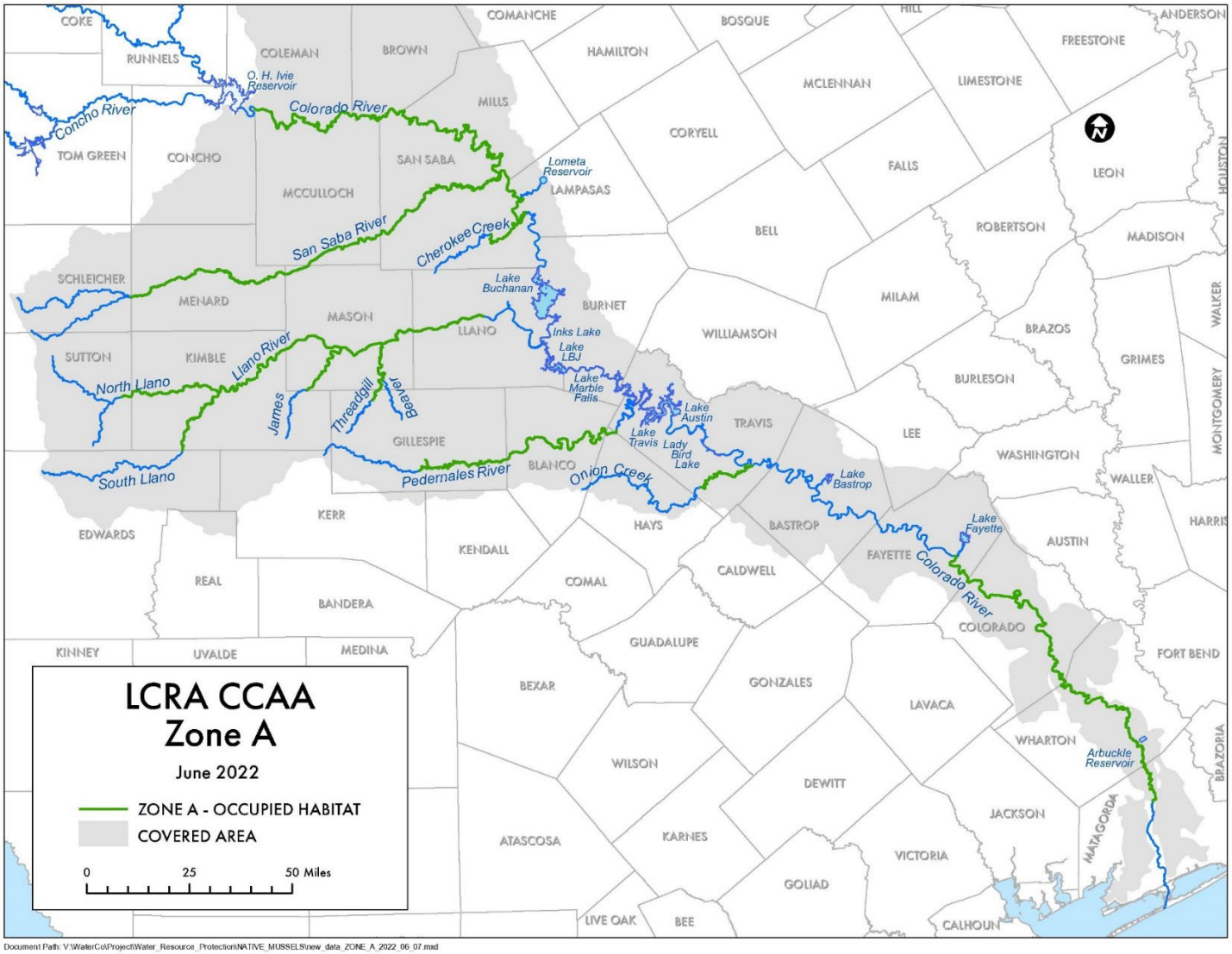

Figure 3. LCRA and LCRA TSC CCAA Conservation Zone A:
Suitable Occupied Habitat of all Covered Species.

6.1.1 Zone A-1: Texas Pimpleback Suitable Occupied Habitat

Zone A-1 (Figure 3-a) consists of Suitable Occupied Habitat for the Texas pimpleback within the Covered Area. Zone A-1 encompasses approximately 419 stream miles within the Colorado River basin. USFWS has identified five populations of Texas pimpleback, which comprise Zone A-1:

1) In portions of the lower Concho River within Concho County;
2) In portions of the upper San Saba River in Menard County;
3) In portions of the lower San Saba River in San Saba County and a section of the middle Colorado River downstream of O.H. Ivie Reservoir to approximately 2 miles beyond the Highway 190 crossing downstream of the confluence of the Colorado and San Saba rivers;
4) A small portion of the Llano River near FM 1871 downstream to the RR 2389 bridge in Mason County; and
5) A portion of the lower Colorado River in Colorado and Wharton counties.

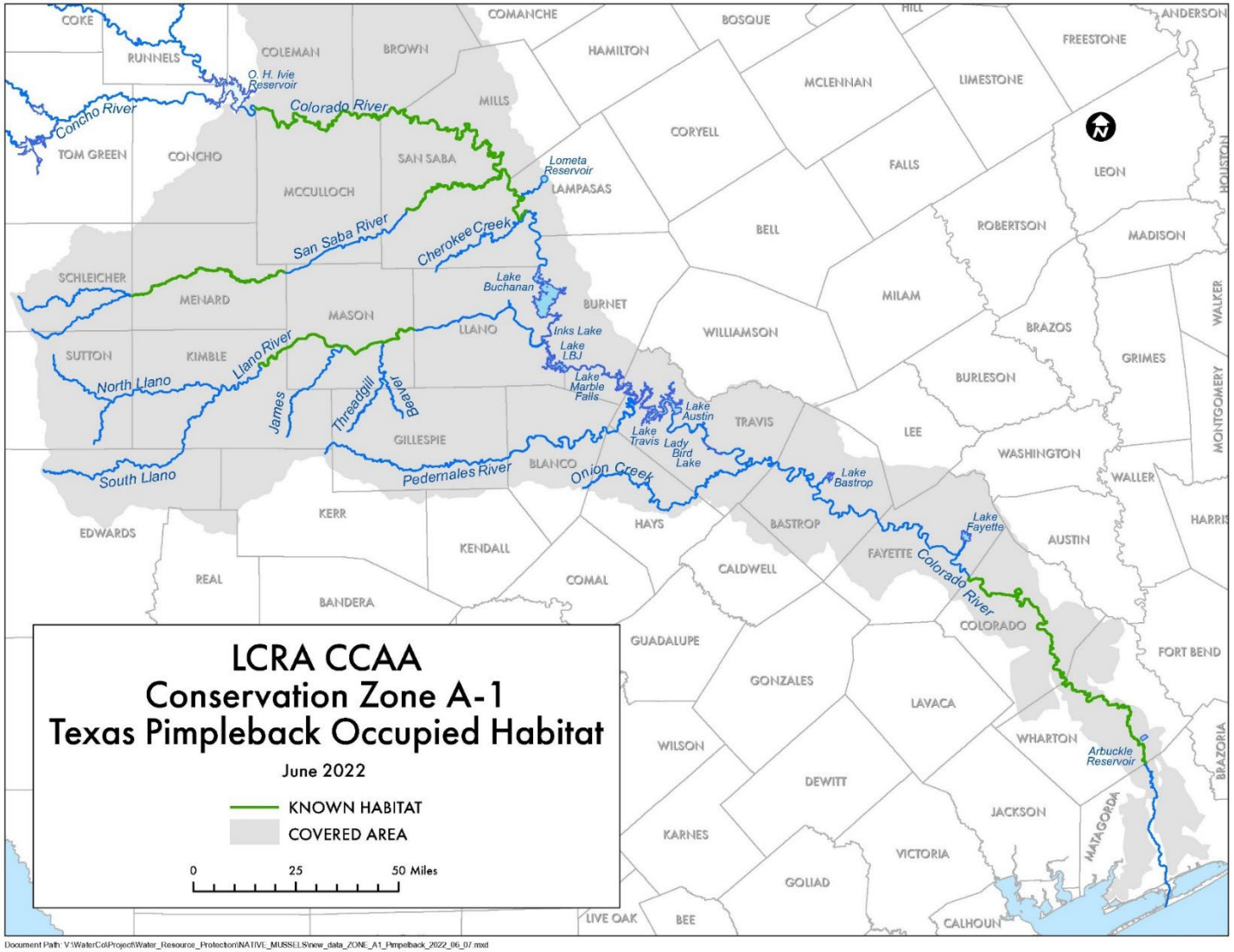

Figure 3-a. Zone A-1. Suitable Occupied Habitat for Texas Pimpleback.

6.1.2 Zone A-2: Texas Fawnsfoot Suitable Occupied Habitat

Zone A-2 (Figure 3-b) consists of Suitable Occupied Habitat for the Texas fawnsfoot within the Covered Area. The Texas fawnsfoot is known to occur in a combined approximately 198 stream miles in the Colorado River basin. Zone A-2 includes two populations identified by USFWS (2019) within the Covered Area:

1) In a portion of the lower San Saba River and a portion of the middle Colorado River near the confluence with the San Saba River; and
2) In the lower Colorado River, in a portion of Fayette County, all of Colorado and Wharton counties, and a portion of Matagorda County.

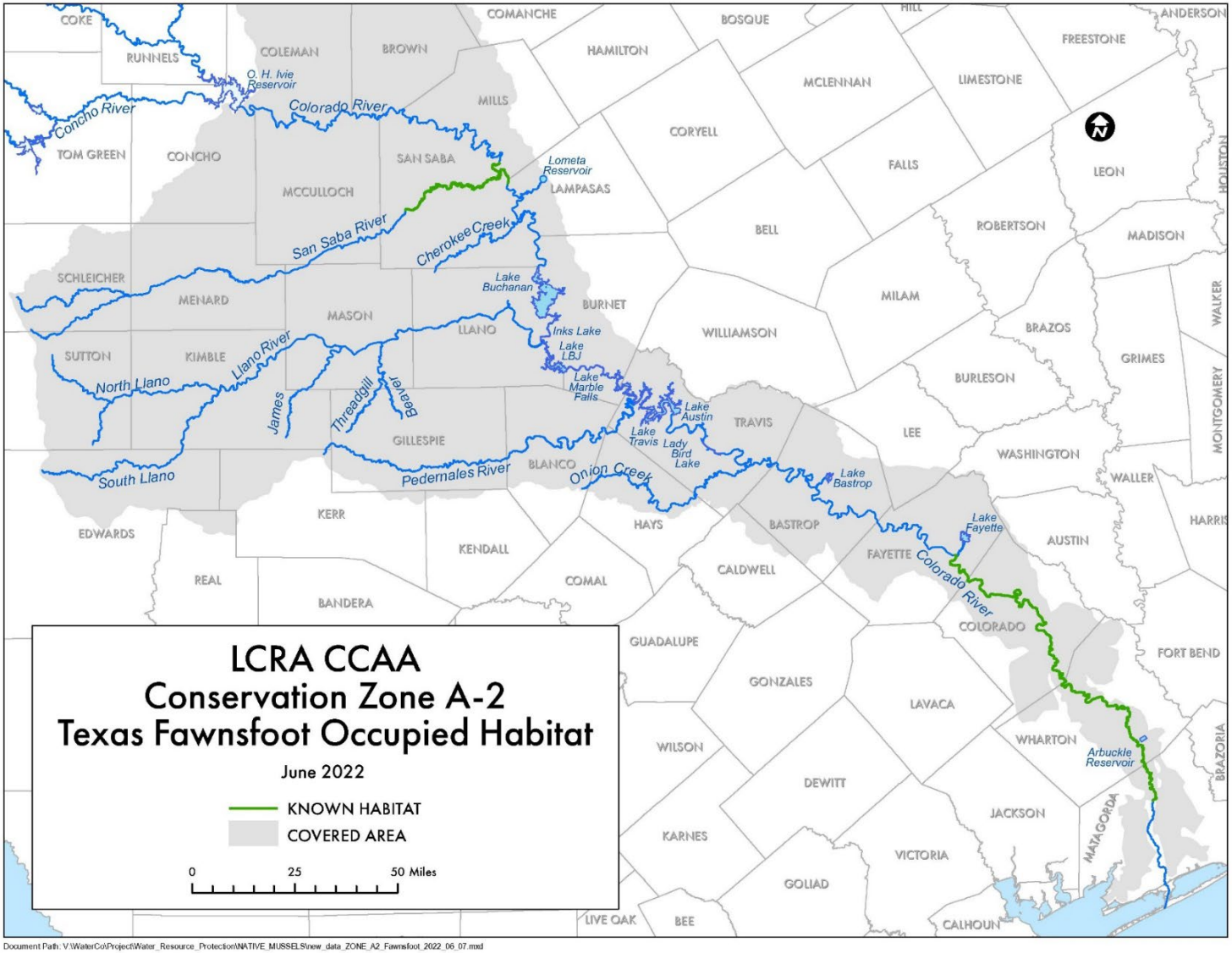

Figure 3-b. Zone A-2 Suitable Occupied Habitat for Texas Fawnsfoot.

6.1.3 Zone A-3: Balcones Spike Suitable Occupied Habitat

Zone A-3 (Figure 3-c) consists of Suitable Occupied Habitat for the Balcones spike within the Covered Area. Zone A-3 encompasses approximately 101 stream miles within the Colorado River basin. Zone A-3 includes two populations of Balcones spike identified by USFWS (2019) within the Covered Area:

1) In a portion of the San Saba River in San Saba County; and
2) In the Llano River in a very small section in the immediate vicinity of FM 1871 bridge crossing in Mason County.

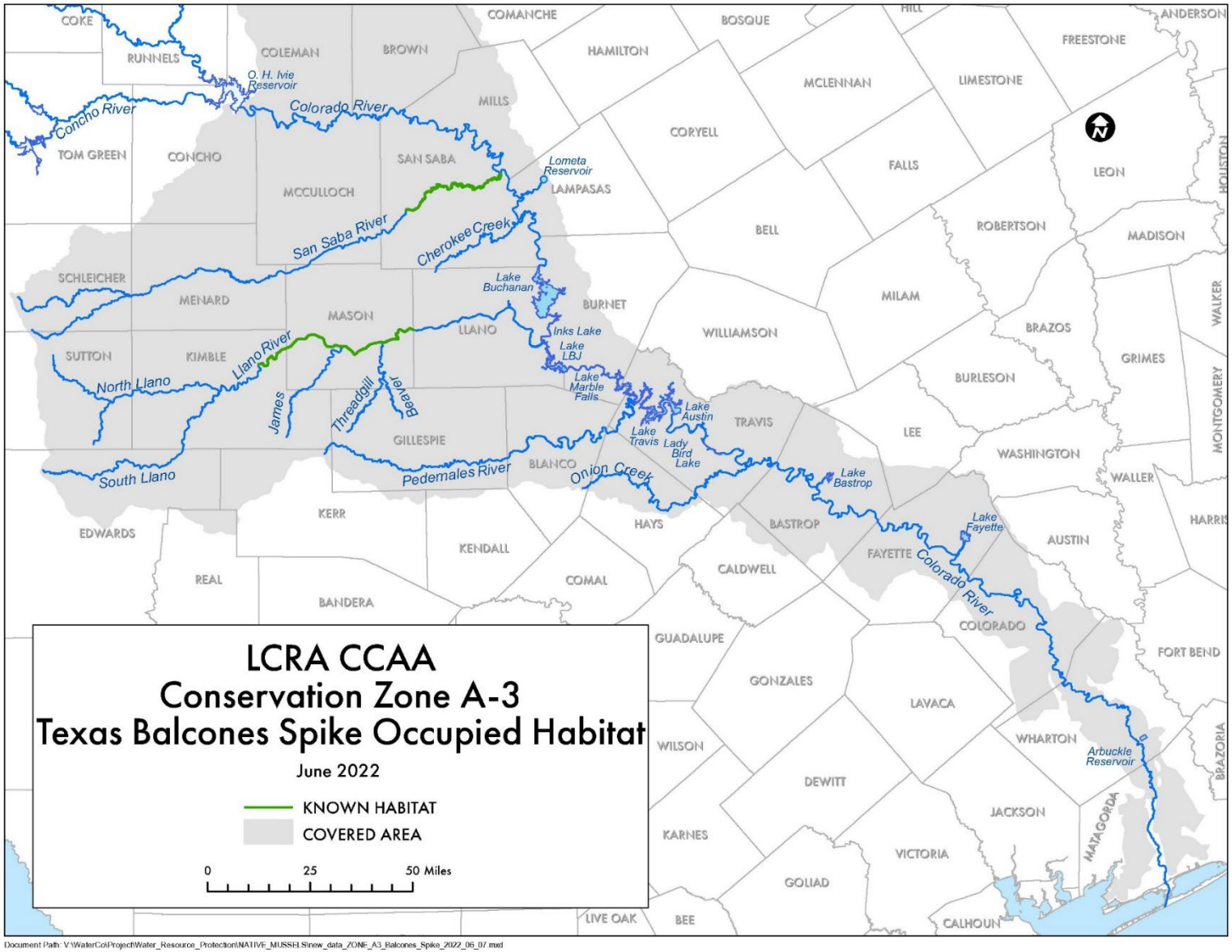

Figure 3-c. Zone A-3 Suitable Occupied Habitat for Balcones Spike.

6.1.4 Zone A-4: Texas Fatmucket Suitable Occupied Habitat

Zone A-4 (Figure 3-d) consists of Suitable Occupied Habitat for the Texas fatmucket within the Covered Area. Zone A-4 encompasses approximately 399 stream miles within the Colorado River basin. Zone A-4 includes four populations of Texas fatmucket identified by USFWS in the SSA within the Covered Area, as well as one additional population on Cherokee Creek that was added after the SSA was published in 2019:

1) In a portion of the upper and middle reaches of the San Saba River;
2) In a portion of the Llano River withinin Llano, Mason and Kimble counties, and in portions of the James River and Threadgill Creek (both tributaries to the Llano River);
3) In portions of the Pedernales River and Live Oak Creek in Gillespie, Blanco and Hays counties;
4) In the lower portion of Onion Creek in Travis County, from the bridge at Interstate 35, approximately 21 stream miles until the confluence with the Colorado River below Austin; and
5) In Cherokee Creek, from the 501 bridge crossing (31.032483° -98.577977°) for approximately 28 miles until the confluence with the Colorado River above Lake Buchanan.

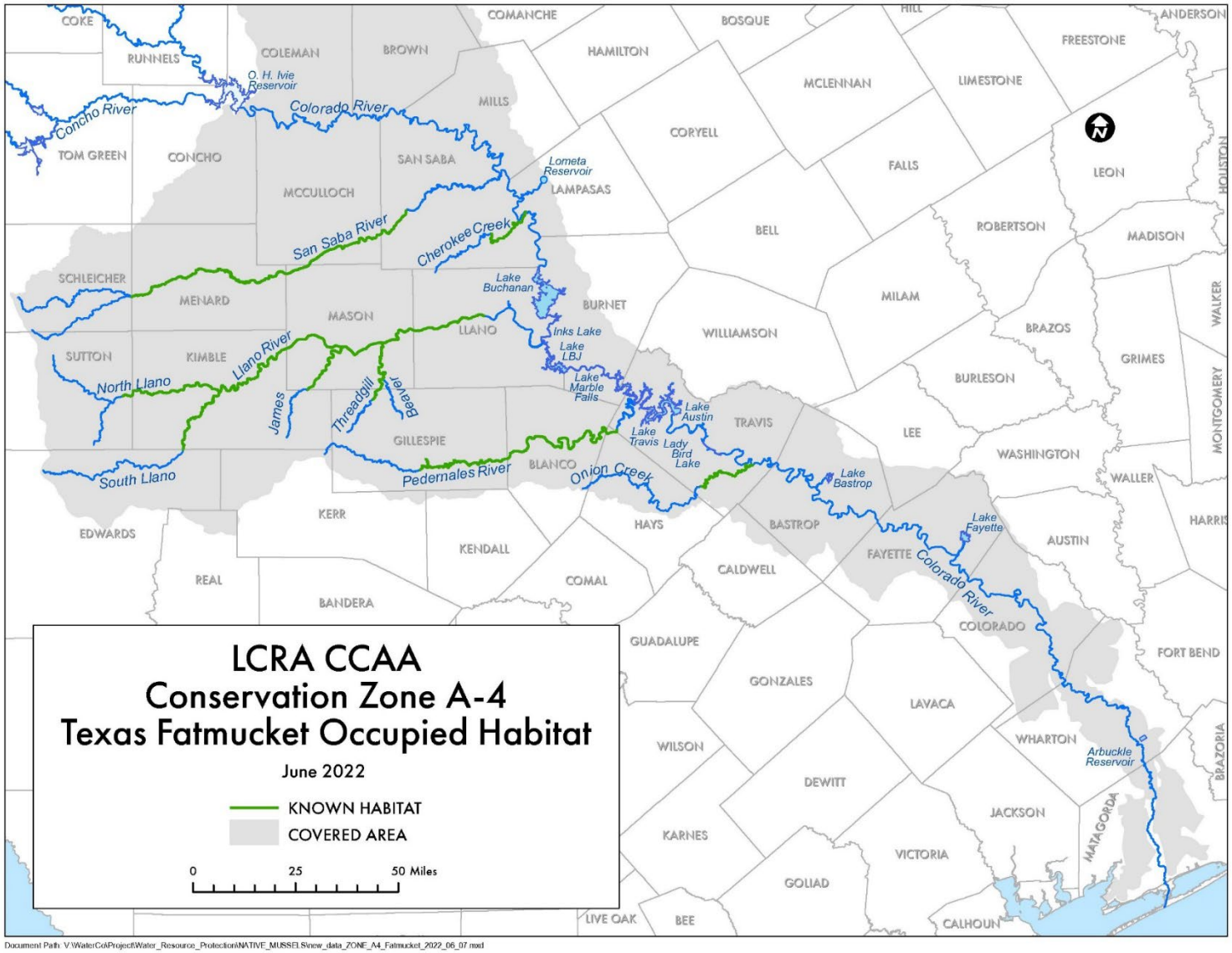

Figure 3-d. Zone A-4. Suitable Occupied Habitat for Texas Fatmucket.

6.2 Zone B – Other Suitable Habitat

Zone B is delineated as the areas adjacent to or between Zone A river reaches that contain Suitable Habitat but no documented occupancy. Zone B includes 315 stream miles. It is believed that these areas could support mussel populations if connectivity is maintained and threats are reduced or removed. Zone B (Figure 4) includes all main stem sections of the San Saba River, Llano River, Pedernales River, Onion Creek and the Colorado River below O.H. Ivie Reservoir and above the Bay City dam within the Covered Area that are not included in Zone A and are not one of the Highland Lakes, Lady Bird Lake, or any other reservoir (such as those located off the main channel of the Colorado River). Zone B also generally includes those portions of the watershed within the Covered Area that drain into the river segments or tributaries identified as Zone B.

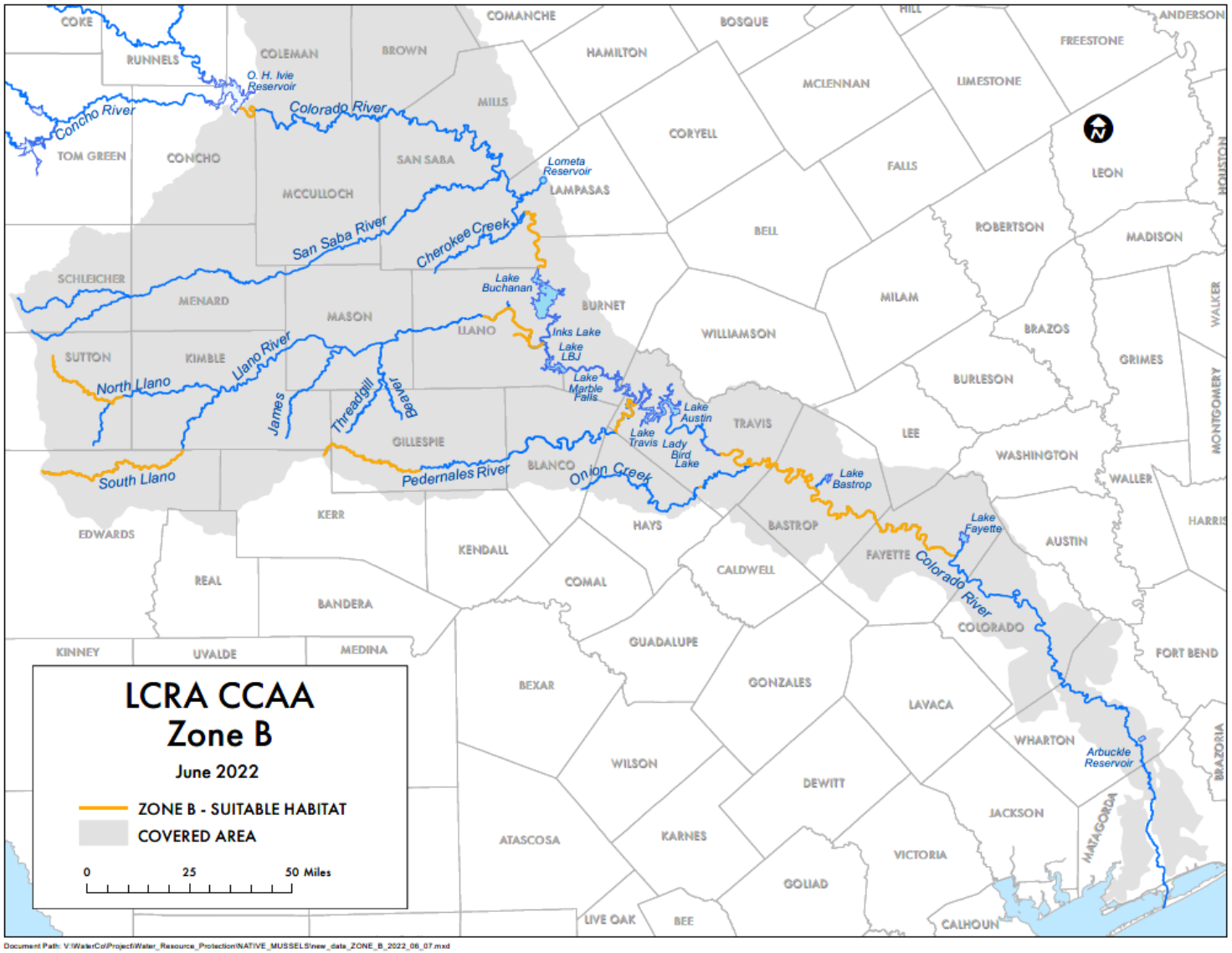

Figure 4. LCRA and LCRA TSC CCAA Conservation Zone B: Other Suitable Habitat

6.3 Zone C – LCRA Gulf Coast, Lakeside, and Garwood Divisions

Zone C includes facilities owned or operated by LCRA within the service areas of its Gulf Coast, Lakeside and Garwood divisions, including several pumping plants and a network of approximately 887 miles of canals that convey water to customers within these operations, but excluding Arbuckle Reservoir. LCRA TSC also owns and operates electric transmission facilities within Zone C. These facilities are located largely within the lower section of the Colorado River basin in Colorado, Wharton, and Matagorda counties, and extend into adjacent coastal basins and, in one system, into a portion of the Lavaca River basin. Zone C is further divided into two subgroups, which reflect the different manner in which LCRA operates the canals, as shown in Figure 5.

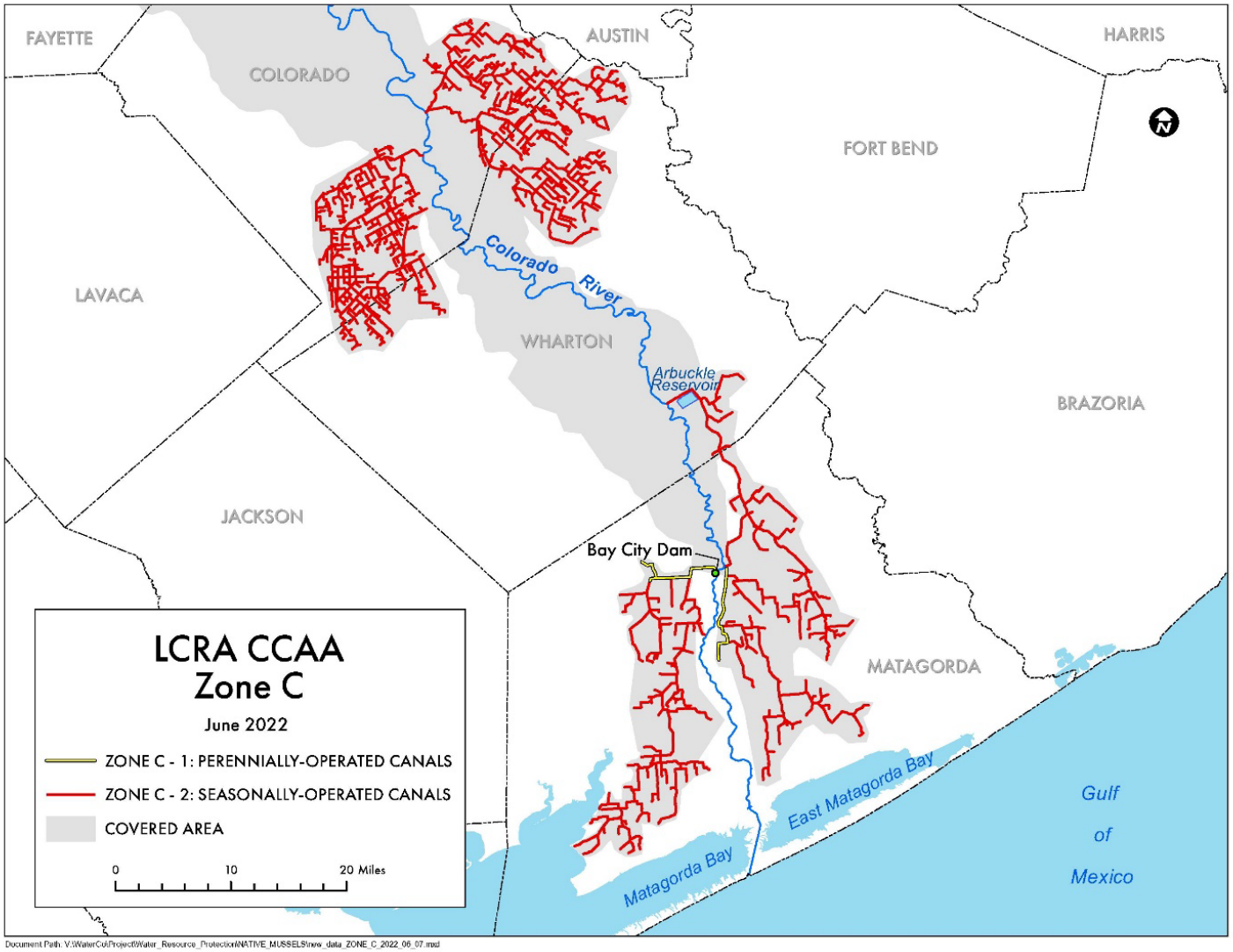

Figure 5. LCRA and LCRA TSC CCAA Conservation Zones C-1 and C-2: Perennially and Seasonally Operated Canals.

6.3.1 Zone C-1: Perennially Operated Canals

Perennially operated canals include those sections of canals that supply water to customers on a year-round basis (i.e., not operated seasonally). Presently, LCRA operates portions of approximately 19 miles of canals on a perennial basis within its Gulf Coast Division.

6.3.2 Zone C-2: Seasonally Operated Canals

Seasonally operated canals include those sections of canals that generally deliver water only from mid-March to mid-October, primarily for agricultural purposes. LCRA operates all of its canals, other than perennial canals, on a seasonal basis.

6.4 Zone D: Reservoirs (Not Habitat)

Zone D is comprised of approximately 715 miles of shoreline along and the area within the following reservoirs of the lower Colorado River basin: lakes Buchanan, Inks, LBJ, Marble Falls, Travis, Austin, Lady Bird, Bastrop, and Fayette, and Arbuckle Reservoir (Figure 6).

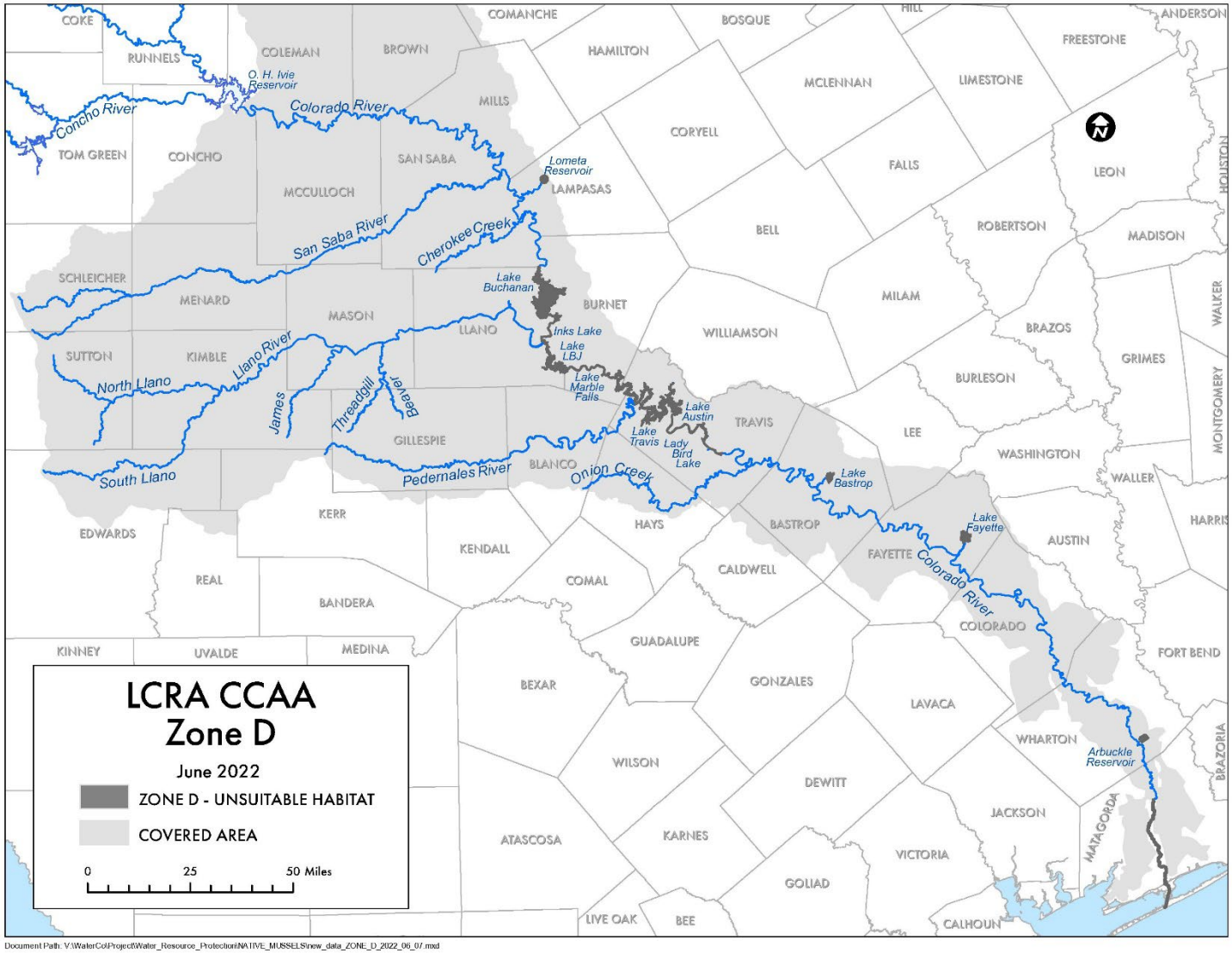

Figure 6. LCRA and LCRA TSC CCAA Conservation Zone D: Reservoirs (Not Habitat).

7 CONSERVATION STRATEGY

The ultimate goal of this CCAA is to facilitate a long-term approach to protect and manage the Covered Species and their habitat within the Covered Area in a manner that provides a net conservation benefit to the Covered Species. To that end, depending on the type of Covered Activity and location within a particular Conservation Zone within the Covered Area, LCRA and LCRA TSC will implement various Avoidance and Minimization Measures (Section 7.2), and specific Conservation Measures (Section 7.3) that are expected to reduce or eliminate threats or otherwise provide a net conservation benefit to the Covered Species. As outlined in Section 7.1, these measures are consistent with and informed by the Freshwater Mollusk Conservation Society's National Strategy for the Conservation of Native Freshwater Mollusks (FMCS 2016), tailored to the specific threats to the Covered Species within the Colorado River basin, which are summarized in Section 4. The Conservation Measures and Avoidance and Minimization Measures are set forth below in more detail and summarized in Table 2. These Avoidance and Mimization Measures and Conservation Measures, when implemented within the Adaptive Management framework, reflect a Conservation Strategy that is reasonably expected to help maintain existing populations of Covered Species and help occupied habitats to expand naturally, contributing to a substantial net conservation benefit for the Covered Species in the Covered Area.

7.1 Consistency With the National Strategy for the Conservation of Freshwater Mollusks

LCRA's and LCRA TSC's Conservation Strategy, including the Conservation Measures and Avoidance and Minimization Measures described below, was developed to be consistent with the Freshwater Mollusk Conservation Society's National Strategy for the Conservation of Freshwater Mollusks (FMCS 2016). This publication outlines 10 issues considered top priorities for freshwater mollusk conservation. Table 1 provides a summary of these 10 issues, along with a summary of how this CCAA's specific Conservation Measures and Avoidance and Minimization Measures address these issues with regard to the Covered Species within the Covered Area.

Table 1. LCRA and LCRA TSC CCAA Conservation Strategy's Support of National Strategy for the Conservation of Native Freshwater Mollusks

Issues	Goals	Conservation Measures and Avoidance and Minimization Measure	How Measure Addresses Goals
1. Increase knowledge of the distribution and taxonomy of mollusks at multiple scales over time and make that information available.	Understand the status and trends of mollusk populations to better manage and conserve.	Informative field investigations and modeling	Surveys will help fill data gaps in distributional information. (Section 7.3.4.3)
		Long-term monitoring and mussel surveys	Long-term monitoring, as well as data from site-specific mussel surveys conducted in association with other Covered Activities, will provide information to assess trends in existing populations over time. (Sections 7.2.1, 7.3.4.3, 9.1)
2. Address the impacts of past, ongoing, and newly emerging stressors on mollusks and their habitats.	Minimize threats to mollusks and their habitats.	Informative field investigations and modeling	Hydrologic modeling will identify spatial and temporal hydrologic patterns that could pose a risk to mussel populations and assist in prioritizing conservation actions and guide Adaptive Management. (Section 7.3.1.2)
		Environmental flow protection	Promotes flow conditions adequate for survival and long-term persistence of Covered Species. (Sections 7.2.1, 7.2.2, 7.2.3, 7.3.1, 7.3.2.1)
		Avoidance and minimization	Avoids or reduces impacts to Covered Species in areas of occupied or suitable habitat for Covered Species and prevents further fragmentation. (Section 7.2)
		Applied research	Aids in identifying habitat, water quality, and flow-related stressors important in supporting populations of Covered Species and will be used to guide Adaptive Management. (Section 7.3.4.3)

Issues	Goals	Conservation Measures and Avoidance and Minimization Measure	How Measure Addresses Goals
3. Understand and conserve the quantity and quality of suitable habitat for mollusks over time.	Increase understanding of physical, chemical, and biological characteristics of habitat to support sustainable assemblages of mollusks.	Informative field investigations and modeling	Hydrologic modeling will identify spatial and temporal hydrologic patterns that could pose a risk to mussel populations and assist in prioritizing conservation actions and guide Adaptive Management. (Section 7.3.1.2)
		Applied research	Aids in identifying habitat, water quality, and flow-related stressors important in supporting populations of Covered Species. This information will be used to guide Adaptive Management. (Section 7.3.4.3)
		Long-term monitoring	Habitat utilization surveys will assist in understanding habitat requirements of the Covered Species. This data will be essential to the Adaptive Management process. (Sections 7.3.4.3, 9.1)
		Avoidance and minimization	Conserves habitat through avoidance or minimization of impacts to Covered Species in areas of occupied or suitable habitat. (Section 7.2)
4. Understand the ecology of mollusks at the individual, population, and community levels.	Increase fundamental knowledge of the biology of mollusks so managers can more effectively conserve them.	Applied research	Proposed applied research studies will increase the knowledge of the biology of Covered Species at the individual and population level. (Section 7.3.4.3)
		Long-term monitoring and mussel surveys	By evaluating population trends in response to various environmental factors, long-term monitoring and site-specific mussel surveys conducted in association with other Covered Activities will provide data on the ecology of Covered Species. (Sections 7.2.1, 7.3.4.3, 9.1)

Issues	Goals	Conservation Measures and Avoidance and Minimization Measure	How Measure Addresses Goals
5. Restore abundant and diverse mollusk populations until they are self-sustaining.	Conserve and restore viable populations and communities of mollusks.	Long-term monitoring and mussel surveys	Population demographic data from long-term monitoring and site-specific mussel surveys conducted in association with other Covered Activities will assist in determining if populations are self-sustaining. (Sections 7.2.1, 7.3.4.3, 9.1)
		Applied research	Mussel habitat assessment and survivability studies will evaluate areas suitable for reintroduction of Covered Species. (Section 7.3.4.3)
		Captive propagation	Should restoration or supplementation of existing populations be desired, successful captive propagation of Covered Species is necessary to supply organisms. (Section 7.3.4.2)
6. Identify the ecosystem services provided by mollusks and their habitats.	Improve science-based consideration of the social and economic values of mollusk communities and functioning aquatic systems.	Communication / education / outreach / land conservation	Education and outreach activities, including land conservation programs, will highlight the ecosystem services of freshwater mussels and the social and economic value of functioning aquatic systems. (Section 7.3.5)
7. Strengthen advocacy and build support for the conservation of mollusks and their habitats.	Increase information sharing and communication among citizens and decision-makers at multiple levels regarding conserving mollusk resources.	Communication / education / outreach / water and land conservation	Information sharing will occur with state and federal agency personnel through work groups (Sections 7.2.4.1 and 7.3.4.7), and communication with the public will occur through education and outreach opportunities, including water conservation and land conservation programs. (Sections 7.3.1.3 and 7.3.5)

Issues	Goals	Conservation Measures and Avoidance and Minimization Measure	How Measure Addresses Goals
8. Educate and train the conservation community and future generations about the importance of mollusks to help ensure conservation efforts continue into the future.	Provide a suite of training opportunities to the greater conservation community, and inspire future generations to work on the conservation of mollusks.	Communication / education / outreach	Education and outreach activities will include presentations and/or educational webpage targeted to the greater conservation community and also will focus on educating youth and young professionals about mussel conservation through social media and other avenues. (Section 7.3.5)
9. Seek consistent, long-term funding to support mollusk conservation efforts.	Increase funding for mollusk conservation.	Commitment of long-term funding provided by LCRA and LCRA TSC to support this CCAA.	This CCAA represents an example of long-term funding by LCRA and LCRA TSC to support mollusk conservation. (Table 5)
10. Coordinate a national strategy for the conservation of mollusk resources.	Increase coordination and information sharing among local, state, national, and international partners in conserving mollusk resources.	Communication / education / outreach	Coordination with state and federal agency personnel will occur through an interagency work group. Conservation successes of the program will be communicated to national partners in mollusk conservation. (Sections 7.2.4.1, 7.3.4.4, 7.3.4.7)

7.2 Avoidance and Minimization Measures Within Certain Management Zones

During the term of this CCAA, LCRA and LCRA TSC will each implement their respective Avoidance and Minimization Measures as described below. These measures are reasonably expected to reduce the severity and extent of water quality and flow-related impacts to populations of the Covered Species within Suitable Occupied Habitat within Zone A and areas of Suitable Habitat within Zone B associated with LCRA's and LCRA TSC's Covered Activities (Section 11). LCRA's and LCRA TSC's commitment to implement these Avoidance and Minimization Measures does not limit or otherwise restrict LCRA's rights and obligations to provide water to third parties consistent with state law. Neither LCRA nor LCRA TSC is obligated to impose conditions on facilities owned, operated, or constructed by or on behalf of third parties within the Covered Area that divert, impound, or discharge water or treated wastewater derived from water provided by LCRA, use power provided by LCRA, or receive electric transmission service from LCRA TSC.

7.2.1 General Measures to Reduce Site-Level Disturbance of LCRA Covered Activities

Where applicable, and feasible and consistent with other regulatory requirements, LCRA and LCRA TSC will each implement their respective Covered Activities in a manner that reduces or avoids impacts to freshwater mussels and water quality by implementing the measures set forth below.

1. Prior to initiating any disturbance associated with a Covered Activity within an intermittent or perennial watercourse within Zones A and B, mussel surveys and relocations will be conducted consistent with applicable USFWS and TPWD protocols and requirements. Short-term refugia will be used whenever possible, if requested.
2. Where possible, any new infrastructure allowed as a Covered Activity (see Section 11.2.5) will avoid occupied mussel beds unless USFWS agrees that placement within occupied habitat is necessary for the implementation of the Conservation Measures.
3. During any site-level disturbance activities, standard erosion and sediment

control measures that are consistent with any state or local requirements and tailored to each site will be implemented, maintained, and regularly inspected to minimize the amount of sediment entering any watercourse within the Covered Area. These control measures will follow the guidance of the Highland Lakes Watershed Ordinance to the maximum feasible extent.

4. Within Zones A and B, the area of new disturbance within a streambed will be minimized as much as feasible.
5. Staging areas for the storage and containment of equipment, hazardous materials, chemicals, fuels, lubricating oils, construction debris, and other such substances will be at least 100 feet outside of the ordinary high water mark.
6. Vegetation clearing within riparian zones as part of a Covered Activity will be minimized as much as feasible.
7. For activities within Zone A and B, streamflow will be monitored to help ensure the activity does not reduce flows below subsistence levels within known occupied habitat.
8. Temporary coffer dams will be made of nontoxic materials.
9. Streambanks, vegetation, and streambeds and all temporary work areas will be restored after completing any construction that is a Covered Activity to pre-existing conditions or better.

7.2.2 Dams

LCRA will not construct any additional permanent dams on the main stem of the Colorado River or any of its tributaries. Temporary coffer dams may be constructed when associated with Covered Activities.

7.2.3 Water Diversions Within Zones A and B

Operation of existing or new diversion projects[11] that LCRA owns or controls

[11] Construction of new diversion projects is not a Covered Activity. *See* Section 12.2.5. Construction of a new diversion project would require separate Section 7 consultation.

within Zones A and B will be conducted in accordance with the Avoidance and Minimization Measures set forth in this Section 7.2.3. Except as provided below, these commitments apply only where the facilities or water rights are solely owned by LCRA.

1. LCRA will not sponsor new diversion projects that increase the amount of water that LCRA can divert within either Zone A or Zone B over existing amounts in LCRA's water rights within each respective zone. (See Appendix A.)[12]
2. LCRA will limit diversions from any new diversion projects it may own or control so as not to reduce flows below subsistence flow levels.
3. LCRA will limit modifications to existing water intakes or related infrastructure to those necessary to allow LCRA to use its existing water rights. (See Appendix A.)
4. LCRA will include the restrictions in items (1)-(3) above as part of any new co-ownership agreements related to diversion projects that LCRA might enter during the term of this CCAA.

7.2.4 Other Measures to Minimize Impacts to Covered Species

7.2.4.1 Zone A-4 – Work Group to Minimize Impacts to Texas Fatmucket

As described in more detail in Section 7.3.4.7, LCRA will convene a work group comprised of TPWD, USFWS, the City of Austin Watershed Protection Department, Travis County, and the Texas Department of Transportation to evaluate Texas fatmucket mussel populations within the Onion Creek portion of Zone A-4. Among other things, this work group will help identify whether there are other nonflow measures that, if implemented, would minimize threats and benefit the Covered Species. The work group also will identify potential funding sources, if any, to assist with implementing the identified strategies.

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between the USFWS and USACE as part of any required Clean Water Act, Section 404, permitting. However, if fully permitted and constructed, operation of such new diversion projects would fall under the Covered Activities more fully described herein when operated in accordance with applicable standards and requirements.

[12] The water rights LCRA presently owns within Zone A and Zone B are summarized in Appendix A.

7.2.4.2 Zones A and B – Encourage Minimization of Disturbance During Design and Construction of Non-LCRA/Non-LCRA TSC Owned or Operated Infrastructure

If LCRA provides comments in response to a timely received notification of a construction project occurring in Conservation Zones A and B that neither LCRA nor LCRA TSC owns or operates, LCRA will include information in its comments notifying the responsible party of the likelihood of the Covered Species being present in the project area, recommend they perform a survey for freshwater mussels to determine if the Covered Species will be affected by the proposed activity, encourage avoidance of disturbance in areas where surveys identify Covered Species are present, and recommend they include aquatic and/or riparian habitat restoration as a component of their project, as applicable.

7.2.4.3 Zone C

Within LCRA perennially operated canals (Zone C-1), prior to conducting any necessary dredging, repair, maintenance, or covered construction activities[13] within LCRA's existing canals or draining water from a section of canal for more than 24 hours, LCRA will perform mussel relocations within affected canal segments. Mussels found during these relocations will be placed in suitable habitat in the Colorado River, as agreed upon by TPWD, USFWS and LCRA biologists. Prior to conducting these planned activites, LCRA will provide notice to the USFWS (and TPWD) at least 30 days prior to dewatering. In the event of unplanned, emergency dewatering, LCRA will provide notice to the USFWS (and TPWD) as early as possible. Within seasonally operated canals (Zone C-2), LCRA will perform mussel surveys and relocation within up to 2 miles of canals (total for multiple sites across all irrigation divisions) at routinely designated locations at the end of each irrigation season (October-November time range). These locations will be selected based on proximity to the river, the frequency with which the segment conveyed water on a continuous basis during that irrigation season, and any historical data indicating likely presence of live mussels or host fish. All mussels found during these relocations will be placed in suitable habitat in the Colorado

[13] Covered construction activities within the canals are described in Section 12.2.5.

River, as agreed upon by TPWD, USFWS, and LCRA biologists. All surveys and relocations associated with dewatering of canals will be conducted in accordance with applicable USFWS and TPWD protocols and requirements. Furthermore, to the maximum extent practicable and consistent with other regulatory requirements, LCRA will implement any maintenance, repairs, or construction in LCRA canals in a manner that minimizes impacts to freshwater mussels and water quality in the Colorado River and the Zone C canals.

7.2.4.4 Zone D

Within Zone D, to the maximum extent practicable and consistent with other regulatory requirements, LCRA and LCRA TSC will implement any maintenance, repairs, or construction of LCRA or LCRA TSC infrastructure in riparian areas or streambed in a manner that minimizes impacts to freshwater mussels and water quality, including, but not limited to, appropriate erosion controls, mussel relocations, etc.

7.3 Conservation Measures

In addition to the Avoidance and Minimization Measures outlined in Section 7.2, LCRA and LCRA TSC will implement the following Conservation Measures that generally protect suitable habitat from identified threats, support field investigations and other activities that will help identify opportunities for expanding such habitat, and provide refugia for Covered Species, thus providing an overall net conservation benefit to the Covered Species and their habitats. Table 2 briefly summarizes the Conservation Measures, the Conservation Zones in which they will be implemented, and the threats addressed by each measure. More detailed descriptions follow. As discussed in more detail below, these Conservation Measures, combined with an Adaptive Management Program (Section 10) that is tied to Changed Circumstances (Section 14.1), are reasonably expected to reduce threats to Covered Species by incorporating consideration of applied research, long-term monitoring, hydrologic modeling, and the ecological needs of the Covered Species, including when LCRA makes drought management decisions. The combination of reduced threats associated with the disturbance of Suitable Habitat for the Covered Species associated with LCRA's and LCRA TSC's Covered Activities within Zones A and B, the protection of water quality,

and maintenance of subsistence flows is reasonably expected to allow populations to naturally increase in terms of both numbers of individuals and extent of Suitable Occupied Habitat, thus providing a net conservation benefit.

Table 2. Summary of Conservation Measures

Category	Conservation Measure	Threats Addressed	Zones
Water Quality	Conduct routine water quality monitoring of sites near existing freshwater mussel populations.	Chemical contaminants	A, B
	Continued implementation of the Highland Lakes Watershed Ordinance to reduce water quality impacts from nonpoint-source pollution in areas surrounding the Highland Lakes.	Chemical contaminants; Sand and gravel mining; Sedimentation	A, B, D
	Continued implementation of On-Site Sewage Facilities program to reduce water pollution from septic systems in areas surrounding the Highland Lakes.	Chemical contaminants	B, D
Water Quantity	Provide water for environmental flows protection in the Colorado River below Austin.	Dewatering	A, B (below Lady Bird Lake)
	Implement robust water conservation programs to reduce water use	Dewatering	A, B, C, D
	Limit new subordination agreements to protect instream flows	Dewatering	A, B (above Highland Lakes)
	Collaborate with USFWS and TPWD to develop and implement a drought contingency plan for freshwater mussels, including short-term refugia.	Dewatering; Chemical contaminants	A
Invasive Species	Monitor for zebra mussels and all other invasive aquatic species in the Colorado River below Longhorn Dam to better understand the known and potential threats to freshwater mussels.	Nonnative species	A, B
	Help reduce spread of aquatic invasive species by adhering to invasive species spread prevention plan and conducting public outreach/education (in collaboration with the TPWD).	Nonnative species	A-D
Population Enhancement and Protection	Maintain the raw water contract with USFWS for the Inks Dam National Fish Hatchery, which provides 100 acre-feet per year of water at no cost, as an in-kind contribution to the captive propagation effort.	All	A, B, D
	Collaborate with USFWS and others to help support captive propagation studies.	All	A, B

Category	Conservation Measure	Threats Addressed	Zones
	Fund the mark-recapture project that was initiated with funding by Texas Comptroller and conducted by BIO-WEST and Texas State at the middle and lower Colorado River sites and expand at the lower Colorado River site to provide additional habitat suitability science.	All	A, B
	Partner with USFWS to conduct an assessment of stream reaches for conservation and restoration prioritization of habitat for Covered Species and other native freshwater mussels.	Chemical contaminants; Water quality	A, B
Population Enhancement and Protection	Mussel survivability study in the lower Colorado River below Austin to apply results of habitat assessment.	All	A, B
	Fund mussel tolerance studies and applied research to help further develop science on mussel needs.	Chemical contaminants; Dewatering; Sedimentation; Inadequacy of existing mechanisms	A, B
	Lead or assist, as needed, the development of a statewide coordinated monitoring and research web platform for mussel biologists throughout the state.	Inadequacy of existing mechanisms	A-D
	LCRA and LCRA TSC will work with USFWS to develop a drought contingency plan for short-term refugia. In addition, when mussel relocations occur in Zone C, any mussels found will be relocated to the Colorado River to augment existing populations of Texas pimpleback and Texas fawnsfoot, as well as all other native mussels found within the Zone C survey area.	All	A, C
Land Conservation and Public Outreach	LCRA Creekside Conservation Program, which provides cost-sharing grants to help eligible landowners plan and implement conservation practices that reduce soil erosion and protect water quality.	Chemical contaminants; Sedimentation; Dewatering	A, B
	Work with land trusts and other land conservation organizations in the basin to prioritize opportunities for placing key properties under conservation easements, with special targeted focus on tributaries in Zone A that could help protect mussel habitat into the future.	Chemical contaminants; Sedimentation	A-D
	Educational outreach to landowners and land trusts in key areas of the watershed to provide information on land management strategies to protect watershed health.	Chemical contaminants; Sedimentation; Sand and gravel mining	A, B
	Organize and help lead a work group for the Onion Creek Texas fatmucket population (Zone A-4) and section of the Colorado River downstream of Longhorn Dam within Travis County (Zone B).	All	A, B

7.3.1 Measure to Address Water Quantity

7.3.1.1 Environmental Flows Protection in Colorado River Below Austin

For the term of this CCAA, LCRA will conduct its water supply operations consistent with the state-issued water rights solely owned or operated by LCRA, including LCRA's WMP in effect at any particular time during this CCAA. As discussed in Section 5.2, the water rights solely owned by LCRA require LCRA to either refrain from diverting water or release stored water from lakes Buchanan and Travis that is needed to help maintain levels of instream flows that are consistent with the state's environmental flow standards for the lower Colorado River basin.[14]

Development and implementation of LCRA's WMP is inherently an adaptive management process, informed by science, hydrologic conditions, and the changing water needs within the basin. By maintaining operations in compliance with LCRA's WMP and special conditions for instream flows in its other water rights for the life of this CCAA, LCRA is able to manage water use under all of its permits to support water supply needs in the basin, while also providing water for environmental flows. Operations pursuant to LCRA's WMP provide flows that are protective of freshwater mussel habitat downstream of Lady Bird Lake (Bonner et al. 2018), and the WMP amendment process will continue to consider any new science on environmental flows and mussel habitat protection as it is updated and through the Adaptive Management framework included in LCRA's WMP.

Importantly, the 2020 WMP includes specific requirements related to subsistence instream flow levels, which help provide adequate flows for freshwater mussels. Specifically, to help maintain subsistence flows under the 2020 WMP, LCRA either passes inflows it could otherwise legally store under its water rights for lakes Buchanan and Travis or makes releases of water previously stored in those lakes. With limited exceptions, the 2020 WMP is designed to supply water to help meet subsistence flows

[14] As discussed previously, LCRA has no ability to manage flows upstream of the Highland Lakes, or on tributaries such as the Llano, Pedernales, or San Saba rivers. LCRA acknowledges that efforts by others within the middle and upper basin tributaries, such as those underway by TPWD and The Nature Conservancy using TPWD's Environmental Flows Information Toolkit, may help provide flows during critical flow periods in those areas.

at all times. At the Wharton gauge, when the amount of water stored in lakes Buchanan and Travis is below 900,000 acre-feet, LCRA will maintain flows of at least 107 cubic feet per second (the August subsistence flow level) by releasing previously stored water, and flows up to the full subsistence level to the extent of inflows legally available to LCRA under the lakes Buchanan and Travis water rights. This rare circumstance is expected to occur only about 3% of time over a repeat of the 77-year historic period of record. Figure 7 compares the low flows experienced at the Wharton gauge during the summer of 2013 with the minimum subsistence flows now required by the 2020 WMP. Further, even if water stored in lakes Travis and Buchanan drops below 600,000 acre-feet and the hydrology is more severe than historic records (i.e., the basin is experiencing a “drought worse than the drought of record” due to climate change or other factors), LCRA will continue providing water for environmental flow needs, albeit at a reduced level. For example, if LCRA’s firm water customers are curtailed by 20% under a drought worse than the drought of record, LCRA would continue to make water available from lakes Buchanan and Travis to help meet 80% of subsistence flow levels (well above the 2013 low flows). Additional details of LCRA’s WMP can be found online at the LCRA website (https://www.lcra.org).

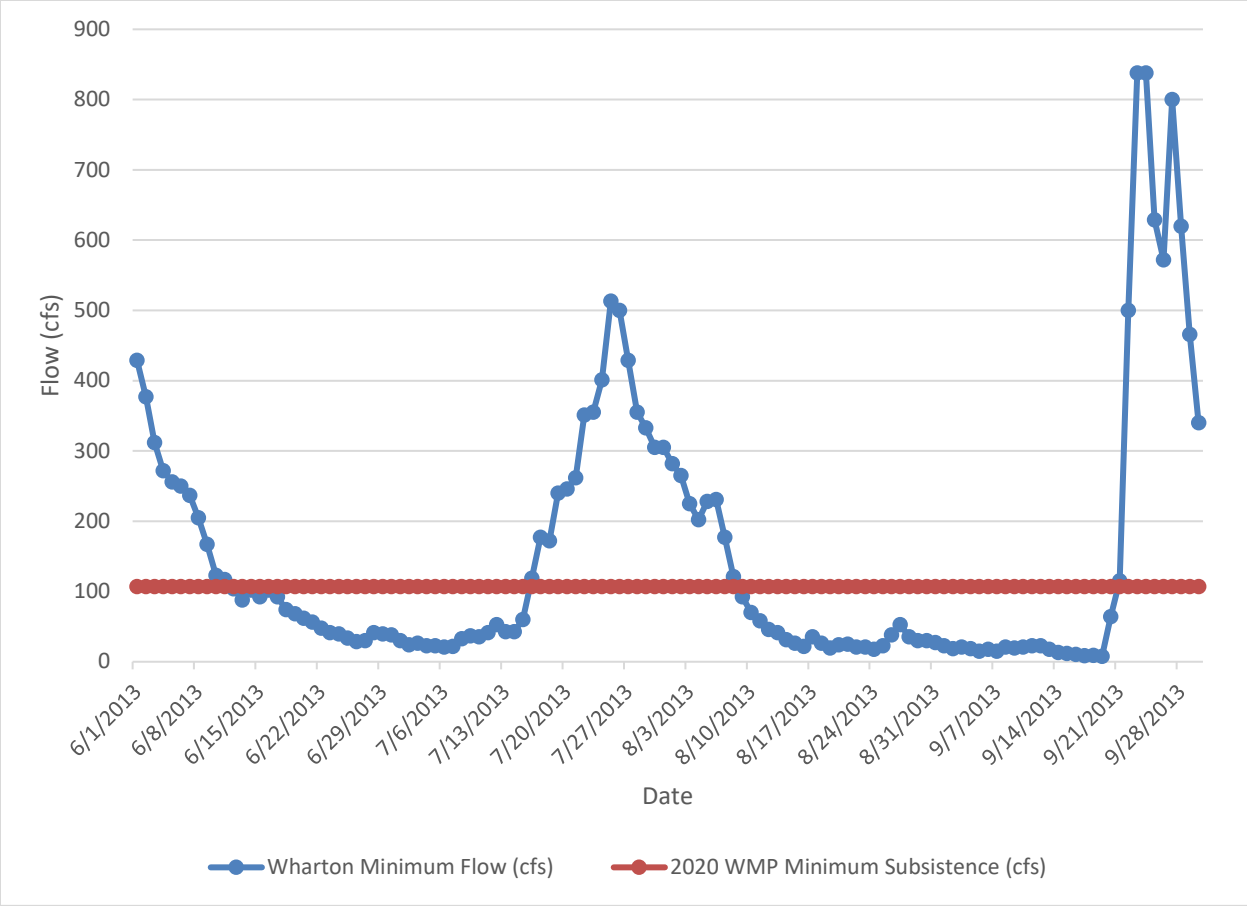

Figure 7. 2013 Wharton Gauge:
Summer Low Flows Compared With 2020 WMP Minimum Subsistence Flow (107 cfs).

Environmental flow conditions within LCRA's WMP and LCRA's other water rights are informed by the 2008 instream flow study (BIO-WEST 2008) that collected extensive biological and physical data used to develop subsistence and base flow recommendations (LCRA 2020, § 2.4.1) and are consistent with the TCEQ Environmental Flow Standards for the lower Colorado River ("SB3 Standards") (TCEQ 2012). In a study conducted by Texas State and BIO-WEST (Bonner et al. 2018), researchers concluded that mussel habitat availability peaks at flows lower than most fish habitat guilds used in the BIO-WEST (2008) study and that the study's environmental flow recommendations (which included minimum subsistence flows that are consistent with the SB3 Standards) are protective of mussel habitat from a water quantity perspective.

To further support the Freshwater Mollusk Conservation Society's National Strategy (2016) for Issues 2 and 3 (*see* Table 1), LCRA conducted a hydrologic

modeling analysis to characterize streamflow in the lower Colorado River basin across a range of flow conditions and future scenarios. This analysis can be found in Appendix B. This analysis helps identify those areas most at risk of low-flow conditions within the Covered Area. The modeling analysis was based on a repeat of the available and highly variable hydrologic conditions experienced from 1940-2016 and included a “full authorization scenario” in which all water rights are simulated to the fullest extent and there are no wastewater discharges that would otherwise contribute streamflows into the Colorado River or its tributaries. This scenario is conservative (in terms of potential low-flow scenarios) relative to the conditions expected during the 20-year term of the CCAA. Specifically, during the term of the CCAA, most water rights are not expected to be fully used and treated wastewater discharges are expected to contribute significantly to downstream flows. In the area of the river within LCRA’s ability to manage flow (i.e., the Colorado River below Lake Travis), simulated flows were only below minimum subsistence flows 0.1% to 0.2% of the time, corresponding to one or two months out of the 77-year period of record. Further, the analysis identified no periods in the historic record from 1940 to 2016 or the “full authorization scenario” simulation that experienced dewatering (i.e., zero flow). Thus, the modeling shows that flows within those portions of the lower Colorado River within the control of LCRA are not at risk of subcritical or zero flows during the term of this CCAA. While this modeling analysis did not incorporate hydrologic variability worse than that experienced in the historic record that might result from climate change, LCRA’s commitments regarding subsistence flows in the lower river as discussed above and elsewhere (Section 7.2.3) are reasonably expected to ensure sufficient flows for freshwater mussels even if such hydrologic variability were to occur over the 20-year term of the CCAA. Further, LCRA’s commitment to consider new hydrology (Section 7.3.1.2) in subsequent amendments to the WMP will also capture any such trends. Finally, as discussed earlier, the 2020 WMP includes real-time tracking of inflows and other factors that allow LCRA to assess and respond to conditions that indicate occurrence of a drought worse than the drought of record, such as might result from climate change.

7.3.1.2 Consideration of New Science and Hydrological Modeling to Inform Operations

LCRA's continued water management within the Colorado River downstream of Lady Bird Lake, which is consistent with TCEQ's environmental flow standards and based on the best available science, will continue to provide substantial conservation benefit to the habitat of the Covered Species in the Covered Area from a water quantity standpoint and also buffer against water quality degradation impacts, such as temperature, that were observed under prior operational conditions. As discussed in Section 5.2, LCRA's WMP has undergone regular amendments. If LCRA initiates such an amendment during the term of this CCAA, LCRA will continue its long-standing practice of considering any new hydrology that significantly departs from the historic record (such as that which may result from climate change) or other scientific information as part of the amendment process and the Adaptive Management program described in Section 10 of this CCAA. If specific information regarding flow or temperature needs for freshwater mussels or host fish indicates changes to LCRA's WMP's instream flow criteria may be warranted, LCRA will consider asking the TCEQ for approval to include such changes if it is otherwise feasible in light of other requirements in LCRA's WMP, including the need to maintain minimum storage levels and ensure firm water demands can be fully satisfied. As shown in Appendix B and discussed above in Section 7.3.1.1, LCRA conducted hydrologic modeling to provide additional insights into future hydrologic scenarios, including scenarios assuming conditions that are more extreme than those reasonably expected to occur over the 20-year term of this CCAA. To keep pace with changing water planning and water use projections within the basin, LCRA will conduct a similar analysis whenever it initiates the process to amend the 2020 WMP or subsequent versions of the LCRA WMP during the term of this CCAA. Amendment of the 2020 WMP is expected to occur no later than March 1, 2025. In the event LCRA has not begun a subsequent WMP amendment process by March 1, 2033, LCRA will conduct a subsequent similar hydrologic analysis in year 2033.

7.3.1.3 Implement Water Conservation Cost-share and Rebate Programs

LCRA has a robust Water Conservation Program designed to encourage reductions in water use among its customers on a long-term basis and that supports innovative programs to conserve water. Water conservation is an important strategy for mitigating the effects of urban growth on the region's water resources, particularly in Travis County and surrounding areas. In addition to reducing future water demands, water conservation can make important contributions toward satisfying the water and wastewater service requirements of growing urban populations and economies. LCRA has been implementing water conservation measures since the late 1980s. More than 25 years ago, LCRA implemented a comprehensive water conservation program targeted at the two largest water use sectors within the water service area – irrigated agriculture and municipal – which together account for more than 70 percent of LCRA's total annual water use, even in drought years when irrigated agriculture is curtailed. Industrial use, mainly from LCRA's power plants, has become significantly more water efficient over time as older facilities have been replaced by more efficient facilities.

Today, LCRA's strategies and goals for conserving water in the basin are based on a Raw Water Conservation Plan. The plan, which is routinely updated, is developed for municipal, irrigation, recreation, industrial and agricultural water use and fulfills requirements of the TCEQ's regulations for Water Conservation Plans. 30 Tex. Admin. Code ch. 288.

Over the term of this CCAA, the municipal population served by LCRA is expected to grow significantly. As such, LCRA expects that the majority of municipal water conservation savings to come from landscape irrigation standards and permanent watering schedules implemented by customers, and infrastructure upgrades such as reuse, water loss reduction and irrigation efficiency projects implemented through the water conservation incentives grant and rebates program. LCRA has two programs that provide significant funding opportunities for water conservation efforts of its firm water customers.

LCRA's Firm Water Conservation Cost-Share Program provides funding for water efficiency projects and programs established by LCRA's firm water customers. Customers include cities, utilities, industries, irrigation and recreational water users.

LCRA has helped fund projects to convert landscape irrigation systems from raw or potable water to recycled water, reduce water losses within utility systems by reducing water pressure or detecting and repairing water leaks. This cost-share program for firm customers encourages and accelerates the adoption of water conservation measures by providing funding to help offset the cost of water efficiency projects and programs. Depending on overall project cost and estimated water savings, a firm water customer may receive a grant up to $100,000 under the current program. Since the inception of this program in 2012, LCRA has provided customers with over $1.3 million in cost-sharing grants for projects with a total capital cost of $14.5 million.

In addition, LCRA has a WaterSmart Rebate program available for residential, commercial, institutional and industrial customers. This program currently reimburses a portion of the costs for various water-saving efforts. The current residential program offers rebates for such things as irrigation evaluations, retrofitting or replacing irrigation system equipment, new pool filters and covers, soil aeration, addition of compost and mulch, and soil testing at residential properties. The rebate program for commercial, institutional and industrial customers provides rebates for water audits and water-savings technology, such as upgrading irrigation system equipment, or water-saving equipment specific to improving the efficiency of individual customers' processes. Rebates for these commercial, institutional and industrial customers are also available for water-efficient toilets, urinals and spray rinse valves, soil aeration, and addition of compost and mulch. LCRA periodidcally adjusts the rebate amounts and eligibility requirements to reflect technological advances and other factors that affect which rebates are likely to offer the best investment towards water savings.

LCRA has also invested significantly in water conservation within the lower basin where irrigated agriculture is predominant. This has included investments in laser-leveling of rice fields, thus reducing the amount of water needed for rice production. LCRA has also automated gate structures and installed a centralized control system to remotely monitor those structures within its Garwood and Gulf Coast agricultural operations, providing significant water efficiency gains for customers. LCRA has also made significant changes to its water rate billing structure, shifting to a completely volumetric billing rate and implementing a tiered water rate structure, sending clear

price signals to customers to reduce water use. These changes are expected to continue to yield water savings for years to come, well beyond the term of the CCAA.

LCRA expects to continue to implement a rigorous water conservation plan for the term of this CCAA. Although the specific terms of its Raw Water Conservation Plan may change from time to time to address legal requirements, LCRA commits as part of this CCAA to continue to fund its Firm Water Conservation Cost-Share program and WaterSmart Rebate program at levels no lower than those budgeted for fiscal year 2024 ($250,000 annually).

7.3.1.4 Subordination Agreements above Highland Lakes

Historically, LCRA has entered into subordination agreements upstream of Lake Buchanan with certain municipal water providers. Subordination agreements are interlocal agreements where a senior water right holder waives their right to make priority calls on water upstream of the location of their water right. LCRA does not expect to execute any new subordination agreements during the term of the CCAA; however, to the extent that any such agreements are considered, LCRA will include provisions in any such agreements to ensure the passage of available instream flows sufficient to protect the Covered Species.

7.3.2 Measures to Address Water Quality Threats

7.3.2.1 Provide Instream Flows Affecting Temperature

LCRA's continued implementation of its WMP also helps ensure that the risk of temperature-related impacts to mussels in the lower Colorado River below Austin is significantly reduced. While water temperatures in the lower river are subject to influence from many factors, releases of water from upstream storage to help maintain the subsistence flows as required by the 2020 WMP provide a buffer in the hotter summer months against increased water temperatures that can otherwise negatively affect freshwater mussels. Temperature data collected at LCRA's Wharton water quality monitoring site 12286 from 2011 to 2014 (in the midst of a drought) showed a maximum measured temperature in August 2013 of 31.7 °C (Figure 8). Texas pimpleback and Texas fawnsfoot are the two Covered Species known to occur in the lower Colorado River where instream flows are managed by LCRA. According to research focused on

reproductive timing for Texas pimpleback in the San Saba and Llano rivers (Mitchell and Schwalb 2021) and on closely related species to the Texas fawnsfoot in other regions (Barnhardt et al. 2008) (see Table 3), spawning is not believed to occur for these two Covered Species during this hottest time of the year. Therefore, based upon the best available science and under the 2020 WMP flow requirements, temperature impacts on glochidia survival raised by Khan et al. (2019) are limited or reduced for the Texas fawnsfoot and Texas pimpleback populations in the lower Colorado River as a result of LCRA's commitments regarding instream flows as reflected in Sections 7.2.3, 7.3.1, and 7.3.2.1.[15] As noted above, these populations and temperature impacts will continue to be monitored, and the WMP amendment process will continue to consider any new science or substantial changes to hydrology as it is updated through the Adaptive Management framework set forth in Section 10.

[15] Note that the information in this section is focused on the Colorado River below Austin because this is the region of the Covered Area where LCRA has any ability to affect flow conditions outside of Zone D. This portion of the Covered Area is home to populations of Texas fawnsfoot and Texas pimpleback. Texas fatmucket and Balcones spike are not known to occur in the Colorado River below Austin.

Table 3. Reproductive Timing and Average Maximum Water Temperature Information for Covered Species

Species	Type of Brooder	Spawning Timing	Brooding Timing	Glochidia Release Timing	Research on Thermal Tolerance of Glochidia	Average Maximum Water Temperature* During Glochidia Release	Water Quality Monitoring Site Used	References
TEXAS PIMPLEBACK	short term	late winter/early spring	late winter to early spring	spring to early summer	No studies found on glochidia; sublethal effects observed in adults at 36 ºC (Haney et al. 2020)	**27.7 ºC**	Colorado River at Wharton	Mitchell and Schwalb 2021; Haney et al. 2020
TEXAS FAWNSFOOT	long term	fall	late fall and winter	spring	No studies found on glochidia	**27.7 ºC**	Colorado River at Wharton	Barnhardt et al. 2008 (extrapolating research on reproductive timing for related *Truncilla* species)
TEXAS FATMUCKET	long term	fall	late fall and winter	spring	25.5 +/- 0.8 ºC (24-h LT05) from Llano River	**26.1 ºC**	Llano River at Scott's Crossing	Barnhardt et al. 2008 (extrapolating research on reproductive timing for related *Lampsilis* species); Khan et al. 2019
					27.9 +/- 0.7 ºC (24-h LT05) from San Saba River	**27.5 ºC**	San Saba River at SH 16	
BALCONES SPIKE⁺	short term	late winter/early spring	March to June	spring to early summer	36.1 +/- 0.4 ºC (12-h LT50)	**26.1 ºC**	Llano River at Scott's Crossing	Dudding et al. 2020; Khan et al. 2019
						27.5 ºC	San Saba River at SH 16	

* Average Maximum Water Temperature from years 1980-2021 for March, April, May and June

⁺ Closely related false spike (*F. mitchelli*) used as surrogate due to lack of studies on Balcones spike in the Colorado River basin

The substantially higher subsistence flows required by the 2020 WMP at this location in the lower Colorado River should help reduce the likelihood of a recurrence of the conditions observed in the last drought. It follows that temperature-related impacts to survival of adult mussels are largely avoided in the lower Colorado River under these flow commitments.

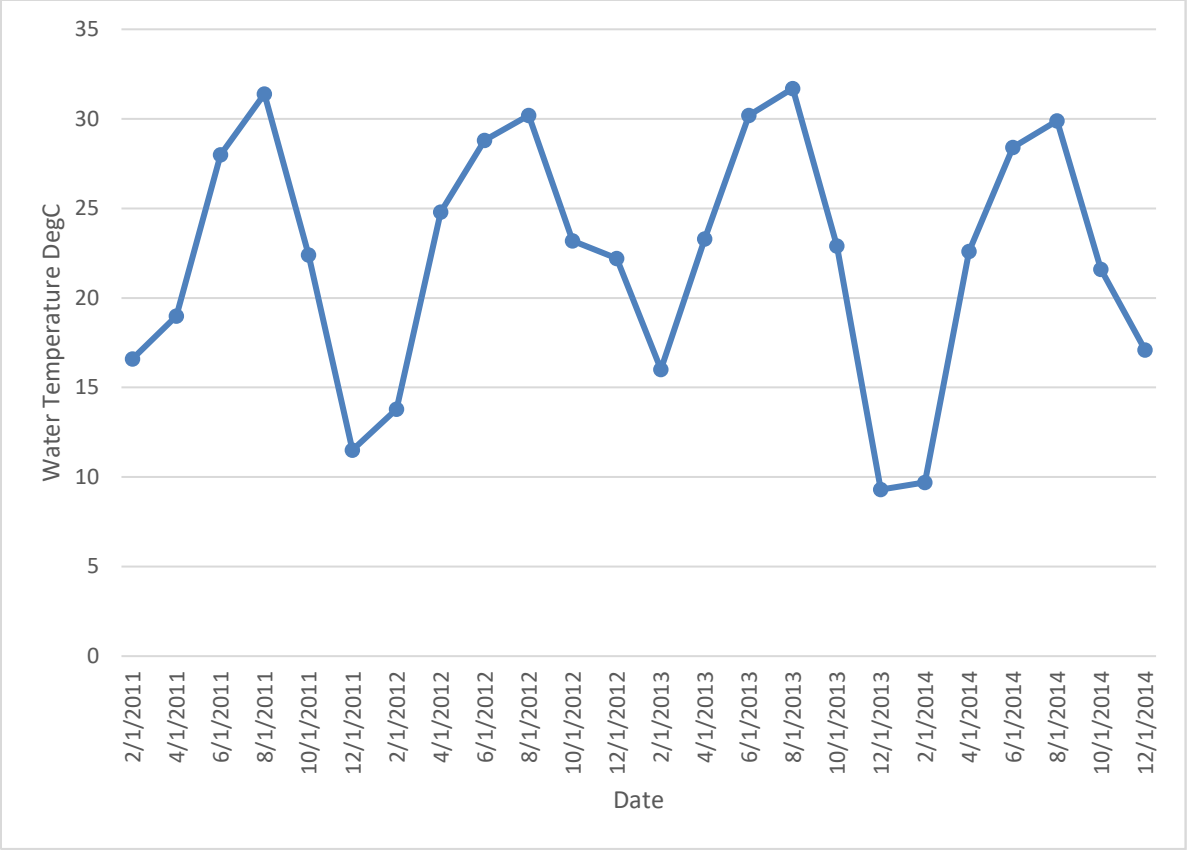

Figure 8. Surface Water Temperature Data from LCRA Routine Monitoring Site 12286 in the Colorado River at Wharton during the 2011-2014 Drought.

For informational purposes, historic surface water temperatures for sites listed in Table 3 are provided in Figure 9 during the months of March-June and July, which correspond with glochidia release for all of the Covered Species as referenced in the table.

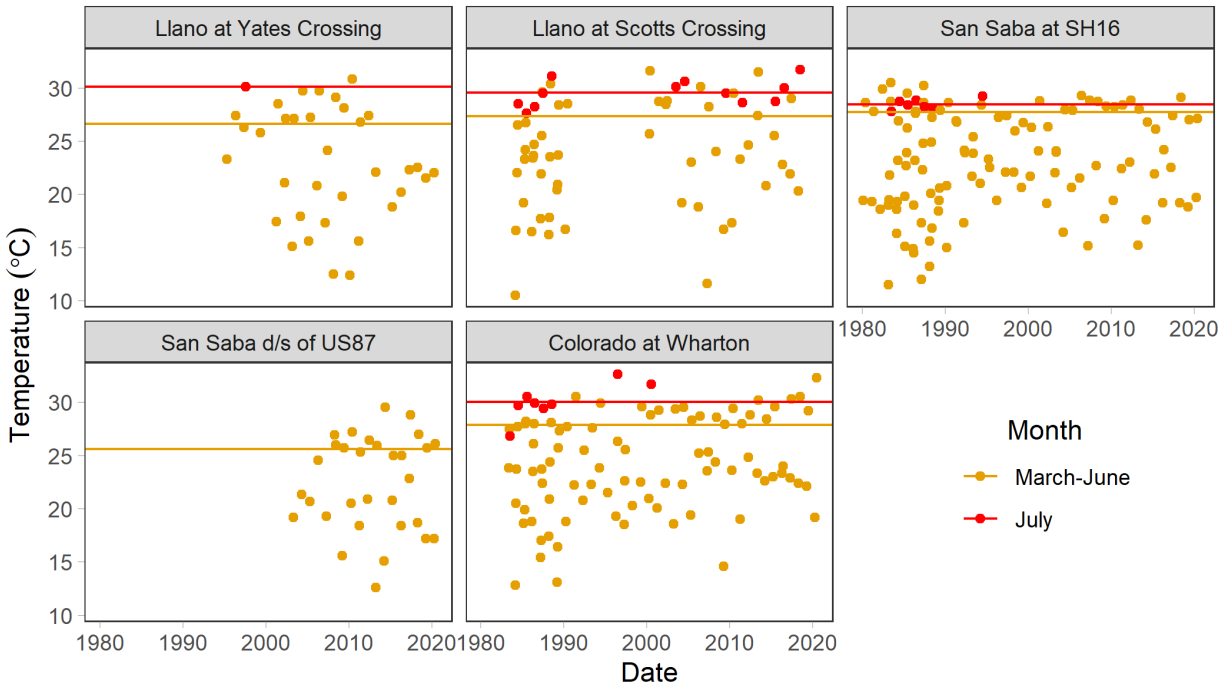

Figure 9. Surface Water Temperature Data (<1 m depth) Collected Since 1980.
Horizontal lines indicate the average maximum temperature for each site during each time period (March-June or July).

7.3.2.2 Water Temperature Monitoring in Upper Basin

As discussed earlier, wthin the limits and restrictions of its own water rights and the prior appropriation system, LCRA's ability to manage flow of water within the Colorado River watershed is limited to the main stem of the Colorado River from Lake Buchanan downstream to Matagorda Bay and on the downstream tributaries where Lake Bastrop and Cedar Creek Reservoir (Lake Fayette) are located. LCRA does not control any facilities that affect the flow of water upstream of Lake Buchanan, or in the San Saba, Llano, and Pedernales rivers, or in any other tributaries to these rivers or tributaries to the main stem of the Colorado River. However, to help provide additional benefit to the Covered Species located within these areas, LCRA and LCRA TSC commit to installing continuous water temperature monitoring sensors at three of its existing hydromet gauges on the San Saba, Llano and Pedernales rivers, to be determined after consultation with USFWS and TPWD. This effort is expected to help provide a net conservation benefit to the species by improving the understanding of the relationships between temperature and flow as it affects freshwater mussels in these

areas, which could, in turn, help inform future management actions by third parties with more direct control over flow conditions in these areas.

7.3.2.3 Water Quality Monitoring

LCRA is the lead agency for the Texas Clean Rivers Program in the Colorado River basin, which is a statewide water quality monitoring, data assessment, and public outreach program that provides funding and resources for regional watershed protection efforts. The program is administered by TCEQ in partnership with river authorities and other regional governments. As Clean Rivers Program partners, LCRA and the Upper Colorado River Authority (UCRA) monitor more than 100 sites throughout the basin, and coordinate with the City of Austin Watershed Protection Department and TCEQ regional offices to help ensure efficient use of monitoring resources in the Colorado River basin. In total, there are typically between 150 and 160 sites monitored throughout the Colorado River basin each year. The data collected by these agencies are used to determine if water bodies in the state meet Texas Surface Water Quality Standards.

In addition, LCRA administers and supports the Colorado River Watch Network (CRWN) program that trains citizen volunteers throughout the Colorado River basin to collect water quality data, report it to LCRA and serve as educated advocates within their communities for the protection of water quality. This program has trained more than 500 volunteers throughout its almost 30-year history. Volunteers are part of an early warning system for pollution events. If the data they collect or the visual inspection of the waterways reveals a potential pollution issue, they immediately report it to LCRA so that action can be taken to address the water quality concern. The CRWN volunteers enable LCRA to assess water quality at more locations throughout the basin than the Clean Rivers Program can cover. As a part of this Conservation Measure, LCRA will train all CRWN volunteers (with targeted focus especially for those volunteers who are monitoring water quality in waterways in Zones A and B) on what to do if they see a live mussel or spent shells so that additional native mussel data can be collected and documented. Volunteer training will also include instruction on how to identify and avoid harm to instream mussel habitats. All of this data will be reported under LCRA's scientific collection permit granted by TPWD.

Additionally, for this Conservation Measure, LCRA commits to routinely

monitoring water quality at 10 sites located within Zones A and B during the term of this agreement. These sites are listed in Table 4 below. LCRA will implement monitoring of these sites, at an estimated cost of $30,000 per year, even if funding from the TCEQ through the Clean Rivers Program is suspended during that time. During each Coordinated Monitoring Meeting held annually for the LCRA Clean Rivers Program, water quality monitoring data gaps near existing or newly discovered mussel populations will be included in the monitoring schedule if deemed important to monitoring and protecting habitat of any of the Covered Species. This will provide valuable information for any potential permit applications in these areas and also allow any pollution events that are documented through the data collection effort to be caught and addressed, therefore leading to better protection of key mussel habitats.

Table 4. Water Quality Monitoring Sites

Site Name	Zones	Nearby Covered Species
Colorado River at U.S. 190 east of San Saba (12355)	A, B	Texas fawnsfoot, Texas pimpleback, Balcones spike
San Saba River at SH 16 north of San Saba (12392)	A, B	Texas fawnsfoot, Texas pimpleback, Balcones spike
Llano River at Yates Crossing on RR 385 (14231)	A, B	Texas fatmucket
Llano River near RR 1871	A	Texas fatmucket, Texas pimpleback, Balcones spike
Pedernales River downstream of SH 281 near Johnson City	A, B	Texas fatmucket
Colorado River at Loop 150 south of Bastrop	B	Texas pimpleback, Texas fawnsfoot
Colorado River downstream of SH 95 in Smithville (12293)	B	Texas pimpleback, Texas fawnsfoot
Colorado River at SH 71 at La Grange	B	Texas pimpleback, Texas fawnsfoot
Colorado River at Old Hwy 71 in Columbus	A, B	Texas pimpleback, Texas fawnsfoot
Colorado River downstream of US Alt 90 near Altair	A	Texas pimpleback, Texas fawnsfoot
Colorado River upstream of US 59 west of Wharton	A	Texas pimpleback, Texas fawnsfoot

This monitoring will help increase knowledge of the impacts of past, ongoing, and newly emerging water quality stressors on freshwater mussels and their habitats and can aid in identifying stressors important to supporting populations of the Covered

Species that can be used to guide Adaptive Management. Long-term trends or emerging trends in water quality in various stream reaches could inform adjustment of Conservation Measures or Avoidance and Minimization Measures within that reach.

7.3.2.4 Water Quality Protection

7.3.2.4.1 Implement LCRA Highland Lakes Watershed Ordinance

Pollution carried by stormwater runoff represents a threat to the water quality of the Highland Lakes and its tributaries. According to data and research from USEPA, the TCEQ, the City of Austin, and LCRA, activities that convert woodlands, meadows and ranchland to subdivisions, parking lots, roadways, lawns and industrial facilities result in a three-fold increase in nutrients, more than double the total suspended sediment loads, and introduce harmful chemicals, metals, and other pollutants to Hill Country watersheds. Quarry and mining activities have the potential to cause similar runoff effects (LCRA 2017). LCRA actively protects the Highland Lakes from stormwater runoff and sedimentation from these activities around the Highland Lakes and the lower Colorado River under its Highland Lakes Watershed Ordinance (HLWO). The HLWO helps protect water quality throughout the Highland Lakes region within portions of the following counties: Burnet, Llano, Williamson and Travis (Figure 10).

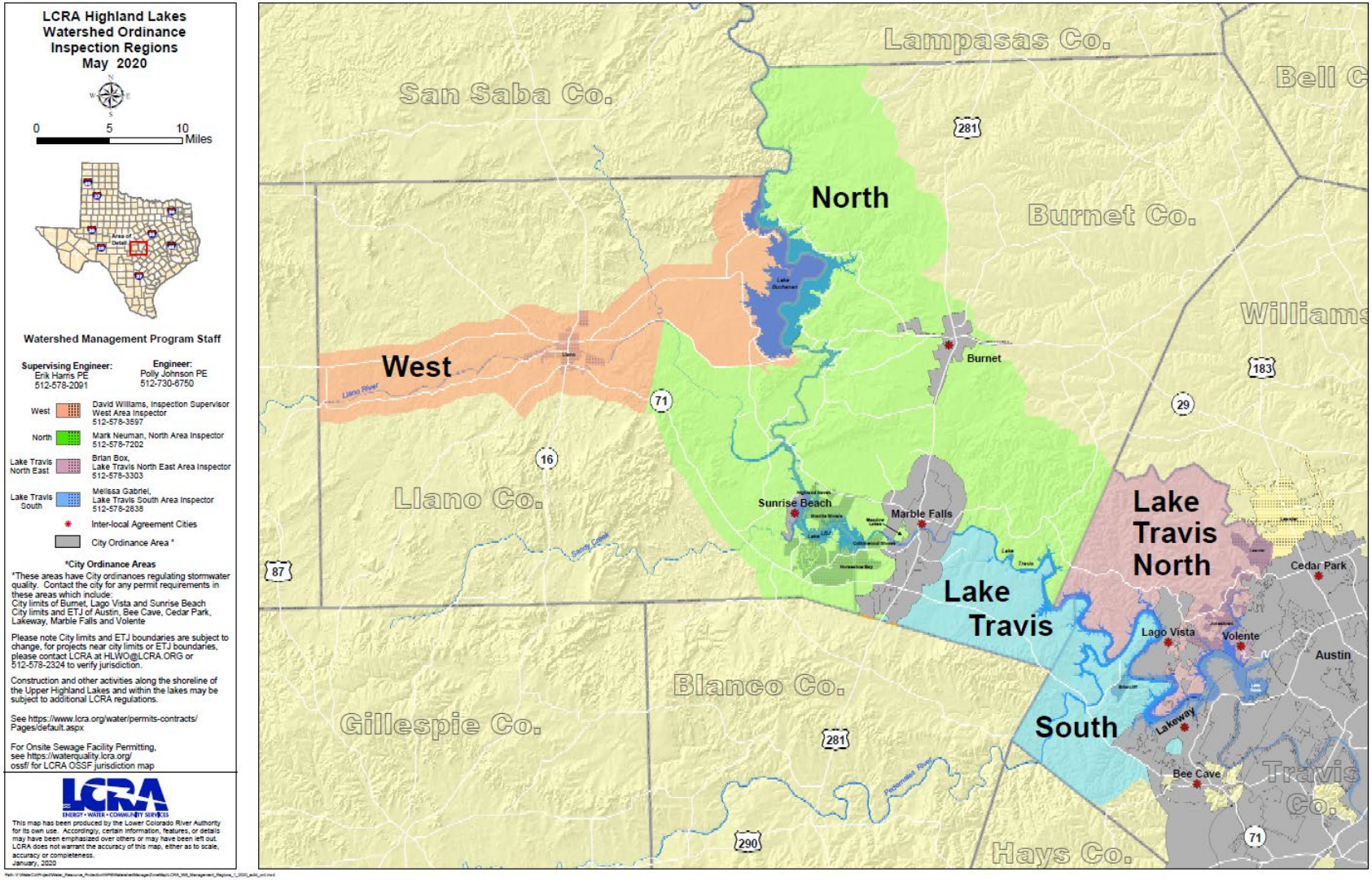

Figure 10. LCRA Highland Lakes Watershed Ordinance Area.

LCRA estimates that its HLWO manages up to 90% of stormwater pollution generated by development projects and quarry and mine operations within its reach, resulting in removal of at least 70% of the total suspended solids, oil and grease, and total phosphorus from stormwater (LCRA 2017). Developments within the jurisdiction of the HLWO are required to protect water quality and reduce creek erosion by providing:

- Approved water quality management facilities (vegetated filter strips and/or water quality basins) to collect stormwater runoff.
- Creek buffer zones that remain free of development and absorb pollutants that escape best management practices and protect the riparian zone.
- Temporary erosion and sediment controls.
- Permanent systems to minimize sediment migration from the site.
- Annual maintenance inspections of permanent water quality basins to ensure performance.

As a part of this program, LCRA encourages the use of native and adapted plants and discourages the use of chemicals on landscapes, which may have a negative impact on water quality. New quarries and mines also are regulated under the HLWO and must implement measures similar to other developments. Standards for dredge and fill activities also are included in the ordinance. Over time, the HLWO has been and will continue to be regularly reviewed and revised by the LCRA Board to respond to changing needs within the watershed affecting the Highland Lakes.

For the term of this CCAA, LCRA commits to continue implementing the HLWO, as it may be amended from time to time, to help address water quality threats that might otherwise negatively impact the Covered Species or their habitat. Specifically, continued implementation of the HLWO will reduce the amount of sediment and other pollutants from regulated development activities that might otherwise enter areas of suitable habitat within Zones A and B within the Llano River in Llano County, portions of the lower Pedernales River, and the Colorado River above Lake Buchanan. Further, by protecting water quality of the Highland Lakes, the HLWO also will protect water quality of the lower Colorado River below Austin, which is heavily influenced by releases of water from these lakes.

7.3.2.4.2 Regulate On-Site Sewage Facilities

Since 1971, LCRA has regulated the installation and operation of septic systems within a zone around the Highland Lakes through its On-Site Sewage Facility (OSSF) Program. LCRA's OSSF program is authorized by TCEQ under Chapter 341 and Chapter 366 of the Texas Health and Safety Code. The rules limit pollution that could be detrimental to aquatic life habitat and protect public health. LCRA also has the authority to operate regulatory programs under Tex. Spec. Dist. Code § 8503.004(q) LCRA's Enabling Act. Over time, LCRA's OSSF Program has been and will continue to be regularly reviewed and revised by the LCRA Board to respond to changing legal requirements and needs within those areas subject to OSSF regulation.

For the term of this CCAA, LCRA will continue to inspect septic systems in the Highland Lakes region to reduce threats to freshwater mussels by limiting pollution from wastewater effluent consistent with TCEQ's authorization to implement this program and the OSSF Program, as it may be amended from time to time. This Conservation Measure will help protect water quality within portions of Zone B near the Highland Lakes. Further, by protecting water quality of the Highland Lakes, this measure also will help protect water quality within Zones A and B downstream of Austin, which is heavily influenced by releases of water from these lakes.

7.3.3 Measures to Address Threats from Invasive Species

7.3.3.1 Monitor Invasive Species

As a Conservation Measure, LCRA will continue monitoring for all invasive aquatic species within the Covered Area that may impact freshwater mussels. Presence/absence monitoring for invasive aquatic species that may impact mussels will coincide with the water quality monitoring events at the sites identified in Section 9.1. If invasive species are identified at any monitoring site, the size of the initial infestation will be estimated and then monitored routinely. Infestations of invasive species also will be reported to TPWD and a Sighting Report will be submitted to the USGS Nonindigenous Aquatic Species database. This important component of habitat monitoring, applied in an Adaptive Management framework and with other Conservation Measures, is reasonably expected to help reduce threats associated with invasive species,

contributing to a substantial net conservation benefit for the Covered Species.

Zebra mussels were first discovered in the Colorado River basin in 2017 at Lake Travis. Since that time, LCRA and City of Austin biologists have tracked the spread of zebra mussels into Lake Austin, Lady Bird Lake, and the Colorado River downstream of Austin. In 2020, biologists detected adult zebra mussels as far downstream as Colorado County at the mark-recapture site in the Colorado River near Altair. LCRA biologists, in conjunction with Texas State University biologists who have been contracted to conduct survey work at the site, will continue to track, monitor and understand the impacts of zebra mussels on native unionids at this location and throughout the lower Colorado River basin in Zones A-D. This monitoring will provide insight into the threat that zebra mussels pose to native mussels in this stretch of river that is more than 100 stream miles downstream from an infested reservoir. It also will help track any impacts to the mussels tagged for this study to understand causes of mortality within this section of the river that serves as important habitat for the Texas fawnsfoot and Texas pimpleback in the Colorado River basin.

7.3.3.2 Limit Spread of Zebra Mussels

To help ensure that LCRA research and monitoring activities do not cause further spread of zebra mussels or other invasive species, LCRA will implement a Zebra Mussel Spread Prevention Plan. Further, LCRA will continue to conduct outreach/education in collaboration with TPWD to help limit the further spread of zebra mussels in the Colorado River basin and elsewhere in Texas.

7.3.4 Population Enhancement and Protection Measures

Several Conservation Measures are designed and intended to support USFWS efforts to augment existing populations and reintroduce populations using captive-reared individuals. These are described in more detail below. These specific Conservation Measures combined with other Conservation Measures related to protection of water quality and streamflow support an aspirational goal to reestablish at least one population for each of the Covered Species in the Covered Area. A 20 year period (the term of this CCAA) represents approximately two to five generations for the Covered Species, and increases in population numbers and extent are reasonably

expected to be measurable within 20 years. The long-term monitoring program will be implemented to document changes in populations throughout the term of this CCAA. Even if the populations cannot be reestablished under this aspirational goal during the term of this CCAA, the Conservation Strategy as a whole is nevertheless reasonably expected to result in a net conservation benefit.

Opportunities to accelerate natural increases in population numbers and extent also are anticipated by this CCAA as LCRA and LCRA TSC will provide funding for or otherwise assist TPWD and USFWS with population augmentation and species reintroduction efforts, including identification of stream reaches appropriate for restoration of mussels.

For populations separated by barriers or otherwise vulnerable to acute events, such as dewatering or chemical spills, developing captive propagation techniques can eventually provide organisms to augment existing populations and/or expand the distribution of the Covered Species. Captive propagation also is useful in providing organisms for research purposes so that existing natural populations are protected. LCRA and LCRA TSC will support and assist TPWD and USFWS with captive propagation efforts and any related reintroductions of the Covered Species, assuming such actions are deemed to be appropriate by TPWD and USFWS at that time. Specifically, LCRA and LCRA TSC are committed to supporting these efforts through both in-kind and direct financial contributions as set forth below.

7.3.4.1 Provide Water to USFWS' Inks Dam National Fish Hatchery

Since 1981, LCRA has provided up to 100 acre-feet/year of water at no cost to the USFWS Inks Dam National Fish Hatchery. As an in-kind contribution to the USFWS captive propagation efforts at this facility, LCRA will continue its commitment to supply 100 acre-feet per year of water at no cost through the term of this CCAA. In today's dollars, this commitment is valued at approximately $15,000 per year.

7.3.4.2 Support Captive Propagation Studies

In addition to the in-kind support through water supply, LCRA and LCRA TSC commit to providing funds to support ongoing efforts by USFWS hatcheries to establish captive propagation for the Covered Species. Starting in year three of this CCAA, LCRA

and LCRA TSC will provide $25,000 per year for five years, and then an additional $15,000 per year for five years to support applied research activities necessary to support propagation and reintroduction efforts. Other field studies LCRA will conduct as part of this CCAA, such as the habitat suitability study, will also assist in understanding important parameters that can affect the success of any reintroduction efforts.

7.3.4.3 Field Investigations

7.3.4.3.1 Mark-Recapture Project

As part of this CCAA, LCRA and LCRA TSC will provide funding for five additional years of monitoring at the middle and lower Colorado River mark-recapture sites that were initiated with funding by the Texas Comptroller and conducted by BIO-WEST and Texas State University (Bonner et al. 2018). This work will advance scientific understanding of the unique needs and physiological adaptations of the Covered Species.

Specifically, this mark-recapture project will document population changes at the Middle Colorado River site since the last 2019 collection and continue population monitoring of freshwater mussels at the Altair site in the lower Colorado River. Previous work (Sotola et al. 2021) quantified population dynamics (i.e., detection probability, abundance, and apparent survival) of mussels using a closed-robust design framework at one riffle habitat at the San Saba site and at the Altair site. This study will continue quantifying population dynamics of freshwater mussels at the same riffle habitat at the San Saba site and at the Altair site. In addition, the study will quantify population dynamics in other nearby habitats (e.g., riffle, run-edge, pool-channel) to improve site-level inferences at the Altair site as suggested by Sotola et al. (2021).

Objectives of the study will be (1) to estimate detection probability, abundance, and apparent survival of freshwater mussels using shellfish tags (all mussel species will be tagged) and passive integrated transponder (PIT) tags (all individual mussels collected that are Covered Species will be tagged) among multiple habitat types at the Altair site; and (2) to estimate detection probability, abundance, and apparent survival of freshwater mussels using shellfish tags (all mussel species will be tagged) and PIT tags (all individual mussels collected that are Covered Species will be tagged) at the San

Saba site.

Methodologies for this study will follow those described in detail by Sotola et al. (2021). Below is a summary of the sampling protocols and study design.

Field sampling — Robust design mark-recapture methods will be used to estimate detection probability, abundance, and apparent survival of freshwater mussels. Robust design methods consist of primary and secondary periods. Primary periods are when populations are assumed to be closed (i.e., no mortality or migration), and intervals or secondary periods are defined as the time between primary periods, when the populations are assumed to be open (i.e., mortality or migration can occur). A minimum of two primary periods, sampled at least three months apart, will be sampled annually among the habitat types. Additional primary periods could be added to capture unique hydrological conditions (e.g., low flows and high-flow events).

In addition to the 300-square-meter (m^2) area located in a riffle habitat, two to four additional habitats (e.g., riffle, run-edge, pool-channel) will be delineated. Areas sampled in the habitats will not exceed 300 m^2 but could be less, depending on habitat area available. For initial tagging and during subsequent primary and secondary periods, four corners of the area of each delineated habitat will be georeferenced so the same area could be delineated during subsequent visits. During initial sampling, survey crews will spread evenly across the downstream boundary and search for mussels visually and tactilely, moving upstream while crawling, floating, or snorkeling. Per delineated habitat, detected mussels will be removed and placed into mesh bags kept in the river. Upon completion of the habitat survey, mussels will be taken to a central processing station on the riverbank and identified morphologically to species. Mussels will be affixed with two laminated vinyl shellfish tags (Floy®) on each valve. For Covered Species that are collected, a PIT tag (Biomark ®) also will be affixed to a valve. Cyanoacrylic glue (Loctite Gel Control Super Glue®) will be used to affix tags to the mussel valves. Mussel length, width, and girth will be measured to the nearest millimeter. Mussels will be returned to the habitat and placed in substrates with their posterior end in an upright position. For subsequent primary and secondary period sampling, areas within the delineated habitats will be surveyed using a Biomark reader to locate PIT tagged individuals. After scanning, mussels will be visually and tactilely

captured, tagged, and returned as during initial tagging. For previously tagged mussels, the unique tag number per recaptured individual will be recorded. Average person hours (calculated as total search time divided by number of people) will be calculated for each primary and secondary search. Per delineated habitat, the following measurements will be taken: dissolved oxygen, water temperature, specific conductance, pH, mean depth, mean current velocity, as well as substrate types and their percent distribution.

Data Analysis — A Bayesian closed robust design model will be used to estimate apparent survival and abundance while accounting for imperfect detection separately for each species. Mussel species with less than 15 observations total will be excluded from the analysis.

All data and reported findings from this study will provide a net conservation benefit to the species. The information gathered, which will be provided to USFWS to aid in the conservation of the Covered Species, will develop additional science on meso-habitat preferences, growth rates, recruitment, and long-term survival of one of the most robust unionid populations within Zone A. This study is expected to provide information on all native mussel species encountered at the site, providing valuable long-term data for a variety of native mussel species that co-occur within these mussel beds. Information gathered from this study will help inform the recovery process for the Covered Species by providing insight into habitat, survivorship, population dynamics across more than five years of varying flow levels in a riffle habitat, and threat of zebra mussels. The information also will be valuable to consider as a part of the Adaptive Management Plan and Program to inform actions that may be taken to further protect and enhance the species' populations.

7.3.4.3.2 Assessment of Stream Reaches for Conservation and Restoration of Texas Fatmucket, Texas Pimpleback, and Other Co-Occurring Species

LCRA and LCRA TSC will partner with USFWS to fund a study that will evaluate and prioritize stream reaches for restoration and reintroduction for Texas fatmucket, Texas pimpleback, and other co-occurring mussel species in the middle and lower Colorado River Zone B reaches (i.e., historical range that was not occupied when this CCAA was developed). LCRA and LCRA TSC specifically will fund the expansion of the USFWS study that already is underway to include an expanded geography into habitats

occupied by the Texas pimpleback. The study will allow for a more informed evaluation of locations where reintroduction may be most successful in the future. This study will involve the following tasks:

1) Conduct field assessments of habitat and landscape variables at the reach scale in stream reaches within Zones A and B to identify instream habitat characteristics that are associated with species presence and absence. Data collected at these sites will be used to develop stream habitat indices;
2) Conduct rapid field assessments of instream and riparian zone habitats of extended reaches of middle and lower Colorado River (and any warranted tributaries), utilizing methods such as a Basinwide Visual Estimation Technique (BVET) or Index of Biota Integrity (IBI);
3) Complete an Ecological Risk Assessment for assessed stream reaches, including the development of habitat suitability indices for habitat quality and risk factors present within the study area; and
4) Develop a system to prioritize stream reaches that could be explored further for potential future species augmentation, restoration, or reintroduction sites for the Covered Species.

The Ecological Risk Assessment is anticipated to consist of two analyses. The first analysis will include documentation of physical habitat composition, availability, and distribution throughout the study area. The second analysis will rank stream reaches and their associated habitats based on a list of potential risk factors. These two analyses will then be combined to identify stream reaches with the highest quality or available instream habitat that have the lowest risk of ecological or human threats that would preclude the reach from serving as a suitable site for future augmentation, restoration, reintroduction or other conservation activities.

LCRA will coordinate closely with USFWS on these research activities and any possible reintroductions, which applied in an Adaptive Management framework, are ultimately reasonably expected to contribute to population increases for the Covered Species, thus providing a net conservation benefit. This effort includes a financial commitment by LCRA and LCRA TSC of $50,000 over an approximate two-year period during the term of this CCAA.

7.3.4.3.3 Mussel Survivability Study in the Lower Colorado River Below Austin

Using the scientific knowledge gained from the above-stated "Assessment of Stream Reaches for Conservation and Restoration of Texas Fatmucket, Texas Pimpleback and Other Co-Occurring Species," LCRA and LCRA TSC will fund a mussel survivability project in the lower Colorado River below Austin. This study will involve the following tasks:

1) Mussels propagated at the Inks Dam National Fish Hatchery or relocated from the Zone C canals will be placed in both open plots and enclosed cages in the lower Colorado River below Austin at sites selected based upon results from the assessment outlined in Section 7.3.4.2.
2) Growth, fitness and survivability of all freshwater mussels will be routinely documented throughout the period of study using similar data collection methods employed by the San Antonio River Authority for the Mission Reach mussel survivability study (SARA 2021). In addition, water quality parameters will be routinely collected at the study sites, including ammonia, chlorine residual, dissolved oxygen, turbidity, temperature, specific conductivity pH, and flow (based on the nearest gauge).

The results of this study will provide robust data to determine if reintroduction of Covered Species and other native freshwater mussels will be possible at the sites identified by the study outlined in Section 7.3.4.3.2 of this CCAA. If specific threats or limitations to the growth and survival of the species are identified as a result of this study, then this information will be used during the Adaptive Management process to inform on the feasibility and implementation of possible mitigation actions.

LCRA will coordinate closely with USFWS and TPWD on the research design, approach and implementation activities for this study and any possible large-scale reintroductions. When applied in an Adaptive Management framework, this Conservation Measure is reasonably expected to contribute to population increases for the Covered Species, thus providing a net conservation benefit to the Covered Species. This effort includes a financial commitment of up to $100,000 during the term of this CCAA.

7.3.4.3.4 Mussel Tolerance Studies

To advance the science on physiological tolerance of the Covered Species, LCRA and LCRA TSC will provide funding for laboratory studies on water quality tolerance limits for freshwater mussels (glochidia, juveniles and/or adults). If available, this analysis will focus on test organisms produced via captive propagation, rather than specimens collected from the wild. Also, where possible and needed, opportunities will be explored to collaborate with other partners and expand these studies to include populations of the Covered Species outside the Colorado River basin. These studies will focus on the influence of water quality parameters such as water temperature, ammonia, dissolved oxygen, salinity, chlorine, and/or turbidity that are believed to pose the highest risk to Covered Species. Information from these studies will be used in conjunction with other routine water quality monitoring in the basin to evaluate potential water quality impacts to the Covered Species for a variety of life stages. This understanding, applied in an Adaptive Management framework with other Conservation Measures, will reduce threats associated with water quality degradation, contributing to a substantial net conservation benefit for the Covered Species. This effort includes a financial commitment of up to $140,000 during the term of this CCAA.

7.3.4.4 Coordinated Monitoring, Research, and Data Sharing

As LCRA conducts the field investigations contemplated by Section 7.3.4.3 of this CCAA, it will engage on a routine basis with USFWS, TPWD, and other agencies and scientists working on freshwater mussel issues in the Colorado River basin. Regular communication and coordination will allow scientists from various agencies and universities to share research and monitoring plans and prevent overuse of existing populations for scientific research. Data sharing will allow all parties to stay up to date on ongoing research and assist in making sound conservation and management decisions.

Additionally, to facilitate data sharing and coordination of monitoring efforts, LCRA plans to design a web-based platform for mussel biologists modeled after the Coordinated Monitoring Schedule used by TCEQ’s Clean Rivers Program (and managed by LCRA) (located at cms.lcra.org), if USFWS and TPWD determined that it

would be beneficial and useful. LCRA and LCRA TSC also will contribute data to the Mussels of Texas Project when data is collected by LCRA biologists.

Further, LCRA will work in collaboration with USFWS, TPWD and other relevant agencies and scientists, as needed, to more specifically determine the timing, scoping, and prioritization of the Conservation Measures outlined in Section 7.3.4.3. This effort could be based on a cost-benefit framework similar to that under development for the Guadalupe Basin Mussel Conservation Plan (TPWD 2021a) and may consider any other relevant conservation efforts or field investigations.

7.3.4.5 Contingency Plan for Short-Term Refugia

Extreme drought-induced dewatering or flood-related scour and sedimentation can devastate local populations of freshwater mussels. To address this potential threat during the term of this CCAA, LCRA will work directly with USFWS and TPWD to develop and, where necessary, implement a contingency plan for short-term refugia and translocation of individuals of Covered Species in the event of catastrophic drought. This contingency plan will describe the exact methods and facilities to be used to collect and temporarily maintain a refuge population of Covered Species if an extreme event occurs and both parties agree that it threatens to extirpate an existing population. Under such a scenario, LCRA and USFWS will work together to collect remaining live individuals, transport them to a temporary off-site holding location or relocate them to an *in situ* holding location, and potentially restock the original location upon return of appropriate conditions. Further, LCRA will assist with the reintroduction of the refuge populations within currently occupied or historically occupied stream reaches, assuming those actions are deemed appropriate by TPWD and USFWS at that time. Development of this contingency plan will be initiated as soon as this CCAA is finalized, so that appropriate methodologies will be in place for short-term refugia should the need arise. As part of this effort, LCRA will investigate the conditions under which the canals it operates within Conservation Zone C could serve as a short-term refugia.

Efforts to develop short-term and long-term contingency plans for restoring Covered Species in the event of a natural disaster or other event outside of LCRA's or LCRA TSC's control will bolster resiliency, redundancy, and representation of the Covered Species, contributing to a substantial net conservation benefit.

7.3.4.6 Population Augmentation as a Result of Canal Relocation

When mussel relocations are required within Zone C (Section 7.2.4.3), LCRA and LCRA TSC will place all mussels found within the survey areas of the canals into designated locations within the Colorado River that are agreed upon by USFWS, TPWD and LCRA biologists. This provides an augmentation of existing mussel populations of Texas fawnsfoot (and potentially Texas pimpleback) known to occur in the lower Colorado River, as well as augments populations of the other native unionids that may be found in Zone C. This contributes a net conservation benefit for all native mussel species that may be encountered in the Zone C canals.

7.3.4.7 Work Group for Onion Creek Texas Fatmucket Population

LCRA will organize and help lead a work group focused specifically on the Onion Creek Texas fatmucket population starting in year two of this agreement. This lowermost section of Onion Creek is home to the most downstream known population of Texas fatmucket. LCRA will invite participants from TPWD, USFWS, the City of Austin Watershed Protection Department, Travis County, and the Texas Department of Transportation. Other participants may be invited based on their expertise regarding this species and portion of Onion Creek.

The purpose of the work group is to study and advise on mussel conservation priorities in Onion Creek. Moreover, the work group is neither managed nor controlled by USFWS or any other federal agency and is therefore not subject to the requirements of the Federal Advisory Committee Act.

7.3.5 Land Conservation Measures

7.3.5.1 LCRA Creekside Conservation Program

For the last 30 years, LCRA has helped private landowners become better land stewards by administering the Creekside Conservation Program. The program is a partnership between LCRA, the U.S. Department of Agriculture’s Natural Resources Conservation Service (NRCS), the Texas State Soil and Water Conservation Board (TSSWCB), and local soil and water conservation districts to provide cost-sharing incentives to help private landowners plan and implement Best Management Practices (BMPs) within the lower Colorado River basin.

BMPs implemented through this program are designed to reduce soil erosion and protect water resources and include practices such as brush management, cross-fencing, rangeland planting and alternative water source development. Landowners within the Colorado River watershed of Bastrop, Blanco, Burnet, Colorado, Fayette, Lampasas, Llano, Matagorda, San Saba, Travis, and Wharton counties are eligible to participate in the program.

For the term of this CCAA, and so long as EPA Clean Water Act, Section 319(h), Nonpoint Source Grant Program funding is available through the TSSWCB, LCRA will continue to collaborate with partnering agencies to implement this program and enroll landowners within Conservation Zones A and B. In addition, LCRA will provide in-kind support and share information regarding the TPWD Landowner Incentive Program and Healthy Creeks Initiative with landowners, when it deems appropriate. By targeting these efforts in those areas where conservation efforts would be most likely to benefit the Covered Species by enhancing water quality in or near suitable habitat, this Conservation Measure is reasonably expected to provide a net conservation benefit for the species.

7.3.5.2 Public Outreach and Education

Public outreach and education are critical for successful implementation of any conservation strategy for freshwater mussels. LCRA has a long history of reaching out to landowners within its service area to provide education materials related to water quality, water supply, and land conservation. The general public in the Colorado River basin is not largely aware of freshwater mussels, their value, the implications of their decline, activities that may negatively impact them, or the supporting science.

To address this knowledge deficit, LCRA will develop and implement an educational outreach program to provide information to landowners and the public throughout the Covered Area regarding land management strategies to protect watershed health and a general awareness of the value and importance of native mussels. Each year of this CCAA, this will be accomplished by:

1) providing training to Colorado River Watch Network volunteers about native mussels and their habitats so they can help document mussels they may encounter at their monitoring sites, identify and avoid disturbance of instream

mussel habitats, and also teach citizens and students in their communities about mussel biology and conservation;

2) making information publicly available about native mussels and Covered Species in particular through social media, LCRA's website, or other similar publicly accessible forum; and/or
3) providing education on the science and conservation of mussels during LCRA Clean Rivers Program Water Quality Advisory Committee[16] and other public meetings on the topic of water quality in the basin.

These outreach and education efforts are expected to result in a reduction in threats related to water quality, sedimentation, and erosion, thus providing a net conservation benefit to the Covered Species. LCRA and LCRA TSC will commit up to $10,000 per year of in-kind services for the term of this CCAA and report outreach and education activities in the Annual Reports.

In addition to this general education and outreach effort, within the Covered Area, LCRA also will work with existing land trusts to help them identify and prioritize opportunities for placing properties in conservation easements that provide the best opportunity for protecting mussel habitat into the future. Protection of land from development pressures through conservation easements will help reduce the potential for increased stress on habitat for the Covered Species by limiting allowed land use and development on easement properties in a manner that reduces the potential for adverse impacts to water quality or water quantity.

8 IMPLEMENTATION TIMELINE

LCRA and LCRA TSC commit to the implementation and funding of the Conservation Measures described above in Section 7.3 on the timeline set forth below in Table 5. LCRA and LCRA TSC will meet with USFWS on an annual basis, or more frequently if requested, to discuss the Conservation Measures that were implemented each year prior. This meeting also will be a time to discuss planned activities for the coming year and adjust the implementation schedule as needed based upon monitoring

[16] See https://www.lcra.org/water/quality/texas-clean-rivers-program/public-outreach/.

results of Adaptive Management review and any input regarding timing, scoping, and prioritization of the Conservation Measures in Section 7.3.4.3 received during the coordination effort required by Section 7.3.4.4.

Table 5. Implementation Timeline and Cost Estimation for Each Conservation Measure

Measure Number	Conservation Measure	Preparation for Implementation (One Year Prior)	Costs Year 1	Costs Year 2	Costs Year 3	Costs Year 4	Costs Year 5	Costs Year 6	Costs Year 7	Costs Year 8	Costs Year 9	Costs Year 10	Costs Years 11-14	Costs Years 15-20	TOTAL ESTIMATED COST COMMITMENT
7.3.1.1	Environmental Flows Protection in Colorado River Below Austin	n/a	*	*	*	*	*	*	*	*	*	*	*	*	**n/a**
7.3.1.2	Consideration of New Science and Hydrological Modeling to Inform Operations	n/a	*	*	*	*	*	*	*	*	*	*	*	*	**n/a**
7.3.1.3	Implement Water Conservation Cost-share and Rebate Programs	n/a	$250,000	$250,000	$250,000	$250,000	$250,000	$250,000	$250,000	$250,000	$250,000	$250,000	$1,000,000	$1,500,000	**$5,000,000**
7.3.1.4	Subordination Agreements above Highland Lakes	n/a	*	*	*	*	*	*	*	*	*	*	*	*	**n/a**
7.3.2.1	Provide Instream Flows Affecting Temperature	n/a	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$60,000	$90,000	**$300,000**
7.3.2.2	Water Temperature Monitoring in Upper Basin	*	*	*	*	*	*	*	*	*	*	*	*	*	**n/a**
7.3.2.3	Water Quality Monitoring	n/a	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$120,000	$180,000	**$600,000**
7.3.2.4.1	Implement LCRA Highland Lakes Watershed Ordinance[1]	n/a	$750,000	$750,000	$750,000	$750,000	$750,000	$750,000	$750,000	$750,000	$750,000	$750,000	$3,000,000	$4,500,000	**$15,000,000**
7.3.2.4.2	Regulate On-Site Sewage Facilities[1]	n/a	$750,000	$750,000	$750,000	$750,000	$750,000	$750,000	$750,000	$750,000	$750,000	$750,000	$3,000,000	$4,500,000	**$15,000,000**
7.3.3.1	Monitor Invasive Species	n/a	*	*	*	*	*	*	*	*	*	*	*	*	**n/a**
7.3.3.2	Limit Spread of Zebra Mussels	n/a	*	*	*	*	*	*	*	*	*	*	*	*	**n/a**
7.3.4.1	Provide Water to USFWS' Inks Dam National Fish Hatchery	n/a	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$60,000	$90,000	**$300,000**
7.3.4.2	Support Captive Propagation Studies	n/a			$25,000	$25,000	$25,000	$25,000		$15,000	$15,000	$15,000	$30,000		**$200,000**
7.3.4.3.1	Mark-Recapture Project	$46,000	$46,000	$46,000	$46,000										**$138,000**
7.3.4.3.2	Assessment of Stream Reaches for Conservation and Restoration of Texas Fatmucket, Texas Pimpleback, and Other Co-Occurring Species	$25,000	$25,000												**$50,000**
7.3.4.3.3	Mussel Survivability Study in the Lower Colorado River Below Austin					$25,000	$25,000	$25,000	$25,000						**$100,000**
7.3.4.3.4	Mussel Tolerance Studies					$35,000	$35,000	$35,000	$35,000						**$140,000**
7.3.4.4	Coordinated Monitoring, Research, and Data Sharing			$10,000	$10,000	$10,000									**$30,000**
7.3.4.5	Contingency Plan for Short-Term Refugia		*	*	*	*	*	*	*	*	*	*	*	*	**n/a**
7.3.4.5	Population Augmentation as a Result of Canal Relocation		*	*	*	*	*	*	*	*	*	*	*	*	**n/a**
7.3.4.6	Work Group for Onion Creek Texas Fatmucket Population			*	*	*	*	*	*	*	*	*	*	*	**n/a**
7.3.5.1	LCRA Creekside Conservation Program[2]	n/a	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000	$320,000	$480,000	**$1,600,000**
7.3.5.2	Public Outreach and Education			$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$40,000	$60,000	**$190,000**
Section 9	Reporting		*	*	*	*	*	*	*	*	*	*	*	*	**n/a**
Section 10	Adaptive Management		*	*	*	*	*	*	*	*	*	*	*	*	**n/a**
														TOTAL	**$38,648,000**

* In-kind; no cost contribution estimation available

[1] Partially funded through permittee fees

[2] Funded in part by an EPA Clean Water Act 319(h) grant. Program funding varies for both LCRA and federal contribution, and this is a conservative estimation.

9 MONITORING AND REPORTING

LCRA and LCRA TSC will be responsible for annual monitoring and reporting related to the CCAA. During all monitoring activities, LCRA and LCRA TSC will follow procedures to prevent the spread of zebra mussels and other aquatic invasive species by properly cleaning, draining, drying and maintaining boats and equipment. In addition, LCRA and LCRA TSC will follow all genetic management plans that have been established for the Covered Species to prevent inadvertent gene flow, as well as prevent the spread of invasive species, parasites or diseases that could harm mussel populations.

9.1 Biological Monitoring

9.1.1 Key Mussel Populations

Long-term monitoring will focus on four key reaches within Zones A and B known to have existing populations of the Covered Species:

1. Colorado River at Lane City,
2. Colorado River at Altair (as part of the mark-recapture study),
3. Colorado River near the confluence with the San Saba River (site monitored by Sotola et al. 2021), and
4. Llano River near RR 1871.

Both site-specific and reach-scale monitoring approaches will be employed to monitor changes in populations of Covered Species throughout the term of this CCAA. For site-specific monitoring, one area with high densities of the Covered Species will be identified within each of the four key reaches above and monitored over the life of the permit at least once at each site every five years. To avoid harming sensitive populations, monitoring will be conducted in close coordination with USFWS and TPWD and may include mark-recapture techniques to evaluate capture probability, survival probability, immigration/emigration rates, local population size, longevity, and mussel growth rates. Additionally, quantitative quadrat-style sampling may be employed to help ensure capture of small-bodied mussels such as Texas fawnsfoot, to assess recruitment, and to analyze patterns in mussel density. Monitoring protocol development will be coordinated with, and approved by, USFWS prior to implementation.

Reach-level habitat utilization surveys similar to those included in Section 7.3.4.3.2 also may be employed within each key reach to examine broader-scale patterns in population abundance and habitat utilization, and to evaluate population expansion/contraction. Sampling locations will be spaced longitudinally throughout the reach and data will be collected by timed searches at multiple mesohabitat types within each sampling location. Detailed habitat data (depth, velocity, substrate, shear stress, etc.) also will be collected at each mesohabitat. This sampling approach will allow for quantification of habitat utilization data and assessment of broader-scale trends in the occurrence and abundance of Covered Species.

Monitoring data will be invaluable in supporting several aforementioned Conservation Measures. Results of monitoring will be summarized in Annual Reports to USFWS. LCRA and LCRA TSC will coordinate closely with USFWS and other key partners on these monitoring efforts, providing the foundation for a successful Adaptive Management program, which is reasonably expected to contribute to population increases for the Covered Species, providing a substantial net conservation benefit.

9.1.2 Host Fish Populations

For the Covered Species to persist, host fish populations must exist in adequate numbers to help ensure survival of early life stages. To monitor host fish populations, LCRA will continue fish assemblage monitoring in the Covered Area. Data from monitoring will be evaluated for trends in occurrence and abundance of all native fishes found within the survey areas so that known mussel host species (i.e., freshwater drum, red shiner, blacktail shiner, centrarchids) can be documented as well as other fish that may be discovered to serve as unionid host fish with more research and documentation. Annual accounting of all fish monitoring results will be provided to USFWS. Because host fish provide such an important life history resource for mussels, including the Covered Species, this information applied in an Adaptive Management framework and combined with other Conservation Measures contributes to a substantial net conservation benefit for the Covered Species.

9.2 Reporting

LCRA and LCRA TSC will submit an Annual Report to the USFWS by April 1 of each year that this CCAA is in effect. The Annual Report will include information related to LCRA and LCRA TSC Covered Activities conducted over the calendar year preceding the date of the Annual Report, including but not limited to the following information:

- Summary of mussel conservation, research, and monitoring activities included as Conservation Measures in this CCAA;
- Results of any freshwater mussel surveys or relocations conducted by or on behalf of LCRA or LCRA TSC;
- Summary of any public outreach activities (Section 7.3.5.2) conducted in the preceding year;
- Summary of flow conditions in the lower Colorado River below Lady Bird Lake compared with environmental flow standards and LCRA water rights requirements and any updates to hydrologic modeling done to comply with Section 7.3.1.2 of this CCAA;
- Summary and results of applied research studies (Section 7.3.4.3) (years one through seven only);
- Any results of long-term monitoring (Section 9.1), to include key mussel populations, host fish, and water quality;
- Any mortality/injury to Covered Species observed during the preceding year;
- Estimates of incidental take that has occurred both annually and cumulatively as a result of Covered Activities, compared to the amount of incidental take authorized under the Permit, based on the amount of Covered Species habitat adversely affected by Covered Activities conducted within the Covered Area and consistent with Section 12;
- Any other interim updates or interesting findings; and
- Any concerns related to compliance with this CCAA, with lessons learned to avoid issues in the future.

10 ADAPTIVE MANAGEMENT PLAN AND PROGRAM

Adaptive management is an important component of any successful conservation agreement, and this CCAA will be adaptively managed with collaborative and substantial involvement from both parties. Many of the Conservation Measures described in this CCAA will help refine our knowledge of the status of Covered Species populations within the Covered Area and will aid in identifying habitat, water quality, and water quantity factors important to Covered Species populations. Applied research along with trends in long-term monitoring data will aid in identifying if and when stressors occur, or are predicted to occur, in the Covered Area. Together, these Conservation Measures will provide the basis for Adaptive Management into the future. It also should be noted that the long-term monitoring program (habitat, mussels, host fish, water quality, and water quantity) will serve as the baseline for evaluation as the CCAA moves forward. As discussed in Sections 5.2 and 7.3.1.2, LCRA has consistently considered new scientific information when it amends its Water Management Plan and will continue to do so during the term of this CCAA, including specific consideration of information related to the flow needs of the Covered Species.

Adaptive management will be implemented collaboratively with USFWS. Approximately one month following submittal of each Annual Report, or upon the request of any party, LCRA, LCRA TSC, and USFWS will meet to discuss results from CCAA Conservation Measures that year and discuss any potential modifications to this CCAA that may be appropriate due to Changed or Unforeseen Circumstances. This will include sharing of any information developed by the work group created by LCRA to evaluate other nonflow related measures or avoidance and minimization strategies, that if implemented, would help reduce threats and provide further net conservation benefit. Further, LCRA and LCRA TSC will share any input regarding timing, scoping, and prioritization of the Conservation Measures in Section 7.3.4.3 received during the coordination effort required by Section 7.3.4.4. In addition, an Adaptive Management Program check-in discussion between USFWS, LCRA, and LCRA TSC will be held during year eight in the implementation timeline to help ensure goals are being met.

Specific Conservation Measures that will be systematically reviewed and discussed, along with potential adaptive actions, are provided in Table 6. Each of these

measures could directly influence potential management adjustments as new information is acquired through time.

Table 6. Conservation Measures and Examples of Potential Adaptive Management Actions

Conservation Measure	Potential Adaptive Action
Mussel Survivability Study in the Lower Colorado River Below Austin (Section 7.3.4.3.3)	Science gained from this study will be used to evaluate whether population augmentation is feasible in this stretch of river and will provide better understanding of specific threats to mussels in this section of river that, if feasible, can be addressed.
Updated Hydrologic Modeling (Section 7.3.1.2)	Updated water use projections, and other scientific information will influence hydrologic modeling and result in changes to expected future risk of key mussel populations that require reevaluation of avoidance and minimization measures.
Public Outreach and Education (Section 7.3.5.2)	Newly available or more efficient methods and newly emerging media outlets will be used for education and outreach opportunities.
Long-Term Monitoring (Section 9.1)	Long-term trends in habitat, flow, water quality (including temperature), fish host, or Covered Species populations in a certain reach may inform on appropriate adjustments to boundaries of the mussel Conservation Zones and may inform changes to operations considered under Section 7.3.1.2
Short-Term Refugia (Section 7.3.4.5)	The contingency plan for short-term refugia will be modified through time as new information, facilities, and technologies become available.
Captive Propagation (Section 7.3.4.2)	Should successful captive propagation of the Covered Species occur, management decisions will be made regarding the best use of propagated individuals.

11 COVERED ACTIVITIES

Take of Covered Species is expected to be minimal and incidental to the Covered Activities discussed below. Incidental take associated with the Covered Activities outlined in this Section will be covered by the Permit, should any of the

Covered Species become listed as threatened or endangered. Covered Activities are those activities described below when conducted by or overseen by LCRA or LCRA TSC, or conducted on behalf of LCRA or LCRA TSC within the Covered Area.

11.1 CCAA-Related Conservation Measures and Avoidance and Minimization Measures

Covered Activities for this CCAA include the proposed Conservation Measures and Avoidance and Minimization Measures, including any measures implemented under the Adaptive Management or Changed Circumstance provision of this CCAA. These Conservation Measures and Avoidance and Minimization Measures are designed to reduce or eliminate impacts to the Covered Species, and increase populations and improve habitat for the Covered Species, thus providing a substantial net conservation benefit over the 20-year term of the CCAA and Permit. Table 1 generally summarizes the Conservation Measures and Avoidance and Minimization Measures and how they address the National Strategy for the Conservation of Freshwater Mussels and, hence, provide a net conservation benefit. Table 2 more specifically describes how each of the Conservation Measures addresses potential threats to the Covered Species and provides a net conservation benefit.

11.2 Other LCRA and LCRA TSC Activities

This CCAA covers certain activities conducted by or on behalf of LCRA or LCRA TSC within the Covered Area that have some potential to impact Suitable Occupied Habitat or Suitable Habitat of the Covered Species. These day-to-day activities, summarized in more detail below, are undertaken by LCRA as a regional provider of reliable water supply and power generation, as well as recreational facilities, and by LCRA TSC as an electric transmission provider.

11.2.1 Operations

LCRA and LCRA TSC operations are Covered Activities when performed in accordance with applicable standards and requirements (e.g., local, state, and federal permits and related statutory and regulatory requirements) and the Conservation Measures and Avoidance and Minimization Measures described in this CCAA. LCRA

and LCRA TSC operations activities generally include, but are not limited to:

- Water storage in and releases from reservoirs, including the Highland Lakes, lakes Bastrop and Fayette, and Arbuckle Reservoir;
- Delivery, discharge, and diversion of water;
- Provision of water to help meet environmental flow needs through reservoir releases or by restrictions on diversions;
- Reservoir drawdowns to allow for maintenance of LCRA facilities, customer intakes, and lakeside residents' repairs to docks and retaining walls;
- Management of LCRA lands, including but not limited to habitat and vegetation management activities;
- Provision of recreational opportunities on or near the Colorado River and its tributaries, including but not limited to parks, camping, hiking, fishing, motorized and nonmotorized navigation, water access (boat ramps, docks, etc.), events, camps, educational programs, aquatic obstacle courses, lodging on or near the water, and similar activities;
- Generation of power, including discharge of process or stormwater;
- Water safety activities, such as patrols, placement and maintenance of hazard and no-wake buoys and related signage, and occasional removal of navigation hazards;
- Regulation and inspection of marinas and private docks;
- Implementation of regulatory programs related to nonpoint-source pollution and on-site sewage facilities around the Highland Lakes;
- Lake cleanup activities;
- Access to LCRA and LCRA TSC infrastructure and facilities by LCRA personnel or contractors and guests, including access by vehicles; and
- Operation of electric transmission facilities and substations.

11.2.2 Inspections, Maintenance and Repairs

Maintenance, repairs, or rehabilitation of LCRA and LCRA TSC facilities and land in or immediately adjacent to the Colorado River, its reservoirs, or its tributaries is a Covered Activity when performed in accordance with applicable statutory and regulatory

standards (e.g., TPWD relocation permits and U.S. Army Corps of Engineers (USACE) permits (if required), etc.) and the Conservation Measures and Avoidance and Minimization Measures described in this CCAA. These include such activities as: inspections, cleaning, replacing or repairs to intake structures and pump stations; inspecting, cleaning, replacing or repairs to dam gates and other mechanical structures on dams; dam safety inspections and repairs; inspecting, cleaning, replacing or repairs to boat ramps, docks, and piers, and pedestrian bridges, trails, and other recreational facilities; inspections, cleaning, replacing or repairs to electric transmission lines and associated facilities; and similar activities. Routine operations and maintenance also may include site inspections and maintenance; testing, repairs, right-of-way and road maintenance and repairs; traffic; and aquatic, riparian, or shoreline vegetation management. Such activities also may involve temporary changes to water levels or temporary dewatering around structures to allow this work to be performed.

11.2.3 Dredging

Removal of silt and other materials, such as woody or storm- or flood-related debris that has accumulated in and around LCRA facilities located within the Colorado River, or its tributaries, or within LCRA-operated reservoirs, or canals adjacent to the Colorado River through dredging or other means is necessary to help ensure the continued reliable operation of LCRA facilities, such as water intakes. These are Covered Activities when performed in accordance with applicable standards and requirements (e.g., state water rights permits, water supply contracts, and state and federal statutory and regulatory requirements, such as TPWD relocation permits and U.S. Army Corps of Engineers (USACE) permits (if required), etc.) and the Conservation Measures and Avoidance and Minimization Measures described in this CCAA.

11.2.4 Riverbank stabilization projects

Constructing, replacing, or adding bank stabilization materials for erosion control on the banks of the Colorado River, its tributaries, or storage facilities thereon is a Covered Activity when performed in accordance with applicable standards and requirements (e.g., state water rights permits, water supply contracts, and state and

federal statutory and regulatory requirements, such as TPWD relocation permits and USACE permits (if required), etc.) and the Conservation Measures and Avoidance and Minimization Measures described in this CCAA. In large part, these projects are initiated in response to damage incurred as a result of flood events or included as part of necessary maintenance of existing facilities. In limited situations, the work might be undertaken proactively to provide additional bank stabilization on LCRA-owned or managed lands.

11.2.5 Construction

Construction is defined as the process of creating infrastructure or other facilities in support of one or more of the other Covered Activities when performed in accordance with applicable standards and requirements (e.g., local, state, and federal permits and related statutory and regulatory requirements, such as TPWD relocation permits and USACE permits (if required), etc.) and consistent with the Avoidance and Minimization Measures described in this CCAA. Activities include construction associated with the routine operation, repair, replacement, or maintenance of LCRA's and LCRA TSC's existing facilities, and installation of new equipment and structures associated with implementing any of the Conservation Measures described in this CCAA.

For purposes of this CCAA, the term "Construction" includes, for example, installation of infrastructure associated with river and weather gauges and similar equipment associated with the monitoring and operation of the river, reservoirs, and irrigation canals within LCRA's control that will improve the accurate measurement of water, improve efficiency of operations and reduce water loss, equipment for sampling or monitoring chemical, physical, or biologic conditions, placement of fish or mussel habitat structures and similar research equipment, and other infrastructure necessary to effectively monitor river and water supply conditions and implement the Conservation Measures, and navigation aids such as buoys, lights, markers, warning signs, sirens, and similar equipment used to improve public safety. Placement of such infrastructure is expected to have little to no permanent impact on the hydrology or hydraulic condition of the stream and to result in minimal, and often temporary, disturbance of the streambed. Placement of this type of new infrastructure is often accomplished in a matter of hours, or a day or two, and generally occupies a few square feet or less of riverbed when

installed. These activities may include measures such as clearing of vegetation; stabilizing soils; installing erosion controls (including silt fencing, earthen berms, etc.), temporary fencing, or temporary coffer dams; relocating utilities; remediation, restoration, or temporary placement of construction materials and structures; and mobilization and demobilization of equipment. Replacement of existing infrastructure within the riparian area or streambed of the Colorado River or its tributaries, or the Highland Lakes, is a Covered Activity so long as the replacement infrastructure is installed in accordance with the General Avoidance and Minimization Measures (Section 7.2.1) and, for replacements within Zones A or B, LCRA or LCRA TSC (as applicable), demonstrates that the replacement infrastructure will have no greater impact, or even reduce the impacts to the Covered Species, than the existing infrastructure.

Construction of entirely new infrastructure that has more than minimal or temporary disturbance of the riparian area or streambed of the Colorado River or its tributaries within the Covered Area, such as new dams, river intakes, or vehicular crossings, is not a Covered Activity. Construction of any such new infrastructure is expected to be the subject of a separate Section 7 consultation between the USFWS and USACE as part of any required Clean Water Act, Section 404, permitting. Construction activities outside of the riparian zone or streambed of the Colorado River or its tributaries are not Covered Activities because those activities are not expected to have any direct or indirect effects on freshwater mussels and thus avoid incidental take of Covered Species.

11.2.6 Flood operations

Flood operations conducted by LCRA are Covered Activities under this CCAA. LCRA operates the Highland Lakes dams to reduce the intensity of flooding downstream by managing the flow of floodwaters through the lakes and river system in accordance with applicable requirements (e.g., USACE Water Control Manual for Mansfield Dam and Lake Travis). Flood control operations for lakes Bastrop and Fayette also are Covered Activities. Other Covered Activities described herein also may be required as part of flood operations.

11.2.7 Remediation Activities and Restoration Activities

Remediation Activities and Restoration Activities are Covered Activities when performed in accordance with applicable standards and requirements and the Conservation Measures and Avoidance and Minimization Measures described in this CCAA. These activities include, but are not limited to, removal and restoration of: access roads, fences, coffer dams, soil erosion controls, bank stabilization structures, and similar activities, and may include other Covered Activities associated with remediation and restoration. In some instances, such activities are implemented to repair damage to facilities, flood operations, or other Natural Disaster. Remediation Activities and Restoration Activities also may include any conservation projects or actions that benefit the Covered Species and their habitats listed in this document.

11.2.8 Vehicular and Pedestrian Water Crossings

LCRA and LCRA TSC may use and maintain existing water crossings, including but not limited to low-water crossings, bridges, or recreational trails, as part of other Covered Activities. Construction of new crossings within Zones A and B is not a Covered Activity. Construction of new crossings and associated site-specific impacts is expected to be the subject of a separate Section 7 consultation between the USFWS and USACE as part of any required CWA, Section 404, permitting.

11.2.9 Research and Monitoring

Conservation, research and monitoring activities related to water resources that are conducted or overseen by LCRA are Covered Activities. These activities may be directly or indirectly related to the Conservation Measures and Avoidance and Minimization Measures and Covered Species and may include, but are not limited to: mark-recapture studies; presence/absence surveys; captive breeding and reintroduction; population surveys; habitat assessments; geomorphological or bathymetric studies; Hydromet gauge installation and operation; installation and operation of devices used to measure water flow or diversions, improve efficiency, and reduce water loss; water quality monitoring; and other similar activities to study, monitor, and assess the river, LCRA reservoirs and canals, and aquatic species.

11.2.10 Invasive Species Management

Activities related to management or control of aquatic invasive species, such as zebra mussels, *Corbicula*, hydrilla, Eurasian watermilfoil, water hyacinth, and any other invasive species that could potentially cause issues for LCRA and LCRA TSC operations at any of LCRA's or LCRA TSC's facilities are Covered Activities. This includes but is not limited to use of coatings and paint on underwater structures, use of state-approved pesticides/herbicides that are approved for aquatic use, use of biopesticides such as Zequanox®, manual removal of invasive species, and plant removal in riparian and upland areas to achieve natural resource conservation goals.

12 INCIDENTAL TAKE

12.1 General

As part of this CCAA, a variety of voluntary Conservation Measures and Avoidance and Minimization Measures will be implemented to benefit the Covered Species, and population monitoring will be conducted to examine trends in population status through time. Should the Covered Species become listed, exact levels of incidental take associated with the activities in this CCAA are undeterminable at this time, but are expected to be minimal. Although minimal incidental take could occur as a result of activities in this CCAA, implementation of this CCAA and associated Conservation Measures and Avoidance and Minimization Measures is reasonably expected to result in an overall net conservation benefit to the Covered Species. If the USFWS determines that the CCAA meets issuance criteria and is approved, it will issue a Permit to LCRA and LCRA TSC providing incidental take coverage for the Covered Activities, including the Conservation Measures and Avoidance and Minimization Measures, described in this CCAA in the event one or more of the Covered Species is subsequently listed as threatened or endangered. Any take will be incidental to otherwise lawful activities described in this CCAA.

12.2 Physical Consequences of Covered Activities

The Covered Activities, which include the Conservation Measures and Avoidance and Minimization Measures, have physical consequences that may result in adverse or

beneficial effects on the Covered Species and their habitat. Such effects may arise directly or indirectly from the physical consequences of the Covered Activities. The types of physical consequences to habitat of the Covered Species that may be expected from the Covered Activities are:

- Alterations in flow that change the rate or elevation of water in the rivers, streams, or canals;
- Changes in water temperature in rivers, streams, or canals;
- Changes in water quality from increases or decreases in pollutants (i.e., sediment, nutrients, chemicals, or hazardous materials) in rivers, streams, or canals;
- Changes that disturb or modify the substrate of rivers, streams, or canals; and
- Changes in ecological communities (including changes due to invasive species) within rivers, streams, or canals, that influence the composition, relative abundance, or distribution of the Covered Species, or their host fish.
- In addition, there may be direct physical contact with individuals of the Covered Species by people, vehicles, equipment, or structures.

Several of the Covered Activities involve the performance or support of research, monitoring, planning, and educational efforts[17] that may not have direct or immediate physical consequences. However, the commitments in the CCAA for adaptive management help ensure that these efforts inform how other Covered Activities with physical consequences are implemented over time. Moreover, educational and outreach efforts are expected to positively influence the manner in which third parties conduct activities that could have physical consequences. Therefore, research, monitoring, planning, and educational efforts have indirect physical consequences that are considered in this analysis.

In some cases, the effect of the physical consequence of a Covered Activity (particularly those that are Avoidance or Minimization Measures, *supra* Section 7.2) is to help ensure that potential adverse effects do not occur. For example, LCRA's

[17] *See* Sections 7.2.4.1, 7.3.2.2, 7.3.2.3, 7.3.3.1, 7.3.4, 7.3.5.2.

commitment to maintain subsistence flows in the main stem of the Colorado River below Longhorn Dam helps ensure that adverse effects of low-flow conditions that might otherwise occur will be avoided (Sections 7.2.3, 7.3.1, 7.3.2). Similarly, LCRA's and LCRA TSC's commitment to not construct any additional permanent dams on the main stem of the Colorado River or its tributaries (Section 7.2.2) entirely avoids associated physical consequences relevant to the Covered Species.

The connections between Covered Activities and physical consequences are summarized in Table 7. For the purpose of tracing the beneficial effects of the Covered Activities, Table 7 also considers physical consequences that are avoided by the Covered Activity. This table is not intended to be an exhaustive assessment of the various direct and indirect ways that each of the Covered Activities may manifest. Instead, Table 7 highlights the most proximate and reasonably certain to occur types of physical consequences of the Covered Activities. Taken together, the types of physical consequences identified above and in Table 7 are a reasonable approximation of the range of physical consequences (both positive and negative) that are expected from one or more of the Covered Activities.

Table 7 describes the anticipated physical consquences of the Covered Activities. The nature of the physical consequences is further described in the table based on how each Covered Activity may affect the Covered Species and their habitat compared to if the Conservation Strategy (Section 7) and Covered Activities (Section 11) were not in place. Specifically, each column denotes whether the effect of the Covered Activity with regard to each potential physical consequence is a direct effect (DE), indirect effect (IE), beneficial (+), adverse (-), minimized (M), avoided (A), or not applicable (N/A).[18]

[18] The USFWS regulations for Section 7 consultations were revised in 2019 to no longer speak to direct or indirect effects of an action, and instead more broadly speak to "consequences of the action," (50 C.F.R. § 402.02; 84 Fed. Reg. at 49,976-49,977). Although there was a period in the interim—between July 5, 2022, and September 21, 2022—when the 2019 regulations became vacated and the pre-2019 regulations therefore governed, the 2019 regulations are now in effect and govern Section 7 consultations (see Center for Biological Diversity v. Haaland, No. 4:19-cv-05206-JST, Doc. 168 (N.D. Cal. July 5, 2022) (CBD v.

Table 7. Anticipated Physical Consequences of Covered Activities

Covered Activity	Flow Alterations	Water Temperature Change	Water Quality Change	Substrate Change	Ecological Community Change	Potential for Physical Contact
Avoidance and Minimization Measures						
Sections 7.2.1. General Measures to Reduce Site-Level Disturbance of LCRA Covered Activities	IE, +	AM	IE, +	IE, +	DE, +	DE, M
Sections 7.2.2. No New Dams	A	A	A	A	A	A
Sections 7.2.3. Protect Instream Flows During Water Diversions Within Zones A and B	DE, +	IE, +	IE, +	N/A	IE, +	N/A
Sections 7.2.4.1 and 7.3.4.7. Work group to minimize impacts to Texas fatmucket	N/A	N/A	DE, +	DE, +	DE, +	DE, M
Section 7.2.4.2. Encourage Minimization of Disturbance During Design and Construction on Non-LCRA/Non-LCRA TSC Owned or Operated Infrastructure	IE, +	IE, +	IE, +	IE, +	IE, +	DE, M
Section 7.2.4.3. Zone C-1 Mussel Relocations Prior to Maintenance	IE, +	N/A	IE, +	IE, +	N/A	DE, M

Haaland) (vacating the 2019 regulations and thereby reinstating the pre-2019 regulations)); In re: Cattlemen's Ass'n, No. 22-70194 (9th Cir. Sept. 21, 2022) (staying the district court's order vacating the 2019 regulations until the district court resolved a pending motion to amend the order); Center for Biological Diversity v. Haaland, No. 4:19-cv-5206-JST, Doc. Nos. 197, 198 (N.D. Cal. Nov. 16, 2022) (granting plaintiffs' motion to amend July 5, 2022, order and granting government's motion for remand without vacatur). The effect of the November 16, 2022, court order is that the 2019 regulations were remanded and not vacated, meaning that the 2019 regulations remain the applicable regulations. While the 2019 Regulations that are in effect do not contain the terms "indirect and direct effect", Table 7 retains the pre-2019 indirect and direct effect analysis to assist the reader in understanding the effect pathway and, in a sense, also helps place the effect pathway in the spectrum of certainty. However, the outcome of any effects analysis would not differ under the 2019 regulations as the effects all equally describe the consequences of the action.

Covered Activity	Flow Alterations	Water Temperature Change	Water Quality Change	Substrate Change	Ecological Community Change	Potential for Physical Contact
Section 7.2.4.4. Zone D Avoidance Measures	N/A	N/A	IE, +	IE, +	N/A	DE, M
Conservation Measures						
Section 7.3.1.1. Environmental Flows in Colorado River Below Austin	DE, +	IE,+	IE,+	IE,+	IE,+	N/A
Section 7.3.1.2. Consideration of New Science and Hydrological Modeling to Inform Operations	DE, +	IE, +	IE, +	IE, +	IE, +	N/A
Section 7.3.1.3 Implement Water Conservation Cost-share and Rebate Programs	IE, +	IE, +	IE, +	IE, +	IE, +	N/A
Section 7.3.1.4. Subordination Agreements above Highland Lakes	IE, +	IE, +	IE, +	IE, +	IE, +	N/A
Section 7.3.2.1. Provide Instream Flows Affecting Temperature	DE, +	DE, +	DE,+	N/A	IE, +	N/A
Section 7.3.2.2. Water Temperature Monitoring in Upper Basin	IE, +	IE, +	IE, +	N/A	N/A	DE, M
Section 7.3.2.3. Water Quality Monitoring	IE, +	IE, +	IE, +	N/A	N/A	DE, M
Section 7.3.2.4.1. Implement LCRA Highland Lakes Watershed Ordinance	N/A	N/A	IE, +	N/A	IE, +	N/A
Section 7.3.2.4.2. Regulate On-Site Sewage Facilities	N/A	N/A	IE, +	N/A	IE, +	N/A
Section 7.3.3.1. Monitor Invasive Species	N/A	N/A	N/A	N/A	IE, +	DE, M
Section 7.3.3.2. Limit Spread of Zebra Mussels	N/A	N/A	N/A	IE, +	DE, +	DE, M
Section 7.3.4.1. Provide Water to USFWS Inks Dam National Fish Hatchery	N/A	N/A	N/A	N/A	DE, +	IE, +

Covered Activity	Flow Alterations	Water Temperature Change	Water Quality Change	Substrate Change	Ecological Community Change	Potential for Physical Contact
Section 7.3.4.3.1. Mark-Recapture Project	IE, +	IE, +	IE, +	IE, +	DE, +	DE, M
Section 7.3.4.3.2. Assessment of Stream Reaches for Conservation and Restoration of Texas Fatmucket	DE, +	DE, +	DE, +	DE, +	DE, +	DE, +
Section 7.3.4.3.3. Mussel Survivability Study in the Lower Colorado River Below Austin	IE, +	IE, +	IE, +	IE, +	DE, +	DE, M
Section 7.3.4.3.4. Mussel Tolerance Studies	IE, +	IE, +	IE, +	IE, +	DE, +	DE, M
Section 7.3.4.4. Coordinated Monitoring, Research, and Data Sharing	DE, +	N/A	N/A	N/A	DE, +	DE, M
Section 7.3.4.5. Contingency Plan for Short-Term Refugia	DE, +	N/A	N/A	N/A	DE, +	DE, M
Section 7.3.4.6. Population Augmentation as a Result of Canal Relocation	N/A	N/A	N/A	N/A	DE, +	DE, +
Section 7.3.5.1. LCRA Creekside Conservation Program	IE, +	DE, +	DE, +	N/A	DE, +	DE, +
Section 7.3.5.2. Public Outreach and Education	IE, +	IE, +	IE, +	IE, +	IE, +	IE, +
Other LCRA and LCRA TSC Activities						
Section 11.2.1. Operations	IE, M	IE, M	IE, M	IE, M	IE, M	DE, M
Section 11.2.2. Inspections, Maintenance and Repairs	IE, M	N/A	IE, +	IE, M	IE, M	DE, M
Section 11.2.3. Dredging	N/A	N/A	DE, M	DE, -	IE, M	DE, M
Section 11.2.4. Riverbank Stabilization Projects	N/A	N/A	IE, M	DE, +	IE, +	DE, M

Covered Activity	Flow Alterations	Water Temperature Change	Water Quality Change	Substrate Change	Ecological Community Change	Potential for Physical Contact
Section 11.2.5. Construction	N/A	N/A	IE, M	IE, M	IE, M	DE, M
Section 11.2.6. Flood Operations	DE, -	N/A	IE, + & -	IE, + & -	IE,	N/A
Section 11.2.7. Remediation Activities and Restoration Activities	IE, +	N/A	Yes	Yes	Yes	DE, M
Section 11.2.8. Use of Vehicular and Pedestrian Water Crossings	N/A	N/A	IE, -	IE, -	IE, -	DE, -
Section 11.2.9. Research and Monitoring	IE, +	IE, +	IE, +	IE, +	IE, +	DE, +
Section 11.2.10. Invasive Species Management	N/A	N/A	N/A	IE, +	DE, +	DE, M

12.3 Use of Habitat Surrogate

Incidental take should be expressed in terms that are measurable and enforceable in the CCAA and in the Permit associated with this CCAA. The unit of take must be practicable, which means it can be monitored and the results of monitoring can be applied to Adaptive Management decisions.

Incidental take of Covered Species will be difficult to quantify for the following reasons: finding a dead or impaired specimen is unlikely; and losses may be masked by seasonal fluctuations in environmental conditions and/or numbers of each species. Therefore, it is not possible to provide precise numbers of mussels that will be harassed, harmed, or killed during implementation of this CCAA. In such instances where take is otherwise difficult to detect and/or quantify precise numbers of mussels that are taken, USFWS regulations provide for use of a surrogate indicator, such as habitat (50 C.F.R. § 402.14(i)(1)(i)). Accordingly, LCRA, LCRA TSC, and the USFWS may quantify take in terms of some aspect of the species' habitat that may be diminished or removed by the action. In this CCAA, the USFWS, LCRA, and LCRA TSC are using a percentage of the stream miles per zone that may be affected as a habitat surrogate measure to identify when take has been exceeded (details below). Negative

effects to mussel habitats associated with LCRA's and LCRA TSC's Covered Activities are expected to be temporary in nature, and the magnitude of those effects is expected to vary from year to year. Through implementation of the CCAA, possible temporary habitat disturbances are expected to naturally recover with time.

The causal link between using stream miles of riverine habitat as a surrogate (50 C.F.R. § 402.14(i)(1)(i)) for take of individual mussels is the fact that mussels spend the majority of their life cycle relatively immobile with most of their bodies buried in sediment of the streambed. LCRA's and LCRA TSC's Covered Activities include disturbance of streambeds, as well as possible changes to water quality, water levels, and flow rates. Activities that disturb streambeds and alter water quality, water levels, and flow rates could injure or kill the Covered Species (adult mussels, juveniles, larval glochidia) or displace mussels or their host fish (possibly disrupting reproduction) to unsuitable habitats. Low water levels could expose mussels to desiccation, heat stress, and predation. Water quality degradation could result in excessive valve closure, which has been reported to have negative effects on mussel health and reproduction (through increased energetic costs and reduced feeding rates; Haney et al. 2020).

These take approximations can help inform of possible levels of injury or death to individuals of the Covered Species due to LCRA's and LCRA TSC's Covered Activities and help set targets that can be monitored and reported annually. LCRA and LCRA TSC can monitor and document the percentage of stream miles in each Conservation Zone affected by its actions (and possibly others), through a variety of measures, including remote sensing and habitat monitoring. Additionally, dead shells and recently dead individuals may be detected during routine or contemporaneous monitoring visits and reported to the USFWS.

12.4 Anticipated Type of Incidental Take

The extent to which individuals of the Covered Species are exposed to the various physical consequences of the Covered Activities influences if and how they respond. The Covered Area is categorized into seven Conservation Zones, including subzones, that describe the extent of known occupancy and suitable habitat for the Covered Species. These zones and subzones approximate the likelihood of individuals

of the Covered Species being exposed to the physical consequences of the Covered Activities:

- Zone A is the estimated extent of Occupied Suitable Habitat for one or more of the Covered Species. Individuals of the Covered Species will be exposed to the physical consequences of Covered Activities that occur in this zone for the duration of the CCAA. Zone A is divided into four subzones, each of which separately depict the estimated extent of Occupied Suitable Habitat for one of the Covered Species. As can be seen from the figures in Section 6.1, these sub-zones overlap in some areas.

- Zone B is the estimated extent of Suitable Habitat for the Covered Species that is not currently known to be occupied but is expected to become occupied by one or more of the Covered Species within the duration of the CCAA. It is assumed that individuals of the Covered Species will be exposed to the physical consequences of Covered Activities that occur in this zone for an unknown portion of the CCAA duration.

- Zone C is marginal habitat for two of the Covered Species. It is possible that individuals of these Covered Species occur from time to time in perennially operated canals in Zone C and will be exposed to the physical consequences of Covered Activities. The potentially affected Covered Species are not reasonably expected to occur in seasonally operated canals in Zone C. Thus, it is reasonable to conclude that individuals of these Covered Species are not likely to be exposed to the physical consequences of Covered Activities that occur in seasonally operated canals.

- Zone D is not habitat for the Covered Species and occurrence of the Covered Species in Zone D is not expected. Therefore, Covered Species are not expected to be exposed to the physical consequences of Covered Activities in Zone D.

The physical consequences of the Covered Activities may have adverse effects, beneficial effects, or both, on individuals of the Covered Species that are exposed to

such physical consequences. For adverse effect pathways, when the risk of death or of injury (i.e., significantly reduced fitness due to altered breeding, feeding, sheltering, or movement activities) is reasonably certain to occur, then there is the potential for incidental take to occur (Table 8). For beneficial effect pathways, the potential for incidental take is eliminated or minimized (thereby reducing the amount of incidental take that is reasonably certain to occur) or the Covered Activity generates other positive biological outcomes that offset the population-level impacts of incidental take or generally reduces threats to the Covered Species (Table 8). Zone D is not included in Table 8 because this Conservation Zone does not provide habitat for Covered Species; therefore, none would be affected and no individuals would be taken.

Table 8. Responses by Individuals of the Covered Species and Potential for Incidental Take and Net Conservation Benefit Within Each Conservation Zone

Physical Consequences of Covered Activities	Zone A: Exposure is Reasonably Certain	Zone B: Exposure is Reasonably Certain in the Future	Zone C: Exposure is Possible in Perennially Operated Canals
Alterations in flow	Increases in flow rate or water elevations in watercourses exceeding habitat tolerances would impair sheltering. Individuals could be dislodged and swept into unsuitable microhabitat or microhabitat conditions at occupied locations could be degraded. Normal variations in flow rate and water levels as a result of LCRA operations are not expected to exceed habitat tolerances and thus not reasonably likely to result in incidental take. Incidental take via injury or death when water releases are higher than normal, such as during flood operations, is reasonably certain to occur for species with demonstrated occupancy within the main stem of the river below Longhorn Dam. LCRA's commitments to maintain subsistence flows in the river downstream of Longhorn Dam and to otherwise implement environmental flow protections as required by its water rights and the 2020 WMP avoid incidental take associated with low flows within areas of demonstrated occupancy downstream of Longhorn Dam. Covered Activities do not substantially influence water flow within the tributaries to the Colorado River or areas on the main stem of the river upstream of Lake Buchanan with demonstrated occupancy and are thus not reasonably certain to result in incidental take via death or injury.	See Zone A for effect pathways and the circumstances that are reasonably certain to cause incidental take. In Zone B, reasonably certain incidental take also depends on future occupancy by Covered Species.	Reduced or ceased flow within portions of perennially operated canals (Zone C-1, Figure 5) to conduct necessary maintenance and draining of seasonally operated canals is reasonably certain to result in incidental take via injury or death at some point during the CCAA duration for two of the Covered Species. The relative number of taken individuals is assumed to be considerably lower than in Zones A or B below Austin due to the marginal quality of the habitat in Zone C and the Avoidance and Minimization Measures LCRA is committing to implement within Zone C (Sections 6.3, 7.2.1).

Physical Consequences of Covered Activities	Zone A: Exposure is Reasonably Certain	Zone B: Exposure is Reasonably Certain in the Future	Zone C: Exposure is Possible in Perennially Operated Canals
Water temperature change	Increased water temperature may occur as a consequence of reduced water flow. Breeding and sheltering would be impaired when water temperature exceeds habitat tolerances. LCRA's commitments to maintain subsistence flows in the river downstream of Longhorn Dam and to otherwise implement environmental flow protections as required by its water rights and the 2020 WMP avoid reasonably certain incidental take due to temperature impacts in the river downstream of Longhorn Dam. Covered Activities do not substantially influence water flow within the tributaries to the Colorado River or areas on the main stem of the river upstream of Lake Buchanan with demonstrated occupancy and are thus not a reasonably certain cause of incidental take via this type of effect.	See Zone A for effect pathways and the circumstances that are reasonably certain to cause incidental take.	See Zone A for effect pathways. Because water delivered through Zone C is diverted from the Colorado River, LCRA's commitments to maintain instream flows in the river downstream of Longhorn Dam also reduce temperature impacts in Zone C and avoid reasonably certain incidental take due to temperature impacts.
Water quality change	Pollution entering the water from increased sediments, chemicals, or hazardous materials in exceedance of Covered Species' tolerances would impair breeding, feeding, and sheltering. LCRA's commitments to minimize the likelihood and amount of pollution entering waterways substantially reduces the likelihood that the Covered Activities will cause incidental take via this pathway (See Sections 7.2.1 and 7.3.2). Incidental take due to pollution from the Covered Activities is not reasonably certain to occur. Furthermore, LCRA's commitments also reduce the likelihood of other parties causing pollution that would adversely affect the Covered Species (Section 7.3.2.4), thereby addressing an identified threat to the Covered Species for a net conservation benefit.	See Zone A for effect pathways and analysis of potential for incidental take and net conservation benefit.	See Zone A for effect pathways and analysis of potential for incidental take.

Physical Consequences of Covered Activities	Zone A: Exposure is Reasonably Certain	Zone B: Exposure is Reasonably Certain in the Future	Zone C: Exposure is Possible in Perennially Operated Canals
Substrate change	Physical disturbance or indirect modification (e.g., sedimentation, scouring) of the bottom or submerged banks of watercourses would alter microhabitats used by Covered Species and impair sheltering. Incidental take via injury or death from Covered Activities is reasonably certain to occur in limited circumstances for species with demonstrated occupancy in Zone A reaches. LCRA's commitments to minimize or avoid in-stream disturbances substantially reduce the amount of incidental take due to substrate change by Covered Activities in Zone A.	See Zone A for effect pathways and circumstances leading to incidental take. In Zone B, reasonably certain incidental take is also dependent on future occupancy by Covered Species.	See Zone A for effect pathways and circumstances leading to incidental take. Incidental take via injury or death is assumed to be reasonably certain at some point during the CCAA duration for two of the Covered Species. The relative number of taken individuals is assumed to be substantially lower than in Zones A or B due to the marginal quality of the habitat in Zone C.
Change in ecological community	Movement of equipment within and between river basins could expand the distribution of invasive species in ways that change the distribution or abundance of host fish and the resiliency of the Covered Species. Similarly, prolonged alterations to flow regimes could change the distribution or abundance of host fish. Changes to ecological communities in areas occupied by Covered Species could increase competition for food and space and decrease dispersal of glochidia, leading to impaired breeding, feeding, or sheltering. LCRA's commitments to address the introduction or spread of invasive species, and to maintain flow regimes supportive of the Covered Species and their fish hosts substantially minimize the likelihood that the Covered Activities will cause incidental take via this pathway. Incidental take due to ecological community changes is not reasonably certain to occur. Furthermore, LCRA's commitments also reduce the likelihood of other parties causing ecological changes that would adversely affect the Covered Species. These efforts, such as education, work groups, and control of pollution and invasive species, address an identified threat to the Covered Species for a net conservation benefit.	See Zone A for effect pathways and circumstances leading to incidental take and net conservation benefit. Additional net benefit is achieved by supporting captive propagation and reintroduction efforts, particularly into Zone B.	See Zone A for effect pathways. Covered Activities are not reasonably certain to cause incidental take due to ecological community changes in Zone C.

Physical Consequences of Covered Activities	Zone A: Exposure is Reasonably Certain	Zone B: Exposure is Reasonably Certain in the Future	Zone C: Exposure is Possible in Perennially Operated Canals
Opportunity for physical contact	Physical contact with Covered Species or their host fish containing glochidia may occur when handling individuals during TPWD-permitted relocations, monitoring, or research studies. Incidental take via killing, wounding, harassing, capturing, and/or collecting is reasonably certain to occur for species with demonstrated occupancy in Zone A reaches.	See Zone A for effect pathways. Incidental take via injury or death is assumed to be reasonably certain in Zone B reaches at some point during the CCAA duration for any or all of the Covered Species.	See Zone A for effect pathways. Incidental take via injury or death is assumed to be reasonably certain at some point during the CCAA duration for two of the Covered Species. The relative number of taken individuals is assumed to be substantially lower than in Zones A or B due to the marginal quality of the habitat in Zone C.

The Covered Activities will cause some amount of incidental take, primarily as a consequence of substrate changes or flow alterations due to disturbances or river operations, and physical contact with individuals of the Covered Species (Table 8). For example, the Covered Species may be subject to adverse effects as a result of: removal or treatment of invasive species; flow operations that may indirectly affect temperature and/or dissolved oxygen; or through sediment transport downstream following maintenance of existing infrastructure, including dams, rip-rap, intakes, electric transmission facilities, and stilling basins. Where such adverse effects actually result in death or injury to an individual Covered Species, take of such species will occur. Further, the Covered Species may be inadvertently taken during population surveys and other long-term monitoring activities, or habitat manipulations in the short term.

While this CCAA uses a surrogate metric of “stream miles of disturbance” within each Conservation Zone (and subzone) to estimate and track incidental take from Covered Activities, the Conservation Measures help ensure that the number of individuals of the Covered Species that will be incidentally taken will be small. Adverse effects related to other types of flow alterations, water temperature changes, water quality changes, and ecological community changes are possible, but are avoided or substantially minimized by the Conservation Strategy within this CCAA and incidental take arising from these effect pathways is not reasonably certain to occur. The Conservation Measures that encourage or support beneficial actions by other parties through sharing information, providing education, and driving collaboration address broader threats to the Covered Species and contribute to a net conservation benefit. Considered altogether, incidental take associated with LCRA’s and LCRA TSC’s Covered Activities is not expected to be of a scale, duration, or extent great enough to compromise the viability of populations of the Covered Species in the Colorado River basin or otherwise jeopardize the Covered Species. Instead, the Conservation Strategy included in this CCAA, which includes these Covered Activities, is expected to result in a net conservation benefit to the Covered Species over the term of this CCAA.

Subject to other variables, the Covered Species are expected to increase in population size and extent following implementation of the Conservation Measures and Avoidance and Minimization Measures and associated activities, or if they are otherwise

reintroduced within the Covered Area. With reintroductions, there is an increased likelihood of adverse effects and resulting take of the Covered Species as a result of LCRA's and LCRA TSC's Covered Activities (including Conservation Measures and Avoidance and Minimization Measures). Take of the Covered Species could occur in the forms of killing, wounding, or through harm resulting from significant impairment of essential behavioral patterns such as breeding, feeding, and sheltering. For example, an individual Covered Species may be inadvertently killed or wounded during population surveys and other long-term monitoring activities, or harmed by habitat manipulations in the short term that result in impairment of essential behavioral patterns. Sub-adult life stages, including glochidia and juveniles, may be especially sensitive. Covered Species may be killed or wounded as a result of adverse effects caused by infrastructure operation, maintenance and repairs, the minimal construction covered by this CCAA, or catastrophic failure of such infrastructure. Covered Species also may be killed or wounded during routine water management activities (i.e., delivering water from LCRA reservoirs to downstream customers via the bed and banks of the Colorado River). Non-incidential take of Covered Species in connection with authorized applied research, would be provided for in individual 10(a)(1)(A) scientific and enhancement permits issued to the relevant researchers, and not in this CCAA.

The USFWS anticipates that incidental take of Covered Species will be difficult to detect for the following reasons: juveniles of the Covered Species have a small body size and finding a dead or impaired juvenile is unlikely; losses may be masked by seasonal fluctuations in population size (and detectability) or by losses associated with actions or events outside of LCRA's or LCRA TSC's control; losses are most likely to be sublethal and difficult to measure. Larger individuals are easier to detect, especially because they are usually found in aggregations called mussel beds. Although this CCAA does not anticipate large-scale dewatering events of entire mussel beds leading to stranding of adult mussels because of LCRA's or LCRA TSC's activities, it is still possible that, in combination with factors outside of LCRA's or LCRA TSC's control, the death of mature individuals could be visibly detectable if entire riffles or bank habitats are persistently dewatered. Sub-adult life stages are not likely to be detected. The level of monitoring identified in this CCAA would detect this level of take, especially because

LCRA will have knowledge of flow conditions in occupied stream reaches. Larger individuals also are more likely to be encountered during monitoring activities, and take associated with such encounters is relatively easy to quantify, track, and report.

12.5 Estimated Incidental Take

LCRA or LCRA TSC owns or controls a limited amount of property and facilities within or adjacent to waterways and canals within the Covered Area. LCRA and LCRA TSC evaluated these parcels for purposes of developing an estimate of the number of stream miles owned or controlled within each Conservation Zone as of May 2022, including whether a parcel was within those portions of the Conservation Zones on the main stem of the Colorado River below Longhorn Dam. As reflected in Table 9, as of May 2022, LCRA and LCRA TSC estimated that together they own or control property that may be affected by LCRA Covered Activities along less than 12 stream miles within all of the subzones within Zone A and less than 45 stream miles within Zone B. Over the term of this CCAA, LCRA and LCRA TSC have conservatively estimated that their respective ownership or control of property and facilities within each Conservation Zone could grow by an average of 2% per year within Zones A and B. This equates to about 17 stream miles within Zone A (or less than 2.5% of the total) and about 66 stream miles within Zone B (about 21% of the total). As discussed earlier in this CCAA, LCRA helps manage river flows within the Colorado River downstream of Longhorn Dam. This includes 137 miles of the total estimated 740 stream miles (about 19%) of the total stream miles of occupied habitat for the Covered Species (i.e. Zone A) and about 125 miles of the total estimated 315 stream miles (about 40%) of the total stream miles that comprise suitable, but unoccupied habitat (Zone B). LCRA owns or controls all of the 887 miles of canals within Zone C. For purposes of this CCAA, LCRA has assumed it will retain this level of ownership or control of the canals for the 20-year term of this CCAA. Because Zone D does not provide suitable habitat for the Covered Species (Section 6.4), further analysis of Zone D is not carried forward in this section.

Table 9. Estimated Stream Miles with Facilities
Owned or Controlled by LCRA or LCRA TSC by Conservation Zone

Conservation Zone or Subzone	Location*	Estimated stream miles with facilities owned or controlled by LCRA or LCRA TSC (As of May 2022)	Estimated stream miles with facilities owned or controlled by LCRA or LCRA TSC (In 20 Years)	Total stream miles within each zone or subzone	Percent of total stream miles within each zone or subzone owned or controlled by LCRA or LCRA TSC over 20-year term
Zone A-1**	Upstream	0.72	1.07	307.70	0.35%
Zone A-1**	Downstream	5.37	7.98	111.21	7.18%
Zone A-1**	upstream + downstream	6.09	9.05	418.91	2.16%
Zone A-2**	Upstream	0.71	1.06	60.93	1.73%
Zone A-2**	Downstream	5.92	8.80	136.77	6.43%
Zone A-2**	upstream + downstream	6.63	9.85	197.70	4.98%
Zone A-3**	Upstream	0.71	1.06	100.94	1.05%
Zone A-3**	Downstream	0.00	0.00	0.00	N/A
Zone A-3**	upstream + downstream	0.71	1.06	100.94	1.05%
Zone A-4**	Upstream	5.08	7.55	398.90	1.89%
Zone A-4**	Downstream	0.00	0.00	0.00	N/A
Zone A-4**	upstream + downstream	5.08	7.55	398.90	1.89%
All Zones A**	Upstream	6.03	8.96	603.42	1.48%
All Zones A**	Downstream	5.49	8.16	136.77	5.96%
All Zone A**	upstream + downstream	11.52	17.12	740.19	2.31%
Zone B	Upstream	37.00	54.98	189.51	29.01%
Zone B	Downstream	7.48	11.11	125.47	8.86%
Zone B	upstream + downstream	44.48	66.09	314.98	20.98%
Zone C	N/A	887	887	887	100%
Zone C-1***	N/A	19	19	19	100%

* "upstream" includes tributaries to the main stem of the Colorado River within the Covered Area
"downstream" includes the main stem of the Colorado River downstream of Longhorn Dam

** Significant portions of Zones A-1, A-2, A-3, and A-4 overlap, as can be seen when comparing Figure 3-a, Figure 3-b, Figure 3-c, and Figure 3-d.

*** Zone C values reflect miles of canals, rather than natural river or stream miles.

12.5.1 Zone A

Zone A includes approximately 740 stream miles of suitable occupied habitat for one or more of the Covered Species. Occupied habitat for several of the Covered

Species overlap. LCRA or LCRA TSC anticipates that, by the end of the 20-year term of this CCAA, they may own or control land or facilities in or along about two to seven percent of the total stream miles within each subzone of Zone A, as depicted in Table 9.[19] LCRA and LCRA TSC infrastructure within those portions of Zone A and its subzones on tributaries to the Colorado River or upsteam of Longhorn Dam is generally comprised of facilities such as monitoring equipment (i.e., river gauges), recreational facilities such as boat ramps or fishing piers, and electric transmission facilities. The vast majority of LCRA TSC structures are transmission lines that completely span the waterway and riparian area, with a much smaller number of substations or other structures. These types of facilities generally occupy very small parts of the actual riverbed. For example, an LCRA river gauge occupies about three square feet of streambed. Within Zones A-1 and A-2 downstream of Longhorn Dam, LCRA infrastructure is primarly associated with the measurement and control of water (i.e., river gages, intakes, etc.). LCRA river intakes generally occupy anywhere from about 200 square feet to 0.03 acres of area along and below the ordinary high water mark.

Because Zone A is comprised of occupied habitat for one or more of the Covered Species, LCRA and LCRA TSC have conservatively assumed incidental take associated with Covered Activities will occur within all of those stream miles owned or controlled by LCRA or LCRA TSC at some point during the term of this CCAA, although adverse impacts resulting in incidental take will be substantially minimized by the Avoidance and Minimization Measures contained within this CCAA. Moreover, some of the Covered Activities are intended to provide an overall net conservation benefit to the species. For instance, LCRA's commitments related to protection of instream flows is expected to minimize or avoid incidental take of Covered Species as a result of LCRA's Covered Activities that may affect flow, temperature, or water quality in those areas within Zone A-1 and Zone A-2 on the main stem of the river downstream of Longhorn

[19] *See supra*, n. 10, for an explanation of the methods used by LCRA and LCRA TSC to estimate stream miles within each zone. Similar to this approach, LCRA and LCRA TSC used GIS layers that included data related to LCRA and LCRA TSC infrastructure and real estate assets to estimate its ownership or control of stream miles within each Conservation Zone (or subzone).

Dam. These and other Conservation Measures implemented within Zone A are also expected to benefit those portions of the river where neither LCRA nor LCRA TSC own land or facilities along or within the river.

12.5.2 Zone B

Zone B includes about 315 stream miles of suitable habitat. Most of these stream miles are distant from LCRA or LCRA TSC infrastructure and thus unlikely to result in incidental take as a result of the Covered Activities. LCRA or LCRA TSC anticipate that, by the end of the 20-year term of this CCAA, they may own or control land or facilities within or along about 66 stream miles (about 21%) of the total stream miles within Zone B, as depicted in Table 9. More than two-thirds of this property is located within areas of Zone B outside of the main stem of the Colorado River below Longhorn Dam. The nature and location of LCRA and LCRA TSC infrastructure is similar to that described in Zone A. LCRA and LCRA TSC infrastructure within those portions of Zone B on tributaries to the Colorado River or upsteam of Longhorn Dam is generally comprised of facilities such as monitoring equipment (i.e., river gauges), recreational facilities such as boat ramps or fishing piers, and electric transmission facilities. The vast majority of LCRA TSC structures are transmission lines that completely span the waterway and riparian area, with a much smaller number of substations or other structures. These types of facilities generally occupy very small parts of the actual riverbed. For example, an LCRA river gauge occupies about three square feet of streambed. Within Zone B downstream of Longhorn Dam, LCRA infrastructure is primarly associated with the measurement and control of water (i.e., river gages, intakes, etc.), all of which occupy relatively small footprints, as described above.

For planning purposes, LCRA and LCRA TSC assume that portions of Zone B will become occupied by one or more of the Covered Species during the term of this CCAA. This may occur as a result of natural expansion outward from existing populations within Zone A, relocation of populations to points downstream as a result of high-flow events, or through deliberate population enhancement measures, such as those described by the Conservation Measures outlined in Section 7.3.4. It is not possible to predict precisely what areas of Zone B may become occupied over the term of this CCAA. USFWS has estimated that stream reaches of at least 50 miles are an

important component of a riverine system with habitat to support all life stages of the Covered Species (86 Fed. Reg. at 47,950-51). For purposes of predicting future exposure of Covered Species to Covered Activities, LCRA and LCRA TSC have assumed that no more than one new population spanning this desired number of contiguous stream miles will be established within Zone B upstream of the Highland Lakes over the term of this CCAA. This is not only because changes in population sizes generally occur over decades, rather than years (86 Fed. Reg. at 47,952), it is also unlikely that any significant portion of the upstream portion of Zone B will develop all of the physical or biological features necessary to support new populations of the Covered Species. For example, stream flow conditions within this portion of the Covered Area are subject to extreme fluctuations that are likely to recur over the term of this CCAA, including very low or zero flow (or even cessation of flow) and unregulated floods. Although LCRA and LCRA TSC currently own or control or expect to own or control about 29% of the total stream miles within the upstream portion of Zone B over the term of this CCAA, these 55 miles reflect segments that are discontinuous and generally occupy less than one quarter of a mile of continguous stream miles in any single location. Thus, it is unlikely that all of LCRA and LCRA TSC owned or controlled stream miles within this portion of Zone B will coincide within newly occupied habitat. Instead, this CCAA assumes that no more than one-half of the newly occupied habitat (25 miles) will occur within the upstream portion of Zone B that LCRA or LCRA TSC expects to own or control. It is more likely that portions of Zone B downstream of Longhorn Dam will become occupied, particularly considering the numerous Conservation Measures contained within this CCAA that will benefit this portion of the river. LCRA or LCRA TSC expect to own or control about 11 stream miles within Zone B downstream of Longhorn Dam by the end of this CCAA and assume for planning purposes that all of these stream miles will become occupied.

In summary, for planning purposes, LCRA and LCRA TSC have assumed that about 55% (36 out of 66) of the stream miles expected to be under LCRA or LCRA TSC ownership or control within Zone B over the term of this CCAA will become occupied. Adverse impacts resulting in incidental take will be substantially minimized or avoided by the Avoidance and Minimization Measures contained within this CCAA. Moreover,

many of the Covered Activities are expected to provide an overall net conservation benefit to the species. For instance, LCRA's commitments related to protection of instream flows is expected to minimize or avoid incidental take of Covered Species as a result of LCRA's Covered Activities that may affect flow, temperature, or water quality in those areas within Zone B on the main stem of the river downstream of Longhorn Dam. These measures are further expected to benefit those portions of the lower Colorado River where neither LCRA nor LCRA TSC own land or facilities along or within the river. Moreover, incidental take associated with other Covered Activities is expected to be more than offset by the Conservation Measures that LCRA and LCRA TSC have agreed to implement and will provide benefit to those portions of Zone B that are not under LCRA's direct ownership or control.

12.5.3 Zone C

Zone C includes 887 miles of canals, with all but 19 miles of the LCRA canals system being seasonally operated. Seasonally operated canals are not suitable habitat for freshwater mussels. Although not suitable habitat, one or more Covered Species occasionally have been found in portions of perennially operated canals. Therefore, it is reasonable to assume that the Covered Activities would only adversely affect Covered Species in those portions of the canals that are operated on a perennial basis. LCRA TSC activities within Zone C rarely involve any disturbance within these canals. Canal dredging activities related to maintenance are likely to occur along approximately one mile of the total 19 miles of perennially operated canals (Zone C-1) every two years. Over the course of this 20-year agreement, that equates to about 10 miles of marginally suitable habitat within Zone C-1 that could be somehow adversely affected, or about 8.9% of the total miles within Zone C.

12.5.4 Zone D

Zone D does not include suitable habitat for Covered Species and is distant from LCRA's Covered Activities that could cause incidental take to Covered Species. Therefore, we are not including Zone D in our analysis of incidental take.

12.5.5 Summary

In summary, not more than 16 stream miles of suitable habitat within Zone A, 36

stream miles within Zone B, and 10 miles of marginal habitat within Zone C are expected to be significantly modified by the Covered Activities cumulatively over 20 years in ways that might cause harm to one or more of the Covered Species. Table 10 summarizes the amount of potential habitat of Covered Species (in stream miles) present and likely to be affected during implementation of the CCAA, by Conservation Zone.

Table 10. Maximum Amount of Potential Habitat Present and Likely to be Affected (Stream Miles)

Mussel Zone	Texas Pimpleback	Texas Pimpleback	Texas Fawnsfoot	Texas Fawnsfoot	Balcones Spike	Balcones Spike	Texas Fatmucket	Texas Fatmucket
	present	potentially affected	present	potentially affected	present	potentially affected	present	potentially affected
A-1	419	9	N/A	N/A	N/A	N/A	N/A	N/A
A-2	N/A	N/A	198	10	N/A	N/A	N/A	N/A
A-3	N/A	N/A	N/A	N/A	101	1	N/A	N/A
A-4	N/A	N/A	N/A	N/A	N/A	N/A	390	8
B*	125	36	125	36	125	25	125	25
C-1**	19	10	19	10	N/A	N/A	N/A	N/A
TOTAL	563	55	198	56	226	26	515	33
Percent		9.8%		28.3%		11.5%		6.4%

* Because Zone B is not presently occupied by any one of the Covered Species, this estimate assumes the estimated impacts to 36 stream miles may result in incidental take of both Texas Pimpleback and Texas Fawnsfoot, which occur both upstream and downtream of Longhorn Dam and that the estimated impacts to 25 stream miles upstream of Longhorn Dam may result in incidental take of both Balcones Spike and Texas Fatmucket.
** Because Zone C-1 provides marginal habitat for two of the Covered Species, this estimate assumes the estimated impacts to 10 canal miles of marginal habitat may result in incidental take of both Covered Species found in Zones A-1 (Texas pimpleback) and A-2 (Texas fawnsfoot) .

12.6 Impact of Take and Net Conservation Benefit

The purpose of this CCAA is to protect suitable habitat of the Covered Species, and to reduce threats so these habitat areas can expand; therefore, USFWS expects that the conservation activities covered by the CCAA and Permit will increase the amount and quality of suitable habitat for the Covered Species. There may be minimal, short-term negative effects to some of the Covered Species' habitat features associated with some of the Covered Activities, but generally the level of incidental take associated with this CCAA is expected to be offset by the benefits to the species associated with the Conservation Measures contained within this CCAA that are reasonably expected to result in a net conservation benefit for the Covered Species in the 20-year term of this

CCAA.

As described in Section 7.1, this CCAA is consistent with the National Strategy for the Conservation of Freshwater Mollusks by identifying actions that address issues influencing the conservation of freshwater mussels and help achieve the goals of the FMCS National Strategy (Table 1).

The Species Status Assessment for the Central Texas Freshwater Mussels (USFWS 2019) contemplates a net conservation benefit for the Covered Species in the Colorado River basin from enacting the types of conservation measures included in this CCAA (i.e., Scenario 2) as compared with a continuation of current conditions (i.e., Scenario 1) (Table 11). The USFWS's projections under Scenarios 1 and 2 consider the adverse effects of ongoing land and water use activities that are consistent with LCRA's and LCRA TSC's use, operation, and maintenance of water supply, power generation, electric transmission, and recreational facilities, as well as ongoing or currently planned activities by other entities in the Colorado River basin (e.g., continued land development and urbanization). Not only are the Conservation Measures in this CCAA designed to support the National Strategy for the Conservation of Native Mussels (Table 1), they also are reflective of the conservation measures considered by USFWS in Scenario 2. These include: (1) activities that support collaborative and coordinated monitoring and research, (2) adaptive management to continually improve the effectiveness of conservation actions, (3) actively maintaining or improving habitat conditions for the Covered Species (i.e., water quality, water quantity, and microhabitat substrates), (4) managing invasive species, (5) relocating and bolstering Covered Species populations, (5) community education and engagement on freshwater mussel conservation issues, and (6) organizing collaborative actions (e.g., Onion Creek). Therefore, the projections in USFWS (2019) for Scenario 2 are a reasonable assessment of the likely net conservation benefit of this CCAA in the Colorado River basin.

Table 11. Current and Projected Conditions for Central Texas Freshwater Mussels in the Colorado River Basin and Projected Net Conservation Benefits

Covered Species	Current Condition by River Segment*	Projected Current Conditions* (Scenario 1) by River Segment in 25 Years	Projected Conditions* with Conservation Actions (Scenario 2) by River Segment in 25 Years	Projected Net Conservation Benefits
Balcones spike**	Lower San Saba: U Llano: U	Lower San Saba: X Llano: X	Lower San Saba: U Llano: X	Conservation Strategy achieves a net conservation benefit with improved condition in the Lower San Saba River segment.
Texas fatmucket	Elm Creek: U Upper/Middle San Saba: M Llano: M Pedernales: U Onion Creek: X	Elm Creek: X Upper/Middle San Saba: U Llano: U Pedernales: U Onion Creek: X	Elm Creek: U Upper/Middle San Saba: U Llano: M Pedernales: U Onion Creek: U	Conservation Strategy achieves a net conservation benefit with improved condition in Elm Creek, Llano River, and Onion Creek populations and with stabilization of projected declines in the Upper/Middle San Saba River populations.
Texas fawnsfoot	Lower San Saba: U Lower Colorado: M	Lower San Saba: X Lower Colorado: U	Lower San Saba: X Lower Colorado: M	Conservation Strategy achieves a net conservation benefit with improved condition in the Lower Colorado River segment.
Texas pimpleback	Concho: U Upper San Saba: U Upper Colorado/Lower San Saba: M Llano: U Lower Colorado: M	Concho: X Upper San Saba: X Upper Colorado/Lower San Saba: U Llano: X Lower Colorado: U	Concho: X Upper San Saba: U Upper Colorado/Lower San Saba: U Llano: U Lower Colorado: M	Conservation Strategy achieves a net conservation benefit with improved condition in the Upper San Saba River, Llano River, and Lower Colorado River populations and with stabilization of projected declines in the Upper Colorado/Lower San Saba River populations.

* Current conditions and projected conditions (i.e., Scenarios 1 and 2) for the Covered Species are from USFWS (2019). X = Extirpated; U= Unhealthy; M = Moderately Healthy.
** The Balcones spike is identified as the false spike in USFWS (2019).

12.7 Tracking and Notification of Incidental Take

Incidental take of the Covered Species authorized under the Permit will be exceeded if: 1) the miles of LCRA and LCRA TSC ownership or control of Zone A or

Zone C exceeds the amounts in Table 10 (which reflect areas known to be occupied habitat); or 2) the miles of LCRA and LCRA TSC owned and occupied habitat within Zone B exceed the amounts in Table 10. Accordingly, LCRA and LCRA TSC will annually verify and, if necessary, update the miles of ownership or control of stream miles within each Conservation Zone. Further, for Zone B, LCRA and LCRA TSC will annually verify and, if necessary, update the occupancy data based on the most currently information available from USFWS upon request. This information will allow LCRA and LCRA TSC to verify the continued accuracy of the assumptions included in Table 10 and assess whether the amount of authorized incidental take has been exceeded and will be used to comply with the reporting obligation under Section 9.2.

Further, LCRA and LCRA TSC will internally track on a quarterly basis those Covered Activities within the Covered Area where an Aquatic Resources Relocation Permit (ARRP) from TPWD is anticipated for any of the Covered Species and notify the Service of such activities as soon as reasonably possible and no later than the date on which the ARRP application is submitted to TPWD. LCRA and LCRA TSC will use this information in conjunction with the annually updated information discussed in the preceding paragraph to further assess whether the specific ARRP-related Covered Activities remain within the limits of incidental take reflected in the estimates described in Section 12.5. In the event that LCRA and LCRA TSC determine that such activities may result in an exceedance of these estimates, LCRA and LCRA TSC will notify the USFWS as soon as reasonably possible.

13 REGULATORY ASSURANCES

USFWS provides regulatory assurances to LCRA and LCRA TSC through this CCAA and the associated Permit. For the Covered Activities, consistent with 50 C.F.R. §§ 17.22(d)(5) and 17.32(d)(5) and USFWS's Candidate Conservation Agreement with Assurances Final Policy (64 FR 32,726 (June 17, 1999)), USFWS will not require additional Conservation or Avoidance and Minimization Measures nor impose additional land, water, or resource-use restrictions, beyond those voluntarily agreed to and described in Sections 7.2 (Avoidance and Minimization Measures), 7.3 (Conservation Measures), and 14 (Changed or Unforeseen Circumstances), as long as the CCAA is

properly implemented. These assurances will be authorized for the Covered Activities through issuance of the Permit, which will become effective if one or more of the Covered Species is listed in the future. As described in more detail below, these assurances also apply in the event of unforeseen circumstances. USFWS may request additional conservation but because it is voluntary on the part of LCRA and LCRA TSC, consent of LCRA and LCRA TSC must be in writing. The Permit, if it becomes effective, also will authorize the incidental take of the species by LCRA and LCRA TSC if the take is associated with the Covered Activities and consistent with the terms of this CCAA.

The assurances listed above apply to LCRA and LCRA TSC so long as the CCAA is being properly implemented, even if the anticipated population or habitat gains are not ultimately realized.

14 CHANGED OR UNFORESEEN CIRCUMSTANCES

In the case of changed or unforeseen circumstances, assurances listed in this document apply to LCRA and LCRA TSC when the CCAA is being properly implemented.

USFWS regulations define Changed Circumstances as “changes in circumstances affecting a species or geographic area covered by a conservation plan that can reasonably be anticipated by plan developers and the [USFWS] and that can be planned for (e.g., the listing of new species, or a fire or other natural catastrophic event in areas prone to such events)” (50 C.F.R. § 17.3).

“Unforeseen circumstances” are “changes in circumstances affecting a species or geographic area covered by a conservation plan that could not reasonably have been anticipated by plan developers and the [USFWS] at the time of the conservation plan’s development, and that result in a substantial and adverse change in the status of the covered species” (50 C.F.R. § 17.3).

Changed Circumstances provided for in this CCAA. If additional Conservation Measures or Avoidance and Minimization Measures are necessary to respond to Changed Circumstances and the measures were set forth in this CCAA, LCRA and LCRA TSC will implement the measures specified herein and remain eligible for the regulatory assurances provided herein.

Changed Circumstances not provided for in this CCAA. If additional Conservation Measures or Avoidance and Minimization Measures not provided for in the CCAA are necessary to respond to Changed Circumstances, USFWS will not require any Conservation Measures or Avoidance and Minimization Measures for the Covered Species in addition to those provided for in the CCAA without the consent of LCRA and LCRA TSC, provided LCRA and LCRA TSC are properly implementing the CCAA.

14.1 Changed Circumstances

LCRA and LCRA TSC identify the following Changed Circumstances that may occur over the term of the CCAA and the responsive actions LCRA will implement to address each Changed Circumstance. Changed Circumstances require written acknowledgment by LCRA, LCRA TSC, and USFWS to trigger the responses prescribed below.

14.1.1 New Listing or Critical Habitat Designation Within the Covered Area

USFWS occasionally adds new species to the federal list of threatened and endangered species or designates new or revised areas of critical habitat associated with listed species. This Changed Circumstance will have occurred when USFWS publishes a Proposed Rule in the Federal Register that would create a new listed freshwater mussel or other aquatic species that occurs within the Covered Area or that creates or expands areas of critical habitat for Covered Species or such newly proposed species within the Covered Area. USFWS will notify LCRA and LCRA TSC of the occurrence of this Changed Circumstance.

Within 120 days of notification, LCRA and LCRA TSC will evaluate LCRA's and LCRA TSC's Covered Activities within the conservation zones and its Conservation Measures or Avoidance and Minimization Measures to assess LCRA's and LCRA TSC's potential impact on the newly proposed species or critical habitat designation and whether the existing Conservation Measures and Avoidance and Minimization Measures and zones adequately address the new species. With this assessment, LCRA and LCRA TSC will also notify USFWS if it intends to seek an amendment (following the process in Section 15.9) to address the new proposed species or new proposed critical habitat. USFWS may provide technical guidance to LCRA and LCRA TSC as it

considers whether an amendment is warranted. Regardless of this Changed Circumstance, LCRA and LCRA TSC reserve the discretion to seek an amendment to the CCAA, Permit, and related documents to add a Covered Species or add new conservation measures or avoidance and minimization measures that avoid the destruction or adverse modification of critical habitat. Any amendment(s) will be focused solely on new conservation measures and avoidance and minimization measures or revisions to existing Conservation Measures and Avoidance and Minimization Measures to specifically address the new species or critical habitat and will not affect any other Conservation Measures or Avoidance and Minimization Measures or Conservation Zones that are not affected by the new species or critical habitat. For new critical habitat, LCRA and LCRA TSC will seek amendments to update the zones to include such critical habitat.

14.1.2 Adding a Covered Species

LCRA and LCRA TSC may seek to amend the CCAA, Permit, and related documents to add new species to the list of Covered Species, either because of the Changed Circumstance or for other reasons. A notice from LCRA and LCRA TSC to USFWS indicating the intent to seek such as amendment will trigger this Changed Circumstance. Under this Changed Circumstance, LCRA, LCRA TSC, and USFWS agree to streamline the addition of new Covered Species by adopting, to the maximum extent practicable, the metrics for estimating take and basics of the Conservation Strategy already specified in the CCAA for species that use similar ecological niches.

14.1.3 Delisting of a Listed Covered Species

USFWS may delist a listed Covered Species during the CCAA Term due to recovery, extinction, or error. This Changed Circumstance will have occurred when USFWS publishes a Final Rule in the Federal Register that delists a Covered Species. USFWS will notify LCRA and LCRA TSC of the occurrence of this Changed Circumstance.

In response to this Changed Circumstance, USFWS agrees that LCRA and LCRA TSC may, in their discretion, amend the CCAA and related documents to remove the delisted species from the list of Covered Species and strike some or all the

provisions of these documents that pertain to the delisted species. USFWS rationale for delisting, as published in the Final Rule, will determine the extent to which LCRA and LCRA TSC may retire its obligations related to the delisted species through this Changed Circumstance:

- In all delisting cases, LCRA and LCRA TSC may, at its discretion, amend the CCAA, Permit, and related documents to remove obligations to address the delisted species for Covered Activities;
- In the case of delisting due to recovery, where LCRA's and LCRA TSC's previously completed Conservation Measures and Avoidance and Minimization Measures contributed to the delisting decision, LCRA and LCRA TSC will not be relieved of any obligations under this CCAA related to those previously completed Conservation Measures and Avoidance and Minimization Measures actions without USFWS's expressed consent. This commitment applies only to Conservation Measures and Avoidance and Minimization Measures directly implemented by LCRA and LCRA TSC – the actions of third parties are outside of LCRA's or LCRA TSC's control; and
- In the case of delisting due to error or extinction, the USFWS will no longer require LCRA or LCRA TSC to maintain any Conservation Measures or Avoidance and Minimization Measures established specifically for the delisted species directly implemented by LCRA or LCRA TSC.

In some cases, LCRA and LCRA TSC may prefer to maintain the delisted species as a Covered Species or to continue to implement Conservation Measures and Avoidance and Minimization Measures to protect against future re-listing of the species. If LCRA and LCRA TSC desire continued coverage of the delisted species, it will request an adminstrative amendment from USFWS that updates the listing status of the delisted species.

14.1.4 Special Rules for Threatened Species

USFWS may issue a special rule for threatened species under Section 4(d) of the ESA ("4(d) Rule") that specifies the circumstances under which the prohibitions of ESA Section 9 apply to the threatened species. This Changed Circumstance will have

occurred when USFWS issues a 4(d) Rule in the Federal Register for a Covered Species during the CCAA and Permit Term. USFWS will notify LCRA and LCRA TSC of the occurrence of this Changed Circumstance.

In the event of this Changed Circumstance, USFWS agrees that LCRA and LCRA TSC may amend the CCAA, Permit, and related documents to incorporate any applicable provisions of the Special Rule into the CCAA and Permit. For instance, if the Special Rule exempts certain types of activities from the prohibitions on take and those exempted activities are consistent with aspects of the LCRA and LCRA TSC Covered Activities, then LCRA will not be obligated to account for take associated with those exempted aspects of the Covered Activities during CCAA implementation.

14.1.5 Taxonomic Changes

The taxonomic classification of one or more of the Covered Species may change over the CCAA and Permit Term. It is possible that new science will emerge that indicates one or more of the Covered Species is not a valid taxon or that it belongs to a different taxon. It also is possible that an unlisted species that is not a Covered Species will be synonymized with a Covered Species. Such taxonomic changes may alter the known range, distribution, or abundance of a Covered Species in ways that change the impact of LCRA's and LCRA TSC's Covered Activities under the CCAA and Permit. Delistings of a listed Covered Species due to taxonomic changes, which would likely be categorized as a delisting due to error, are addressed in Section 14.1.3. This Changed Circumstance will have occurred if researchers publish new scientific information involving any Covered Species in a peer-reviewed, scientific journal that changes the taxonomic classification and USFWS formally accepts the taxonomic change in writing. USFWS will notify LCRA and LCRA TSC of the occurrence of this Changed Circumstance.

If this Changed Circumstance occurs, LCRA and LCRA TSC will coordinate with USFWS to change the CCAA, Permit, and related documents using one or more of the processes in Section 15.9, as appropriate, to update the names of the Covered Species, adjust assessment of impacts necessary to conform to the new species designations, and clarify how Conservation Measures and Avoidance and Minimization Measures already in place address the updated taxonomy of the Covered Species. If

the taxonomic change expands the range of a Covered Species in ways not already considered by the CCAA, LCRA and LCRA TSC may coordinate with USFWS to determine if the revision warrants a Formal Amendment.

14.1.6 Catastrophic Events

Catastrophic events such as wild fires, hurricanes, floods, prolonged periods of drought, dam failure, toxicant or contaminant spill, wastewater treatment plant failure, or other similar events could temporarily (i.e., where the adverse effects would be expected to last for a period of no more than approximately 15 years) reduce or degrade suitable habitat for the Covered Species within the Covered Area for this CCAA. Some of these acute and catastrophic events occur naturally and are a normal or at least occasional occurrence.

If such an event occurs within the Covered Area, USFWS will hold LCRA and LCRA TSC harmless for those impacts that are not a result of LCRA's gross negligence. However, consistent with LCRA's and LCRA TSC's intent to provide a meaningful net conservation benefit to the Covered Species, LCRA and LCRA TSC will coordinate with TPWD and USFWS and assist those agencies in habitat and population restoration efforts, at the sole discretion of TPWD and USFWS. LCRA and LCRA TSC will make funds and in-kind resources available (not to exceed $5,000 per year) to assist in those efforts. USFWS may contribute funds or in-kind support for restoration efforts, at its sole discretion at the time and depending on availability of funds and other resources.

14.1.7 Lack of Self-Sustaining Population Within Suitable Habitat

It is possible that a self-sustaining population of the Covered Species within Zone A will no longer be self-sustaining within 10 years from the date of this CCAA or that efforts to promote a self-sustaining population within portions of Zone B could be unsuccessful (Zones A or B). A large chemical spill, for example, could wipe out a population that cannot be reestablished. If this occurs, LCRA and LCRA TSC will coordinate with USFWS to modify or amend the CCAA, Permit, and related documents using one or more of the processes in Section 15.9, as appropriate, to reclassify the affected portions of Conservation Zone(s) as a different management zone. And if the threats that led to the demise of the population are resolved or can be resolved through

feasible means, then LCRA and LCRA TSC will work with USFWS and TPWD to consider reintroduction into the same reach.

14.1.8 Environmental Flow Standards Substantially Revised or Abolished or LCRA Water Management Plan Instream Flow Obligations Reduced

The TCEQ may substantially revise or abolish the environmental flow standards for the Colorado River or reduce LCRA's instream flow obligations under its Water Management Plan. In either case, LCRA will coordinate with USFWS to evaluate whether such changes have the potential to adversely affect the Covered Species and whether revisions to the Conservation Measures and Avoidance and Minimization Measures are necessary and feasible.

14.1.9 Invasive Species Threaten Covered Species in Covered Area

It is possible that invasive species, such as the zebra mussel, could threaten the persistence of Covered Species in the Covered Area. In that case, LCRA and LCRA TSC will work with USFWS and TPWD to conduct research or investigate potential removal and control efforts. Further, LCRA and LCRA TSC will implement invasive species removal and control efforts that would not exceed $2,000 per year (in-kind and/or financial contribution). LCRA and LCRA TSC will seek to cost share or secure matching grants if costs exceed the $2,000 per year spending cap for this Changed Circumstance. TPWD and USFWS may contribute funds or in-kind support for invasive species control efforts, at their sole discretion at the time and depending on availability of funds and other resources.

14.1.10 Predation or Disease Threaten Covered Species in Covered Area

There is a possibility that diseases, parasites or other forms of predation may impact the health of the Covered Species in the Covered Area. If this is documented to be occurring, LCRA and LCRA TSC will work with USFWS and TPWD to investigate methods of control and research the disease, parasite or other form of predation to gain a better understanding of this potential threat. Such efforts shall not result in an increase in LCRA's and LCRA TSC's annual budget for implementation of this CCAA by more than $2,000 per year (in-kind and/or financial contribution). LCRA and LCRA TSC will seek to cost share or secure matching grants if costs exceed the $2,000 per year

spending cap for this Changed Circumstance.

14.1.11 Host Fish Populations Decline

It is possible that the host fish populations for the Covered freshwater mussel species decline within the Covered Area. In that case, LCRA and LCRA TSC will work with USFWS and TPWD to conduct investigations to determine the cause of the decline and possible actions that could reverse or prevent further decline. Further, LCRA and LCRA TSC will implement host fish population augmentation efforts that would not exceed $5,000 per year (in-kind and/or financial contribution) if USFWS and TPWD agree that such efforts would be helpful to the Covered Species under the circumstances. LCRA and LCRA TSC will seek to cost share or secure matching grants if costs exceed the $5,000 per year spending cap for this Changed Circumstance. USFWS may contribute funds or in-kind support for host fish restoration efforts, at their sole discretion at the time and depending on availability of funds and other resources.

14.1.12 Change in LCRA Canal Operations

As discussed above, LCRA operates canals within its Gulf Coast, Lakeside and Garwood operations in Colorado, Wharton, and Matagorda counties solely for purposes of delivering water to its customers. Accordingly, as the location and demands of customers served from LCRA's canals change over time, LCRA must necessarily change its operations. Some canals could be changed from seasonal to perennial operations, or vice versa, and in some cases, canal operations may cease all together. Prior to draining any canal segment that LCRA is converting from perennial to seasonal operations, LCRA will notify USFWS and initiate a relocation of mussels as agreed upon by USFWS, TPWD, and LCRA. LCRA will work with USFWS to develop an appropriate notification schedule to help ensure adequate time to develop the relocation plan. LCRA will provide updated maps to reflect which canal segments fall within Zones C-1 and C-2 and thereafter implement the Conservation Measures and Avoidance and Minimization Measures for the zone that applies to the reclassified canal segments.

14.1.13 Change in LCRA Ownership or Control of Water Rights or Associated Infrastructure

LCRA presently owns or co-owns three water rights for which it has no direct control over the operation or maintenance of the intakes or other facilities associated with these water rights because the faciltiies that rely on these water rights are either owned by or leased to third parties. (See Appendix A). The third parties that operate these facilities are not parties to this CCAA and, accordingly, the commitments and assurances included in this CCAA do not presently apply to those water rights and associated facilities. Should LCRA obtain direct control over these facilities in the future, however, these facilities will become subject to the terms and conditions of this CCAA and associated Permit. Further, during the term of this CCAA, LCRA may acquire new water rights from third parties that may include existing infrastructure, the operation and maintenace of which might have potential to adversely impact Covered Species or their habitat. In such case, LCRA will coordinate with USFWS to determine whether to amend this CCAA to include operations and maintenance of the faciltiies associated with newly acquired water rights. Finally, should LCRA's ownership or control of water infrastructure change during the term of this CCAA such that LCRA no longer controls the operation and maintenance of the infrastructure or underlying water rights, LCRA will notify USFWS of such change and these facilities will no longer be subject to the terms of this CCAA or associated Permit.

14.1.14 Change in Law

LCRA and LCRA TSC have relied on their existing legal authority and obligations to make the commitments included in this CCAA. A change in the law, including LCRA's Enabling Act (Tex. Spec. Dist. Code Ch. 8503), rule, or order from an entity with regulatory authority over LCRA or LCRA TSC activities, could affect LCRA's or LCRA TSC's ability to implement its commitments as set forth in the CCAA. In such instance, LCRA and LCRA TSC will coordinate with USFWS to evaluate whether revisions to the Conservation Measures and Avoidance and Minimization Measures are necessary and feasible to help ensure a continued net conservation benefit to the species.

14.1.15 Change in Anticipated Grant Funding

LCRA relies on third-party grants to fund portions of the Clean Rivers Program (CRP) and Creekside Conservation Program (CCP). Some of the funds for these programs come from the State of Texas (CRP and CCP) and the NRCS (CCP). If the grant funding is decreased or no longer available for either of these programs, LCRA and LCRA TSC will notify USFWS of such reduction and provide its assessment of how such reductions will affect LCRA's ability to implement certain Conservation Measures in this CCAA, such as continued water quality monitoring within Zones A and B (Section 7.3.2.3). LCRA and LCRA TSC will work with USFWS to identify potential sources of alternative funding for these programs and to prioritize the activities under these programs that LCRA is able to continue with available funds that provide the most benefit to freshwater mussels.

14.1.16 Costs to Address Changed Circumstances

LCRA's and LCRA TSC's total costs to implement additional conservation measures associated with a combination of Changed Circumstances will not exceed a total of $14,000 per year (in-kind and/or financial contribution), and USFWS will help LCRA and LCRA TSC prioritize which actions would be expected to result in the greatest conservation benefit. USFWS may contribute funds or in-kind support for restoration efforts, at its sole discretion at the time and depending on availability of funds and other resources.

Under no circumstance will such Adaptive Management responses require LCRA and LCRA TSC to increase their financial commitments beyond the limits set forth in this CCAA.

14.2 Unforeseen Circumstances

USFWS shall notify LCRA and LCRA TSC in writing of any Unforeseen Circumstances, as defined in 50 C.F.R. § 17.3, that USFWS believes to exist. As set forth in 50 C.F.R. § 17.22(d), if additional Conservation Measures or Avoidance and Minimization Measures are necessary to respond to Unforeseen Circumstances, USFWS may require additional measures of LCRA and LCRA TSC, but only if such measures are limited to modifications within the CCAA's Conservation Strategy for the

affected species, and only if those measures maintain the original terms of the CCAA to the maximum extent possible. In accordance with Section 12.7 of this CCAA and 50 C.F.R. § 17.22(d), these additional Conservation Measures or Avoidance and Minimization Measures will not involve the commitment of additional land, water, financial compensation, or additional restrictions on the use of land, water, or other natural resources available for development or use under the original terms of the CCAA without the consent of LCRA and LCRA TSC.

As set forth in 50 C.F.R. § 17.22(d), USFWS will have the burden of demonstrating that Unforeseen Circumstances exist and must base the determination on the best scientific and commercial data available. These findings must be clearly documented and based upon reliable technical information regarding the status and habitat requirements of the Covered Species. USFWS will consider, but is not limited to, the following factors:

- Size of then-current range of the species;
- Ecological significance of that portion of the range affected by the CCAA;
- Level of knowledge about the affected species and the degree of specificity of the species' conservation program under the CCAA; and
- Whether failure to adopt additional measures would appreciably reduce the likelihood of survival and recovery of the Covered Species in the wild.

In the unlikely situation in which an Unforeseen Circumstance results in likely jeopardy to a species covered by this CCAA and Permit, USFWS could revoke this CCAA and permit. However, USFWS and its cooperators would first exercise all possible means to remedy the situation through other means (50 C.F.R. § 17.22(d)(7)).

15 AGREEMENT TERM, RESPONSIBILITIES, AMENDMENT, AND OTHER CONDITIONS

15.1 Agreement Term

This CCAA will have a duration of 20 years from the date of the last signature by LCRA, LCRA TSC, and USFWS. It may be renewed upon application by LCRA and LCRA TSC, provided USFWS determines that the CCAA still provides net conservation benefit and still complies with the applicable CCAA policy.

Should any of the Covered Species become listed as “threatened” or “endangered,” the Permit will become effective and remain in effect until the CCAA’s expiration date, unless it is suspended or revoked by USFWS or LCRA and LCRA TSC, as provided in its permitting regulations.

So long as LCRA and LCRA TSC remain in compliance with the CCAA, LCRA, LCRA TSC and their Covered Activities will be covered by this Permit from its effective date until the CCAA’s expiration date or the date on which LCRA and LCRA TSC terminate this CCAA, whichever comes first.

15.2 Termination of CCAA, Suspension or Revocation of Permit

LCRA and LCRA TSC may terminate the implementation of the CCAA’s voluntary management actions at any time for any cause prior to the CCAA’s expiration date, even if the expected benefits have not been realized. In such a case, if any of the Covered Species have been listed and a Permit has been issued, LCRA and LCRA TSC will surrender the permit and thus relinquish all associated take authority and assurances.

If issued, USFWS may suspend or revoke the Permit for cause in accordance with the laws and regulations in force at the time. Criteria for revocation are identified in 50 C.F.R. § 17.22 (d)(1) for species that are subsequently listed as endangered and 50 C.F.R. § 17.32 (d)(1) for species that are subsequently listed as threatened.

15.3 Responsibilities of the Parties

15.3.1 LCRA and LCRA TSC

LCRA and LCRA TSC shall be responsible for:

- Funding, administering, and implementing this CCAA and associated voluntary Conservation Strategy consistent with the terms and conditions set forth in this CCAA and the designated timeline (Section 8);
- Reporting to USFWS as described in Section 9.2; and,
- Notifying USFWS if any lands, waters, or other rights subject to this CCAA are transferred to another entity.

15.3.2 USFWS

USFWS shall be responsible for:

- Reviewing the CCAA and determining if it meets issuance criteria. Upon a successful review of this CCAA, the USFWS would issue an Enhancement of Survival Permit to LCRA and LCRA TSC in accordance with 50 C.F.R. §§ 17.22(d) or 17.32(d). Should, at a later date, any of the Covered Species become listed as endangered or threatened, the terms of this CCAA would go into effect and the issued permit will authorize incidental take while conducting Covered Activities within the Covered Area and its associated zones and sub-zones;
- Evaluating the results of monitoring data and Conservation Strategy to assess if Conservation Measures and Avoidance and Minimization Measures are providing the desired net conservation benefit to the Covered Species;
- Reviewing and approving LCRA's and LCRA TSC's Annual Report; and
- Maintaining a system of record that provides the confidentiality of certain information as described in Section 15.8.

15.3.3 All Parties

All parties shall be responsible for alerting any other party should any conflicts with ongoing conservation programs for the Covered Species arise or become known.

15.4 Dispute Resolution

USFWS, LCRA, and LCRA TSC agree to work together to resolve any disputes using dispute-resolution procedures agreed upon by the Parties.

15.5 Availability of Funds

USFWS is subject to the requirements of the Anti-Deficiency Act and the availability of appropriated funds. Nothing in this CCAA will be construed by the Parties to require the obligation, appropriation, or expenditure of any money from the U.S. Treasury. The Parties acknowledge that USFWS will not be required under this CCAA to expend any federal agency's appropriated funds unless and until an authorized official of that agency affirmatively acts to commit to such expenditures in writing.

15.6 No Third-Party Beneficiaries

This CCAA does not create any new right or interest in any member of the public as a third-party beneficiary, nor shall it authorize anyone not a Party to this CCAA to maintain a suit for personal injuries or damages pursuant to the provisions of this CCAA. The duties, obligations, and responsibilities of the Parties to this CCAA, with respect to third parties, shall remain as imposed under existing law. Specifically, LCRA's and LCRA TSC's commitments herein do not limit or otherwise restrict LCRA's and LCRA TSC's rights and obligations to provide water to third parties consistent with state law nor obligate LCRA or LCRA TSC to impose conditions on facilities owned, operated, or constructed by or on behalf of third parties that divert, impound, or discharge water or treated wastewater derived from water provided by LCRA or who receive electric transmission service from LCRA TSC within the Covered Area.

15.7 Relationship to Authorities

The terms of this CCAA shall be governed by and construed in accordance with applicable federal law. Nothing in this CCAA is intended to limit the authority of USFWS to fulfill its responsibilities under federal laws. All activities undertaken pursuant to this CCAA or its associated Permit must be in compliance with all applicable local, state, and federal laws and regulations.

15.8 Confidentiality

The Parties to this CCAA acknowledge that they are subject to open government laws, including the Freedom of Information Act (FOIA) or the Texas Public Information Act (TPIA). The Parties recognize that certain information, such as critical infrastructure information and information that is confidential pursuant to court order, is considered confidential and may be exempt from disclosure under FOIA and the TPIA. The Parties agree to (i) hold confidential information in strict confidence and to take all reasonable precautions to protect the confidential information (including, without limitation, all precautions the party with custody of the confidential information employs with respect to its most confidential materials), (ii) not to divulge the confidential information to any third parties (except as authorized herein), and (iii) not to make any use whatsoever at

any time of the confidential information except in connection with the purposes of this CCAA.

The Parties may disclose the confidential information to their respective officers, directors, employees, attorneys, subsidiaries and affiliates ("Representatives") working in connection with the purpose for which the confidential information is disclosed, but only to the extent necessary to carry out that purpose and subject to all requirements of confidentiality set forth in this CCAA. Each Party shall be responsible for any breach of this CCAA by any of its Representatives.

Release of confidential information by LCRA or LCRA TSC to USFWS for the limited purposes authorized herein is not to be construed as a waiver of any exceptions to FOIA or the TPIA's disclosure requirements that may apply to the confidential information. If USFWS receives a request for confidential information (by deposition, interrogatories, requests for information or documents in legal proceedings, subpoena, requests made under FOIA or the TPIA, civil investigative demand or other similar process) it shall promptly, but in any event within no more than three (3) calendars days, notify and provide LCRA and LCRA TSC a copy of the request. LCRA and LCRA TSC shall bear the responsibility and expense for asserting its objections and exceptions to disclosure of its confidential information. USFWS shall reasonably cooperate with LCRA and LCRA TSC in the assertion and presentation of appropriate exceptions, exclusions or objections to release and shall bear sole responsibility and expense for asserting its own confidentiality interests, if any, in the confidential information. If requested by LCRA or LCRA TSC, USFWS shall endeavor to provide LCRA and LCRA TSC the opportunity to intervene to prevent the release or disclosure of the confidential information in accordance with applicable law. USFWS will redact any information deemed or identified as confidential by LCRA, LCRA TSC, and/or USFWS within USFWS's FOIA guidelines. Additional information regarding USFWS's process for responding to FOIA requests for possibly confidential information is set out at 43 C.F.R. §§ 2.26-2.36 (2015).

In the event a Party is directed or ordered by the Justice Department, the United States Attorney General, the Texas Attorney General or a court of competent jurisdiction, or by an international, national, state or local government or regulatory body

to release any confidential information, that Party shall notify the other Party within three (3) business days of such direction or order. If either Party decides to pursue appeals or other legal remedies, the Parties shall cooperate to the fullest extent possible in such proceedings until all appeals or other legal remedies to protect such confidential information are exhausted or the party that decided to pursue an appeal or other legal remedy decides to cease that pursuit. In pursuing such appeals and/or other legal remedies, the Party deciding to pursue the appeal or other legal remedy shall bear the responsibility and expense of preparing pleadings, arguments, and other documentation and support necessary to the assertion of its position.

15.9 Modifications and Amendments

Any Party to this CCAA may propose modifications or amendments to this CCAA by providing written notice to the other Party. This written notice will include a description of the proposed amendment, the justification for the amendment, and the expected results or outcomes. The Party proposing the amendment will coordinate a meeting or conference call between the other Party to discuss the proposal. The Parties will respond in writing or electronic mail to proposed amendments within 60 days of receipt of such notice. After any National Environmental Policy Act (NEPA) requirements have been met, any proposed amendments upon which the parties agree will become effective only upon written concurrence of both parties.

In addition to amending the CCAA itself, and subject to the notice requirements of this Section, USFWS may amend the Permit associated with this CCAA in accordance with all applicable legal requirements including, but not limited to, the ESA, NEPA, and USFWS's general permitting regulations at 50 C.F.R. Parts 13 and 17, and formal USFWS policy.

15.10 Remedies

Each Party to this CCAA shall have all remedies otherwise available to enforce the terms of this CCAA and the Permit, except that no Party shall be liable in monetary damages for any breach of this CCAA, any performance or failure to perform an obligation under this CCAA, or any other cause of action arising from this CCAA.

As described in Section 5, LCRA and LCRA TSC are related, but separate entities and are separate parties under this CCAA, each with specific rights and obligations. For this reason, USFWS agrees that it shall not deem or consider LCRA or LCRA TSC to be in noncompliance with this CCAA by reason of the failure of the other Party to comply. In all events, responses and remedies for noncompliance shall be designed to impose the least possible adverse effect on a complying party.

16 AUTHORIZED SIGNATURES

IN WITNESS, WHEREOF, THE PARTIES HERETO have, as of the last signature below, executed this CCAA to be in effect as of the date of the last signature.

JEFFREY M FLEMING

Digitally signed by JEFFREY M FLEMING
Date: 2023.11.13 07:53:32 -07:00'

Regional Director ..... Date 11-13-2023
U.S. Fish and Wildlife Service, Southwest Region

Phil wilson (Nov 17, 2023 13:33 CST)

General Manager ..... Date 11-17-2007
Lower Colorado River Authority
LCRA Transmission Services Corporation

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APPENDIX A – SUMMARY OF LCRA WATER RIGHTS

Water Rights Owned and Controlled by LCRA

Water Right	Authorized Diversion (acre-feet per year, AFY)	Diversion Location(s)	Maximum Diversion Rate (cubic feet per second/cfs)	Relevant Conservation Zones
1. 14-5478 & 14-5482, including amendments (Lakes Buchanan & Travis)	1,500,000 (subject to limits and conditions in LCRA Water Management Plan). Authorized for hydroelectric generation.	From perimeter of each lake and any point along the Colorado River downstream of each lake. Diversions upstream of reservoirs allowed subject to customer securing separate water rights permit from TCEQ.	unspecified	A-1, A-2 & B (water deliveries via main stem of Colorado River downstream of Longhorn Dam) C (water deliveries) D

Water Rights Owned and Controlled by LCRA (cont'd)

Water Right	Authorized Diversion (AFY)	Diversion Location(s)	Maximum Diversion Rate (cfs)	Relevant Conservation Zones
2. 14-5479 (Inks Lake)	No consumptive diversions specified. Can divert water released from Lake Buchanan. Authorized for hydroelectric generation.	From perimeter of Inks Lake.	Unspecified	D
3. 14-5480 (Lake LBJ)	Unspecified diversion amount; consumptive use not to exceed 15,700 AFY in forced evaporation for LCRA's power plant. Other consumptive diversions are based on diversion of water released from Lake Buchanan Authorized for hydroelectric generation.	Perimeter of Lake LBJ.	5,270 cfs	D

Water Rights Owned and Controlled by LCRA (cont'd)

Water Right	Authorized Diversion (AFY)	Diversion Location(s)	Maximum Diversion Rate (cfs)	Relevant Conservation Zones
4. 14-5481 (Lake Marble Falls)	No consumptive diversions specified. Can divert water released from Lake Buchanan. Authorized for hydroelectric generation.	From perimeter of Lake Marble Falls.	Unspecified	D
5. 14-5434C and E (LCRA portion of Garwood water right)	133,000 AFY combined; includes specific diversion limits for diversions at locations upstream of Colorado County.	1) On west bank of the Colorado River in Colorado County adjacent to LCRA's Garwood Agricultural Operations. 2) Same diversion points as authorized under 14-5473, 14-5474, 14-5475, 14-5476, 14-5477, 14-5437.	Not to exceed a combined 600 cfs at all locations, subject to instream flow conditions for diversions upstream of Colorado County.	A-1, A-2, & B (main stem of Colorado River downstream of Longhorn Dam) C-2 D
6. 14-5473, including amendment (Lake Bastrop)	Unspecified amount of water can be diverted from Colorado River under 14-5482; consumptive use from lake is limited to 10,750 AFY. LCRA also may store and subsequently divert groundwater from Lake Bastrop.	1) River intake is located on the east bank of the Colorado River in Bastrop County, Texas, between Utley and Bastrop. 2) LCRA also diverts water from the perimeter of Lake Bastrop.	1) 33.33 cfs from the Colorado River. 2) Unspecified from perimeter of Lake Bastrop.	B (river intake) D (Lake Bastrop)

Water Rights Owned and Controlled by LCRA (cont'd)

Water Right	Authorized Diversion (AFY)	Diversion Location(s)	Maximum Diversion Rate (cfs)	Relevant Conservation Zones
7. 14-5474, including amendment (Fayette Power Project, including Cedar Creek Reservoir (a.k.a. Lake Fayette) and Baylor Creek Reservoir (not yet constructed))	From the Colorado River not to exceed 73,759 AFY authorized 14-5478 and 14-5482; unspecified amount from lake with consumptive use limit of 38,101 AFY.	1) River intake is located on the east bank of the Colorado River in Fayette County southeast of La Grange, Texas. 2) Perimeter of either reservoir.	1) 117 cfs from the Colorado River. 2) 3,175 cfs from Cedar Creek Reservoir.	A-2 (river intake) D (Cedar Creek Reservoir)
8. 14-5475, including amendments (Lakeside)	186,250 AFY from the Colorado River; (diversion from Eagle Lake is water originating from Colorado River)	1) River intake located on the east bank of the Colorado River in Colorado County, Texas, west of Eagle Lake, Texas. 2) Perimeter of the Eagle Lake.	1) 700 cfs from the Colorado River. 2) 120.30 cfs from Eagle Lake.	A-1, A-2 C-2

Water Rights Owned and Controlled by LCRA (cont'd)

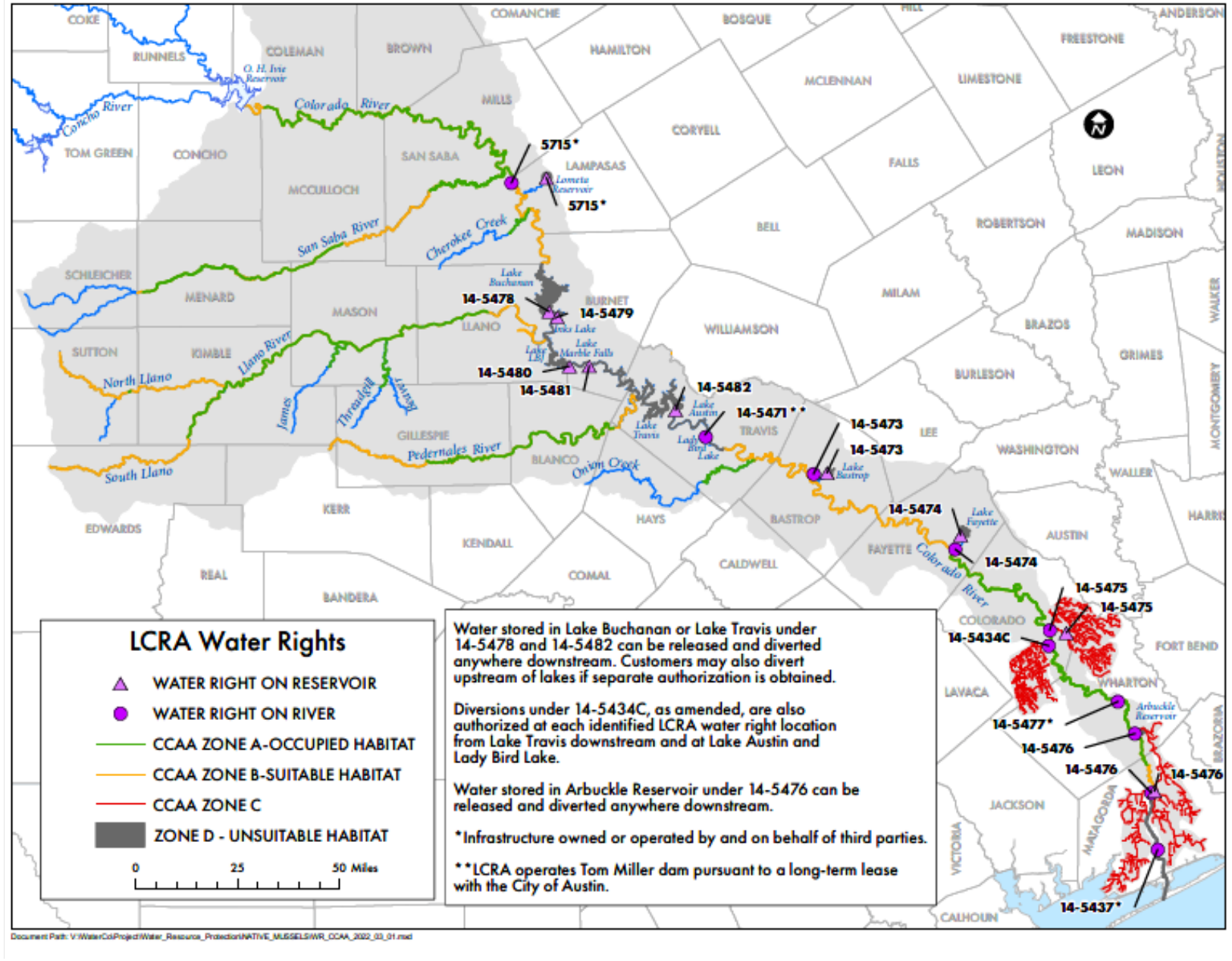
Water Right	Authorized Diversion (AFY)	Diversion Location(s)	Maximum Diversion Rate (cfs)	Relevant Conservation Zones
9. 14-5476, including amendments (Gulf Coast)	262,500 AFY	1) East bank of Lane City Dam Reservoir on Colorado River in Wharton County, Texas, west of Lane City. 2) East bank of Bay City Dam Reservoir on Colorado River in Matagorda County, Texas. 3) West bank of Bay City Dam Reservoir. 4) For water released from Arbuckle Reservoir, any point below the release.	1) 561 cfs 2) 145.20 cfs 3) 561 cfs 4) Water released from Arbuckle Reservoir to the river may be diverted farther downstream. Releases and diversions are limited to up to 450 cfs under normal conditions and 750 cfs under emergency operations.	A-1, A-2 D (Arbuckle Reservoir) C-1, C-2
10. 5731 ("Excess flows")	853,514 AFY from Colorado River; 327,591 AFY from off-channel reservoirs.	Diversion points authorized under 14-5434C, 14-5475 and 14-5476 in Colorado, Wharton and Matagorda counties.	10,000 cfs from the river, subject to environmental flow conditions.	A-1, A-2 D (LCRA has a pending application to use Arbuckle Reservoir under this water right)

Water Rights Associated with Facilities Operated by LCRA

Water Right	Authorized Diversion (AFY)	Diversion Location(s)	Maximum Diversion Rate (cfs)	Relevant Conservation Zones
14-5471, including amendments (The City of Austin owns this water right, but LCRA operates Tom Miller Dam pursuant to a long-term lease)	272,403 AFY; authorized for hydroelectric generation.	Perimeter of Lake Austin.	unspecified	D

Water Rights Owned by LCRA With Facilities Controlled by Third Parties

Water Right	Authorized Diversion (AFY)	Diversion Location(s)	Maximum Diversion Rate (cfs)	Relevant Conservation Zones
1. 5715, including amendment (Lometa) (LCRA owns this water right, but it is leased by Corix Utilities, and a sale to Corix Utilities is pending)	1) 882 AFY from Colorado River. 1) 476 AFY from perimeter of Lometa Reservoir.	1) On the east bank of the Colorado River in Lampasas County, 10 miles west of the city of Lometa and immediately downstream of the US Hwy 190 bridge. 2) Perimeter of Lometa Reservoir.	1) 4 cfs 2) 2.3 cfs	D
2. 14-5477, including amendments (Pierce Ranch owns and operates the intake associated with this water right)	55,000 AFY	West bank of the Colorado in Wharton County, Texas, west of Wharton, Texas.	400 cfs	A-1, A-2
3. 14-5437, including amendments (LCRA co-owns the water right; however, STP Nuclear Operating Company owns and controls the intake and associated off-channel reservoir where the water is used pursuant to long-term contract with LCRA)	102,000 AFY from Colorado River.	West Bank of the Colorado River in Matagorda County.	1,200 cfs	D


LCRA Water Rights
WATER RIGHT ON RESERVOIR
WATER RIGHT ON RIVER
CCAA ZONE A-OCCUPIED HABITAT
CCAA ZONE B-SUITABLE HABITAT
CCAA ZONE C
ZONE D - UNSUITABLE HABITAT
0 25 50 Miles
Water stored in Lake Buchanan or Lake Travis under 14-5478 and 14-5482 can be released and diverted anywhere downstream. Customers may also divert upstream of lakes if separate authorization is obtained.
Diversions under 14-5434C, as amended, are also authorized at each identified LCRA water right location from Lake Travis downstream and at Lake Austin and Lady Bird Lake.
Water stored in Arbuckle Reservoir under 14-5476 can be released and diverted anywhere downstream.
*Infrastructure owned or operated by and on behalf of third parties.
**LCRA operates Tom Miller dam pursuant to a long-term lease with the City of Austin.
5715*
5715*
14-5478
14-5479
14-5480
14-5481
14-5482
14-5471**
14-5473
14-5473
14-5474
14-5474
14-5475
14-5475
14-5434C
14-5477*
14-5476
14-5476
14-5476
14-5437*
Colorado River
San Saba River
Llano River
North Llano
South Llano
Pedernales River
Cherokee Creek
Onion Creek
Concho River
COKE
RUNNELS
COLEMAN
BROWN
COMANCHE
HAMILTON
BOSQUE
MCLENNAN
LIMESTONE
FREESTONE
ANDERSON
LEON
ROBERTSON
MADISON
TOM GREEN
CONCHO
MILLS
SAN SABA
MCCULLOCH
LAMPASAS
CORYELL
FALLS
BELL
SCHLEICHER
MENARD
MASON
LLANO
BURNET
WILLIAMSON
MILAM
BRAZOS
GRIMES
WALKER
MONTGOMERY
SUTTON
KIMBLE
GILLESPIE
BLANCO
TRAVIS
BURLESON
LEE
WASHINGTON
WALLER
EDWARDS
KERR
HAYS
BASTROP
FAYETTE
AUSTIN
KENDALL
CALDWELL
REAL
BANDERA
COMAL
COLORADO
FORT BEND
WHARTON
LAVACA
JACKSON
VICTORIA
MATAGORDA
BRAZORIA
CALHOUN

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AquaStrategies
Water Planning, Science & Engineering

TO: David Wheelock
Director, Water Supply Planning, Water Resources Management
Lower Colorado River Authority

FROM: Tim Osting – 512-627-1563 - tosting@aquastrategies.com
Frank Schalla
Annabeth McCall

DATE: October 11, 2021

RE: Hydrologic Analysis for the Lower Colorado River Authority in support of a potential Candidate Conservation Agreement with Assurances with the U.S. Fish and Wildlife Service for certain freshwater mussels

1 Introduction

This memorandum summarizes hydrologic analysis performed by Aqua Strategies for the Lower Colorado River Authority (LCRA), in support of a potential Candidate Conservation Agreement with Assurances (CCAA) with the US Fish and Wildlife Services (USFWS). If finalized, LCRA expects the CCAA will address several freshwater mussels that are candidates for listing as threatened or endangered under the Endangered Species Act.

The purpose of this hydrologic analysis is to characterize streamflow in the lower Colorado River basin across a range of flow conditions. LCRA can use this hydrologic analysis as it considers various potential conservation measures for inclusion in the CCAA, such as those that might address future low-flow risk or seek to expand habitat.

2 Methods

2.1 Study Area

The spatial scope of this analysis is defined by the Lower Colorado River Authorities' (LCRA) water service area, which is shown in Figure 1. The water service area begins on the Colorado River at the confluence of Brown, McCullough, and Coleman Counties, and continues downstream to its confluence with Matagorda Bay.

The spatial scope used for this analysis is sub-divided into 9 separate LCRA CCAA stream segments, which are closely aligned to TCEQ stream segments, except on the Colorado River main stem downstream of Lady Bird Lake, where segment boundaries coincide with flow monitoring stations. Each stream segment has an associated USGS streamgage, or measurement point, where flows are compared

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to environmental flow standards for each particular reach. Measurement points are referenced from both the LCRA WMP (2020) and the TCEQ Environmental Flow Standards (2012) and are described in more detail in Section 2.3. Figure 2 shows the LCRA water service area and applicable reaches analyzed. The figure also identifies zones included in the CCAA that relate to occupied suitable habitat or suitable habitat for candidate freshwater mussels across the LCRA water service area.

2.2 Hydrologic Scenarios

Surface water hydrology was analyzed from two sources, output from the TCEQ Water Rights Analysis Package (WRAP) Water Availability Model (WAM), and observed USGS stream flow records.

The TCEQ WAM is a modeling program used by the TCEQ as part of the process for granting and authorizing water rights for water basins in the State of Texas, including the Colorado Basin. The WAM modeling tool is used to predict the amount of water that is available in a river system under user defined conditions. It includes a baseline estimate of unimpacted stream hydrology called "naturalized flows" to which all existing water rights in a basin are applied, including permitted diversions, return flow discharges and a diverter's monthly demand distribution. The WAM model also includes the effects of reservoirs, including reservoir storage, evaporation and precipitation. Stream gains and losses, and applicable environmental flow conditions are considered. The TCEQ WAM is simulated on a monthly average time step, from the year 1940 through 2016 for the Colorado Basin.

USGS streamgage observations were used for the Historical Conditions scenario. When available, daily average flow observations were collected from 1940 through 2016. Table 1 lists the periods of available data for each measurement point.

Three different scenarios representing streamflows under different water management practices were considered for this analysis. Each scenario was derived for the period 1940 through 2016, when available, which includes drought, base and high flow conditions. The historical conditions scenario is on a daily timestep using available daily data, while the Naturalized and Full Authorization scenarios are on a monthly timestep consistent with the WAM model. The scenarios analyzed include:

1. **Naturalized Scenario.** This scenario represents natural stream flow conditions on a monthly timestep without anthropogenic effects such as water user diversions, return flow discharges or reservoir operations. Naturalized flow data is flow input in the WAM model.
2. **Historical Conditions.** This scenario uses observed USGS stream flow records on a daily timestep, as available from 1940 through 2016 (Table 1). The historical conditions scenario is considered the baseline condition, indicating what has occurred over the past 75 years.
3. **Full Authorization Scenario.** This scenario considers the impact from all water permits in a basin using their full authorized diversion amounts, and without any return flow discharges. This scenario is a hypothetical future worst-case scenario based on maximum water use in a basin and is on a monthly basis. It is a conservative estimate for future conditions because water demands are not expected to reach full utilization during the CCAA timeframe and a large amount of water users are expected to continue discharging return flows. This scenario is an output from the WAM model.

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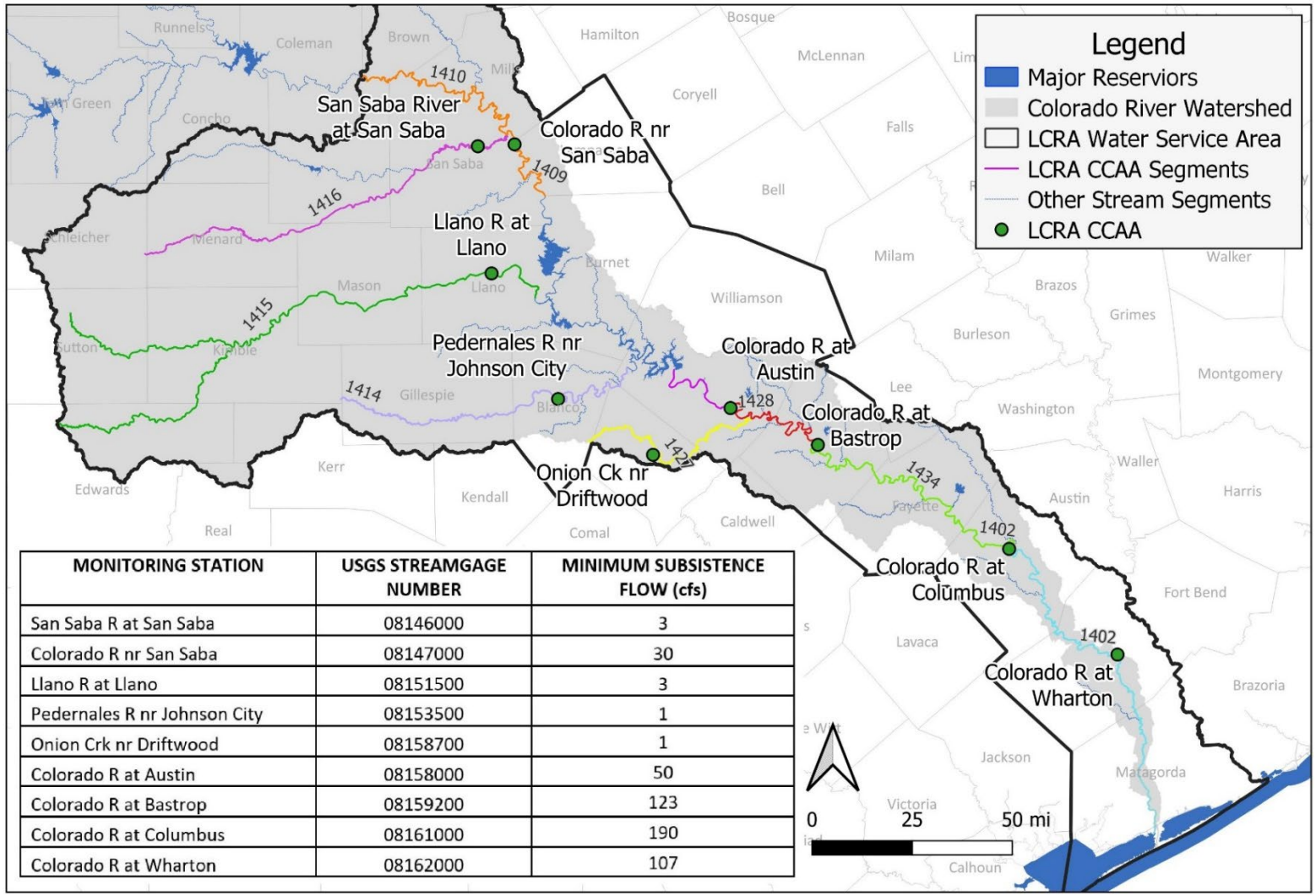

MONITORING STATION	USGS STREAMGAGE NUMBER	MINIMUM SUBSISTENCE FLOW (cfs)
San Saba R at San Saba	08146000	3
Colorado R nr San Saba	08147000	30
Llano R at Llano	08151500	3
Pedernales R nr Johnson City	08153500	1
Onion Crk nr Driftwood	08158700	1
Colorado R at Austin	08158000	50
Colorado R at Bastrop	08159200	123
Colorado R at Columbus	08161000	190
Colorado R at Wharton	08162000	107

Figure 1. Map of stream segments and associated streamgage locations within the Lower Colorado River Authorities Water Service Area used in this analysis.

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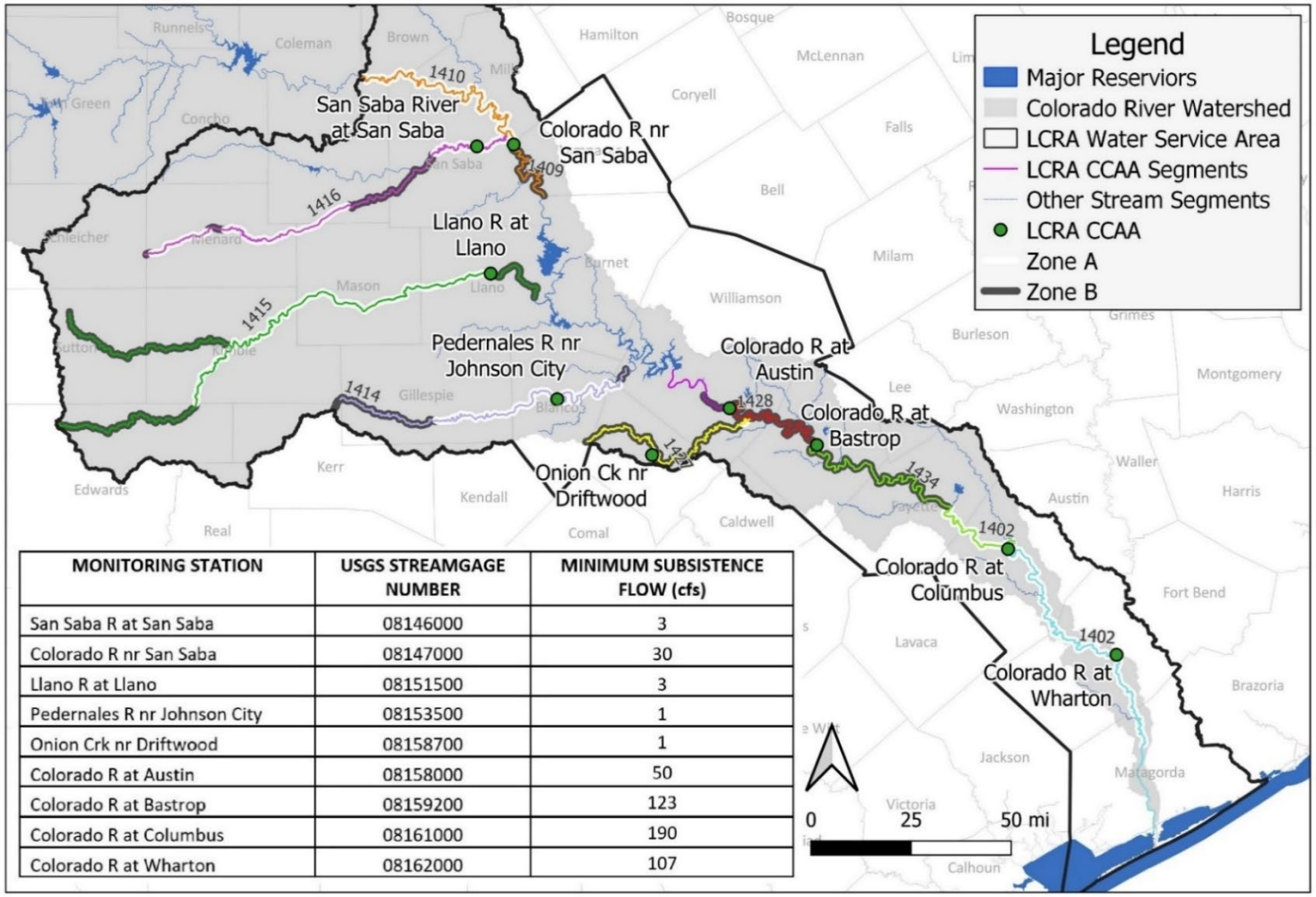

MONITORING STATION	USGS STREAMGAGE NUMBER	MINIMUM SUBSISTENCE FLOW (cfs)
San Saba R at San Saba	08146000	3
Colorado R nr San Saba	08147000	30
Llano R at Llano	08151500	3
Pedernales R nr Johnson City	08153500	1
Onion Crk nr Driftwood	08158700	1
Colorado R at Austin	08158000	50
Colorado R at Bastrop	08159200	123
Colorado R at Columbus	08161000	190
Colorado R at Wharton	08162000	107

Figure 2. Map of stream segments and associated streamgage locations within the Lower Colorado River Authorities Water Service Area used in this analysis. Zones designated in the CCAA for occupied suitable habitat and suitable habitat are also shown.

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Table 1. USGS streamgages and periods of available observation data for the Historical Conditions scenario.

Measurement Point (USGS Gage)	USGS Gage No.	Historical Data Start Date	Historical Data End Date
San Saba River at San Saba, TX [1]	08146000	1/1940	12/2016
Colorado River near San Saba, TX	08147000	1/1940	12/2016
Llano River at Llano, TX	08151500	1/1940	12/2016
Pedernales River near Johnson City, TX	08153500	1/1940	12/2016
Onion Creek near Driftwood, TX	08158700	7/1979	12/2016
Colorado River at Austin, TX	08158000	1/1940	12/2016
Colorado River at Bastrop, TX	08159200	3/1960	12/2016
Colorado River at Columbus, TX	08161000	1/1940	12/2016
Colorado River at Wharton, TX	08162000	1/1940	12/2016

[1] Data gap from 10/1993 through 9/1997

2.3 Flow Conditions and Evaluated Metrics

To assess historic and future potential for low-flow conditions, the occurrence of subsistence flows and the occurrence of zero flows were metrics calculated at various points within the LCRA water service area. The occurrence of zero flow was calculated as a percent of time at zero flow. The occurrence of subsistence flows was calculated as the percent of time below subsistence; for the Naturalized and Full Authorization scenarios the percent of months is calculated, and for the Historical scenario the percent of days is calculated. The occurrence metrics were developed for each hydrologic scenario at each measurement point and its associated stream segment.

Subsistence flows are defined as "the minimum streamflow needed during critical drought periods to maintain tolerable water quality conditions and to provide minimal aquatic habitat space for the survival of aquatic organisms" (NAS 2005). The subsistence flow values and associated measurement points used in this analysis (Table) are from the TCEQ Environmental Flow Standards (2012) for the Colorado River. The exception is the Colorado River at Austin measurement point that uses a subsistence flow value from the LCRA WMP (2020). For each measurement point the minimum of the monthly-varying subsistence flow values from the TCEQ's standards or LCRA WMP was used in this analysis.

The available period of historical daily observation records for USGS San Saba River at San Saba, Onion Creek near Driftwood, and the Colorado River at Bastrop streamgages used for the Historical Conditions scenario (Table 1) is shorter than the TCEQ WAM period of available monthly information (1940 – 2016) that was used for all locations for the Naturalized or Full Authorization scenarios. If comparing evaluation metrics from the daily Historical Conditions scenario to the monthly Naturalized or Full Authorization scenarios, the different time periods (i.e., Table 1) and timesteps (i.e., daily and monthly) used to generate these metrics should be considered. These differences are discussed and analyzed further in Section 3.3.

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Table 2. Measurement points (USGS streamgages) evaluated in this analysis, along with its subsistence flow value used in the analysis. Minimum subsistence flow value sources are from the TCEQ Environmental Flow Standards (2012), except where otherwise noted.

Measurement Point (USGS Gage)	USGS Gage No.	Minimum Subsistence Flow (cfs)
San Saba River at San Saba, TX	08146000	3
Colorado River near San Saba, TX	08147000	30
Llano River at Llano, TX	08151500	3
Pedernales River near Johnson City, TX	08153500	1
Onion Creek near Driftwood, TX	08158700	1
Colorado River at Austin, TX	08158000	50 [(a)]
Colorado River at Bastrop, TX	08159200	123
Colorado River at Columbus, TX	08161000	190
Colorado River at Wharton, TX	08162000	107

[a] Minimum subsistence flow value from the LCRA WMP (2020)

3 Results

3.1 Subsistence Flows

Each scenario's time series of flows were compared against subsistence flow values listed in Table to determine the percent of time below each measurement point's subsistence flow value. A summary of this statistic for all measurement points is listed in Table 3, while Figure 3 through Figure 5 show these statistics spatially across the LCRA water service area for each scenario.

All measurement points had a lower percentage of time below subsistence for the Full Authorization scenario (i.e. future worst-case condition) compared to the Historical Conditions scenario. Some locations exhibited increases in percent of time below subsistence for the Full Authorization compared to the Naturalized Scenario.

3.2 Zero Flows

The percent of time of zero streamflow for each location is documented for each flow scenario (Table 4) and shown spatially in Figure 6 through Figure 8.

Downstream of the LCRA operated dams, which form the six Highland Lakes (i.e. Buchanan, Inks, LBJ, Marble Falls, Travis and Austin), there are no scenarios with zero flow on any of the Colorado River measurement points. Both the Naturalized and Full Authorization scenarios had the same percent of time of zero streamflow in tributaries Pedernales River and Onion Creek.

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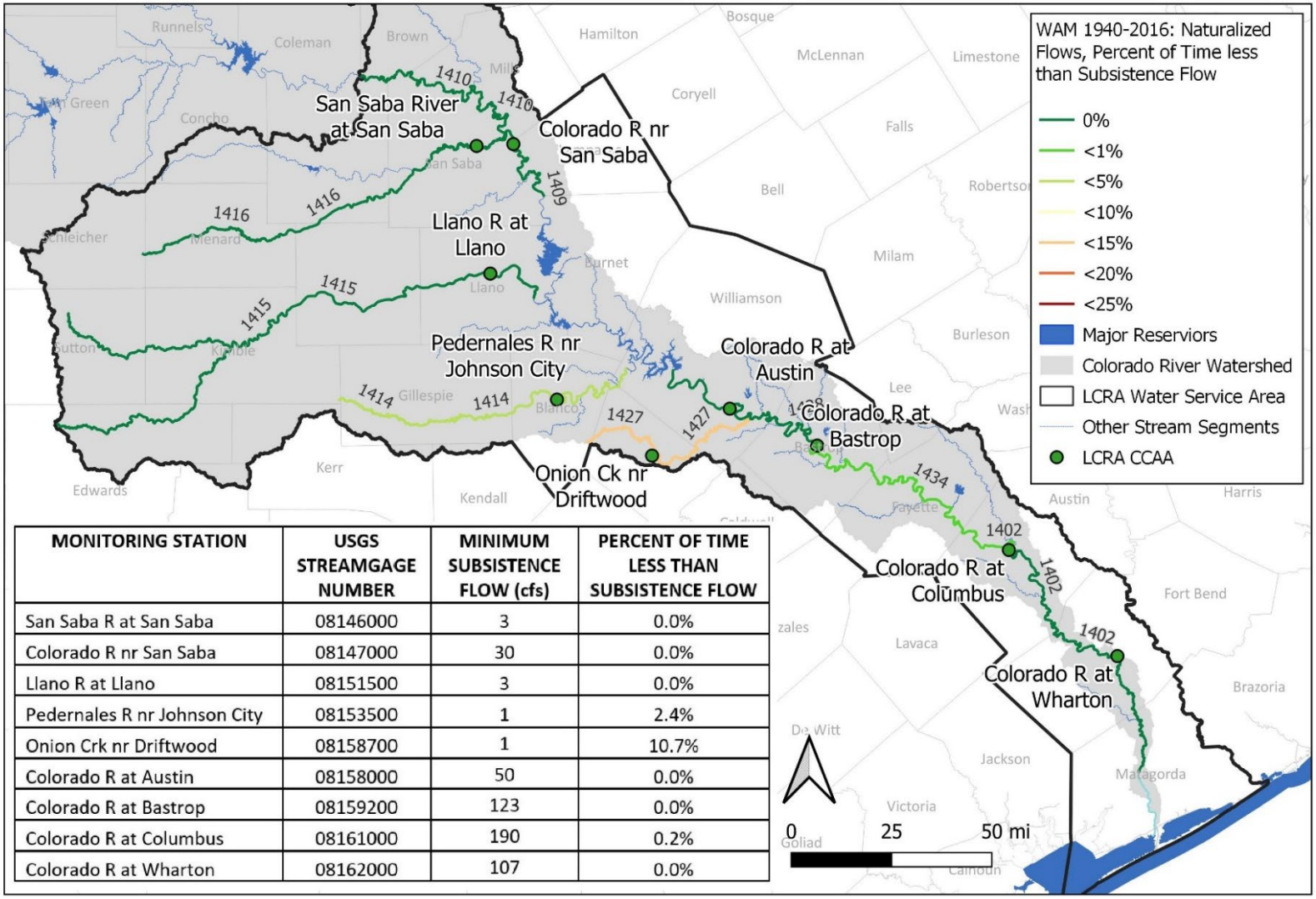

MONITORING STATION	USGS STREAMGAGE NUMBER	MINIMUM SUBSISTENCE FLOW (cfs)	PERCENT OF TIME LESS THAN SUBSISTENCE FLOW
San Saba R at San Saba	08146000	3	0.0%
Colorado R nr San Saba	08147000	30	0.0%
Llano R at Llano	08151500	3	0.0%
Pedernales R nr Johnson City	08153500	1	2.4%
Onion Crk nr Driftwood	08158700	1	10.7%
Colorado R at Austin	08158000	50	0.0%
Colorado R at Bastrop	08159200	123	0.0%
Colorado R at Columbus	08161000	190	0.2%
Colorado R at Wharton	08162000	107	0.0%

Figure 3. Percent of time below subsistence flow under the Naturalized Scenario.

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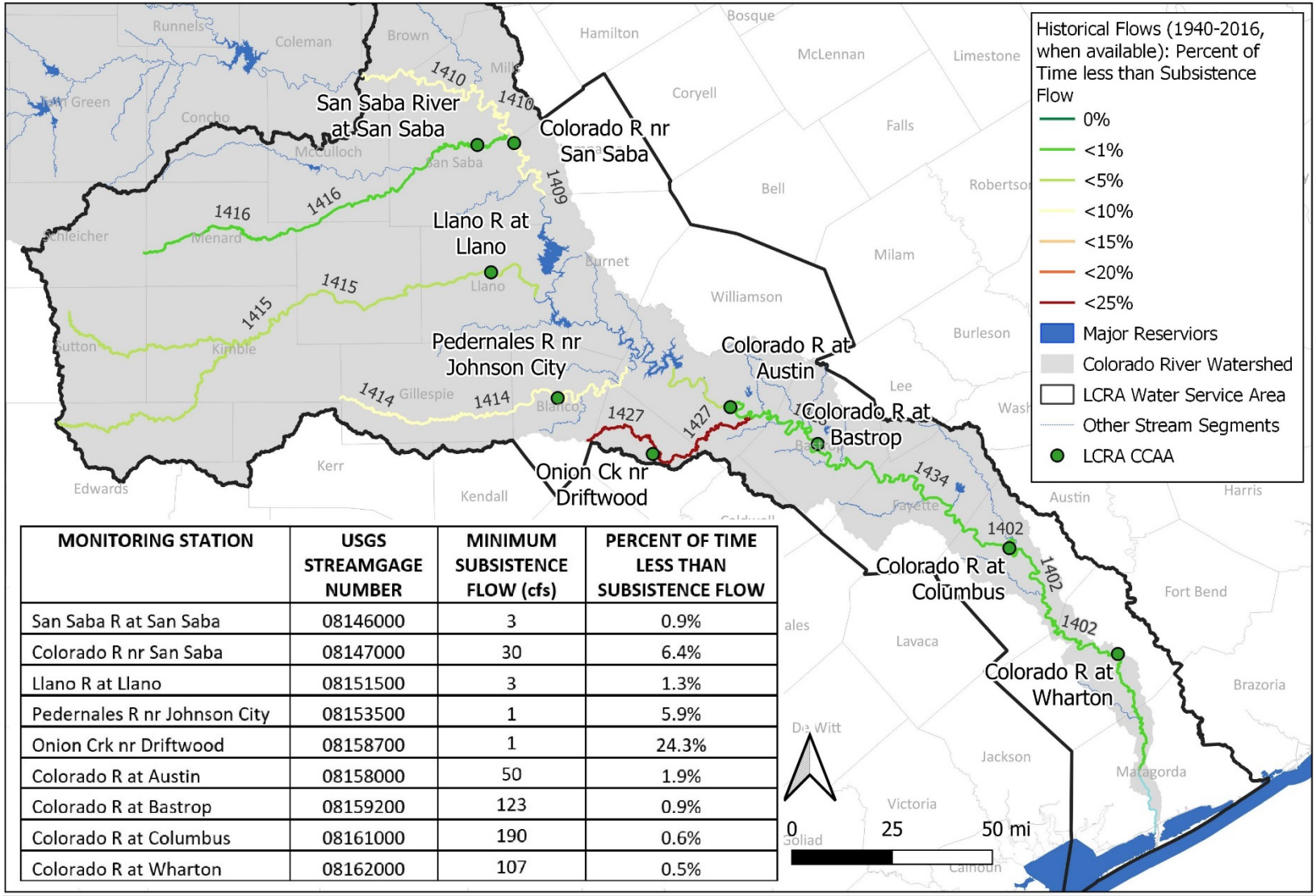

MONITORING STATION	USGS STREAMGAGE NUMBER	MINIMUM SUBSISTENCE FLOW (cfs)	PERCENT OF TIME LESS THAN SUBSISTENCE FLOW
San Saba R at San Saba	08146000	3	0.9%
Colorado R nr San Saba	08147000	30	6.4%
Llano R at Llano	08151500	3	1.3%
Pedernales R nr Johnson City	08153500	1	5.9%
Onion Crk nr Driftwood	08158700	1	24.3%
Colorado R at Austin	08158000	50	1.9%
Colorado R at Bastrop	08159200	123	0.9%
Colorado R at Columbus	08161000	190	0.6%
Colorado R at Wharton	08162000	107	0.5%

Figure 4. Percent of time below subsistence flow under the Historical Scenario.

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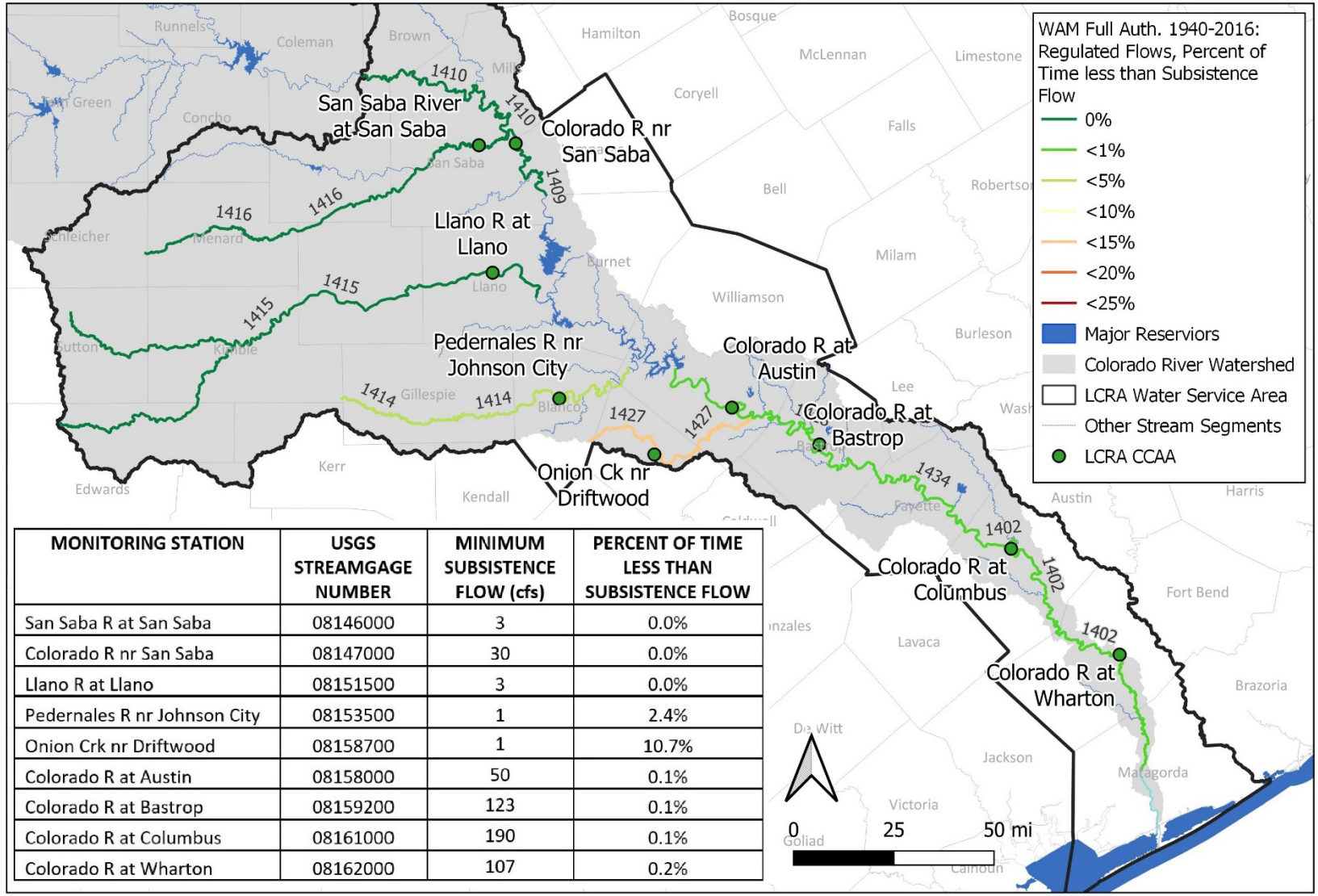

MONITORING STATION	USGS STREAMGAGE NUMBER	MINIMUM SUBSISTENCE FLOW (cfs)	PERCENT OF TIME LESS THAN SUBSISTENCE FLOW
San Saba R at San Saba	08146000	3	0.0%
Colorado R nr San Saba	08147000	30	0.0%
Llano R at Llano	08151500	3	0.0%
Pedernales R nr Johnson City	08153500	1	2.4%
Onion Crk nr Driftwood	08158700	1	10.7%
Colorado R at Austin	08158000	50	0.1%
Colorado R at Bastrop	08159200	123	0.1%
Colorado R at Columbus	08161000	190	0.1%
Colorado R at Wharton	08162000	107	0.2%

Figure 5. Percent of time below subsistence flow under the Full Authorization Scenario.

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Table 3. Percent of time less than subsistence flows for each measurement point, for each scenario[1]

Measurement Point (USGS Gage)	USGS Gage No.	Naturalized Scenario (Percent of time less than subsistence)	Historical Conditions (Percent of time less than subsistence)	Full Authorization Scenario (Percent of time less than subsistence)
San Saba River at San Saba, TX	08146000	0	0.9	0
Colorado River near San Saba, TX	08147000	0	6.4	0
Llano River at Llano, TX	08151500	0	1.3	0
Pedernales River near Johnson City, TX	08153500	2.4	5.9	2.4
Onion Creek near Driftwood, TX	08158700	10.7	24.3	10.7
Colorado River at Austin, TX	08158000	0	1.9	0.1
Colorado River at Bastrop, TX	08159200	0	0.9	0.1
Colorado River at Columbus, TX	08161000	0.2	0.6	0.1
Colorado River at Wharton, TX	08162000	0	0.5	0.2

The largest percent of time of zero streamflow is exhibited for the Historical Condition scenario with Onion Creek at 9.9%, which has a gage period of record from 1979 through 2016. Other measurement points with the existence of zero streamflow were either tributaries of the Colorado River with no upstream LCRA operated reservoirs, or the Colorado River near San Saba, which is near the upper extents of the LCRA Water Service Area and also upstream of LCRA operated reservoirs.

Table 4. Percent of time zero streamflow for each measurement point for each scenario.[1]

Measurement Point (USGS Gage)	USGS Gage No.	Naturalized Scenario (Percent of time zero streamflow)	Historical Conditions (Percent of time zero streamflow)	Full Authorization Scenario (Percent of time zero streamflow)
San Saba River at San Saba, TX	08146000	0	0.5	0
Colorado River near San Saba, TX	08147000	0	0.2	0
Llano River at Llano, TX	08151500	0	0.5	0
Pedernales River near Johnson City, TX	08153500	0.8	3.2	0.8
Onion Creek near Driftwood, TX	08158700	3.7	9.9	3.7
Colorado River at Austin, TX	08158000	0	0	0
Colorado River at Bastrop, TX	08159200	0	0	0
Colorado River at Columbus, TX	08161000	0	0	0
Colorado River at Wharton, TX	08162000	0	0	0

[1]The San Saba River at San Saba, Onion Creek near Driftwood, and Colorado River at Bastrop measurement points have different periods of record for the Historical Conditions scenario compared to the Naturalized and Full Authorization scenarios. Reference Table 1Table 1 for more details.

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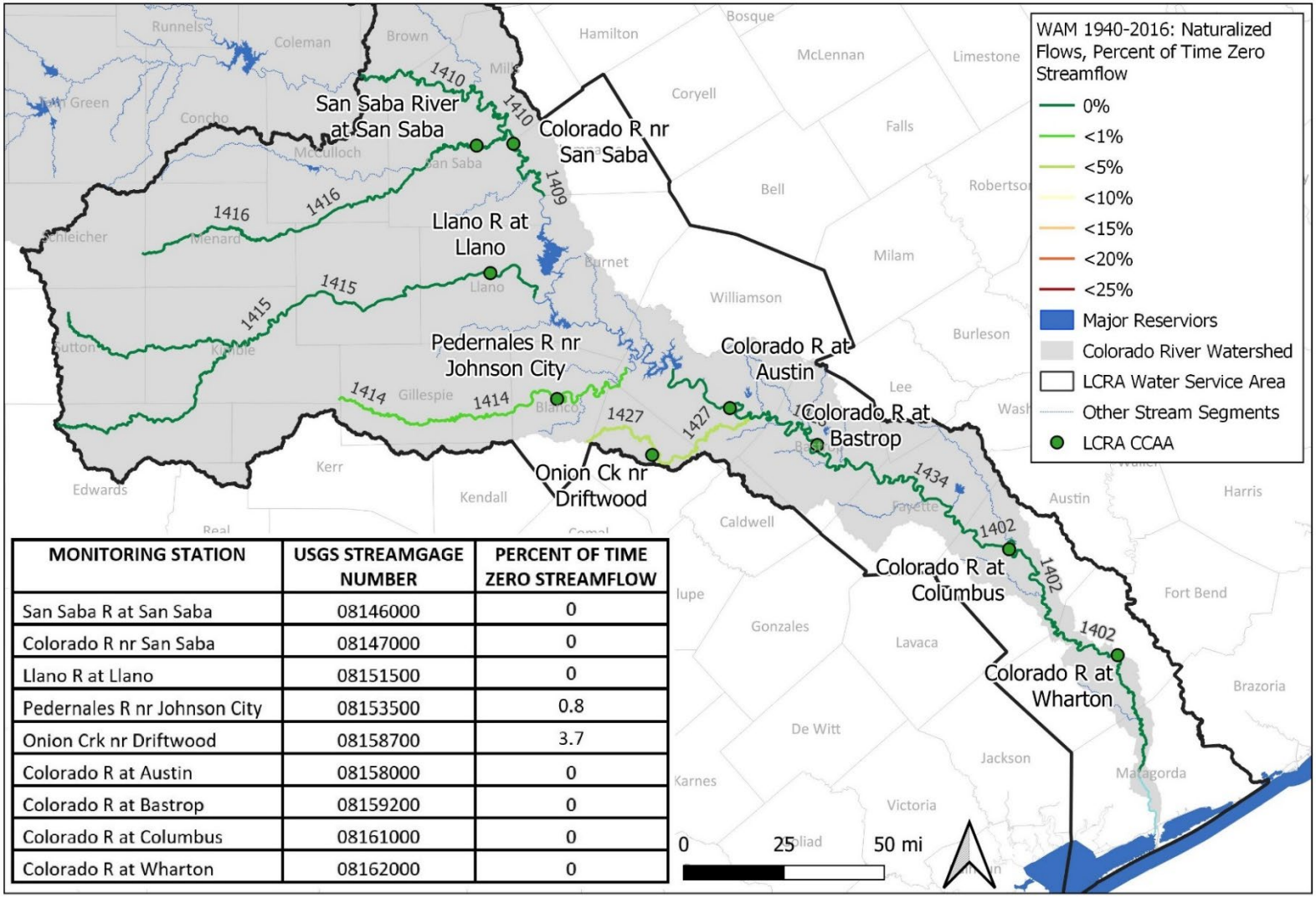

MONITORING STATION	USGS STREAMGAGE NUMBER	PERCENT OF TIME ZERO STREAMFLOW
San Saba R at San Saba	08146000	0
Colorado R nr San Saba	08147000	0
Llano R at Llano	08151500	0
Pedernales R nr Johnson City	08153500	0.8
Onion Crk nr Driftwood	08158700	3.7
Colorado R at Austin	08158000	0
Colorado R at Bastrop	08159200	0
Colorado R at Columbus	08161000	0
Colorado R at Wharton	08162000	0

Figure 6. Percent of time zero streamflow under the Naturalized Scenario.

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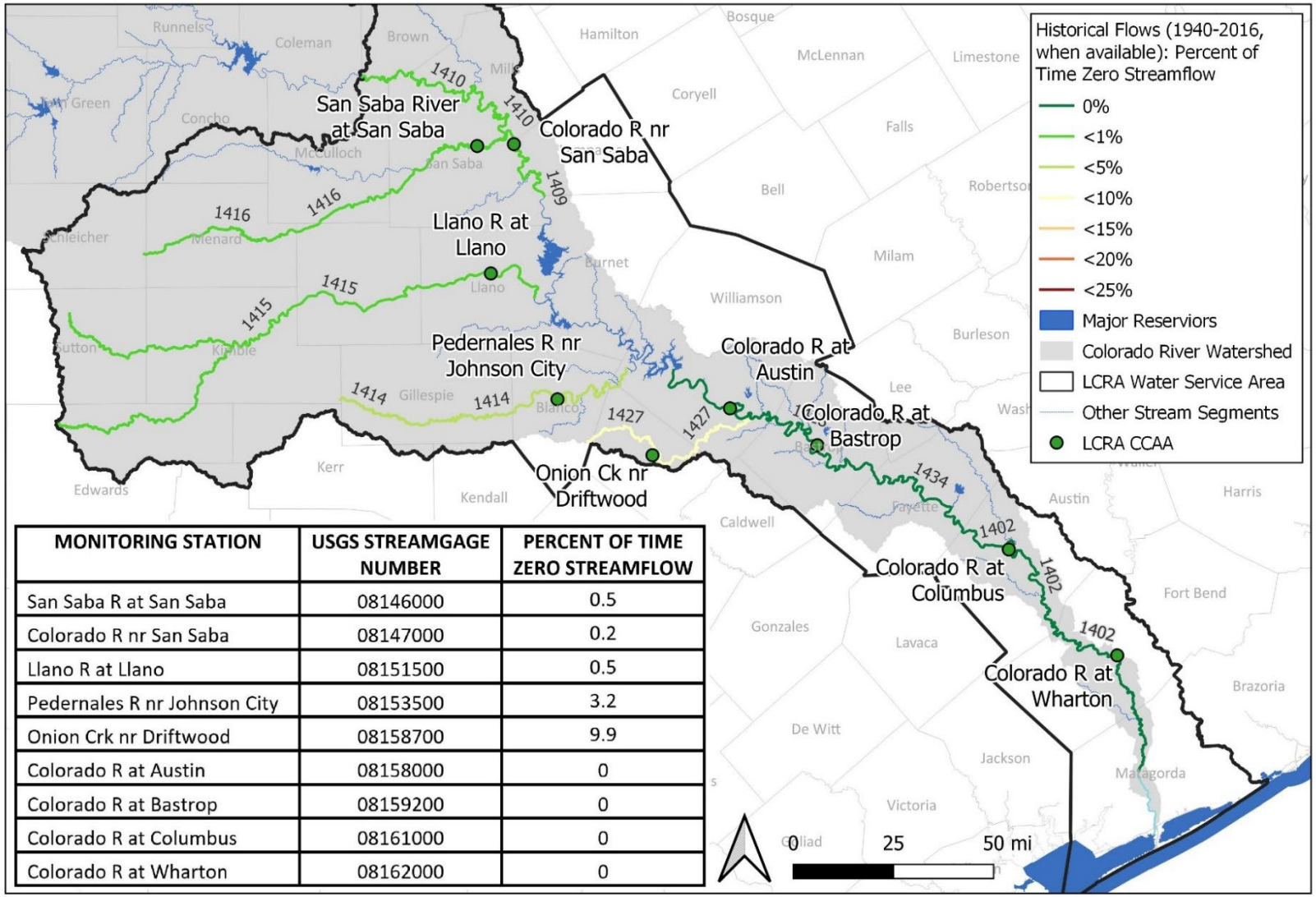

MONITORING STATION	USGS STREAMGAGE NUMBER	PERCENT OF TIME ZERO STREAMFLOW
San Saba R at San Saba	08146000	0.5
Colorado R nr San Saba	08147000	0.2
Llano R at Llano	08151500	0.5
Pedernales R nr Johnson City	08153500	3.2
Onion Crk nr Driftwood	08158700	9.9
Colorado R at Austin	08158000	0
Colorado R at Bastrop	08159200	0
Colorado R at Columbus	08161000	0
Colorado R at Wharton	08162000	0

Figure 7. Percent of time zero streamflow under the Historical Conditions scenario.

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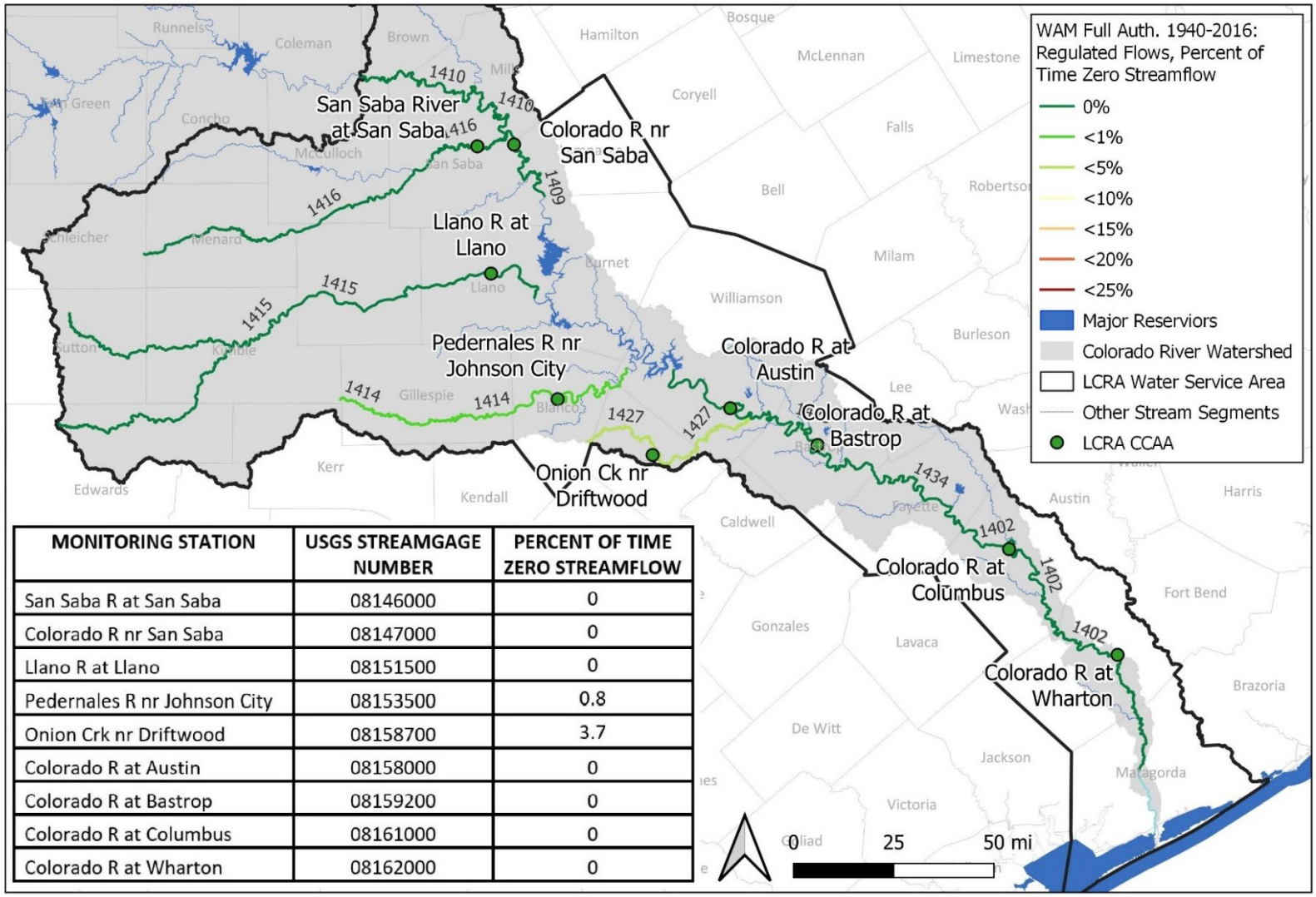

MONITORING STATION	USGS STREAMGAGE NUMBER	PERCENT OF TIME ZERO STREAMFLOW
San Saba R at San Saba	08146000	0
Colorado R nr San Saba	08147000	0
Llano R at Llano	08151500	0
Pedernales R nr Johnson City	08153500	0.8
Onion Crk nr Driftwood	08158700	3.7
Colorado R at Austin	08158000	0
Colorado R at Bastrop	08159200	0
Colorado R at Columbus	08161000	0
Colorado R at Wharton	08162000	0

Figure 8. Percent of time zero streamflow under the Full Authorization Scenario.

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3.3 Analysis using coincident time periods and monthly data

Historical USGS daily observation data at the Saba River at San Saba, Onion Creek near Driftwood, and Colorado River at Bastrop measurement points are available for shorter time periods (Table 1) compared to the TCEQ WAM period of available monthly information (1940 through 2016) for the Naturalized and Full Authorization scenarios. As summarized in Table 3 and Table 4 above, results for each scenario are calculated using the full period of available information for each individual statistic. Since the historical data period at some locations is shorter than the WAM, this results in a non-uniform temporal comparison between scenario statistics.

Additionally, the statistics in Table 3 and Table 4 are calculated using input information of varying timesteps. The Historical Conditions scenario statistics utilize daily observation records while the Naturalized and Full Authorization scenarios utilize TCEQ WAM monthly information. Generally, monthly data do well at estimating extended periods of low flow or high flow conditions, but a monthly timestep does not capture day-to-day variations.

To produce a consistent comparison of measurement point scenario statistics, both the percent of time less than subsistence flows (Table 5) and percent of time zero streamflow (Table 6) statistics were recalculated using month-average data for consistent time periods. The Historical Condition daily observation records were averaged on a monthly timestep before statistics were calculated. The San Saba River at San Saba, Onion Creek near Driftwood, and Colorado River at Bastrop measurement points statistics were calculated using all available historical observation data and using shortened periods of TCEQ WAM monthly records for the Naturalized and Full Authorization scenarios that align with the Historical Conditions available observation records.

The percent of time less than subsistence and percent of time zero streamflow statistics are more similar across all month average scenarios (Table 5 and Table 6) when compared to statistics above across scenarios in Table 3 and Table 4 where the daily Historical Conditions scenario statistics appear higher than the monthly WAM scenarios. While the monthly TCEQ WAM files do not capture day-to-day variability in stream flow, the similarity of monthly TCEQ WAM statistics to month-averaged historical observed conditions indicate the TCEQ WAM can be reasonably compared to historical conditions, and can be used to anticipate how future conditions may change relative to naturalized or historical conditions.

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Table 5. Percent of time less than subsistence flows for each measurement point, for each scenario. Statistics were calculated using a consistent period of record for each measurement point and by converting daily observation records to monthly averages for the Historical Conditions scenario.

Measurement Point (USGS Gage)	USGS Gage No.	Naturalized Scenario (Percent of time less than subsistence)	Historical Conditions (monthly average percent of time less than subsistence)	Full Authorization Scenario (Percent of time less than subsistence)	Analysis Start Date	Analysis End Date
San Saba River at San Saba, TX [1]	08146000	0	0.5	0	1/1940	12/2016
Colorado River near San Saba, TX	08147000	0	3.8	0	1/1940	12/2016
Llano River at Llano, TX	08151500	0	0.5	0	1/1940	12/2016
Pedernales River near Johnson City, TX	08153500	2.4	4.0	2.4	1/1940	12/2016
Onion Creek near Driftwood, TX	08158700	22.0	22.4	22.0	7/1979	12/2016
Colorado River at Austin, TX	08158000	0	0.5	0.1	1/1940	12/2016
Colorado River at Bastrop, TX	08159200	0	0.6	0.1	3/1960	12/2016
Colorado River at Columbus, TX	08161000	0.2	0.2	0.1	1/1940	12/2016
Colorado River at Wharton, TX	08162000	0	0.1	0.2	1/1940	12/2016

[1] Data gap from 10/1993 through 9/1997

Table 6. Percent of time zero streamflow for each measurement point for each scenario. Statistics were calculated using a consistent period of record for each measurement point and by converting daily observation records to monthly averages for the Historical Conditions scenario.

Measurement Point (USGS Gage)	USGS Gage No.	Naturalized Scenario (Percent of time zero streamflow)	Historical Conditions (monthly average percent of time zero streamflow)	Full Authorization Scenario (Percent of time zero streamflow)	Analysis Start Date	Analysis End Date
San Saba River at San Saba, TX [1]	08146000	0	0	0	1/1940	12/2016
Colorado River near San Saba, TX	08147000	0	0	0	1/1940	12/2016
Llano River at Llano, TX	08151500	0	0.1	0	1/1940	12/2016
Pedernales River near Johnson City, TX	08153500	0.8	1.1	0.8	1/1940	12/2016
Onion Creek near Driftwood, TX	08158700	7.6	7.3	7.6	7/1979	12/2016
Colorado River at Austin, TX	08158000	0	0	0	1/1940	12/2016
Colorado River at Bastrop, TX	08159200	0	0	0	3/1960	12/2016
Colorado River at Columbus, TX	08161000	0	0	0	1/1940	12/2016
Colorado River at Wharton, TX	08162000	0	0	0	1/1940	12/2016

[1] Data gap from 10/1993 through 9/1997

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4 Discussion

LCRA CCAA stream segments are generally expected to exhibit increased stream flow conditions for the Full Authorization scenario, i.e., stream segments exhibited decreased frequency of subsistence flow events under the Full Authorization scenario when compared against historical conditions. This is also true for some locations when comparing the Full Authorization scenario to naturalized flow conditions.

The results identified in this analysis are recommended to be viewed within the context of LCRA's historic management activities and their influence on surface water flows downstream of the Highland Lakes and the assumptions within the Full Authorization scenario, which includes a "Run 3" version of the LCRA's 2020 Water Management Plan. The Full Authorization scenario projects that most of the reaches downstream of the Highland Lakes will experience a decrease (as compared to historical) in the percent of time in which low (below subsistence) flow conditions occur and no occurrences of zero streamflow.

5 References

Lower Colorado River Authority (LCRA). 2020. Lake Buchanan and Travis Water Management Plan and Drought Contingency Plan. Available online at: https://www.lcra.org/water/water-supply-planning/water-management-plan-for-lower-colorado-river-basin/.

National Academy of Sciences. 2005. The Science of Instream Flows: A Review of the Texas Instream Flow Program. The National Academies Press. Washington, D.C. https://www.nap.edu/read/11197/chapter/1

Texas Commission on Environmental Quality (TCEQ). 2012. Environmental Flow Standards for Surface Water: Colorado and Lavaca Rivers, and Matagorda and Lavaca Bays. Austin, Texas.

APPENDIX C – COMPLIANCE WITH SECTION 106 NATURAL HISTORIC PRESERVATION ACT

Note: Capitalized terms and acronyms used in this appendix that are not defined herein are defined in the Glossary of the LCRA and LCRA Transmission Services Corporation Candidate Conservation Agreement with Assurances.

Covered Activities described in this CCAA are expected to provide a net conservation benefit for the Covered Species. This protocol outlines the process for compliance with Section 106 of the National Historic Preservation Act (NHPA) while conducting the Covered Activities.

Many of the Covered Activities that are unrelated to specific Conservation Measures involve the maintenance and operation of existing LCRA or LCRA TSC infrastructure. In other words, the lands where these facilities exist have been previously disturbed. Continued operation and maintenance of these facilities as a Covered Activity is unlikely to have the potential to cause effects on any "Historic Property(ies)" as defined by the NHPA and quoted below.

Further, several of the Conservation Measures implemented under this CCAA that involve research, monitoring, and sampling activities or management of water supply deliveries are unlikely to cause physical disturbance or otherwise cause effects on Historic Properties as defined by the NHPA.

> **Historic Property** (or historic resource) is defined as any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion on, the National Register of Historic Places, including artifacts, records and material remains related to such a property or resource. (NHPA 54 U.S.C. § 300308). For the purposes of this protocol, Historic Property also includes sites considered as traditional cultural properties (TCP).

This appendix specifies those Covered Activities that, for purposes of implementing the CCAA:

- Do not have the potential to affect Historic Properties, or
- Require consultation with the Texas State Historic Preservation Officer (SHPO) and/or Tribal Historic Preservation Officer (THPO).

Step 1: Does the Covered Activity occur within a known Historic Property?

For Covered Activities that involve disturbance of land that is above the ordinary high-water mark of the applicable water body, LCRA or LCRA TSC (as applicable) will

make a recommendation to the SHPO regarding the appropriate "area of potential effect" (APE). For purposes of compliance with Sections 101 and 106 of the NHPA for federal undertakings, the APE will include any areas immediately adjacent to Occupied Habitat or Suitable Unoccupied Habitat that will be disturbed as a result of the Covered Activity.

Efforts to identify known Historic Properties may include walking over the entire APE, talking with the landowner, THPOs and others, checking the SHPO's known sites/surveys database, and reviewing historic documents, such as old plat maps and aerial photos. Sites may have been identified as Historic Properties through prior consultations; through verbal or written communications with federal, tribal, or state historic preservation offices; or through review of state and federal cultural resource databases within the SHPO and/or the THPO. LCRA or LCRA TSC (as applicable) shall determine whether the activity would occur in a known Historic Property or within 100 feet of the boundary of a known Historic Property and shall create and maintain documentation of their conclusions for their records. LCRA or LCRA TSC (as applicable) will make the documentation available to the USFWS upon request.

- If the Covered Activity does not occur within a known Historic Property or within 100 feet of the boundaries of a known Historic Property proceed to **Step 2**.
- If the Covered Activity occurs within a known Historic Property or cannot be modified to avoid boundaries of a known Historic Property, the Covered Activity has potential to affect Historic Properties and Section 106 consultation is required. Proceed to **Step 3**.

Step 2: Does the conservation measure have the potential to affect a Historic Property?

The USFWS considers the activities listed below as having no potential to cause effects to a Historic Property provided the activities a) do not occur within 100 feet of a known Historic Property, and b) do not result in soil disturbance beyond the extent or depth of previously disturbed land. If an activity will result in soil disturbance then evidence of previous soil disturbance must be documented and can include aerial imagery analysis, photographs and maps of previous disturbance, or a signed affidavit from the landowner. The activities listed below that meet these criteria are exempted

from further Section 106 review consistent with 36 C.F.R. § 800.3(a)(1).

1. Any Covered Activities that occur below the ordinary high-water mark of the Colorado River, its reservoirs, or its tributaries or at depths above and within areas that have experienced significant prior ground disturbance;
2. Storage, delivery, discharge, and diversion of water;
3. Drawdown or dewatering of submerged lands to allow for maintenance or repair of LCRA facilities, customer intakes, and landowner repairs to docks and retaining walls;
4. Management of LCRA lands, including but not limited to habitat and vegetation management activities that do not involve ground disturbance above the ordinary high-water mark;
5. Provision of recreational opportunities on or near the water;
6. Operation, repair, or restoration of existing infrastructure;
7. Replacement of existing infrastructure within the same previously disturbed area;
8. Water safety activities, such as patrols, placement and maintenance of hazard and no-wake buoys and related signage, and occasional removal of navigation hazards;
9. Regulation and inspection of marinas and private docks;
10. Implementation of regulatory programs related to nonpoint-source pollution and on-site sewage facilities around the Highland Lakes;
11. Lake or river cleanup activities;
12. Aquatic vegetation management;
13. Emergency operations, including flood operations;
14. Flood response operations;
15. Dredging of accumulated sediment;
16. Research and monitoring activities related to species habitat, water quality, and water supply;
17. Invasive species management; and,
18. Activities that do not involve any ground disturbance.

If the Covered Activity fits within one or more of these exemptions and the due diligence review indicates that no Historic Property would be affected, then the USFWS considers the activity to have no potential to cause effects on a Historic Property and the activity can be considered exempted from SHPO and THPO review. LCRA or LCRA TSC (as applicable) shall maintain documentation of those conclusions for their records and make them available to the USFWS upon request. This would conclude USFWS's Section 106 compliance for this activity.

If the Covered Activity does not fit within one or more of the above exemptions, it is considered to have potential to affect a Historic Property. Proceed to **Step 3.**

Step 3: Formal Section 106 consultation for a Covered Activity that has the potential to affect a Historic Property.

For a Covered Activity that has the potential to affect a Historic Property, LCRA or LCRA TSC (as applicable) will assist the USFWS in its Section 106 compliance obligations by completing consultation. For each APE, LCRA or LCRA TSC (as applicable) will initiate procedures outlined in regulations 36 C.F.R. Part 800 working directly with other consulting parties (e.g., SHPO, THPO etc.). In the event a recognized tribe requests government-to-government consultation, LCRA or LCRA TSC will notify the USFWS.

The specific steps for consulting on a Covered Activity that has the potential to affect Historic Properties includes:

1) Define the project site and parameters (APE and timing of activities);
2) Cross-reference the project site to state and federal cultural resource databases within the SHPO and/or the THPO, if applicable, to see if any potential impacts to known Historic Properties can be identified (if not done already);
3) Information resulting from the review and consultation above will be submitted to the SHPO and any other consulting parties LCRA or LCRA TSC has identified as having a potential interest in the APE (e.g., THPOs/tribes). LCRA or LCRA TSC (as applicable) should clearly state to the consulting parties that this is a USFWS undertaking. The SHPO review form can be used, or correspondence with equivalent information, with the supporting documentation including maps and database searches, can be sent to the SHPO/THPO for review. The SHPO or THPO may choose to engage the USFWS directly, rather than LCRA or LCRA TSC, and, if so, the review process and timing may be different;
4) The SHPO should review the Covered Activity within 30 calendar days and the THPO or tribe within 45 calendar days from the date the Covered Activity is submitted for review. Either party may request a field visit or “survey.” If no response is given or no survey is requested, activities can begin as planned

and LCRA or LCRA TSC (as applicable) shall document this for their records, to provide to the USFWS upon request. This would conclude the USFWS's Section 106 compliance for this activity;and,

5) If the SHPO or THPO determines a survey is required, a cultural resources professional that meets the Secretary of Interior's Professional Qualifications Standards (36 C.F.R. Part 61) must conduct the survey;
   a) If possible Historic Properties are not found and the SHPO concurs, LCRA or LCRA TSC (as applicable) will notify the consulting parties and document this for their records. LCRA or LCRA TSC (as applicable) will provide the documentation to the USFWS upon request;
   b) If possible Historic Properties are found and cannot be avoided, LCRA or LCRA TSC (as applicable), in consultation with the consulting parties, will develop a plan to evaluate whether or not the site is eligible for inclusion on the National Register of Historic Places (NRHP) and what effect, if any, the Covered Activity will have on the site. Such plan will be subject to the review and approval of the SHPO. LCRA or LCRA TSC (as applicable) will work with the consulting parties and follow the Section 106 process to conclusion. LCRA or LCRA TSC (as applicable) shall maintain documentation for their records, which will be available to the USFWS upon request. This would conclude the USFWS's Section 106 compliance;and
   c) If, during implementation of any ground-disturbing activities, archaeological deposits are discovered, all activities in the immediate vicinity of the find shall cease and the LCRA or LCRA TSC Cultural Resources Coordinator shall be notified in accordance with 36 C.F.R. Part 800.13

APPENDIX D – RESPONSE TO PUBLIC COMMENTS

Comment Summary	**Commenter(s)**	**Applicants' Response**	**Cite to CCAA with changes (if any)**
Required NEPA review: At least one commenter argues that the CCAA should have gone through a full Environmental Impact Statement process.	Center for Biological Diversity (CBD)	Applicants concur with FWS' assessment of the level of required NEPA review for this CCAA.	None
Net conservation benefit, listing decisions, climate change: Several commenters suggested that the CCAA does not provide for a net conservation benefit or support a FWS determination not to list the proposed species. Several commenters suggest that climate change was not properly considered, including at least one comment that suggested reliance on the FWS Scenario 2 from the Species Status Assessment (SSA) is inappropriate.	CBD, Save our Springs (SOS), Living Waters Project members (LWP)	A CCAA is not required to eliminate all the threats to the Covered Species. That is not the standard for approval of a CCAA. Instead, a CCAA may be approved if the proposed conservation measures are reasonably expected to provide a net conservation benefit to the Covered Species compared to a situation where the proposed measures are not implemented. *See* CCAA §§ 1, 12.6. The Conservation Measures included in the CCAA are fully described in Section 7 of the CCAA and reflect activities within the control of LCRA and LCRA TSC that will be implemented over the term of the CCAA, and which are expected to address key threats to the Covered Species. These measures are specifically designed to maintain and/or increase resiliency, redundancy, and representation for the Covered Species by providing opportunities for population increases, improving species habitat, reducing severity and extent of water quality and flow-related impacts to existing populations, and removing or minimizing other threats to the Covered Species. As detailed in the CCAA, significant portions of habitat will be protected, not destroyed, by the CCAA's Conservation Measures. Accordingly, approval of the CCAA is appropriate. SSA Scenario 2 was based on the modeling reflecting the best available science regarding climate change at the time the SSA was developed. It further assumes implementation of new conservation strategies that may or may not have been proposed. The CCAA's discussion of the SSA Scenario 2 is appropriate because Scenario 2 explores possible conservation strategies that, if implemented, could maintain the current conditions, thus	None

		"slowing or halting declines in habitat and population conditions in 10-25 years and in some cases slightly reversing declines to improve habitat and population conditions in 25-50 years." *See* Species Status Assessment Report for Central Texas Mussels, p. 129 (FWS 2019). Further, the CCAA not only relies on the SSA but cites directly to the scientific information on which the SSA was based as well as scientific information made available after the SSA was published. With respect to other comments regarding climate change considerations, the LCRA WMP adjusts to real-time climate variability. *See* CCAA §§ 5.2, 7.3.1.1. The CCAA also includes specific commitments related to Adaptive Management and Changed Circumstances that will allow for consideration of impacts of climate change during the term of the CCAA. *See* CCAA §§ 10, 41.1. Finally, under the CCAA, the Applicants commit to providing a net conservation benefit for the Covered Species, regardless of whether that benefit affects FWS' listing decision or designation of critical habitat for any of the Covered Species.	
LCRA and LCRA TSC Covered Activities: A few comments suggest that LCRA and LCRA TSC operations, including operations of dams and diversion of water, are not eligible for incidental take coverage through a CCAA.	CBD	LCRA and LCRA TSC operations and the Covered Activities under the CCAA, for which incidental take coverage would be provided, are fully described in Sections 5 and 11 of the CCAA. Applicants' operations are not subject to any periodic review by federal agencies, unlike many water or electric infrastructure systems in other parts of the Western U.S. Finally, FWS has previously determined that it was appropriate under a similar CCAA to include as Covered Activities operation and maintenance of infrastructure where, as here, the CCAA's conservation measures were sufficient to yield a net conservation benefit. *See*, ***e.g.***, Candidate Conservation Agreement with Assurances for the Balcones Spike and Texas Fawnsfoot in the Brazos River Basin.	
Impact of LCRA and LCRA TSC activities on upstream flows: Several commenters suggest that LCRA's issuance of water contracts and/or subordination agreements	CBD, SOS, LWP	LCRA and LCRA TSC do not divert or impound water upstream of the Highland Lakes. Applicants do not have control over the amount of water flowing in the portions of the Covered Area upstream of the Highland Lakes. None of the upstream customers who secure upstream water sale contracts from LCRA can divert or impound water based solely on the contract and issuance of a contract does not result in "take" of protected species. None of these customers are allowed to divert under the contract unless all other	New Conservation Measure, CCAA § 7.3.1.4 and conforming

are responsible for depleting flows in tributaries upstream of the Highland Lakes.		necessary permits are secured. A separate water right from TCEQ is required that will be subject to notice and opportunity for a contested case hearing and will include special conditions to address impacts to instream flow conditions. *See* 30 Tex. Admin. Code § 297.104. Further, a Section 404 permit from the U.S. Army Corps of Engineers is needed for any infrastructure placed within the stream to divert or impound water, which will necessarily trigger a Section 7 consultation process with FWS in those areas where the proposed mussels or their proposed critical habitat might be affected. The contracts further include re-opener provisions to address any such special conditions. LCRA has entered into a limited number of subordination agreements with upstream regional water suppliers, which ensure that those suppliers are able to secure water supplies during drought. LCRA does not expect to enter into any further subordination agreements during the term of the CCAA; however, to the extent that any such agreements are considered, LCRA has revised the CCAA to include a commitment to include provisions in any such agreement to ensure the passage of available instream flows sufficient to protect the Covered Species. Although LCRA does not control flow in these upstream tributaries, the CCAA includes several Conservation Measures aimed at improving conditions within these reaches and an improved understanding of the conditions that threatened the Covered Species found in these reaches. *See* CCAA §§ 7.3.2.2., 7.3.3.3, 7.3.4.3, 7.3.4.7, 7.3.5.	changes to Table 2 & 7

Impact of LCRA and LCRA TSC activities on downstream flows: Some comments suggest that LCRA needs to change its operations to provide more or less water downstream of its dams and that its activities will destroy significant portions of river habitat. Several commenters suggest that LCRA's commitments under the CCAA regarding instream flows downstream of Lady Bird Lake are insufficient. Other comments suggest that minimum subsistence flows are not sufficient to keep mussels alive. At least one commenter suggests that, because the WMP is likely to be amended during the term of the CCAA, the CCAA should be amended to: (1) limit the term of the CCAA to the time the current WMP is in place, and/or (2) the CCAA should include a specific commitment to maintain its current firm water commitment for instream flows or maintain a specific instream flow level during the term of the CCAA.	CBD, SOS, LWP	LCRA has demonstrated that the flows provided in the portion of the river basin over which LCRA has control are sufficiently protective of the Covered Species, including provision of minimum monthly subsistence flows that are sufficiently protective of the Covered Species. *See* CCAA §§ 7.2, 7.3.1. As discussed above and detailed in the CCAA, significant portions of habitat will be protected by the CCAA's Conservation Measures. The CCAA expressly recognizes that the WMP is likely to be amended over the term of the CCAA. *See* CCAA §§ 5.2, 7.1. The current WMP will remain in full effect until replaced by an amended WMP that is approved by TCEQ. Stakeholders, which include some members of LWP, are expected to fully participate in any WMP amendment process, as they have historically. The history of LCRA's WMP and water operations demonstrates that LCRA has consistently committed to provide levels of instream flows that are protective of habitat for freshwater mussels in the river below Lady Bird Lake based on the best available science. It should not be assumed that each successive WMP will reduce the amount of water provided for instream flows or that changes to the instream flow criteria, if any, would adversely impact the Covered Species. Scientific studies regarding aquatic habitat and species needs have prompted both increases and decreases in specific instream flow criteria over the history of the LCRA's WMP. The CCAA includes commitments by LCRA to consider new hydrology and other scientific information regarding flow or temperature needs for freshwater mussels or host species in any subsequent amendment to the WMP. *See* CCAA §§ 7.3.1.1-7.3.1.2. The CCAA already discusses the caps and curtailment provisions of the WMP and demonstrates that these actions are expected to have minimal impacts to the Covered Species. CCAA §§ 5.2, 7.3.1.1. The CCAA addresses the sufficiency of maintaining flow levels that are protective of the Covered Species even when storage drops below 900,000 acre-feet. CCAA § 7.3.1.1. The CCAA also includes a lengthy discussion regarding the conditions reflected in Figure 7 and how, even under those conditions, flow conditions were protective of habitat for the Covered Species. *See* CCAA § 7.3.1.1. An amendment to the CCAA to include a commitment to maintain the current firm water commitment is unnecessary. LCRA's full legal obligations to provide water for environmental flows under the WMP is detailed in the CCAA, sections 5. 2 & 7.3.1.1, which demonstrates that LCRA provides flows sufficient to protect the Covered Species. A summary of LCRA's water	Amended Changed Circumstance. CCAA § 14.1.8.

		use for 2022, including water provided for environmental flows, can be found on LCRA's website. *See* https://www.lcra.org/download/2022-water-use-summary/?wpdmdl=29951. This summary also includes information on environmental flow releases dating back to 2018. Notwithstanding the above, while LCRA does not expect the WMP to be amended in a manner that would reduce LCRA's instream flow obligations to levels that would not be protective of the Covered Species during the term of the CCAA, the CCAA has been amended to include a Changed Circumstance to address that remote possibility.	
Specific concerns regarding Avoidance and Minimization Measures: One commenter suggests that LCRA could evade the Avoidance and Minimization measures which are limited to facilities by simply transferring partial ownership of its facilities to another party. In addition, the commenter questions the difference between 7.2.3, subparagraph (1) and (2), suggesting (2) is just a subset of (1). Finally, the commenter questions the value of the commitment to provide comments on others' projects provides limited benefit and suggests that the CCAA include more detail if this is something Applicants intend to do on a large-scale basis.	LWP	LCRA cannot make commitments regarding facilities it does not wholly own and operate. However, the limitation was not intended to create a loophole through which LCRA could deliberately evade the commitment. Accordingly, LCRA has added language to Section 7.2 of the CCAA to specify that, should LCRA enter new agreements for the co-ownership of facilities, they will include these requirements in any new co-ownership agreements within the Covered Area. LWP correctly notes that Section 7.2.3, measure (2) is a further qualification on measure (1). The Applicants' commitment to provide comments on other projects was added at the request of FWS and is expected to provide some benefit, even if limited as LWP suggests. Applicants' decisions on when to weigh in on others' projects is done case-by-case and considers important factors such as Applicants' own jurisdiction, impacts to property, and precedential significance.	Modified CCAA § 7.2.3,

Relationship of LCRA and LCRA TSC operations to growth: Commenters suggest that the CCAA "essentially green-light unchecked sprawl development" and that LCRA and LCRA TSC activities "exacerbate the impacts of drought and growth of human demands for water."	CBD, SOS	Neither LCRA nor LCRA TSC have land use control authority or any other legal authority to control growth. Moreover, the operations of LCRA and LCRA TSC are not the federal action. The federal action is authorizing limited take from operations and maintenance activities and conservation measures in exchange for numerous measures that are not otherwise required to benefit the species. These measures clearly create a net benefit above the status quo. Nonetheless, in reflecting on these comments, Applicants recognized that the CCAA was missing any description of LCRA's Water Conservation Program, which actively encourages the efficient use of water. Accordingly, LCRA has added a section on its Water Conservation Program, including its Firm Water Conservation Cost-Share Program, to the CCAA, and included a commitment for the term of this agreement to continue this cost-share program at or above current funding levels for the term of the CCAA.	New Conservation Measure, CCAA § 7.3.1.3 and conforming edits to CCAA Tables 2, 5 & 7
The modeling in the Appendix was improper or misleading: Several commenters question whether the modeling in the Appendix was appropriate. They point to modeling assumptions in the state's regional water planning process as a more accurate depiction of actual expected conditions or recent streamflows in the upper basin as reasons for their concerns. Other comments dispute the characterization in Appendix B of the sufficiency of minimum subsistence flows to keep mussels alive.	CBD, SOS, LWP	The purpose of Appendix A was primarily to identify those areas most likely to experience stress from low flows in the future. Stretches of the San Saba River that have experienced stress are indeed identified in the appendix. Although LCRA does not control flow in these upstream tributaries, the CCAA includes several Conservation Measures aimed at improving conditions within these reaches and an improved understanding of the conditions that threatened the Covered Species found in these reaches. See CCAA §§ 7.3.2.2, 7.3.3.3, 7.3.4.3, 7.3.4.7, 7.3.5. The modeling included in Appendix A does not reflect the "no call" assumptions used in the state water planning process for this region. However, the modeling included in Appendix A did include subordination to O.H. Ivie Reservoir, which is upstream of Lake Buchanan. There is some incremental amount of flow associated with the difference between the subordination approach and the "no call" approach. LCRA agrees that, were the "no call" assumption included, it would likely not show as much or any improvement in conditions on the upstream tributaries that appear in the Full Authorization model. However, the "no call" assumption would not appreciably impact the modeling results in the river below Longhorn Dam. Importantly, the regional planning model also includes a more realistic look at expected conditions in the next 20 years than included in the Full Authorization model. For example, the regional planning model assumes significant return flows (over 100,000 acre-feet/year) will be available in the	None

		lower river for the 20-year term of the CCAA (and beyond) as a strategy to help meet downstream water needs, including environmental flow needs. *See* 2021 Lower Colorado River Water Planning Group (Region K) Water Plan, Chapter 5, Table 5.2. available at https://www.regionk.org/2021-plan. Section 7.3.1.2. of the CCAA already includes a commitment by LCRA to conduct hydrologic modeling to address changes to water planning and water use projections when it initiates the process to amend the 2020 WMP or subsequent versions of the WMP during the term of this CCAA. This analysis is expected to provide continued insights regarding areas of future concern and could also include adjusted assumptions regarding return flows and priority calls during the term of the CCAA. For these reasons and because it would not affect the evaluation of net conservation benefit in the proposed CCAA, changes to the modeling at this time are not warranted.	
The method for estimating incidental take is inappropriate or underestimates take.	CBD, LWP	The primary source of incidental take anticipated to result from the Covered Activities are those that result in direct disturbance of habitat. Therefore, the metric used to estimate potentially impacted habitat in the CCAA is appropriate. The Conservation Measures provided in the CCAA are intended to protect, maintain, or improve habitat for the Covered Species and therefore, LCRA's management of river flows within its control is not anticipated to cause incidental take during the term of the CCAA.	None