Balcones Canyonlands Preserve
Karst Monitoring and Management
FY 2021 Annual Report



Eidmennella reclusa in Persephepone Caverns, photo by Colin Strickland

Travis County
Department of Transportation and Natural Resources
Natural Resources and Environmental Quality Division
and
City of Austin Balcones Canyonlands Preserve – Austin Water (AW)

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1.0 REGIONAL PERMIT

There are six species of endangered karst invertebrates (ES; Table 1) and 25 karst species of concern (SOC; Table 2) covered by the Balcones Canyonlands Conservation Plan (BCCP), a regional 10(a)1(B) permit issued by the U.S. Fish and Wildlife Service (USFWS) to the City of Austin (COA) and Travis County (TC) in May 1996 (USFWS 1996a). If these 25 species of concern become listed as endangered in the future, no additional mitigation will be necessary to protect them, provided that all karst protection requirements outlined in the BCCP are fully implemented.

The Regional Permit requires protection of 36 endangered species caves and 26 additional caves that support SOC, for a total of 62 karst features (60 caves, one mine and one karst spring). Several of these karst features occur in clusters, identified in the Regional Permit's associated Habitat Conservation Plan/Environmental Impact Statement (HCP/EIS) as the Four Points, McNeil, and Northwood cave clusters (USFWS 1996b). As of Fiscal Year 2021 (FY21), 52 of the 62 BCCP karst features have some form of formal protection on properties owned and managed by COA, TC, and BCCP partners, Texas Cave Management Association (TCMA), as well as private mitigation lands.

Table 1. Federally Listed Karst Species Covered by the BCCP
Footnotes follow table

Common Name	Scientific Name
Tooth Cave pseudoscorpion	*Tartarocreagris texana*
Tooth Cave spider	*Tayshaneta myopica*[1]
Tooth Cave ground beetle	*Rhadine persephone*
Kretschmarr Cave mold beetle	*Texamaurops reddelli*
Bee Creek Cave harvestman	*Texella reddelli*
Bone Cave harvestman	*Texella reyesi*

[1] *Tayshaneta myopica* is listed in the regional permit as *Neoleptoneta myopica*, but a 2012 study revised the genus *Neoleptoneta,* thus identifying this species in the genus *Tayshaneta* (Campbell et al. 2012).

Table 2. Karst Species of Concern Covered by the BCCP
Footnotes follow table

Common Name	Scientific Name
Flatworm	*Sphalloplana mohri*
Ostracod	*Candona* sp. nr. *stagnalis*
Isopod	*Caecidotea reddelli*
Isopod	*Trichoniscinae N. S.*
Isopod	*Miktoniscus N. S.*
Spider	*Cicurina bandida*
Spider	*Cicurina cueva*
Spider	*Cicurina ellioti*
Spider	*Cicurina reddelli*
Spider	*Cicurina reyesi*
Spider	*Cicurina travisae*
Spider	*Cicurina wartoni*
Spider	*Tayshaneta concinna*[1]
Spider	*Tayshaneta devia*[1]
Spider	*Eidmannella reclusa*
Pseudoscorpion	*Aphrastochthonius* N. S.
Pseudoscorpion	*Tartarocreagris comanche*[2]
Pseudoscorpion	*Tartarocreagris reddelli*
Pseudoscorpion	*Tartarocreagris intermedia*
Pseudoscorpion	*Tartarocreagris* N. S. 3
Harvestman	*Texella spinoperca*
Millipede	*Speodesmus* N. S
Ground Beetle	*Rhadine s. subterranea*
Ground Beetle	*Rhadine s. mitchelli*
Ground Beetle	*Rhadine austinica*

[1] *Tayshaneta concinna* and *Tayshaneta devia* are listed in the regional permit with the genus *Neoleptoneta*, but a 2012 study revised the genus *Neoleptoneta,* thus identifying these species in the genus *Tayshaneta* (Campbell et al. 2012).
[2] *Tartarocreagris comanche* is improperly listed in the regional permit as the New Comanche Trail Cave harvestman.

2.0 CAVE MANAGEMENT SUMMARY

This annual report covers the fiscal year 10/01/20 - 9/30/21 (FY21). In FY21, the BCCP partners continued efforts to determine and track the status of the 62 karst features covered by the BCCP 10(a) permit. The permit holders continued efforts to acquire, protect, and monitor the karst species in the caves included in the Permit (see Tables 3 and 5 for species localities).

Of the 62 BCCP permit caves, a total of 24 are still in the hands of private landowners and 38 are formally protected on the BCP. Of the 24 that are privately owned, three caves (Pennie's, Pipeline, and Cave X) have protection agreements that include development setbacks from the cave entrance, and two cave entrances (Lost Oasis and Whirlpool Caves) are located on lands owned in part by Texas Cave Management Association (TCMA). As of May 4, 2021 the City of Austin BCP finalized a Cave Management Agreement with TCMA, this agreement spells out the responsibilities of both parties for managing, monitoring and protecting Lost Oasis and Whirlpool Caves. Also, in February 2020, AW BCP purchased the 5-acre lot that encompasses most of Whirlpool Cave, including the Travis County Room. TC BCP also conducts species monitoring for the privately owned Cold Cave for the Preston Oaks HOA. This brings the total to 52 caves that are afforded some level of protection or monitoring, and nine (Armadillo Ranch Cave, Bandit Cave, Bee Creek Cave, Ceiling Slot, Fossil Garden Cave, Hole-In-The-Road Cave, Jacks Joint, McNeil Bat Cave and Moss Pit) that are still unprotected, and it is unclear what management activities are conducted, if any at these nine caves. Lost Gold Cave has development setbacks but is considered unprotected since the owner has removed the buffer fencing, cleared vegetation in the surface catchment area, and installed infrastructure within the surface catchment area years ago with no resolution or mitigation yet. It should be noted that some of these protected caves only have protected entrances but could be threatened by surrounding development or planned development. The 48 BCCP caves that are formally part of the BCP are currently managed as follows: 22 caves protected and managed to some extent as part of the BCP on COA land; one cave protected on the Texas Nature Conservancy (TNC) land; two caves protected on combined TCMA/CoA land; 15 caves protected as part of the BCP on TC land; eight caves protected as part of private Section 10(a) or Section 7 agreements with USFWS. Ownership and protection status of each of the 62 BCCP caves is detailed in Table 7.

The monitoring and management of BCCP permit caves entails faunal surveys annually for 15 caves, bi-annually for 25 caves; cricket exit counts are conducted at 28 caves, and red-imported fire ant treatments are performed at various times of the year for 35 caves. Of the permit caves, COA BCP conducts faunal surveys in 22 caves, cricket exit counts at 17 caves, and red

imported fire ant treatments at 18 caves. TC BCP conducts faunal surveys in 18 caves, cricket exit counts at 11 caves, and red imported fire ant treatments at 17 caves. Zara Environmental is contracted to conduct bi-annual faunal surveys and red imported fire ant treatments at Pennie's Cave.

In addition to protecting and monitoring caves covered by the BCCP permit, COA and TC also provide protection for other karst features found on the BCP containing ES and SOC (Tables 4 and 6). Some of these additional karst features are incorporated into TC and COA's shared biological monitoring program, as described in Section 6.0. As of FY21, 13 endangered species karst features which were not listed on the BCCP permit are being protected on BCP lands (six features on TC BCP; seven features on COA BCP; Table 4). Additionally, 14 SOC karst features not listed on the Permit are also being protected on BCP lands (six features on TC BCP; eight features on COA BCP; Table 6).

To assist with analyzing the adequacy of the current preserve design for each karst feature, including the amount of surface and subsurface habitat needed to support these ecosystems, the COA and TC have been working together to maintain a comprehensive database for the 62 features and other features identified within the BCP since the regional permit was issued in 1996. The database also incorporates monitoring data and management issues for each karst feature. The karst database is discussed in more detail in Section 5.0.

Table 3. Endangered Karst Invertebrate Locations within BCCP caves of Travis County, Texas

This table, originally in the BCCP 1996 documents, has been revised to show new species location information. *Key and footnotes follow table.*

Cave Name	Current Preserve Status	Karst Fauna Region	Tooth Cave Pseudoscorpion *Tartarocreagris texana*	Tooth Cave Spider *Tayshaneta myopica*	Tooth Cave Ground Beetle *Rhadine persephone*	Kretschmarr Cave Mold Beetle *Texamaurops reddelli*	Bee Creek Cave Harvestman *Texella reddelli*	Bone Cave Harvestman *Texella reyesi*
Amber Cave	BCP Jollyville/ TC	Jollyville Plateau	X 1996		X 2010 (Reddell)	X 1996		
Bandit Cave	Private	Rollingwood					P 1996 X 2009	
Beard Ranch Cave	BCP Ivanhoe/COA	Jollyville Plateau						X 1996
Bee Creek Cave	Private	Rollingwood					X 1996	
Broken Arrow Cave	BCP Lime Creek Preserve/COA	Cedar Park			X 1996			
Cold Cave	Private	McNeil/Round Rock						X 1996
Cotterell Cave	BCP Spicewood Springs Park/COA	Central Austin						X 1996
Disbelievers Cave	BCP Private 10(a)	Jollyville			X 1996			
Eluvial Cave	BCP Private 10(a)	Jollyville						X 1996
Fossil Cave	BCP Schroeter Park/COA	McNeil/Round Rock						X 1996
Fossil Garden Cave	Private	McNeil/Round Rock						X 1996
Gallifer Cave	BCP Jollyville/TC	Jollyville Plateau		P 1996 X 2010 (Ledford)	P 1996 X 2005	X 2009 (Chandler)		X 1996
Hole-in-the-Road Cave	Private	McNeil/Round Rock						X 1996
Japygid Cave	BCP Private 10(a)	Jollyville			X 1996	P 1996 X 2005		
Jest John Cave	BCP Forest Ridge/COA	Jollyville Plateau					X 1996 Delete X 2017 (Ubick)	X 2017 (Ubick)

Cave Name	Current Preserve Status	Karst Fauna Region	Tooth Cave Pseudoscorpion *Tartarocreagris texana*	Tooth Cave Spider *Tayshaneta myopica*	Tooth Cave Ground Beetle *Rhadine persephone*	Kretschmarr Cave Mold Beetle *Texamaurops reddelli*	Bee Creek Cave Harvestman *Texella reddelli*	Bone Cave Harvestman *Texella reyesi*
Jester Estates Cave	BCP Forest Ridge/COA	Jollyville Plateau	X 2008 (Cokendolpher)	X 2010 (Ledford)			X 1996	
Jollyville Plateau Cave	BCP Private 10(a)	Jollyville			X 1996			X 1996
Kretschmarr Cave	BCP Jollyville/TC	Jollyville Plateau			X 1996	X 1996		
Kretschmarr Double Pit	BCP Jollyville/TC	Jollyville Plateau	P 1996 X 2005		P 1996 X 2005	X 2016 (Reddell)		
Lamm Cave	Private Section 7	Jollyville Plateau			X 1996			
Little Bee Creek Cave	BCP Ullrich WTP/COA	Rollingwood					X 1996	
McDonald Cave	BCP Jollyville/TC	Jollyville Plateau						X 1996
McNeil Bat Cave	Private	McNeil/Round Rock		X 2010 (Ledford)				X 1996
M.W.A. Cave	BCP Private 10(a)	Jollyville	P 1996 X 2005		X 1996	P 1996 X 2005		X 1996
New Comanche Trail Cave	BCP Lake Travis/TC	Jollyville Plateau		X 1996				X 1996
No Rent Cave	BCP McNeil/TC	McNeil/Round Rock						X 1996
North Root Cave	BCP Jollyville/TC	Jollyville Plateau			X 1996			X 2017 (Ubick)
Pickle Pit Cave	Private Section 7	Jollyville Plateau						X 2018 (USFWS)
Rolling Rock Cave	BCP Lime Creek Preserve/ COA Sec.10(a)	Cedar Park			X 1996			
Root Cave	BCP Jollyville/TC	Jollyville Plateau		X 2010 (Ledford)	X 1996			X 1996

Cave Name	Current Preserve Status	Karst Fauna Region	Tooth Cave Pseudoscorpion *Tartarocreagris texana*	Tooth Cave Spider *Tayshaneta myopica*	Tooth Cave Ground Beetle *Rhadine persephone*	Kretschmarr Cave Mold Beetle *Texamaurops reddelli*	Bee Creek Cave Harvestman *Texella reddelli*	Bone Cave Harvestman *Texella reyesi*
Spider Cave	BCP Park West/COA	Jollyville Plateau			X 2004 (Reddell)		X 2004 (Reddell)	
Stark's North Mine Cave	BCP Stark's/TC	Not within a KFR					X 2009 (USFWS)	
Stovepipe Cave	BCP Canyon Creek/ COA	Jollyville Plateau		X 2009 Delete X 2018 (USFWS)	X 1996	X 1996		P 1996 X 2009 (USFWS)
Tardus Hole	BCP Jollyville/TC	Jollyville Plateau			X 1996	X 2009 (Chandler)		
Tooth Cave	BCP Jollyville/TC	Jollyville Plateau	X 1996	X 1996	X 1996	X 1996		X 1996
Weldon Cave	BCP McNeil/TC	McNeil/Round Rock						X 1996

Sources: BCCP Permit 1996; Elliott 1992; Reddell 2004,2005, 2010, 2016; HNTB 2005; USFWS 1994, 2009a, 2009b, 2009c; Ledford 2010, Ubick 2017.

Key and Footnotes

X 1996 = confirmed occurrence based on collected specimen, the designation in the 1996 BCCP permit
P 1996 = probable occurrence based on observation but not confirmed with collected specimen; the designation in 1996 BCCP permit
X 2004 (Reddell) = confirmed by J. Reddell (pers. comm 2004)
X 2005 = was listed as confirmed in the HNTB summary of James Reddell's data, 2005 report for USFWS
X 2008 = Cokendolpher (pers. comm 2008) confirmed that Jester Estates Cave is a new site for *Tartarocreagris texana*, as also reported in USFWS 2009b.
X 2009 = USFWS – according to the 2009 5 year review on *Texella reyesi* the report lists *T. reyesi* as confirmed for Stovepipe Cave (USFWS 2009a); *Texella reddelli* 5-year review confirms *T. reddelli* for Stark's North Mine (USFWS 2009c); *Neoleptoneta myopica* 5-year review confirms this species for Stovepipe Cave (USFWS 2009b).
X 2009 (Chandler) = confirmed by D. Chandler, as reported in USFWS 5-year review (2009b).
X 2010 (Ledford) = confirmed by J. Ledford (pers. comm 2010)
X 2010 (Reddell) = confirmed by J. Reddell (pers. comm 2010)
X 2016 (Reddell) = confirmed by J. Reddell (pers. comm 2016)
Delete X 2017 (Ubick) = *T. reddelli* was accidentally listed as occurring in this cave, the species is actually *T reyesi* (personal communication Ubick 2017)
X 2017 (Ubick) = confirmed by D. Ubick (pers. comm 2017)
X 2018 (USFWS) = according to the 2018 5 year review on *Texella reyesi* the report list *T. reyesi* as confirmed for Pickle Pit Cave (USFWS 2018)
Delete X 2018 (USFWS) = according to the 2018 5 year review on *Tayshaneta myopica* the report list *T. devia* as confirmed for Stovepipe Cave (USFWS 2018)

Table 4. Non-BCCP listed Caves/Karst Features with Listed Invertebrates Protected on BCP

Key follows table

Cave Name	Current Preserve Status	Karst Fauna Region	Tooth Cave Pseudoscorpion *Tartarocreagris texana*	Tooth Cave Spider *Tayshaneta myopica*	Tooth Cave Ground Beetle *Rhadine persephone*	Kretschmarr Cave Mold Beetle *Texamaurops reddelli*	Bee Creek Cave Harvestman *Texella reddelli*	Bone Cave Harvestman *Texella reyesi*
Black-cap Cave	COA	Jollyville Plateau		P				X 2021
Cortana Cave	COA	Jollyville Plateau		X 2010				X 2008
Down Dip Sink	COA	Jollyville Plateau			X 2007a			
Garden Hoe Cave	COA	Jollyville Plateau			X 2007b			
Geode Cave	TC	Jollyville Plateau		X 2008	X 2008			X 2008
Hammett's Cave	Westcave	NA					X 2021	
LU-11	TC	Jollyville Plateau		X 2008				
LU-12	TC	Jollyville Plateau						X 2008
Little Black Hole	COA	Rollingwood					X 2009c	
Persephone Caverns	COA	Jollyville Plateau			P	P		P
Pond Party Pit	COA	Jollyville Plateau			X 2016			X 2010
RI-1	TC	Jollyville Plateau					X 2010	
Tight Pit Cave	TC	Jollyville Plateau		X 2010				

Cave Name	Current Preserve Status	Karst Fauna Region	Tooth Cave Pseudoscorpion *Tartarocreagris texana*	Tooth Cave Spider *Tayshaneta myopica*	Tooth Cave Ground Beetle *Rhadine persephone*	Kretschmarr Cave Mold Beetle *Texamaurops reddelli*	Bee Creek Cave Harvestman *Texella reddelli*	Bone Cave Harvestman *Texella reyesi*
Two Trunks Cave	TC	Jollyville Plateau			X 2008 (USFWS)			

Sources: Reddell 2016; USFWS 2008, 2009c; Zara Environmental 2007a, 2007b, 2008, and 2010 and Ubick 2021.
Key: X = confirmed occurrence based on collected specimen
P = probable location based on proximity to other known sites and being within the known range of the species.

Table 5. Karst Invertebrate SOC within BCCP Caves, Travis County, Texas[1,2]

Key and footnotes follow table

Cave Name	*Aphrastochithonius N.S.*	*Caecidotea reddelli*	*Candona sp. nr. stagnalis*	*Cicurina bandida*[3]	*Cicurina travisae*[4]	*Cicurina sp.*[5]	*Eidmannella reclusa*	*Miktoniscus N.S.*	*Tayshaneta concinna*	*Tayshaneta devia*	*Rhadine austinica*	*Rhadine s. subterranea*	*Rhadine s. mitchelli*	*Speodesmus N.S.*	*Sphalloplana mohri*	*Tartarocreagris comanche*	*Tartarocreagris intermedia*	*Tartarocreagris N.S. 3*	*Texella spinoperca*	*Trichoniscinae N.S.*
Adobe Springs Cave						X														
Airmen's Cave				X							X						X		X	
Amber Cave					X								X							
Armadillo Ranch Sink		X																		
Arrow Cave				X							X									
Bandit Cave				X							X									X
Beard Ranch Cave					X															
Bee Creek Cave				X							X									
Blowing Sink Cave				X							X									
Broken Arrow Cave																				
Buda Boulder Spring		X																		
Cave X		X	X	X				X			X			X						
Cave Y				X							X									
Ceiling Slot Cave						X														
Cold Cave						X						X								

Cave Name	*Aphrastochithonius N.S.*	*Caecidotea reddelli*	*Candona sp. nr. stagnalis*	*Cicurina bandida*[3]	*Cicurina travisae*[4]	*Cicurina sp.*[5]	*Eidmannella reclusa*	*Miktoniscus N.S.*	*Tayshaneta concinna*	*Tayshaneta devia*	*Rhadine austinica*	*Rhadine s. subterranea*	*Rhadine s. mitchelli*	*Speodesmus N.S.*	*Sphalloplana mohri*	*Tartarocreagris comanche*	*Tartarocreagris intermedia*	*Tartarocreagris N.S. 3*	*Texella spinoperca*	*Trichoniscinae N.S.*
Cotterell Cave					X							X								
Disbelievers Cave						X														
District Park Cave				X							X									
Eluvial Cave																				
Flint Ridge Cave				X							X									
Fossil Cave												X								
Fossil Garden Cave						X						X								
Gallifer Cave					X															
Get Down Cave				X							X									
Goat Cave				X										X						
Hole-in-the-Road Cave						X														
Ireland's Cave				X							X									
Jack's Joint		X				X														
Japygid Cave																				
Jest John Cave					X															
Jester Estates Cave					X							X								

Cave Name	*Aphrastochithonius N.S.*	*Caecidotea reddelli*	*Candona sp. nr. stagnalis*	*Cicurina bandida*[3]	*Cicurina travisae*[4]	*Cicurina sp.*[5]	*Eidmannella reclusa*	*Miktoniscus N.S.*	*Tayshaneta concinna*	*Tayshaneta devia*	*Rhadine austinica*	*Rhadine s. subterranea*	*Rhadine s. mitchelli*	*Speodesmus N.S.*	*Sphalloplana mohri*	*Tartarocreagris comanche*	*Tartarocreagris intermedia*	*Tartarocreagris N.S. 3*	*Texella spinoperca*	*Trichoniscinae N.S.*
Jollyville Plateau Cave																				
Kretschmarr Cave					X								X							
Kretschmarr Double Pit					X															
Lamm Cave																				
Little Bee Creek Cave				X							X									
Lost Gold Cave				X					X		X									
Lost Oasis Cave				X							X									
M.W.A. Cave																		X		
Maple Run Cave				X							X									
McDonald Cave					X					X										
McNeil Bat Cave												X								
Midnight Cave				X							X									
Moss Pit																				
New Comanche Trail Cave						X	X									X				
No Rent Cave												X								
North Root Cave					X															

Cave Name	*Aphrastochithonius N.S.*	*Caecidotea reddelli*	*Candona sp. nr. stagnalis*	*Cicurina bandida*[3]	*Cicurina travisae*[4]	*Cicurina sp.*[5]	*Eidmannella reclusa*	*Miktoniscus N.S.*	*Tayshaneta concinna*	*Tayshaneta devia*	*Rhadine austinica*	*Rhadine s. subterranea*	*Rhadine s. mitchelli*	*Speodesmus N.S.*	*Sphalloplana mohri*	*Tartarocreagris comanche*	*Tartarocreagris intermedia*	*Tartarocreagris N.S. 3*	*Texella spinoperca*	*Trichoniscinae N.S.*
Pennie's Cave											X			X						
Pickle Pit					X															
Pipeline Cave														X						
Rolling Rock Cave						X								X						
Root Cave					X															
Slaughter Creek Cave				X																
Spanish Wells Cave		X													X					
Spider Cave					X		X													
Stark's North Mine									X											
Stovepipe Cave	X				X		X			X										
Talus Springs Cave																				
Tardus Hole																				
Tooth Cave					X		X						X							
Weldon Cave	X											X								
Whirlpool Cave				X							X									

Sources: Elliot 1997, Paquin and Hedin 2005, Paquin et al. 2008, TMM 2007, Zara Environmental 2008, 2010, Ledford et al. 2012, Hedin 2015, Reddell 2016.

Key and Footnotes

X = confirmed location based on collected specimen.

[1] *Cicurina ellioti* listed as an SOC in the regional permit is not included in this table because this species has now been synonymized with *Cicurina buwata*, a non-SOC (Cokendolpher 2004).

[2] *Tartarocreagris reddelli* listed as a SOC in the regional permit is not included in this table because this species has now been synonymized with *Tartarocreagris infernalis*, a non-SOC (Muchmore 2001).

[3] Occurrences of *Cicurina bandida* include localities formerly listed as *Cicurina cueva* and *Cicurina reyesi*, which have been formally grouped together into the single species *C. bandida* (Paquin et al. 2008).

[4] Occurrences of *Cicurina travisae* include localities formerly listed as *Cicurina reddelli* and *Cicurina wartoni*, which have been formally grouped together into the single species *C. travisae* (Hedin 2015).

[5] Localities of possible SOCs; blind *Cicurina* specimens not yet confirmed to species level.

Table 6. Non-BCCP Caves/Karst Features with Karst SOC Protected on BCP[1,2]

Key and footnotes follow table

Cave Name	BCP Owner	*Aphrastochithonius N.S.*	*Caecidotea reddelli*	*Candona sp. nr. Stagnalis*	*Cicurina bandida*[3]	*Cicurina travisae*[4]	*Cicurina sp.*[5]	*Eidmanella reclusa*	*Miktoniscus N.S.*	*Tayshaneta concinna*	*Tayshaneta devia*	*Rhadine austinica*	*Rhadine s. 15ubterranean*	*Rhadine s. mitchelli*	*Speodesmus N.S.*	*Sphalloplana mohri*	*Tartarocreagris attenuata*	*Tartarocreagris comanche*	*Tartarocreagris intermedia*	*Tartarocreagris N.S. 3*	*Texella spinoperca*	*Trichoniscinae N.S.*
Black-cap Cave	COA						X	P														
Brewpot Cave	TC										X											
Caverns of Sweet Nora	COA						X															
Cortana Cave	COA						X															
Down Dip Cave	COA						X															
Geode Cave	TC					X		X														
Hammett's Cave	Westcave						X															
IV-3	COA					X																
LU-29	TC						X															
Persephone Caverns	COA					P	X	P					P				P					
Pond Party Pit	COA					X							X									
RI-1	TC						X															
RI-3	TC						X															
Siebert Sink	COA				X					X											X	
Two Trunks Cave	TC					X																

Sources: Bayless pers. comm 2013, Paquin and Hedin 2005, Sanders pers. comm 2013, TMM 2007, Zara Environmental 2008, 2010, Hedin 2015, Reddell 2016.

Key and Footnotes

X = confirmed location based on collected specimen.

P = probable location based on proximity to other known sites and being within the known range of the species.

[1] *Cicurina ellioti* listed as an SOC in the regional permit is not included in this table because this species has now been synonymized with Cicurina buwata, a non-SOC (Cokendolpher 2004).

[2] *Tartarocreagris reddelli* listed as a SOC in the regional permit is not included in this table because this species has now been synonymized with *Tartarocreagris infernalis*, a non-SOC (Muchmore 2001).

[3] Occurrences of *Cicurina bandida* include localities formerly listed as *Cicurina cueva* and *Cicurina reyesi*, which have been formally grouped together into the single species *C. bandida* (Paquin et al. 2008).

[4] Occurrences of *Cicurina travisae* include localities formerly listed as *Cicurina reddelli* and *Cicurina wartoni*, which have been formally grouped together into the single species *C. travisae* (Hedin 2015).

[5] Localities of possible SOCs; blind *Cicurina* specimens not yet confirmed to species level.

3.0 OWNERSHIP AND PROTECTION STATUS

Many karst features listed in the BCCP permit have adequate protection, based on the criteria outlined in USFWS's *Karst Preserve Design Recommendations* (USFWS 2012). However, some of the caves listed in Table 7 as protected may not be adequately protected as defined in USFWS (2012). Efforts are being made by the BCCP Permit Holders to contact owners of privately owned caves to assess their protection efforts and to assist them with protection where possible.

Though not specifically required in the BCCP permit, the updated USFWS karst preserve design recommendations direct that the protected area surrounding the cave should be at least 16–40 ha (40-99 acres) in size to capture the majority of plant and animal community elements needed to support the karst ecosystem, as well as protect the cave footprint and surface/subsurface drainage basins of the cave (USFWS 2014a). Some caves within the BCP meet or exceed these recommendations, while others do not due to conditions that existed before the Permit was issued, such as pre-existing development in the form of subdivisions, roads, power lines, petroleum lines, and sewer lines that preclude complete protection of the recommended preserve areas. BCCP Permit Holders will continue to do what is reasonable to protect these features from pre-existing development and continue efforts to acquire and protect the karst features listed in the BCCP permit.

Per BCCP Permit Conditions S2 and T2, if new karst features "are discovered with a significant diversity of troglobitic fauna, those karst features may be submitted to the Service for consideration for exchange with karst features identified for protection by the BCCP" (USFWS 1996a). In order to allow the Permit holders to implement these Permit conditions, COA and TC created a Cave Substitution Policy that provides a process that allows caves listed in the BCCP permit to be substituted with other suitable caves in a manner that is transparent, science based, and consistent with the vision and intent established for the BCCP. This policy includes a definition of "significant diversity of troglobitic fauna" as it applies to eligibility of a cave for substitution and determines parameters that quantify preservation of environmental integrity for BCCP-listed caves and candidate substitution caves as it applies to management of caves. These defined criteria will be used in determining both the need to substitute a feature listed on the Permit as well as whether the substitution cave will adequately replace the previously identified BCCP cave or caves. The BCCP Cave Substitution Policy was adopted by the BCCP Coordinating Committee in August 2015.

Karst Preserve Management

Karst preserves, even those pre-existing at the time containing permit caves, were not specified in the HCP/EIS. Karst preserves were directed to be created for the 62 listed karst features in the governing documents that generally include the water sources to the caves (surface and subsurface catchment areas) and other management areas.

Twelve of the 62 caves lie on City of Austin property that is managed by Austin Parks & Recreation Department (PARD). An interdepartmental management agreement between PARD and AW that specifies management activities of BCP land management plans are in progress. The dual management sites include Bull Creek District Park and Greenbelt, St. Edward's Park, Barrow Preserve, Commons Ford Park, Shoal Creek Greenbelt (Buda Boulder Spring); Barton Creek Wilderness Area and Greenbelt (Airmen's Cave and Cave Y), Mt. Bonnell, Blowing Sink Research Management Unit (now renamed William H. Russell Karst Preserve with Blowing Sink Cave), Stillhouse Hollow Nature Preserve (Cotterell Cave), Goat Cave Karst Nature Preserve (Goat Cave and Maple Run Cave); Dick Nichols District Park (District Park Cave); Circle C Ranch on Slaughter Creek (Midnight Cave, Arrow Cave, and Slaughter Creek Caves); and Hubert C. Schroeter Neighborhood Park (Fossil Cave). This agreement would allow AW BCP to conduct necessary restoration and cave management, to provide adequate protection for the sites, fence as necessary to protect the preserve, and eliminate toxic chemical application in sensitive water source areas.

William H. Russell Karst Preserve

While Blowing Sink Cave is the deepest cave on the BCCP permit, extending 240 feet to the water table, it has been obstructed since October 2013. The entire preserve contains surface and/or subsurface catchment area for Blowing Sink Cave. This preserve is currently managed by Austin Nature Preserves of Austin Parks and Recreation Department. There is no formal interdepartmental agreement yet that would allow dual management and restoration by AW BCP. In February 2020, a Tier III Management Plan was produced for the newly renamed William H. Russell Karst Preserve by AW BCP and Austin Nature Preserves Division of Austin Parks & Recreation Department. While the land management plan specifies the required management work, the interdepartmental agreement specifies which department is responsible for and empowered to accomplish the management tasks.

Village at Western Oaks Karst Preserve and Watershed Management Area

The Village at Western Oaks Karst Preserve and Watershed Management Area (VWO Karst Preserve) contains the BCCP permit Get Down Cave and was acquired by the City of Austin in June 2016 under Watershed Protection Department management. An interdepartmental

agreement in July 2018 delegated AW BCP with management of the karst preserve and Watershed Protection responsibility for the water quality ponds and Millennium Cave, a non-permit education cave that underlies one pond.

The preserve has public trails maintained by the Village at Western Oaks Homeowners Association, including trash removal, pet waste bags, and trail maintenance. A formal agreement between VWOHOA and AW BCP was drafted in FY21 and is expected completed in FY22 along with a Tier III management plan. AW BCP placed rule signs in FY19 at each entrance, specifying among other things that pesticide use is prohibited. In FY21, AW BCP biologist and preserve manager Drew Thompson and Ethan Perrine entered previously unmapped portions of Getdown Cave and extended its length by about 185 feet.

A Friends of the Preserve group was started by neighbor Stephanie Simmons, which participates in public education of preserve sensitivity through a Facebook page. The Friends educate neighbors on alternatives to pesticides, including the use of boiling water to suppress red imported fire ants, the benefits of increasing our tree canopy, and use of native plants, along with information on endangered songbirds and karst invertebrate ecosystems. They also notify and facilitate events, including neighborhood cave tours, Tree Folks planting, Native Plant Giveaways, Boy Scout projects, and others. An annual report by the Friends of the Preserve is included in the appendix.

Whirlpool Karst Preserve

Whirlpool Cave is the third largest cave of the 62 permit caves and has historically been used in public education. In FY21, AW BCP and TCMA approved a formal management agreement for Whirlpool, Lost Oasis, and Avery Ranch (non-BCCP permit education) caves on May 4, 2021.

Whirlpool Cave is managed by Liz Herren on behalf of TCMA. Liz Herren, Justin Shaw, Rich Zarria and other members of TCMA discovered a new room south of the mapped cave. In May 2021 a drip gauge was installed under active drip formations as part of a hydrogeological studies. Continuous measurement of airflow and carbon dioxide are monitored in the East Cavern passage. Surface measurements of temperature and humidity at 3 ft height were installed on the surface in May 2021 to compare differences between grasslands and forests over the cave.

In February 2020, AW BCP acquired a 4.7-acre private lot that overlies the majority of Whirlpool Cave. Whirlpool Cave Preserve is now a formal BCP karst preserve (Figure 1). A

Tier III management plan is expected to be created in FY22. The majority of the South Caverns passage lies outside the preserve in private homeowners association. A future step will be to seek inclusion of about 200 feet in the preserve through easement, acquisition, or management agreement.

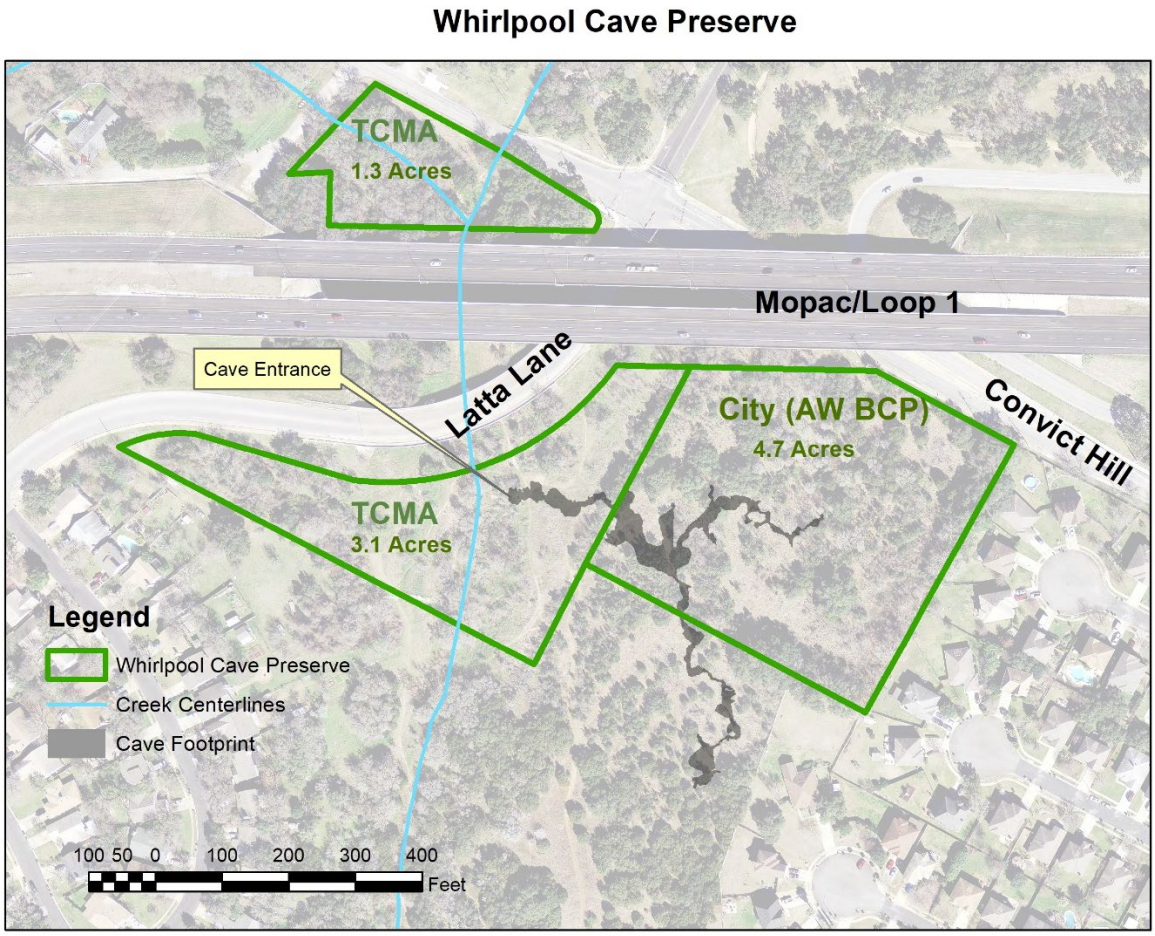

Figure 1. New lot acquired by AW BCP containing a large portion of Whirlpool Cave.

In FY21, TxDOT declined permission for AW BCP to install a cave mural on the Mopac underpass wall adjacent to Whirlpool Cave Preserve in collaboration with the Hill Country Conservancy (HCC), COA Public Works, and contract artist Barbara Attwell. HCC suggested and supported the idea of a cave scene painting adjacent to the Violet Crown trail. HCC and Public Works expects to install other educational signs regarding caves in FY22.

Lost Oasis Karst Preserve

Lost Oasis Cave Preserve is managed by Drew Thompson on behalf of TCMA and is adjacent to Tabor WQPL where Flint Ridge is located. A formal agreement for BCP management was created with TCMA, although the cave is currently being managed per Tier II Karst Land Management Plan with regular fire ant treatments, annual faunal surveys, visitor traffic counts, etc. Significant progress was made on the lead at the bottom of the cave in FY2021, and there is still strong airflow so work will continue in FY2022.

Four Points Private Karst Preserve

On February 27, 2019 AW and TC BCP staff met with representatives of the Four Points Preserves that contain four (Disbelievers, Eluvial, Japygid, and MWA caves) of the 62 permit caves in a private karst preserve. BCP requested ownership and management responsibilities for the preserves. On September 13, 2019, representatives of the owner committed to transferring ownership after buildout of associated development and a certificate of occupancy is issued, which may take approximately 2 years. BCP has no data on what, if any, management has been occurring on this preserve or the status of the four permit caves, as this is reported directly to USFW.

Other AW BCP karst preserves, including the Ullrich Water Treatment Plant (Little Bee Creek Karst Preserve), Testudo Cave Karst Preserve, Lime Creek Preserve, Stovepipe Cave Karst Preserve (Canyon Creek), and Jester Estates Cave Karst Preserve. In FY21, AW BCP utilized Section 7 conservation measures funding from TxDOT to develop formal karst preserves near FM 2222 and FM 620 by excavating previously unknown caves of ranch fill and extending the few previously known caves on Stovepipe (Canyon Creek), Cortaña, Park West, and Kent Butler preserves, as described in the Hydrological Studies and Cave Restoration section. The new caves reveal new cave drip areas and creates habitat to enhance the preserves. Many of these karst areas are associated with springs which are also investigated for fauna and water quality/discharge rate.

Table 7. FY21 Ownership, protection, monitoring and access status of the 62 BCCP caves/karst features (36 caves with ES and 25 caves with SOC)[1, 2].

Cave Name	ES or SOC	BCP or Private/ Current Owner	Gated/ Fenced	Protection Area Status /Adequate Preserve size	Species Monitoring Status	Public Access
Adobe Springs Cave	SOC	BCP/TNC		Protected on preserve	TC bi-annual surface monitoring; bi-annual cave cricket exit counts; bi-annual species monitoring	none
Airmen's Cave	SOC	BCP/COA	Gated	Protected on parkland Seeking access easement from overlying Brodie Oaks Mall.	COA quarterly surface monitoring; bi-annual cave cricket exit counts; bi-annual species monitoring Hydrogeological Study completed Dec. 2021 (Appendices)	access by permit*
Amber Cave	ES	BCP/TC	Gated and fenced	Protected on preserve (very close to road and sewer line)	TC quarterly surface monitoring; red-imported fire ant (RIFA) survey/ control	none
Armadillo Ranch Sink	SOC	Private		Private - Unknown		none
Arrow Cave	SOC	BCP/COA	Gated	Protected on parkland (There are nearby homes immediately south of the cave entrance).	COA quarterly surface monitoring; annual species monitoring	none
Bandit Cave	ES	Private	Gated	Protected by private ecologically concerned landowner		none
Beard Ranch Cave	ES	BCP/COA		Protected on preserve	COA quarterly surface monitoring; annual faunal survey	none
Bee Creek Cave	ES	Private		Private- AW BCP inquired about purchasing in April 2021 but not interested in selling at this time.		none
Blowing Sink Cave	SOC	BCP/COA	Gated	Protected on preserve (200 acre preserve, but subsurface catchment extends more than a mile west). Lower half of the	COA monthly surface and annual species monitoring; RIFA control as needed	none

Cave Name	ES or SOC	BCP or Private/ Current Owner	Gated/ Fenced	Protection Area Status /Adequate Preserve size	Species Monitoring Status	Public Access
				cave has been inaccessible since 2013. A Tier III plan was completed February 28, 2020.		
Broken Arrow Cave	ES	BCP/COA	Fenced	Protected on preserve	COA quarterly surface monitoring; bi-annual cave cricket exit counts; bi-annual species monitoring; bi-annual RIFA control	none
Buda Boulder Spring	SOC	BCP/COA		Protected on parkland (close proximity to a hike and bike trail).	COA bi-annual surface monitoring; annual species monitoring.	none
Cave X	SOC	Private/COA Protection Agreement	Gated and fenced	Protected by landowner with 4.5-acre setback to protect cave entrance. Protected to some extent (not actively managed and the setback is inadequate). Owner rejected COA offer on Sept. 19, 2017 to assist in cave management and monitoring. Regents built a sports field within the Cave X buffer, over the footprint of the cave sometime between January 2018 and November 2019. City staff are currently exploring what measures can be taken to rectify the situation	In the past, occasional species and surface monitoring by COA and SWCA. SWCA completed cave cricket exit counts in October 2015 and one partial cave faunal survey in February 2016 as part of an agreement to allow for on site construction of a berm to reduce flooding concerns. It is unknown if further biological monitoring has been performed	none
Cave Y[1]	SOC	BCP/COA	Gated	Protected on parkland. .	COA quarterly surface monitoring, bi-annual species monitoring; bi-annual cave cricket exit counts; RIFA control as needed	none
Ceiling Slot Cave	SOC	Private		Private - Unknown		none

Cave Name	ES or SOC	BCP or Private/ Current Owner	Gated/ Fenced	Protection Area Status /Adequate Preserve size	Species Monitoring Status	Public Access
Cold Cave	ES	Private	Gated	Private - Unknown	TC bi-annual surface monitoring; bi-annual cave cricket exit counts; bi-annual species monitoring	none
Cotterell Cave	ES	BCP/COA	Gated and fenced	Protected on parkland. (There are nearby homes immediately east of the cave entrance)	COA quarterly surface monitoring; bi-annual cave cricket exit counts; bi-annual species monitoring; RIFA control as needed	none
Disbelievers Cave	ES	BCP/Private Section 10(a)		Protected by 10a permit, hired Plateau Land & Wildlife Management		none
District Park Cave	SOC	BCP/COA	Gated	Protected on parkland.	COA quarterly surface monitoring; bi-annual cave cricket exit counts; bi-annual species monitoring; RIFA control as needed	1st room open past 1st room protected by gate, access by permit*
Eluvial Cave	ES	BCP/Private Section 10(a)		Protected by 10a permit, hired Plateau Land & Wildlife Management		none
Flint Ridge Cave	SOC	BCP/COA	Gated	Protected on Water Quality Protection Land (portions of the cave and its catchment area are overlain by the newly constructed SH45 SW)	COA quarterly surface monitoring; bi-annual cave cricket exit counts; bi-annual species monitoring; RIFA control as needed	none
Fossil Cave	ES	BCP/COA	Access protected by large rocks	Protected on parkland. All caves in park are filled in and require restoration.	Exact location of cave is unknown. COA quarterly surface monitoring of features suspected to be Fossil Cave	none
Fossil Garden Cave	ES	Private		Private – Unknown		none

Cave Name	ES or SOC	BCP or Private/ Current Owner	Gated/ Fenced	Protection Area Status /Adequate Preserve size	Species Monitoring Status	Public Access
Gallifer Cave	ES	BCP/TC	Gated and fenced	Protected on preserve	TC quarterly surface monitoring; bi-annual cave cricket exit counts; RIFA survey/control; bi-annual species monitoring	none
Get Down Cave	SOC	BCP/COA	Gated and fenced	Protected on preserve	COA monthly surface monitoring; annual cave cricket exit counts; annual species monitoring; annual RIFA control	none
Goat Cave	SOC	BCP/COA	Fenced	Protected on parkland.	COA monthly surface monitoring; annual species monitoring; RIFA control as needed	access by permit*
Hole-in-the-Road	ES	Private		Private –Unknown. (very close to a major roadway)		none
Ireland's Cave	SOC	BCP/ TC	Gated and fenced	Protected on preserve	TC quarterly surface monitoring; RIFA survey/control; annual species monitoring	none
Jack's Joint	SOC	Private		Private - Unknown		none
Japygid Cave	ES	BCP/Private Section 10(a)		Protected by 10a permit, managed by Plateau Land & Wildlife Management		none
Jest John Cave	ES	BCP/COA		Protected on preserve	COA annual cave cricket exit count; bi-annual surface monitoring	none
Jester Estates Cave	ES	BCP/COA	Gated and fenced	Protected on preserve (3.2 acre preserve surrounded by homes).	COA monthly surface monitoring; bi-annual cave cricket exit counts; bi-annual species monitoring; bi-annual RIFA control	none

Cave Name	ES or SOC	BCP or Private/ Current Owner	Gated/ Fenced	Protection Area Status /Adequate Preserve size	Species Monitoring Status	Public Access
Jollyville Plateau Cave	ES	BCP/Private Section 10(a)		Protected by 10a permit, managed by Plateau Land & Wildlife Management		none
Kretschmarr Cave	ES	BCP/TC	Gated and fenced	Protected on preserve. Close to roadway and in power line ROW.	TC quarterly surface monitoring; RIFA survey/control; bi-annual cave cricket exit counts; bi-annual species monitoring	none
Kretschmarr Double Pit	ES	BCP/TC	Fenced	Protected on preserve	TC quarterly surface monitoring; RIFA survey/control; annual species monitoring	none
Lamm Cave	ES	BCP/Private Section 7	Gated and fenced	COA negotiated setback (approximately 150')	Occasional surface and species monitoring by COA and TC	none
Little Bee Creek Cave	ES	BCP/COA	Gated	Protected on preserve	COA quarterly surface monitoring; bi-annual cave cricket exit counts; bi-annual species monitoring	none
Lost Gold Cave	SOC	Private	Gated	Private – COA WPD had negotiated a small setback from future development. In FY19, silt-laden runoff from a new water well and playscape structures were found built in the buffer by City inspectors, due to these violations a stop order was in place on the well installation, City staff initially attempted to work with the landowner to remove the illegal improvements and restore the site, however, the City Environmental Officer decided to give property owner a variance which allows all the structures to remain and so therefore, the site will not be restored		none
Lost Oasis Cave	SOC	Private/ TCMA	Gated and fenced	Protected by TCMA. Formal management agreement with AW BCP to ensure permit compliance was signed on May 4, 2021	COA bi-annual cave cricket exit counts; bi-annual species monitoring; bi-annual RIFA control	controlled access**

Cave Name	ES or SOC	BCP or Private/ Current Owner	Gated/ Fenced	Protection Area Status /Adequate Preserve size	Species Monitoring Status	Public Access
M.W.A. Cave	ES	BCP/Private Section 10(a)		Protected by 10a permit, managed by Plateau Land & Wildlife Management		
Maple Run Cave	SOC	BCP/COA	Gated	Protected on parkland.	COA monthly surface monitoring bi-annual cave cricket exit counts; bi-annual species monitoring; RIFA control as needed	access by permit*
McDonald Cave	ES	BCP/TC	Fenced	Protected on preserve	TC quarterly surface monitoring; RIFA survey/control; annual species monitoring	none
McNeil Bat Cave	ES	Private		Private – Unknown (close proximity to high school)		none
Midnight Cave	SOC	BCP/COA	Fenced	Protected on parkland (close proximity to soccer fields).	COA quarterly surface monitoring; bi-annual cave cricket exit counts; bi-annual species monitoring; RIFA control as needed	access by permit*
Moss Pit	SOC	Private		Private – Unknown		none
New Comanche Trail Cave	ES	BCP/TC	Fenced	Protected on preserve	TC quarterly surface monitoring; RIFA survey/control; annual cave cricket exit count; annual species monitoring	none
No Rent Cave	ES	BCP/TC	Gated	Protected on preserve	TC bi-annual surface monitoring; bi-annual cave cricket exit counts; bi-annual species monitoring	none

Cave Name	ES or SOC	BCP or Private/ Current Owner	Gated/ Fenced	Protection Area Status /Adequate Preserve size	Species Monitoring Status	Public Access
North Root Cave	ES	BCP/TC	Fenced	Protected on preserve	TC quarterly surface monitoring; RIFA survey/control; annual species monitoring	none
Pennie's Cave	SOC	Private		Landowner had filled entrance but Zara re-excavated and gated the entrance in May 2008. COA WPD established a 300 ft. buffer around the cave. Zara's Management report is attached in the Appendix	Zara Environmental species monitoring; Zara Environmental RIFA surveys/control	none
Pickle Pit[4]	ES	BCP/Private Sec. 7	Gated	Protected by Section 7 permit.	TC/COA occasional species monitoring; sporadic surface inspections by concerned neighbor	none
Pipeline Cave	SOC	Private	Gated	Private – nearby petroleum pipeline exists. Lacks formal management agreement to ensure permit compliance. Permission granted for temporary access to allow for restoration, faunal surveys, and hydrogeological studies. Hydrogeological Report completed by Zara Environmental in Jan 2020 in appendices.	COA quarterly surface monitoring; bi-annual cave cricket exit counts; bi-annual species monitoring; RIFA control as needed	none
Rolling Rock Cave	ES	BCP/COA	Fenced	Protected on preserve	COA quarterly surface and annual species monitoring; RIFA control as needed	none
Root Cave	ES	BCP/TC	Fenced	Protected on preserve	TC quarterly surface monitoring; RIFA survey/control as needed; annual species monitoring	none
Slaughter Creek Cave	SOC	BCP/COA	Gated	Protected on parkland (Nearby homes are immediately south of cave entrance,	COA quarterly surface and annual species monitoring; RIFA control	none

Cave Name	ES or SOC	BCP or Private/ Current Owner	Gated/ Fenced	Protection Area Status /Adequate Preserve size	Species Monitoring Status	Public Access
				and Mopac South excavation to cave level 500' east).	as needed.	
Spanish Wells Cave	SOC	BCP/TC	Fenced	Protected on preserve	TC quarterly surface monitoring; bi-annual cave cricket exit counts; RIFA survey/control; bi-annual species monitoring	none
Spider Cave	ES	BCP/COA	Fenced	Protected on preserve	COA quarterly surface monitoring; bi-annual cave cricket exit counts; bi-annual species monitoring; bi-annual RIFA control	none
Stark's North Mine[2]	ES	BCP/TC	Gated	Protected on preserve	TC quarterly surface monitoring; bi-annual cave cricket exit counts; RIFA survey/control; bi-annual species monitoring	none
Stovepipe Cave	ES	BCP/ COA	Fenced	Protected on preserve	COA quarterly surface monitoring; bi-annual cave cricket exit counts; bi-annual species monitoring; RIFA control as needed	none
Talus Springs Cave[3]	N/A	BCP/Private Section 10(a)	Gated	Protected by Homeowners Association and TC, only has 50' setback from houses and is probably affected by uphill development.	TC bi-annual surface monitoring; RIFA survey/control; annual species monitoring	none
Tardus Hole	ES	BCP/TC	Fenced	Protected on preserve	TC quarterly surface monitoring; RIFA survey/control; annual species monitoring	none
Tooth Cave	ES	BCP/TC	Gated and Fenced	Protected on preserve	TC quarterly surface monitoring; bi-annual cave cricket exit counts; RIFA survey/control; bi-annual species monitoring	none

Cave Name	ES or SOC	BCP or Private/ Current Owner	Gated/ Fenced	Protection Area Status /Adequate Preserve size	Species Monitoring Status	Public Access
Weldon Cave	ES	BCP/TC	Gated	Protected on preserve	TC quarterly surface monitoring; bi-annual cave cricket exit counts; bi-annual species monitoring	none
Whirlpool Cave	SOC	Private/ TCMA	Gated	Protected by TCMA. Formal management agreement with AW BCP to ensure permit compliance was finalized and signed by all parties on May 4, 2021. On February 2020, AW BCP acquired a private lot that overlies much of the cave	TCMA routine surface monitoring; COA bi-annual species monitoring and cave cricket exit counts to assess tawny crazy ant impacts	controlled access**

[1]Cave Y was considered an ES cave *(Texella reddelli*) in the 1996 BCCP Permit, but has since been determined not to contain *Texella reddelli* (Reddell 2004).
[2]Stark's North Mine was listed as a SOC cave in the 1996 BCCP Permit, but has since been determined to contain *Texella reddelli* (USFWS 2009c).
[3] Talus Springs Cave has never been known to contain ES or SOC. This cave was placed on the BCCP permit because it contained the amphipod *Stygobromus birfurcatus*, originally considered as a SOC candidate; however, *S. birfurcatus* was not included in the Permit's final list of 25 SOC karst species to be protected.
[4] Pickle Pit was listed as a SOC cave in the 1996 BCCP Permit, but has since been determined to contain *Texella reyesi* (USFWS 2018).

* Access by Permit - Permit may be issued by COA – Austin Water Utility or Austin Parks and Recreation Department (PARD) staff.
** Controlled Access - Private cave owners control the access.

4.0 ACCESS STATUS AND KARST EDUCATION/RESTORATION ACTIVITIES

Public education on caves and cave ecosystems is recognized as vital for karst species preservation in the BCP Karst Land Management Plan (2016). Currently, most opportunities for children to enter caves and learn about cave ecosystems is through programs provided by COA Watershed Protection Department (WPD), the Balcones Canyonlands Preserve Program of Austin Water (BCP), and Austin Nature and Science Center (ANSC) summer camps. Adult wild cave tours in the Austin area are not widely available, although many tours are conducted through TCMA and the Underground Texas Grotto. Overall, there is more demand for cave education than can be met with existing programs.

One factor limiting cave education is a deficit of caves suitable for immersion, particularly considering the high demand and its effectiveness as both a teaching tool and management practice to support stewardship for cave ecosystems. Cave education/recreation primarily occurs in 10% of the BCCP caves, which have been used for this purpose prior to the 1996 permit. Whirlpool Cave (owned and managed by TCMA) has the highest traffic of all the BCCP caves, totaling 721 person trips in FY20. Although studies on human impacts to cave ecosystems are limited, it is assumed that high human traffic in a cave will negatively impact the cave fauna.

Wildflower and LaCrosse caves are relatively small non-BCCP caves on the Lady Bird Johnson Wildflower Center that received 1,818 and 455 visitors respectively in FY20. Wildflower Cave has been used for education by COA Earth Camp since 1997 after it was restored by cleaning out trash fill. Wildflower Cave is unsuitable for many cave tours due to its currently limited extent and small size, but is heavily utilized in 5th grade Earth Camp cave education (see Cave Education Summary below).

Restoring Non-BCCP Caves for Education

By developing non-BCCP caves as a safe and accessible option for adequately trained and responsible groups for guided education/recreation tours, education can be promoted while reducing BCCP cave impacts. Restoration of filled non-BCCP caves for educational purposes is expected to reduce traffic/impact to other publicly accessed BCCP listed caves, namely District Park, Goat, Lost Oasis, Maple Run, and Whirlpool Caves. Caves are a heritage for the Austin area and provide resources for public education and opportunities to connect with local communities.

While fairly obvious once trash and ranch fill are removed, the cave ecosystem improves in education caves such as LaCrosse, Wade, and Wildflower caves are, it is still assumed that

excessive traffic is detrimental to cave ecosystems until more detailed analysis is conducted and reported. Consequently, it is a goal to restore new education caves to both provide more resources for public cave education and to reduce traffic on federal permit caves. A compilation of historic traffic in both BCCP permit and education caves is shown below in Figures 2 & 3. In FY21, an interlocal agreement with the Lady Bird Johnson Wildflower Center will allow AW BCP to restore filled caves there for education and cave ecosystem preservation. No significant progress was made in restoring new education caves or improving existing education caves in FY21.

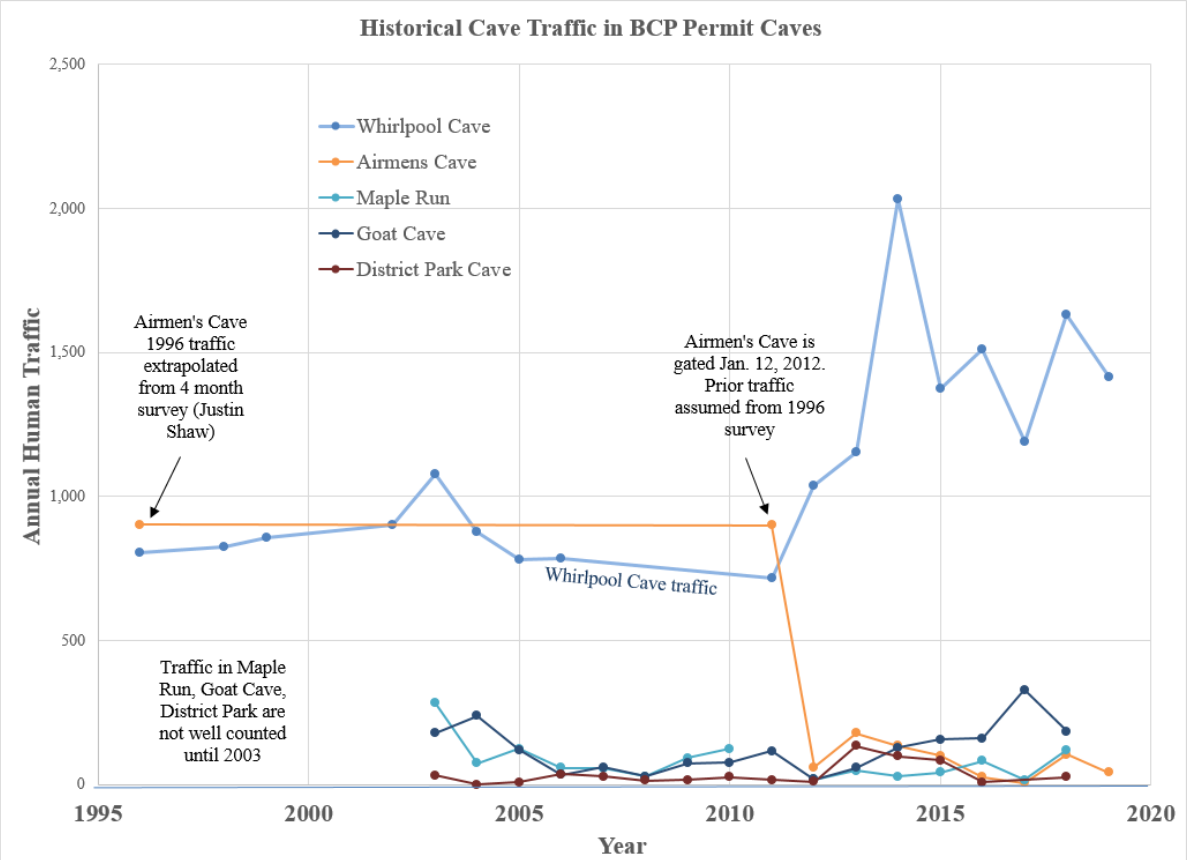

Figure 2. Historical traffic in BCP permit caves

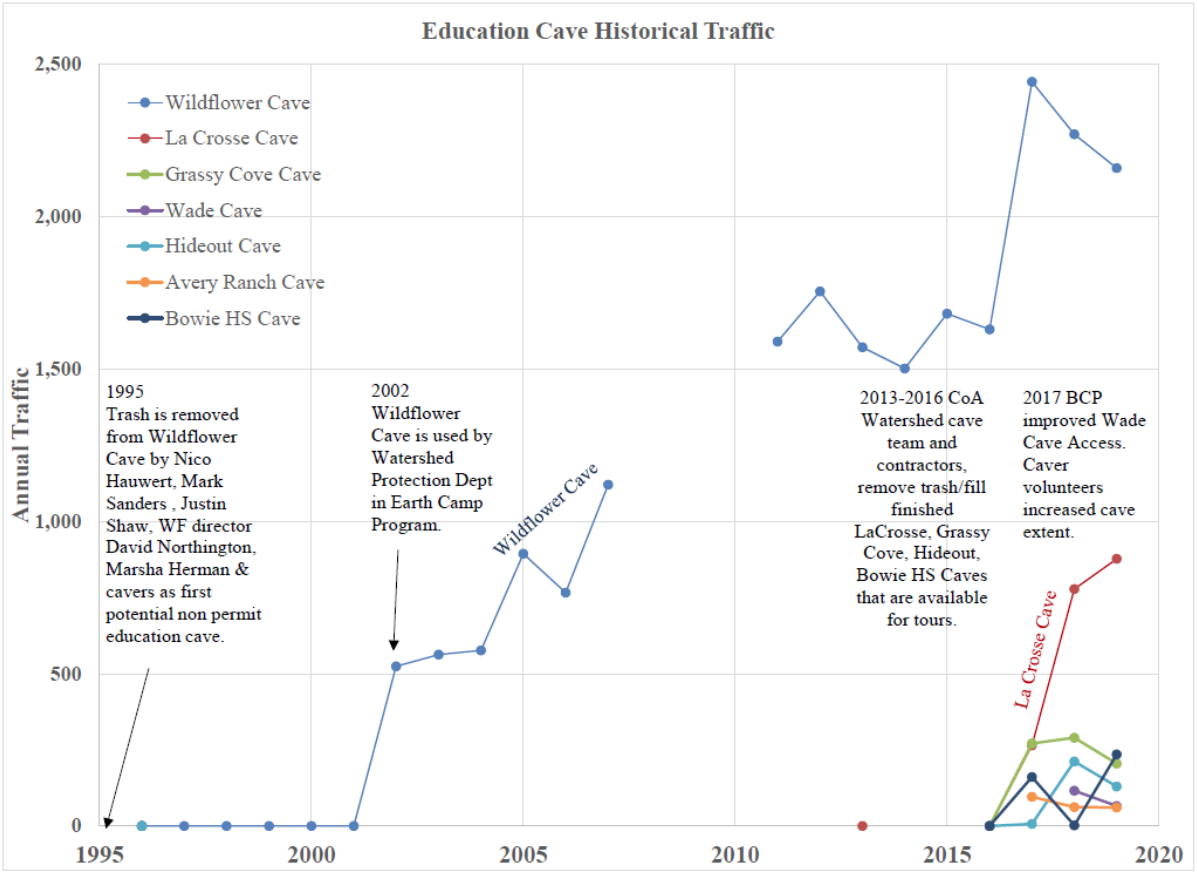

Figure 3. Historical traffic in education caves

FY21 Cave Education Summary

City of Austin (COA) Education Programs:

During the 2020-2021 school year, the COA Watershed Protection Department (WPD) conducted virtual cave and aquifer education through Earth Camp and Earth School (water quality programs for fifth graders) and through supporting additional remote outreach though CaveSim's online programs. The 2020-2021 school year updates are detailed below:

Earth Camp and **Earth School**:

Earth Camp is available to Title I (low socio-economic) schools in Austin Independent School District (AISD). The Lady Bird Johnson Wildflower Center is partnered with Earth Camp. During the 2020-2021 school year, students participated in a virtual fieldtrip to Wildflower Cave to learn about the cave habitat, how water flows through karstic limestone from the recharge zone of the Edwards Aquifer to Barton Springs, and how actions on the land affect water quality. Earth Camp's virtual program provided cave tours with staff live streaming to 5th grade classes from Wildflower Cave via Zoom. Through this program, students also

participated in remote hands-on activities (such as making speleothems and karstic limestone out of clay). Throughout the school year, 1,047 fifth-grade students participated in virtual cave tours through this program. An additional 1,463 fifth graders in AISD and Eanes ISD received Earth School, which included live demonstrations (via Zoom) of a watershed model that features a recharge zone with sinkholes and a karst aquifer model (Table 8). More details on these programs can be found online at: www.austintexas.gov/EarthCamp and www.austintexas.gov/earthschool.

CaveSim:

CaveSim provides standards-aligned programs for schools. They align the program with what students are currently learning, exciting demos, and hands-on labs. All programs are taught by experienced educators and use the theme of cave exploration to get students excited about learning traditional subjects. COA WPD provided funding for CaveSim to reach 702 students at Cities Connection Children to Nature target Elementary Schools and 306 middle school students, reaching a total of 1,008 students (Table 8). Programs covered many topics including groundwater (hydrogeology), conservation of caves and water, biology, physics, chemistry, and exploration of natural places. More details on these programs can be found online at: www.cavesim.com

Table 8. Summary of school year 2020-2021 COA WPD education programs providing virtual cave field trips and aquifer outreach.

Program	Grade	Total reached
Earth Camp (virtual cave tour)	5th	1,047
Earth School (virtual demonstrations of watershed model that features a recharge zone with sinkholes and a karst aquifer model)	5th	1,463
CaveSim outreach	3rd-8th	1008

Austin Water Balcones Canyonlands Preserve Program

AW BCP conducted few cave tours during the pandemic but have instead given virtual presentations over Zoom or other software covering Cave Biology, Cave Conservation, and Hydrogeology. Below is a list of presentions given and other outreach activites.

- **October 1st, 2020**: Geology and Soils, by Nico Hauwert and Tim Beach (UT), virtual presention to Balcones Canyonlands Master Naturalist Chapter
- **Oct 17th, 2020:** Central Texas Cave life, by Colin Strickland, presented to the Texas Speleological Association
- **Oct 29th, 2020:** Central Texas Cave life, by Colin Strickland, presented to the Camacho Nature Club
- **Nov 23rd, 2020:** Central Texas Cave life, by Colin Strickland, presented to the Bexar Grotto
- **December 1st, 2020:** Presentation and tour of cave at McNeil High School, by Mark Sanders and Justin Shaw
- **February 6th, 2021:** Geology and Soils, by Nico Hauwert and Jacob Eickstead, presented to CAMN Master Naturalist Chapter
- **March 18th, 2021:** Central Texas Cave life, by Colin Strickland, presented to the Texas Master Naturalist Lindheimer Chapter (Comal County)
- **March 2021 - present:** Old Bakery and Emporium Online exhibit of Barbara Attwell's "Austin's Underground Frontier" endangered species paintings: https://spark.adobe.com/page/qJ5eLc6l6ZSzh
- **April 2021:** Barbara Attwell's cave life prints "Austin's Underground Frontier" article in the Austin Sierran newsletter
- **May 12th, 2021:** Presentation and tour of cave at McNeil Highschool, by Mark Sanders and Justin Shaw
- **May 24th - Jun 1st, 2021:** Barbara Attwell's cave life prints "Austin's Underground Frontier" were on display at the state capitol.
- **June 6th, 2021:** Cave Day Proclamation sponsored and recorded by Councilwoman Leslie Pool, accepted by the June 4th, 2021 Austin City Council, with engaged stakeholders The National Cave and Karst Research Institute, Texas Speleological Survey, The National Speleological Society, Texas Cave Management Association, Underground Texas Grotto, Merlin Tuttle's Bat Conservation, and City of Austin. Council Member Leslie Pool reads Cave Day Proclamation: https://www.youtube.com/watch?v=VOj6iVa1-Bg
- **June 29th, 30th and July 1st:** Austin Fire Department Cave Training (Intro to caves, cave biology, and cave safety issues), presented by Mark Sanders, Drew Thompson, Cait McCann, and Carolyn Bull (AFD)
- **July 2021:** McNeil High School cave outreach, Nico Hauwert, Mark Sanders, Jenny Wilson (USFWS) and artist Barbara Attwell met with science teacher Tina Vic to discuss ways to engage students and faculty with their courtyard caves (Millipede and Milliped Annex) and to better restore the cave habitat.

- **Aug 27th, 2021:** Central Texas Cave life, by Colin Strickland, presented to the Travis County Wild Neighbors Speaker Series group

Colin Strickland continues to produce short educational videos about karst invertebrates that are shared on the Wildlands Facebook page and used in cave training classes. They can be viewed on his YouTube channel:
Biosubterranea – https://www.youtube.com/channel/UCQFvoKJbPjTF1-HiTrSfugg

Austin Parks and Recreation
The Splash! Exhibit in Zilker Park includes a simulated cave and indoor displays, movies, and activities regarding the Edwards Aquifer.
http://www.austintexas.gov/department/austin-nature-science-center

FY21 Access Status

Because of the COVID 19 pandemic, subsequently many caves were closed after March 2020 for cave tours and fewer cave tours were offered. In FY21, access was granted to COA-owned BCCP caves, TCMA-owned BCCP caves and other non-BCCP caves for educational/recreational/rescue training. The increased number of non-BCCP caves available has reduced traffic to BCCP caves. In FY21, 69 people entered COA-owned BCCP Caves, with visitors issued access permits by COA staff. COA-owned BCCP Caves include: Airmen's Cave (24), District Park (6), Goat Cave (31), Maple Run Cave (4), and Midnight Cave (4). A total of 239 people were granted access to TCMA-owned BCCP caves including: Lost Oasis (98) and Whirlpool (141) caves. An additional 164 people visited non-BCCP caves including Avery Ranch Cave (8), Grassy Cove Cave (20), Hideout Cave (0), LaCrosse Cave (0), Wildflower Cave (136), and Wade Cave (0) (Table 9). Cave tours from WPD, the Austin Nature and Science Center, COA PARD Rangers, and the BCP, have been on hold due to the ongoing pandemic. The traffic in Wildflower cave was mostly from city staff live streaming from the cave to students virtually. The UT Grotto began taking small groups to Whirlpool Cave once vaccines became widely available. See Table 3 for access and gating status of all the BCCP caves.

Table 9. Summary of FY20 educational and recreational cave trips into Non-BCCP Caves compared to BCCP Caves.

Status	Cave	Visitors	Total Visitors
Non-BCCP Caves	Avery Ranch	8	164
	Bowie	0	
	Grassy Cove	20	
	Hideout	0	
	LaCrosse	0	
	Wildflower	136	
	Wade	0	
BCCP Caves	Airmen's	24	308
	District Park	6	
	Goat	31	
	Lost Oasis	98	
	Maple Run	4	
	Midnight	4	
	Whirlpool	141	
Non-BCCP and BCCP Caves Combined			472

5.0 MANAGEMENT COORDINATION AND OVERSIGHT

COA and TC determined that there was a need to create a master database on BCP karst fauna monitoring and management with the ability to analyze these data to determine current status and compliance with the regional permit, as well as determine future needs of the listed species. The Karst Database houses all faunal survey data from BCCP caves and provides much of the information needed for these karst analyses. This database is now available for use by BCP partners to enter survey data, and all available data have been entered to date. Though the intent is for this database to be a "shared" information source for all the BCP partners, there are still confidentiality challenges on how to establish this protocol. This database will focus on permit compliance, species status, and contribution to recovery.

Based on recommendations made in Dr. Butch Weckerly's analyses of karst survey efforts on the BCP (Weckerly 2010), COA and TC modified and expanded the BCP's cave monitoring program in FY11. COA and TC identified 25 caves within Travis County managed through BCP partners that provide a more evenly distributed dataset across cave clusters and karst fauna regions (KFRs); this dataset includes both BCCP caves and other ES/SOC caves on the BCP. The number and frequency of karst faunal surveys and cave cricket exit counts are now synchronized among managing partners to better accommodate comparisons and determine

species trends. The goal of the cave monitoring program is to provide a clearer understanding of the species distribution and health of karst ecosystems across the BCP.

In FY16, COA/TC BCP staff collaborated on creating guidelines to provide best management practices (BMPs) at construction sites where tawny crazy ants (TCA; *Nylandaria fulva*) have not been confirmed, to supplement BMPs created in FY15 focusing on construction activities within known TCA sites. TCA are a newly discovered non-native ant species which could potentially adversely affect forest and karst ecosystems on the BCP. Implementation of these BMPs will be critical to minimizing the potential of introducing new populations of this destructive species to other parts of Austin and elsewhere. In FY21, these BMPs continue to be disseminated to appropriate TC/COA departments and other agencies.

In FY21, AW BCP contracted Zara Environmental LCC to continue air monitoring in Ireland's Cave, Grassy Cove, and Whirlpool Cave. This monitoring is intended to better understand factors influencing airflow and factors influencing concentrations of carbon dioxide gas, which is a potential hazard. The results of this monitoring are presented in Appendix **.

6.0 BIOLOGICAL MONITORING

Caves containing endangered and rare karst invertebrates on BCP properties are monitored to determine long term trends in populations of cave organisms and overall cave conditions. All COA and TC-owned BCP caves with endangered species are surveyed annually. In addition, TC and COA incorporated the newly expanded monitoring plan in FY11, which includes the 25 Travis County caves selected to represent an evenly distributed dataset across cave clusters and KFRs. Caves included in this monitoring plan are surveyed bi-annually, occurring in Spring (May) and Fall (November) or Summer (August) and Winter (mid-January-mid February). Biomonitoring of the caves follow methodology and techniques supported by USFWS to provide results that can be compared between caves throughout the region for better study and analysis (USFWS 2014a).

Beyond USFWS recommendations, survey methodology also follow guidelines described in the *2016 Balcones Canyonlands Preserve Land Management Plan: Tier II-A Chapter IX Karst Species Management*. The protocol for research and monitoring cave fauna involves the use of one to seven (depending on size of cave and logistics) predesignated, permanent survey zones per cave in which all living organisms encountered are identified and enumerated. Survey zones are either transects approximately 5 meters in length that span the width of the cave, or distinct units of the cave such as a small room or an easily discernible section, so that

the size and location of the survey area remains constant during the study for trend comparison. For each survey zone, start and end time and the presence of trash or new vandalism are recorded. Relative humidity, temperature, nutrient input, dampness condition, and the presence of red-imported fire ants (RIFA; *Solenopsis invicta*) and TCA are also recorded both outside the cave and at each transect or zone. All data collected during cave surveys are entered into the BCP Karst Database.

Any unknown invertebrates observed during faunal surveys are collected and identified by a karst invertebrate specialist. In caves containing endangered species, collecting only occurs with a special collecting permit obtained by USFWS. All collected specimens are deposited within the Texas Memorial Museum or other reputable facility (USFWS 2014a). The date of deposition and collection number is also recorded (USFWS 2014a).

Land managers also monitor the entrances of caves containing endangered species at least once a year for anything that might harm the rare invertebrates including presence of toxic substances, unauthorized access by recreational cavers, and surface disturbances which might have erosive potential or cause changes in surface drainage patterns.

The overall health of caves is also monitored by performing semi-annual cave cricket exit counts. Cave cricket exit counts are done as crickets emerge from caves during good weather nights (i.e., not raining, warm, etc.). The duration of the counts is timed for two hours starting at sunset, to maintain consistency with all surveys done between managing partners. Current weather conditions, surface temperature, and relative humidity are documented for each survey. Crickets emerging are placed in one of three age classes: nymph (up to 5 mm), sub-adult/juvenile (5-12mm) and adult (>12mm). Number of individuals exiting the cave is counted in ten-minute intervals. Time of first cave cricket exit and any other vertebrates exiting the cave are also recorded. An evaluation of TC/COA's cave cricket exit count survey protocol determined that this methodology meets criteria necessary to assess cave cricket abundance at caves as well as estimate changes over time in the number of cave crickets that emerge from cave entrances, both of which are necessary for determining the state of cave ecosystems and evaluating the effectiveness of the BCP's karst management goals (Weckerly 2012).

FY21 TC/COA Collaborative Monitoring Projects

Since FY12, BCP staff have included monitoring for presence of TCA at all visits to cave sites, using a monitoring and collection protocol and reporting procedures created by TC and COA BCP staff and updated in FY15. In FY13, at least two BCCP caves (Whirlpool Cave and No Rent Cave) were confirmed to be infested by TCAs. COA and TC staff continued to conduct quarterly biological surveys at Whirlpool Cave from FY13 – FY17 to document TCA use of

cave environments and assess impacts of this new invasive species on cave fauna (EXHIBIT A). Surveys at Whirlpool Cave were reduced to bi-annually in FY18. For FY 21 staff did not observe any TCA activity in Whirlpool cave. In FY14, TC and COA also expanded monitoring of Weldon and No Rent Caves to document the arrival and impacts of another TCA population in the vicinity of these caves (EXHIBIT A). Subsequently, the TCA population at these caves as disappeared for unknown reasons.

TC and COA BCP staff began conducting bi-annual cave faunal surveys of Millipede Cave and Millipede Annex Cave in FY13 and continued surveys for FY21 to gather baseline data for the McNeil High School courtyard restoration project, which commenced in FY15 (EXHIBIT A). Management activities such as vegetation planting and trash removal were coordinated with McNeil High School staff and students to improve surface conditions of these two non-BCCP ES caves, with the intent of improving nutrient input and benefiting cave crickets and cave fauna. In FY18, staff observed and collected an extremely rare arachnid, Order Schizomida from Millipede Cave for species identification. The specimen was determined to be *Stenochrus portoricensis*, believed to be native to the Yucatan Peninsula and has been discovered in greenhouses in Europe. It's likely that this species was inadvertently introduced via plants purchased at local nurseries by school staff. BCP staff will continue to monitor this newly introduced predator to see what direct and/or indirect impacts it will have on cave fauna.

Starting in FY20, COA and TC staff assisted with the USFWS to address phylogenetic and species determination questions for the federally listed cave mold beetles of Travis and Williamson Counties. The goal was to collect up to 3 specimens from a large list of caves that were within the known ranges of *Texamaurops reddelli*, *Batrisodes reyesi*, *Batrisodes texanus*, and *Batrisodes cryptotexanus*. This phylogenomic approach will help answer the species delimitation questions with a robust molecular dataset. Collections for this project were completed in FY21, and staff along with other collaborators was able to successfully collect from many of the selected caves.

TC and COA BCP also assisted James Reddell with his project of updating the cave faunal lists and accurate locations of area caves for the Texas Speleological Society (TSS) database.

City of Austin FY21 Biological Monitoring

During FY21, COA BCP staff conducted bi-annual monitoring on the following 16 pre-selected caves: Airman's Cave, Broken Arrow Cave, Cave Y, Cortana Cave (non-BCCP cave), Cotterell Cave, District Park Cave, Flint Ridge Cave, Jester Estates Cave, Little Bee Creek Cave, Maple Run Cave, Midnight Cave, Pond Party Pit (non-BCCP cave), Seibert Sink (non-BCCP cave), Spider Cave, Stovepipe Cave, and Testudo Tube (non-BCCP cave) (EXHIBIT A). In an effort to get a better handle on baseline data, in FY 18 COA BCP staff completed one year of quarterly faunal surveys at Get Down Cave, Lost Oasis Cave, and Pipeline Cave. Survey frequency for these caves has been reduced to bi-annual surveys for Pipeline Cave and Lost Oasis and annually for Get Down Cave. The reason why we reduced the frequency for Get Down Cave was to limit staff exposure to soft ticks/ TBRF. With the discovery of the newly restored Persephone Caverns, staff will conduct quarterly surveys for at least one year to try to determine the beneficial impacts restoration efforts have on cave fauna. (EXHIBIT A). Faunal surveys in these caves were conducted by permitted COA biologists in either Fall 2020/Spring 2021 or Winter 2021/Summer 2021. As part of a long-term site restoration project, COA BCP staff continued to conduct bi-annual surveys at Millipede and Millipede Annex Cave (EXHIBIT A). Annual faunal surveys were also conducted in Another Cave, Arrow Cave, Ants in the Pants Cave, Beard Ranch Cave, Big Woof Cave, Black-cap Cave, Blowing Sink, Caverns of Sweet Nora, GCWA Cave, Goat Cave, Grassy Cove Cave, Rolling Rock Cave, and Slaughter Creek Cave. (EXHIBIT A).

In FY21, COA BCP staff, with the help of volunteers, conducted bi-annual cave cricket exit counts at the same 16 caves pre-selected for faunal surveys (EXHIBIT B). (EXHIBIT B). In FY 18 COA BCP staff completed one year of quarterly cave cricket exit counts at Get Down Cave, Lost Oasis Cave, and Pipeline Cave, and has now reduced survey efforts to bi-annual surveys, and will no longer be conducting surveys at Get Down Cave due to safety concerns with soft ticks/TBRF. With the discovery of the newly restored Persephone Caverns, staff will conduct quarterly surveys for at least one year to try to determine the beneficial impacts restoration efforts have on cave fauna (EXHIBIT B). COA BCP staff also conducted one cave cricket exit count at Black-cap cave, and Jest John Cave (EXHIBIT B).

Travis County FY21 Biological Monitoring

TC's BCP staff conducted bi-annual monitoring on the following ten pre-selected caves: Adobe Springs, Cold Cave, Gallifer Cave, Geode Cave (non-BCCP cave), Kretschmarr Cave, No Rent Cave, Spanish Wells Cave, Stark's North Mine, Tooth Cave, and Weldon Cave.

Faunal surveys in these caves, with permitted TC biologists, were conducted in Fall 2020/Spring 2021 or Winter 2021/Summer 2021 (EXHIBIT A). Annual faunal surveys were also conducted in four other TC-owned BCCP caves with federally listed species: Kretschmarr Double Pit, McDonald Cave, New Comanche Trail Cave, and Tardus Hole (EXHIBIT A). TC staff also conducted annual faunal surveys at two additional BCCP listed caves: Ireland's Cave and Talus Springs Cave (EXHIBIT A).

TC BCP staff conducted bi-annual cave cricket exit counts in FY21 at all the caves pre-selected for faunal surveys: Adobe Springs Cave, Cold Cave, Gallifer Cave, Geode Cave, Kretschmarr Cave, No Rent Cave, Spanish Wells Cave, Stark's North Mine, Tooth Cave, Weldon Cave. Exit counts were conducted in Fall 2020/Spring 2021 or Winter 2021/Summer 2021. An annual cricket exit count was also conducted in one TC-owned BCCP cave: New Comanche Trail Cave (EXHIBIT B).

RIFA surveys were only performed in Spring 2021 on twelve of fifteen TC-owned BCCP caves and three additional ES cave with federally listed species. RIFA mounds were surveyed within an 80 m radius around cave entrances, and all active mounds found during surveys were treated with boiling water as recommended by USFWS (2014b). In Spring of 2021, a total of 218 RIFA mounds were treated within these 80 m cave survey areas, with an additional 48 RIFA mounds treated in the vicinity of caves but outside of survey areas. Survey results and treatments for individual caves are documented in Table 10.

In addition to managing the karst features required in the BCCP permit, TC voluntarily managed other karst features located on BCP land in FY21 including Cactus Pit, Brew Pot Cave, Kretschmarr Sink, and karst features RI-1, LU-11 and LU-12.

TC BCP staff is still monitoring caves found on the Kotrla Unit for troglobitic significance in hopes of finding suitable substitutes for Ceiling Slot and Moss Pit Caves. There are currently eight caves that have the potential to harbor significant troglobitic diversity that are undergoing periodic monitoring.

It should be noted that the adjacent ranch (Flying K Ranch) to the Kotrla Unit is interested in selling more land to be incorporated into the BCP. In response to this, TC staff conducted a thorough investigation on 246 acres of uplands to locate potential karst features in FY20. This survey produced 80 locations of interest ranging from existing caves to depressions. Zara Environmental was then contracted to provide an initial investigation of 21 potential karst features. These 21 features were later reclassified to 18 since some exhibited connectivity after excavation. Fifteen of the features met USFWS evaluation criteria for having the potential to

provide habitat for federally listed karst invertebrate species. Notably, two caves were found to harbor blind *Cicurina*, which were sent to Marshal Hedin in FY21 for identification, but results will not be available until FY22. One of these caves (FK-32) seems to be the best potential substitute for Moss Pit/Ceiling Slot that has been found in that area so far. Not only does it have blind *Cicurina*, but it also contains other species such as *Cambala speobia*, Pseudoscorpindia, and roving beetles (which might be *Batrisodies* sp). All collections were recently deposited with James Reddell.

Other Biological Monitoring Efforts

Zara Environmental conducted biological monitoring at Pennie's Cave in FY21 as part of an adaptive cave management plan for a development project that began with the reopening of the cave's entrance in 2012. Due to difficulty with securing a contract due to COVID 19, Zara Environmental scaled back monitoring efforts and conducted one Spring RIFA treatment with boiling water in FY21. Due to high CO_2 levels, in FY18 Zara installed a semi-permanent in-cave air ventilation system that greatly improved air quality, thus allowing for in-cave faunal monitoring, staff was also able to complete the interior cave mapping. A written report of their work in FY21 was also provided (Zara Environmental 2021a; Appendix T10 of BCCP FY20 Annual Report).

COA BCP Staff have continued conducting Bat Exit Counts for Hays Ranch Bat Cave. What once was a large *Myotis velifer* maternity colony has now shown a shocking drop in numbers. Two bat exit count surveys were conducted this year. One on November 11th, 2020 with 3 bats noted exiting and one on July 20th, 2021 with zero bats exiting. The cave is in the middle of one of our most rural properties and access into the cave is extremely restricted. Acoustic bat monitoring equipment and game cameras have been recently placed in the entrance of the cave to hopefully give us a better idea of bat numbers and times that the cave is occupied throughout the year.

COA BCP staff continues to assist James Reddell and the Texas Speleological Survey (TSS) in surveying, excavating, and mapping the karst of the USFWS Balcones Canyonlands National Wildlife Refuge (BCNWR). One cave of interest that may be a suitable substitution for another BCP permit cave that has inadequate protections is Collaboration Cave. Collaboration Cave was initially a 25.5 ft deep shaft plugged with rocks and soil. After 14 days of excavation the shaft is approximately 35 ft deep and there is about 40 ft of horizontal passage with a small stream flowing through it. The stream is inhabited by stygobitic isopods

Caecidotea sp. and amphipods *Stygobromus* sp. Colin Strickland produced a video of this cave stream and its inhabitants which can be viewed here: https://www.youtube.com/watch?v=XbFbXYWo16c.

Excavation activities will continue both upstream and downstream until all promising leads have been exhausted. At which point, the cave will be mapped, and thorough faunal surveys will be conducted. These efforts continue to expand the knowledge of cave fauna in the karst fauna region shared by two BCCP caves: Jack's Joint and Armadillo Ranch Sink. Once the map and faunal surveys are completed, COA BCP staff will provide a written report of their efforts. Due to the pandemic no excavation work was done in FY2020 or FY2021, hopefully work can continue in FY2022.

In FY20 COA BCP started a new project of delineating *Cicurina* species in the Austin area. DNA is analyzed by Bold Systems (https://www.boldsystems.org). Initially *Cicurina* were collected from BCP caves where the species was already confirmed to make sure the species determinations match what we believe is in each cave. In FY21 staff collected in sites where the species is not known. We are interested in determining the boundary between *C. buwata* and *C. travisae* in North Austin. In South Austin and Hays County we are interested in determining how far South *C. bandida* extends and what other species are found on the COA Water Quality Protection Lands (WQPL). Depending on how successful this project is we are planning to expand DNA analysis to other species. We are particularly interested in species where we are unable to find a taxonomist who can make species level determinations. Stygobitic isopods and amphipods are good candidates. Also, *Speodemus*, since there are likely cryptic species that DNA analysis will reveal. There are also likely multiple species of undescribed Trichoniscids in Central Texas caves, and though DNA analysis will not properly describe them, it can give us an idea of the diversity present, and maybe encourage a taxonomist to take on the project.

COA BCP has also been collaborating with Texas State University, Baylor School of Medicine, and the Centers for Disease Control (CDC) on a study to further understand and document the recent increased occurrence of Tick-borne Relapsing Fever (TBRF) in Central Texas. TBRF is a bacterial infection that can cause recurring bouts of fever, headache, muscle and joint aches, and nausea. *Borrelia* bacteria that cause TBRF are transmitted to humans through the bite of infected soft ticks of the genus *Ornithodoros*. All recently confirmed cases of TBRF in the Austin area have been attributed to *Borrelia turicatae*, and the ticks have all been confirmed as *Ornithodoros turicata*. Soft ticks (Family: Argasidae) differ from the more familiar hard ticks (Family: Ixodidae) in two main ways. They have a short feeding duration,

usually less than half an hour, and they do not search for hosts in grass or brush but instead reside in animal burrows (CDC TBRF, 2015).

COA BCP has started monitoring soft tick populations to get a better understand the level of risk that may be associated with caves accessed by the public (Figure 4). Priority has been given to the education caves due to the large number of children visiting them, followed by caves in the Barton Creek Greenbelt that are well known hangouts for hikers that are seeking relief from the Texas heat.

Pit fall traps using dry ice were deployed in caves in the Austin area to survey soft tick populations. Specimens were collected alive and stored in ventilated plastic vials for transport to Texas State University's Professor Dr. Ivan Castro and his students Rosa Ramirez, Matt Milholland, and Michaela Bowlsby. Some ticks were then sent to Job Lopez at Baylor College of Medicine for *Borrelia* identification and further TBRF research, while Michaela took some to research effective chemical deterrents. The information gathered is being shared with Jeff Taylor of the Epidemiology and Disease Surveillance Unit of the Austin Public Health Department, and the CDC.

Large numbers of ticks where only found in Bullet and Live Oak Caves, and warning signs have been placed at their entrances to help minimize the public's exposure to TBRF. It is unclear what causes some caves to have such high numbers. It is likely due to the presence of favorable cave environments (soft, dry soil that is easy to burrow in) and ample access for specific host species such as mice, racoons, and rock squirrels. Reddell (1988) noted that relapsing fever is typically associated with dry, shelter-like cave entrances with specific mammals such as goats and that infections of a cave by *O. turicata* with *Borrelia turicatae* could possibly by cyclic. Some birds and mammals, particularly predators, are associated with reductions in ticks, either by reducing/intimidating host species such as rodents or by directly preying on ticks (Hofmeester et al., 2017; Ostfeld et al., 2018). COA BCP will continue to monitor education and public access caves, such as Airman's and Bullet Caves. The detection of a single tick does not make a cave high risk for relapsing fever; however, cave guides should be informed about the risk of TBRF should later symptoms arise. There is concern that fear-driven over reaction to TBRF could lead to impairment or destruction of cave ecosystems, as was historically the case in earlier planned bat extermination efforts as a result of irrational fear of rabies. Furthermore, the soft ticks must be infected with *Borrelia turicatae* in order to transmit TBRF.

Due to the pandemic, and the lack of cave tours only Live Oak Cave at Village at Western Oaks Karst Preserve was surveyed in FY2021. Since cave tours will begin resuming in 2022,

surveys will be conducted at education caves with favorable soft tick habitat before tours resume. In FY21, caves where people have contracted TBRF and are identified as a high risk for TBRF include Live Oak Cave and Getdown Cave at Village at Western Oaks Karst Preserve; Airmen's Cave, Spider Wire Cave, and Bullet Caves along Barton Creek greenbelt; and Little Black Hole. Drew Thompson got bitten by ticks in Getdown cave so the Biannual cricket counts, and faunal surveys have been dropped to annually, to be performed in January, when hopeful the cold will make the ticks, which are mostly in the entrance room, less active.

7.0 HYDROGEOLOGIC STUDIES & CAVE RESTORATION

The understanding and protection of water sources to caves is vital for preserving cave life that relies on it. Water sources include surface catchment areas that direct runoff to the cave entrance and subsurface catchment areas where overlying water infiltration from either rainfall or runoff supports cave drips. Surface catchment area delineation generally involves examination of a combination of field GPS delineation of catchment divides and drainages as well as surface topographic contour coverages. Subsurface catchment studies may involve direct tracing, water-quality characterization, drip rate monitoring, geological mapping, cave survey mapping, and cave radio surveying.

Cave restoration is an extremely slow and labor-intensive part of cave preserve management that is a necessary prerequisite for conducting hydrogeological studies, vital for re-establishing necessary nutrient input and habitat for cave ecosystems. Historical land use practices over karst areas across the Austin area involved plugging caves and sinkholes to keep water at the surface for livestock ponds, mills, and access to shallow sources. Caves were also historically used for trash disposal. Open caves also created hazards for people and livestock, and filling caves with trash seemed like a practical solution to ranchers, particularly given that, prior to local dye tracing studies, many scientists erroneously believed groundwater flowed slowly through tiny pores and that ground water was completely filtered before reaching the water table. Many caves were also covered by urbanization and many local caves that could have been preserved were filled in under the assumption that this measure protected the underlying aquifer from contamination. Efforts to remove trash and fill from caves is slow and regulated to a small group of cave-trained women and men. Once trash and fill are removed from a cave, utilization of the cave by cave-adapted organisms follow, including cave crickets, bats, and other mammals that bring nutrients from the surface. A large number of the 62 federal permit caves required excavation of fill or trash, and some such as in the case of Pipeline Cave below, still require it. An article on cave restoration by AW BCP was published in the Wildflower Center magazine in November 2019 (Hauwert and Sanders 2019). In addition to restoring cave

habitat, cave restoration can also serve to restore recharge and reduce flooding where the cave catchment area is large, improve water-quality in caves filled with trash, and provide educational resources necessary to allow the public to make connections with natural ecosystems. To support cave restoration efforts, AW BCP produced a Guidelines for Cave Restoration in February 2020. In November 2018, AW BCP released version 3 of Austin Cave Activity Hazards and Safety Report that describes unique cave hazards, protocols for addressing them, and relevant safety regulations.

In addition to the large challenges of widespread historical cave filling, the highly specialized skill and dedicated physical effort required to restore them, and limited resources available for cave restoration, in January 2018, while attempting to unplug BCCP permit Blowing Sink Cave, it was observed that regulation of cave restoration was unclear. In order to clarify the regulatory status of cave restoration and provide distinction of cave restoration from other development activities that could harm caves, Austin Water, Watershed Protection Department, Parks and Recreation Department, and the Development Services Department finalized an MOA which took effect on April 1, 2020 that clarifies that cave restoration using hand-held tools is not a development activity requiring a permit. However, for cave restoration, the use of backhoes and similar heavy machinery, laying of impervious cover and even cave gating requires prior discussion with WPD staff. The Texas Commission on Environmental Quality Edwards Rules similarly requires approval prior to the use of heavy machinery for cave restoration.

Monitoring of Flint Ridge Cave continued in FY21, drip monitoring inside Flint Ridge Cave. A data-logging Hydrolab sonde has been continually recording water quality metrics every hour since July 31st, 2019. It measures water temperature, specific conductivity, pH, and dissolved oxygen, and turbidity. In May 2019 State Highway 45 SW began operation as a toll road over the cave and subsurface catchment area.

A hydrogeological study of Pipeline Cave by Zara Environmental LLC and AW BCP, with funding support from Austin Mobility Corridor Project of Austin Public Works, utilized site geology, elevations of drips and surface features, drip monitoring, water-quality sampling, observations of surface runoff during rain events, and 5 injected tracers Between October 9, 2020 to November 11, 2020 to delineate surface and subsurface areas for Pipeline Cave (Appendix). As part of this study, restoration of many local caves was necessary, as described below, in order to reach cave drips for monitoring, tracer injection sites, and in the process restores impacted cave habitat.

A hydrogeological study report of Airmen's Cave was prepared by AW BCP (Appendix), using observations of geology and water flow from surface exposures, Airmen's Cave, and borings or wells. Surface tracing from distant locations on Slaughter Creek was used to determine the source of aquifer flow that periodically inundates the cave under rare wet conditions. Only active drip areas in the Entrance Room and Formation Room have been identified, although the water table is extrapolated to be 15-20 feet below the entrance portion of the cave closer to Barton Creek. A water sample from the Formation Room suggested the rear of the cave received leakage through the Del Rio Clay, possibly along a fault in that area. Brodie Oaks Mall overlies a portion of Airmen's Cave and is proposing redevelopment, although because of the intervening layer of Del Rio Clay and reduction in impervious cover proposed, no impact to the cave is expected but the cave should be continued to be monitored for potential impacts.

Using Section 7 conservation measure funds provided by TxDOT in 2018, cave restoration and spring evaluations are being conducted in the FM 2222 and FM 620 area as part of a hydrogeological study expected to be completed in FY22, but also to restore cave habitat and establish formal karst preserves based on improved scientific information.

The cave restoration portion of hydrogeological studies is the slowest, most labor and funding intensive portion. There are limited resources for cave restoration, and it requires specialized cave expertise which is not common. FY 21 cave restoration efforts are described below.

City of Austin FY21 Cave Restoration Projects

In preparation for an upcoming hydrological study of Stovepipe Cave multiple features on Stovepipe Preserve are being restored. Cave restoration on this preserve in FY21 was funded by mitigation funds provided by TxDOT. The archeological collection and analysis was conducted by the Texas Historical Commission under a permit 9696 held by archeologist Ron Ralph.

Mossy Elm Cave

Starting in February 2019 restoration work began on a sink named Mossy Elm, by contractor Rich Zarria. The work continued off and on into late 2020. What was initially a shallow depression in now a cave approximately 25 ft deep with a 5 ft tall alcove that is home to large numbers of cave crickets. Excavation of the pit led to a clay filled room and floor that extended outwards in all direction. This made it difficult to choose a direction to dig as there was no obvious lead to follow, though there is still potential to extend the cave. The floor was explored and a general expansion of the bottom of the pit occurred. After rain fell on soil that had been

removed some stone tools were discovered so the Texas Historical Commission was brought in and with the help of volunteers multiple stone tools were documented (Figure 4).



Figure 4. Historical Commission sifting soil and stone tools found, photos by Rich Zarria

Persephone Caverns

The most significant discovery of the year was made right next to Mossy Elm Cave with the restoration of Persephone Caverns. About 50 ft Northeast of Mossy Elm Cave was a feature named Canyon Creek Crevasse. It was a crack about 10 ft long, 1 ft wide, and 2 ft deep filled with soil. In January 2021 Rich Zarria and his crew began excavation work. Soil and loose rocks were removed until a room was discovered but being too small to enter a camera was lowered to see the extent of the room. The room looked promising, so the crack was enlarged to allow access to a room with a floor 17 feet below the surface (Figure 5).



Figure 5. Persephone Caverns before restoration Feb 2019, and after restoration mid-2020, left photo by Nico Hauwert, right photo by Colin Strickland

The entrance room was tall enough to stand in with a low room going 35 ft to the north ending at a lead and a crawl extending 15 ft to the south with another lead. After an initial faunal survey was performed finding multiple troglobites including *Texella reyesi*, *Eidmennella reclusa*, and *Cicurina travisae*, the leads were pushed and going passage was found to both the north and south. The current extent of the cave is now around 600 ft long making it the most extensive cave currently known on the Jollyville Plateau. A cave map is currently being drafted by Andy Edwards; Figure 6 is a draft version with only the plan view.

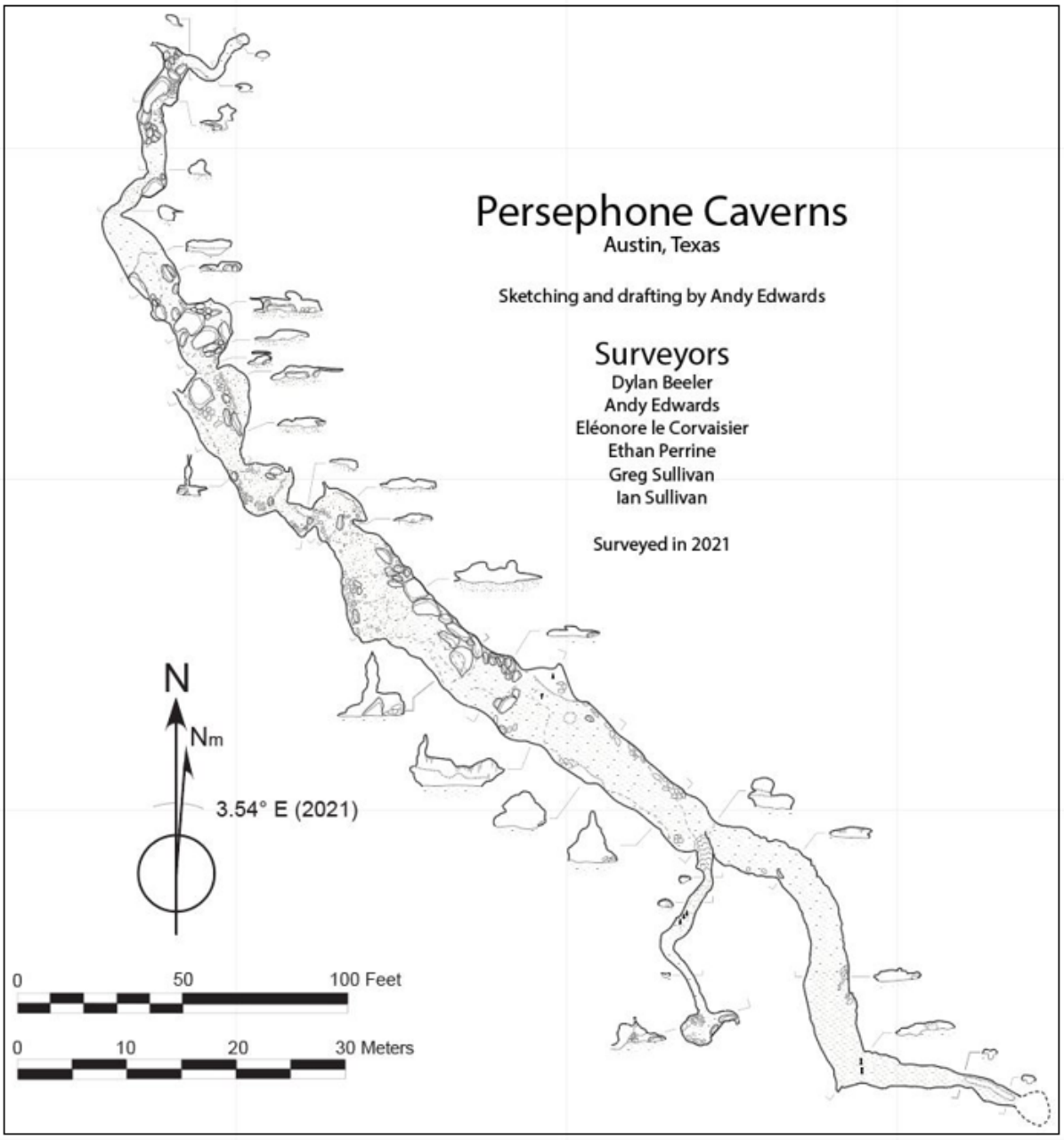

Figure 6. Persephone Caverns draft plan view by Andy Edwards

Once the size and significance of the cave was determined and *Rhadine persephone* were confirmed to be present the cave was renamed Persephone Caverns. Addition faunal surveys have expanded the species list and the cave is currently known to have three endangered species, *Rhadine persephone, Texella reyesi,* and *Texamaurops reddelli* as well as three species of concern, *Cicurina travisae*, *Eidmennella reclusa*, and *Rhadine subterranea* Figure 7.

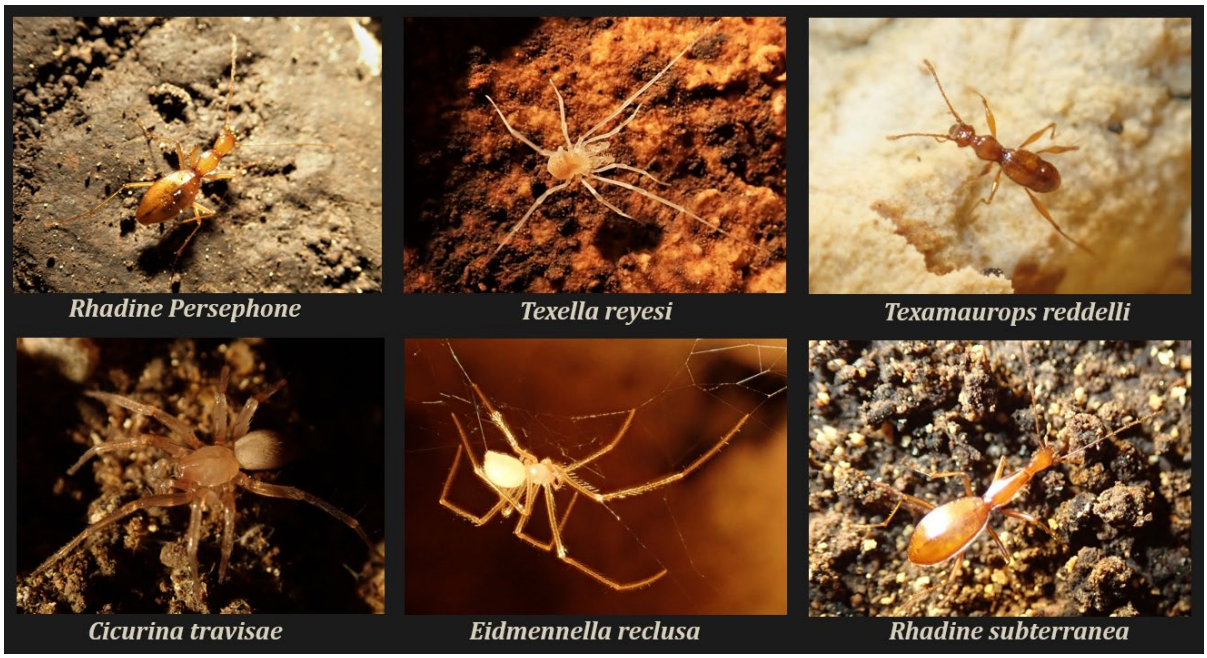

Figure 7. Photos of three endangered species and three species of concern taken in Persephone Caverns, photos by Colin Strickland

After the entrance was unplugged it allowed leaf litter to enter as well as the colonization by cave crickets, whose guano in now providing nutrients to thousands of springtails. From the first faunal survey in February to the one in May the number of springtails in the entrance room increased from around 300 to about 1,000. Initially there was no cricket guano but now there are crickets roosting in domes throughout the cave providing nutrients that will benefit the troglobitic species. Other new inhabitants to the cave since its restoration include Western slimy salamanders and cliff chirping frogs. The first surveys had neither of these species found, but by May Western slimy salamanders were found and during the August faunal survey 28 Western slimy salamanders and 17 Cliff Chirping frogs were found in the survey zones and around 20 salamanders were found between the zones. A game camera was placed inside the entrance and a bat was seen multiple times flying around the entrance room. Another troglobite with a very limited range discovered in Persephone Caverns is *Tartarocreagris attenuata* (Figure 8).



Figure 8. *Tartarocreagris attenuata* in Persephone Caverns February 28th, 2021, photo by Colin Strickland

Faunal surveys are being performed quarterly to document the changes in the cave for two years and will then be dropped to bi-annually. With its proximity to Stovepipe Cave, it is likely *Tayshaneta devia* another species of concern will eventually be found.

Gaping Maw Cave

Another feature on Stovepipe preserve that was restored this year is Gaping Maw Cave. Prior to restoration, the cave was an approximately 2-1/2 ft in diameter shaft that extended down 8ft to a soil floor (Figure 9). There was space between the floor and ceiling about 4 inches high extending in all directions from the shaft. The floor was lowered 4 ft and then a passage was deepened to enter two rooms. Another passage blocked by soil and large stones was enlarged to access the current extent of the cave (Figure 10).



Figure 9. Gaping Maw entrance February 5th, 2019, photo by Colin Strickland

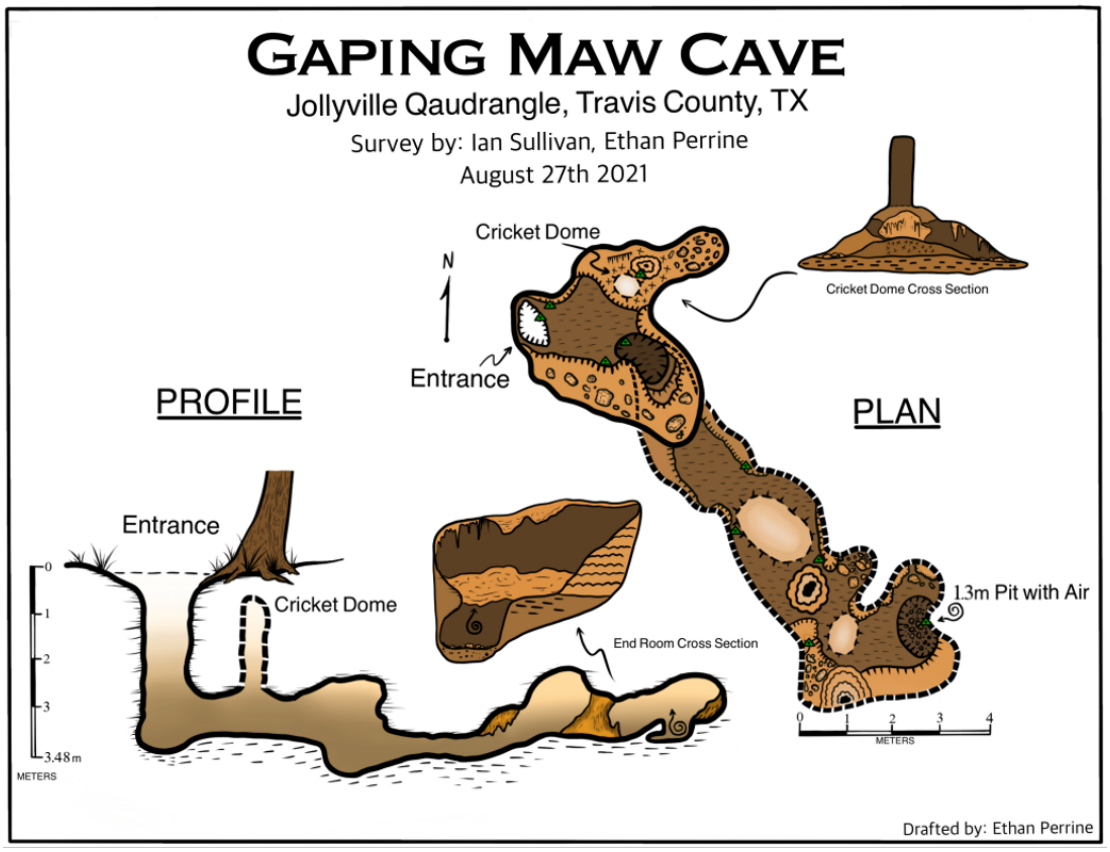

Figure 10. Gaping Maw Cave map, drafted by Ethan Perrine

There is a small crack at the end of the cave with strong airflow. More work is planned for FY 2022 to try and extend this lead. So far notable species observed include, *Tayshaneta devia, Tartarocreacris attenuata*, *Cicurina travisae*, *Rhadine* sp., and *Speodesmus* sp. In a smaller feature named Gaping Jaw just north of Gaping Maw *Texella reyesi* was found, so it will likely be observed in future surveys.

Caverns of Sweet Nora

Caverns of Sweet Nora is northwest of Persephone Caverns. Work was performed from January 15th to January 28th, 2021. The cave began as an approximately 1 ft by 0.3 ft karst feature that was leaf and soil filled.



Figure 11. Caverns of Sweet Nora, January 19th, 2020, photo by Colin Strickland

Excavation of the feature led to the development of a 21 ft deep pit that developed into a small room. During this excavation, several artifacts were discovered (Figure 12).



Figure 12. Stone tools from Caverns of Sweet Nora, photos by Drew Thompson

At the base of the pit, a small 1/3 ft of void space above soil lead was present and was dug upon. However, with the discovery of Persephone Caverns adjacent to Caverns of Sweet Nora, this lead was not pushed as it was estimated that it led into Persephone Caverns and was no longer necessary to be pushed. The lead is within 20 ft of known passage and is oriented that direction. Notable species observed include *Cicurina travisae*, *Speodesmus* sp., *Cambala speobia*, and *Ceuthophilous secretus*.

Cortaña BCP Preserve Cave Restoration

Black-cap Cave

On the Cortaña tract, a feature just east of Cortaña Cave, which was initially a small crack in the ground with slight airflow has been enlarged to reveal what is now Black-cap Cave (Figure 13). The work was done by Rich Zarria and his crew in mid-2020 with more work in FY2021 using mitigation funds provided by TxDOT. The cave is around 12 ft deep with a room 15 ft wide by 20 ft long and 3 ft high. Work will be continued by Justin Shaw in FY2022 to remove more material and push the lead. Troglobitic species observed so far include *Texella reyesi*, *Tayshaneta myopica*, *Eidmennella reclusa Cambala speobia* and *Speodesmus* sp.



Figure 13. Black-cap Cave entrance, August 30th, 2021, photo by Colin Strickland

Sam Hamilton BCP Preserve Cave Restoration

Lost Ham Cave

Lost Ham Cave is located on the Sam Hamilton tract. Work was performed from July 19th to August 17th, 2021 using mitigation funds provided by TxDOT. It began as a 4 ft wide sinkhole with an approximately 3 ft deep boulder choked aperture (Figure 14). A small amount of air was felt before initial excavation began.



Figure 14. Lost Ham Cave prior to restoration, photo by Drew Thompson

Excavation of the sinkhole led to a 6.5 ft deep pit that entered a small clay floored room with large block slabs of limestone comprising the walls. Above and below these large slabs was black soil with two small voids. One of these voids had detectable airflow and was pushed. From this a small room was discovered with a small drain in the floor. The room was about 16 ft in length that slanted upwards. A large portion of this room was kept untouched to preserve cave habitat. Excavating the drain in the room led to a 7.5 ft pit with a complex series of small leads off it. At the current end of excavation, there were to leads being pushed with one having noticeable air flow extruding from it. This was in the lowest level of the pit and had black soil fill still present. Notable species observed were *Speodesmus* sp., *Cambala speobia*, *Ceuthophilous secretus.*



Figure 15. Lost Ham Cave map, drafted by Ethan Perrine

Parke West BCP Preserve

Multiple karst features have been restored on the Parke West tract in FY2021 utilizing mitigation funds provided by TxDOT.

Super Bowl Cave

From August to September of 2021 contractors worked on the feature known as Super Bowl Cave on the Park West tract. Soil was removed from the sink leaving a 20 ft across sink bowl. Contractors continued in the lowest section of the cave excavating over 1000 buckets of material reveling a 10 ft long crawl to a small blowing air lead along a N/S facing joint. Further excavation along the joint revealed a small 8 ft by 5 ft x 2 ft tall room between a ceiling and floor slab. Air lead continues in the back along the joint but would require significant effort to excavate forward.

Spun Funnel Cave

From the beginning to end of April 2021 contractors worked on the feature known as Spun Funnel Cave. What began as a small 1 ft wide solution aperture at 2 ft in depth excavated down to 15 ft in depth. The feature maintained a 2 ft solutional width with two noted fan-outs at 6 ft and 15ft in depth. These expanded to approximately 3 ft in width. The base of the cave continues along the same solutional feature as a dig. No airflow was noted.

BAR Sink

While karst walking out in the woods in March of 2021 contractors discovered a small blowing air lead at the base of a tree which would later become BAR Sink. With further excavation into April the team revealed a solution feature that dropped 10 ft to a talus cone and small 8 ft by 3 ft by 2 ft tall room. With airflow noted along a slab in the south end of the room the team excavated further reveling a joint running approximately east/west. A faunal survey of the cave by Drew Thompson found *Texella reyesi*. Further excavation of the cave is needed to determine the source of the caves southern air source.

Pin and Feather

From March to April of 2021 contractors excavated a feature known as Pin and Feather. What began as a small surface expression lead down to a small slab room at 5ft in depth with a dimension of approx. 5 ft by 4 ft. Upon further excavation at the base of the room a crack in the floor was revealed with noted air flow. Further excavation is needed to explore the source of the air.

FDR Sink

While walking in the woods in late August of 2021 contractors stumbled upon the entrance to FDR Sink. The sink had an initial aperture of 2 ft by 2 ft at a slab collapse and lead down 4 ft to a low-lying room at approximately 4 ft by 4 ft. Upon further excavation contractors followed a solution feature in the floor down another 5 ft. Further excavation is needed.

South Austin Cave Restoration

Pipeline Cave

With the tremendous support of Parkside Village South owner Whitestone Reit, along with the nearby Alamo Drafthouse, COA BCP and Zara Environmental LLC was able to make a major breakthrough in Pipeline Cave, a BCCP permit cave, in FY20. The Austin Mobility Corridor project of City of Austin Public Works funded Zara Environmental to work with AW BCP in a hydrogeological study of federal permit caves along Slaughter Lane. The hydrogeological study report delineating the surface and subsurface catchment areas for BCCP permit caves south of Slaughter Lane west of Mopac South is being completed in FY21. Melissa Beatty of Whitestone Reit generously provided BCP staff permission to access, manage and monitor this cave as well as the adjacent Confusion Cave (non-BCCP cave). From 1966, when cave explorers first reported Pipeline Cave until 2019, Pipeline Cave had a length of 30 feet and depth of 15 feet with an estimated volume of 1,000 feet^3 (Elliott 1997). Pipeline Cave was historically used in Circle C/Covert Ranch as a trash dump site (Ira Yates 2020 personal communication), as was BCCP permit Midnight Cave, and Wildflower Cave. Midnight Cave was restored from 1993-1999 in a huge trash removal project overseen by Mark Sanders then of Austin Parks and Recreation Department. On August 10 and August 17, 2018, Mark Sanders, Drew Thompson, and Colin Strickland of AW BCP removed sixteen 42-gallon trash bags or roughly 90 feet^3 of trash. Faunal surveys began August 21, 2018.

In November 2019 Drew Thompson and Colin Strickland of AW BCP, AW BCP contractor Dylan Beeler, Bill Larsen and Lucas Pustka of Zara Environmental LLC excavated a 30-feet long crawl passage that led into one of the largest cave rooms in Travis County. "The Basement of the Alamo", it is approximately 80 ft long by 40 ft wide with ceiling heights of up to 14ft tall. The calculated volume of Pipeline Cave in FY2020 is now 20,000 ft^3, or 20 times its pre-BCP management 2018 volume.

The cave was surveyed by Aubri Jenson, Colin Strickland and Drew Thompson in late 2019 and then Colin Strickland Sketched and drafted a cave map in 2020. Staff aided by contractor Zara Environmental continued the hydrogeological study for Pipeline Cave which also includes other features found on that property as well as the adjacent Circle C Metro Park.

Confusion Cave

Confusion Cave was evaluated until a low crawling room 10 ft by 10 ft by 2 ft tall was found. With no obvious way forward, efforts were turned to the nearby feature known as Big Woof Sink located on adjacent City of Austin parkland. In July of 2021 Drew Thompson continued to excavate Confusion Cave which is located a few hundred feet to the south of Pipeline Cave.

The lead appeared to be exactly how it was left it in 2019 excavations. There was a rock face with two fist sized holes near the ceiling with slight air flow. By using the hammer drill on chisel mode Drew chipped away at the chalky pulverulite rock face following the aperture with the airflow. After 15 feet of trenching through rock he was able to see into a new room. He returned the next day with contractor Patty Calabrese for one final push into the new room. The room is 15 ft by 20 ft with a 3.5 ft ceiling at its highest. There is a drapery formation with small rimstone dams at the bottom that is not currently active. Notable species observed during a faunal survey included *Rhadine austinica, Pseudosinella violenta, Speodemus* sp., *Cambala speobia, Cicurina bandida, Ceuthophilus secretus*, and *Ceuthophilus* species B.

At the northeast side of the room there was a drop off filled with large rock. They excavated the material 6 ft down to find a conduit running to the Southeast. The floor of the conduit is compact black sediment and rock. Some broken glass, a rusty tin can, and bits of plastic were found. They are able to shoot the Disto-X 30 ft down the conduit. It is clearly where the water goes and has very impressive airflow. Drew and team will continue to pursue it in FY2022.

Big Woof Cave

Initially a large sink approximately 30 feet in diameter by 4 feet deep with discarded fencing and multiple blowing apertures, restoration focused on removing ranch fill in FY20. Big Woof Cave was gated by Charlie Savvas and restoration work continued. On Sunday November 1st, 2021 Rich Zarria's team and BCP Biologist Drew Thompson had a breakthrough in the South Passage in Big Woof Cave that is located on the Southwest of Pipeline Cave. Chasing a drain about 25ft down along the breakdown they found a competent bedrock ceiling. Through black dirt on top of red clay mixed with a wide range of cobble sizes they made their way south horizontally about 20 feet until they encountered another breakdown cone where they could into a room. The new room is about 15 ft by 8 ft wide with a 3 ft to 4 ft tall ceiling that has many stalactites (Figure 16). To the south end of the room there is a belly crawl that is about 20 ft long that is heavily decorated. This passage has air flow and will need to be pushed further by removing a few select formations (Figure 17).



Figure 16. Formations in new room discovered in Big Woof Cave, photo by Colin Strickland



Figure 17. Belly crawl at south end of new room, photo by Colin Strickland

To the west side of the room there is a drop-down between the break down blocks and the wall where they could see down and back through a passage about 8 ft long that had airflow. Drew conducted a faunal survey and notable species include *Texella mulaiki*, *Speodesmus* sp., *Cambala speobia*, and *Cicurina bandida*. The following week Drew Thompson and Rich Zarria pursued the lead on the west side of the new room. The lead continues for 50 ft as a 9-inch high by 2 to 3 ft wide conduit looking into a room that is 2 ft high by 3 ft wide and appears to be approximately 6 ft long with awkward large rocks on the ceiling. The passage continues beyond this room and the lead will be pursued once deemed safe.

Get Down Cave

On Friday March 12th, 2021 Ethan Perrine and BCP Biologist Drew Thompson worked on widening the tight constriction at the back of the southwest side of the Formation Gallery of Getdown Cave. The passage was choked by a large flowstone hump leaving a 7-inch tall by 24-inch wide void along the side and stretching about 8 feet until it widened. Past the restriction it opens to 6 ft long by 3 ft wide and 3 ft tall then takes a 90° turn to the south through another flowstone choke that is passable. On the other side of the choke there is a 15 ft by 20 ft room 18 to 28 inches tall that is dense with formations, a few of which were actively dripping (Figure 18).



Figure 18. Ethan crawling through newly discovered room, photo by Drew Thompson

Making their way through the formations to the west they came to a pancake room that is 20 ft by 40 ft and about 18 to 24 inches tall. To the southwest of that room there is a 12 ft belly crawl that was filled with rock ending in another room 20 ft by 10 ft by 4 ft tall which runs east to west with a drain dropping about 4 ft on each end. They first excavated the west drain to find it dropping even further but filled with solution rock. Excavating their way to the east in the belly crawl they intersected a dried old flow path conduit that was about 20 ft long 4 ft wide and 2 ft tall trending north to south. They found that the north end of the passage lead to the east drain in the previous room that trended east to west. At the south end of the flow path conduit they made their way over a breakdown pile to find the flow path continuing for another 12 ft before the roof dips down too low to about 6 in tall and 3 ft wide. From there they were able to shoot a 22 ft shot with a Disto-X down the passage from their last survey station. The lead has airflow, and the passage is consistently continuing at -4°. They surveyed the new portion from the restriction in the Formation Gallery adding to 185 ft of new passage, almost doubling the amount of known passage in this BCP cave.

Hays County Cave Restoration
Work was conducted on multiple Karst features on the WQPL Hudson Tract in Hays County in FY2021.

Mouse Hole sink
The Mouse Hole complex was encountered as a cluster of three previously documented karst features on the Hudson tract. The second largest feature had been excavated to a small room 6-8 ft down. The December 20th dig focused on the largest of the three entrances, a broad sink approximately 15 ft x 6 ft by 2.5 ft deep. The bottom was an uneven surface of boulders and promising cracks that were filled with loose soil and leaf material. Airflow was not detected at the beginning of the project. After the loose material was removed, it was found that the boulders were actually detached limestone pieces that had been separated from the surrounding parent material by water movement. Multiple large sections were removed which exposed a deeper fissure trending the long dimension of the sink. Material was removed to a depth of about 6 ft and there are two leads remaining.

La Cantera Ranch Cave
During February of 2021 contractors worked on a feature known as La Cantera Ranch Cave. The cave was initially observed to have a slab collapse aperture of approximately 4 ft wide by 2 ft with an initial room right below at 6 ft by 5 ft by 3 ft tall. This room had a small slab passage off to the north with approximate dimensions of 8 ft long by 3 ft wide by 2 ft tall. The room also had a small drain in the floor to the south. Upon exploring the drain in the floor contractors pushed the room down 10 ft and discovered another low-lying flat room confined between flowstone layers facing south. This room is approximately 20 ft long by 15 ft wide

by 2 ft high. Airflow was discovered coming from a flowstone constriction to the east. Further exploration is needed to determine the source of the air.

Poison Ivy Cave

From November into December of 2020 contractors worked on the feature known as Poison Ivy Cave. The once small 4 ft deep sinkhole is now over 70 ft long with a 15 by 20 ft room at its end. The entrance is now a 12 ft drop leading into a 20 ft hands and knees crawl that feeds you into about 30 ft of tight belly crawl that leads into the 15 ft by 20 ft room that is 2 ft tall at its highest and completely covered in popcorn. At the far end of the room there is a lead that has significant air flow but to push it would require damaging formations and mining forward. On December 6th, 2020 BCP Biologist Drew Thompson conducted a faunal survey and found Eyeless *Cicurina* sp., Speodesmus sp., *Ceuthophilus* species B, and *Plethodon albagula*.

8.0 RECOMMENDATIONS

COA and TC should continue to contact the owners of each privately-owned BCCP cave in order to assess current faunal assemblages and negotiate protection of these caves. The precise location of some of these privately owned caves is currently unknown; therefore, COA and TC should attempt to locate these caves in order to make a meaningful assessment. Staff will also continue to search for possible substitutions for some of the caves which are not adequately protected. Additionally, COA and TC will continue to evaluate the adequacy of protection for all 62 BCCP caves by continuing hydrological studies initiated in FY2019 and prioritize efforts accordingly. Karst preserves will be established to preserve the surface and subsurface catchment areas, cave cricket foraging areas, and other guidelines for preserves outlined by USFWS (2012).

Future research needs for the BCP should include an effort to determine to species level currently unknown troglobites such as *Speodesmus* spp., *Eidmannella* spp., and Trichoniscidae found in BCP caves. A recent research need has also been identified by James Reddell concerning *Rhadine* beetles in the region, with the possibility that potentially two undescribed species could be found within BCP caves. Future research and funding may be needed to answer these research questions.

9.0 KARST MANAGEMENT ACTIVITIES

The BCP Karst Land Management Plan (2016) outlines planned activities concerning the 62 BCCP karst features. Table 10 below includes a summary of monitoring and management activities for these features completed in FY20.

Table 10. FY21 BCCP Karst Feature Monitoring and Management Activities.
Adobe Springs Cave The Nature Conservancy 1. TC was granted continued permission from TNC to perform bi-annual faunal surveys and cave cricket exit counts for the expanded BCP Cave Monitoring program. 2. TC performed periodic surface inspections with no signs of vandalism to the cave entrance or in the cave. 3. TC conducted bi-annual cave faunal surveys (see EXHIBIT A). 4. TC conducted bi-annual cave cricket exit surveys due (See EXHIBIT B).
Airmen's Cave City of Austin 1. Conducted bi-annual cave faunal surveys (See EXHIBIT A). 2. Conducted bi-annual cave cricket exit counts. (SEE EXHIBIT B) 3. COA installed a cave gate within 18 feet of the entrance of the cave in January 2012. The cave gate not only protects the cave from ongoing vandalism, but also serves to protect the public from future accidents involving un-trained access. Access is still allowed via permit. 4. Conducted quarterly site inspections and continued to operate security camera. 5. A hydrogeological study report was completed Dec. 16, 2021 6. An interdepartmental agreement between PARD and AW BCP is being sought necessary to establish formal BCCP karst preserve management. 7.0 An access easement with overlying property owners establishes future access for monitoring.
Amber Cave Travis County 1. Performed periodic surface inspections with no signs of vandalism to the cave entrance or in the cave. 2. Maintained fencing and signage to protect this area from unauthorized access and dumping. 3. Surveyed site for RIFA. Treated 7 mounds in Spring 2021.
Armadillo Ranch Sink Private
Arrow Cave City of Austin 1. Completed annual cave faunal survey (See EXHIBIT A). 2. Conducted quarterly site inspections. City staff continues to deal with ongoing dumping problems from the adjacent neighborhood. COA PARD Rangers continue to conduct occasional patrols at these problematic sites. 3. Zara Environmental installed and monitored dye trace packets as part of the area hydrological study, study was completed in FY 21 and equipment was removed from the cave. 4. Contractors also opened up nearby features (most notably St Edwards Sinks) in conjunction with the hydrological study. 5. An interdepartmental agreement between PARD and AW BCP is being sought to establish formal BCCP karst preserve management.

Table 10. FY21 BCCP Karst Feature Monitoring and Management Activities.
Bandit Cave Private
Beard Ranch Cave (Featherman's Cave) City of Austin 1. Completed annual cave faunal survey (See EXHIBIT A). 2. Conducted quarterly site inspections. 3. No RIFA were found. A healthy population of native fire ants was found in close proximity to the cave.
Bee Creek Cave Private 1. The owner was contacted in FY21 to inquire about acquisition or management, with negative results 2. AW BCP will continue seeking acquisition of Bee Creek Cave or acquisition of substitution cave.
Blowing Sink Cave City of Austin 1. Inspected monthly and continued to operate security cameras. 2. Completed annual cave faunal survey (See EXHIBIT A). 3. The lower passageways have been inaccessible since the October 2013 flood; however, it is possible that some of the recently restored adjacent caves may lead to the water table. With the recent installation of the shaft allowing direct entry into the main passage of the cave, future excavation work will be feasible, thus allowing rock and silt to be removed which would open up the lower passageways of the cave. 4. An interdepartmental agreement between PARD and AW BCP is being sought to establish formal BCCP karst preserve management. 5. COA BCP appreciates permission from PARD Natural Resources Division Austin Nature Preserves to access the site.
Broken Arrow Cave City of Austin 1. Inspected quarterly with no sign of human visitation or vandalism. 2. Completed bi-annual faunal surveys (See EXHIBIT A). 3. Completed bi-annual cave cricket exit counts. (See EXHIBIT B). 4. Treated site for RIFA with boiling water.
Buda Boulder Spring City of Austin 1. COA BCP staff conducted bi-annual site visits and noted signs of recent transient camps near the spring. COA PARD Rangers were notified and now periodically patrol the site. 2. An interdepartmental agreement between PARD and AW BCP is being sought to establish formal BCCP karst preserve management.
Cave X Private 1. COA entered into a Private Landowner Agreement entitled "Cave X, Management and Monitoring Plan, Covenants and Restrictions" with the property owners (Regent's School) in Oct. 1999. The agreement sets aside a 4.5-acre area to protect the cave footprint. USFWS was involved in the discussions on protection. 2. Cave entrance is gated and also has a fence for added protection. 3. Regent's School staff conduct periodic surface inspections of the cave including gate and lock maintenance. 4. In an effort to get a better understanding of CO2 levels in Cave X and assist in managing/monitoring, COA BCP staff requested access to install air monitoring equipment but were declined the offer by the owner in September

Table 10. FY21 BCCP Karst Feature Monitoring and Management Activities.
2017. 5. Regents built a sports field within the Cave X buffer, over the footprint of the cave sometime between January 2018 and November 2019. City staff are currently exploring what measures can be taken to rectify the situation.
Cave Y City of Austin 1. Conducted quarterly site inspections. 2. Completed bi-annual cave faunal survey (See EXHIBIT A). 3. Completed bi-annual cave cricket exit counts. (See EXHIBIT B). 4. Surveyed site for RIFA; no mounds were discovered within the cave's treatment area. 5. An interdepartmental agreement between PARD and AW BCP is being sought to establish formal BCCP karst preserve management.
Ceiling Slot Cave Private
Cold Cave 1. TC is negotiating with the landowners concerning the possibility of purchase, conservation easement, or a management agreement for this 8-acre tract. 2. TC gained continued permission from landowner to perform bi-annual faunal surveys and cave cricket exit counts for the expanded BCP Cave Monitoring program. 3. TC performed surface inspections with no signs of vandalism to the cave entrance or in the cave, but the cave gate still in need of repair 4. TC conducted bi-annual cave faunal surveys (see EXHIBIT A). 5. TC conducted bi-annual cave cricket exit surveys. (See EXHIBIT B).
Cotterell Cave City of Austin 1. Conducted quarterly site inspections. 2. RIFA surveys determined that the ants were located approximately 300 feet from the cave, so no treatment was needed. 3. Conducted bi-annual cave faunal surveys (see EXHIBIT A). 4. Conducted bi-annual cave cricket exit surveys. (See EXHIBIT B). 5. An interdepartmental agreement between PARD and AW BCP is being sought to establish formal BCCP karst preserve management.
Disbelievers Cave Private 10a Permit: PRT-808694
District Park Cave City of Austin 1. BCP staff conducted bi-annual cave faunal surveys (See EXHIBIT A). 2. BCP staff and volunteers conducted bi-annual cave cricket exit counts (See EXHIBIT B). 3. Conducted site surveys quarterly, other than trash at the entrance no new major problems noted. 4. Permitted access to this cave was allowed. 5. BCP staff removed trash from the un-gated portion of the cave. 6. COA BCP hydrogeologist continued to work on a hydrological study to determine the sub-surface drainage and to see if the adjacent developed area of the park could negatively impact the cave (ongoing). 7. Surveyed site for RIFA; no mounds were discovered within the cave's treatment area. 8. An interdepartmental agreement between PARD and AW BCP is being sought to establish formal BCCP karst preserve management.
Eluvial Cave

Table 10. FY21 BCCP Karst Feature Monitoring and Management Activities.
Private 10a Permit: PRT-808694
Flint Ridge Cave City of Austin 1. Conducted monthly site visits and continued to operate security cameras. 2. Conducted bi-annual cave faunal surveys (See EXHIBIT A). 3. BCP staff and volunteers conducted bi-annual cave cricket exit counts (See EXHIBIT B). 4. Continuous monitoring of drips was conducted in various rooms. 5. New flow meters and autosamplers were installed at the entrance sink. 6. Four autosamplers were installed inside Flint Ridge Cave. 7. COA BCP drafted a hydrogeologic study report that will delineate the subsurface catchment areas of water sources. This is expected to be released in FY22. 8. BCP staff continuously monitor temperature, pH, dissolved oxygen, salinity, and turbidity with a mini-sonde hydrolab. 9. Construction of SH45SW was completed and sections of this highway are over portions of the cave and its surface/subsurface catchment areas.
Fossil Cave City of Austin 1. Inspected bi-annually and found no new signs of vandalism 2. Inspected for RIFA infestations on all visits. RIFA were observed within close proximity of the "suspected" cave. 3. While there are about 10 filled caves located in Schroeter Park, and it is unclear which might be Fossil Cave, once an interdepartmental Agreement with PARD is completed that would allow AW BCP to restore Fossil Cave and establish a formal karst preserve with protective measures within a city park.
Fossil Garden Cave Private 1. Apple Inc completed construction of their new campus in November 2020, the new campus is located immediately adjacent to Fossil Garden Cave.
Gallifer Cave Travis County 1. Performed periodic surface inspections with no signs of vandalism to the cave entrance or in the cave. 2. Maintained fencing and signage to protect this area from unauthorized access and dumping. 3. In FY21, Zara Environmental restored the entrance of the cave including the removal of the old gate and the construction of a new one. 4. Surveyed site for RIFA. A total of 3 mounds were treated within the 80 m buffer and 9 outside of it in Spring 2021. 5. Conducted bi-annual cave faunal surveys (see EXHIBIT A). 6. Conducted bi-annual cave cricket exit surveys. (See EXHIBIT B).
Get Down Cave City of Austin 1. In July of FY18, COA BCP and WPD signed an Interdepartmental Agreement which allows COA BCP to manage the karst preserve and Get Down Cave according to the Tier II karst management plan and allows WPD to manage the water quality ponds and underlying Millennium Cave, which they use in their aquifer education. 2. BCP staff continued to work with neighbors regarding ways to limit negative impacts to cave crickets while treating for RIFA on adjacent private property. The protocol was posted on their web site in FY21. 3. COA BCP staff helped support neighbor Stephanie Simmons with her "Texas Most Wanted" campaign, whose goal is to promote native plants by offering free plants to the public and encouraging neighbors to remove invasive non-native species. It is hoped that this type of public education will indirectly improve habitat on the preserve. 4. BCP staff completed annual cave faunal survey (See EXHIBIT A).

Table 10. FY21 BCCP Karst Feature Monitoring and Management Activities.
5. Conducted quarterly site visits and continued to operate security cameras. 6. Removed non-native invasive plants. 7. BCP staff continued to collect soft ticks from Live Oak Cave and to collaborate with Texas State and Baylor researchers who are trying to determine more information about tick borne relapsing fever (TBRF). 8. BCP staff and neighbor volunteers helped clear the trail of downed vegetation after the February snow and ice storm.
Goat Cave City of Austin 1. Completed annual faunal survey (See EXHIBIT A). 2. Conducted quarterly site surveys, staff noticed and repaired vandalized fence,and also noticed possible new graffiti inside the cave, so staff decided to install a cellular game camera to continuously monitor the cave 3. Allowed permitted access to this cave. 4. An interdepartmental agreement between PARD and AW BCP is being sought to establish formal BCCP karst preserve management.
Hole-in-the-Road Cave Private
Ireland's Cave Travis County 1. TC acquired the 4.8-acre tract containing the cave from Muirfield Homeowner Association and began full management of the cave and surrounding property in FY12. 2. Fencing was completed in FY15 on the perimeter of the Ireland's Cave tract to protect the cave preserve from trespass. 3. TC conducted an annual cave faunal survey (see EXHIBIT A). 4. TC and COA contracted with Zara Environmental to continuously monitor air quality in Irelands Cave. Ireland's Cave is known to have elevated levels of CO_2, and this study will provide vital information to staff on cave safety.
Jack's Joint Cave Private
Japygid Cave Private 10a Permit: PRT-808694
Jest John Cave City of Austin 1. Conducted 2 site visits found and no signs of vandalism or human visitation. 2. Inspected site for RIFA infestations, no RIFA were observed near the cave. 3. Conducted one cave cricket exist count. (See EXHIBIT B).
Jester Estates Cave City of Austin 1. BCP staff conducted 10 site visits looking for signs of illegally discharged pools, dumped brush and trash from

Table 10. FY21 BCCP Karst Feature Monitoring and Management Activities.
neighbors. It appears that past educational efforts have paid off, since aside from minor brush dumping, no significant illegal activities were observed. 2. BCP staff met with neighbors in regard to wildfire concerns, staff plan to conduct fuel mitigation treatment in January. 3. Conducted bi-annual cave faunal surveys (See EXHIBIT A). 4. Conducted bi-annual cave cricket exit counts. (SEE EXHIBIT B). 5. BCP staff removed non-native invasive vegetation.
Jollyville Plateau Cave Private 10a Permit: PRT-808694
Kretschmarr Cave Travis County 1. Performed surface inspections with no signs of vandalism to the cave entrance or in the cave. 2. Maintained fencing and signage to protect this area from unauthorized access and dumping. 3. Part of the 105 m setback sustained impacts in FY19 from adjacent development in the form of tree clearing. Reparations have been collected and a restoration project was conducted in FY21. 4. In FY21, Zara Environmental restored the entrance of the cave including the removal of the old gate and the construction of a new one. 5. Surveyed site for RIFA. A total of 49 were treated within the 80 m buffer and 13 outside of it in Spring 2021. 6. TC conducted bi-annual cave faunal surveys (see EXHIBIT A). 7. TC conducted bi-annual cave cricket exit surveys (See EXHIBIT B).
Kretschmarr Double Pit Travis County 1. Performed periodic surface inspections with no signs of vandalism to the cave entrance or in the cave. 2. Maintained fencing and signage to protect this area from unauthorized access and dumping. 3. Surveyed site for RIFA. Treated 3 mounds in Fall 2019 and 10 mounds in Spring 2020. 4. Conducted annual cave faunal survey (see EXHIBIT A).
Lamm Cave Section 7 Permit 2-15-93-F-075 (see USFWS files) 1. The City of Austin negotiated protective measures for this cave including a Land Management Plan for this cave. The cave has a setback size of approximately 4.13 acres. The radius of the setback varies from a minimum of 123 feet south of the cave to a maximum of 340 feet north of the cave. 2. The cave was gated, and the preserve area was fenced following COA WPD and BCP staff recommendations and design. 3. No application of fertilizers, pesticides or herbicides will be allowed in the CEF area. 4. TC staff continue to periodically monitor the site to make certain that the gates and fences are secure. 5. Walmart has closed the store and sold the property. COA and TC BCP staff will continue to monitor the site and attempt to contact the new owner regarding management and monitoring needs.
Little Bee Creek Cave City of Austin 1. Conducted quarterly site visits. 2. Conducted bi-annual cave faunal survey (See EXHIBIT A). 3. Conducted bi-annual cave cricket exit counts. (See EXHIBIT B).

Table 10. FY21 BCCP Karst Feature Monitoring and Management Activities.
Lost Oasis Cave TCMA 1. Conducted five site visits. 2. COA WPD led one cave education trip. 3. COA AW led one cave education trip. 4. COA BCP staff treated the site for RIFA with boiling water. 5. Conducted bi-annual cave faunal survey (See EXHIBIT A). 6. Conducted bi-annual cave cricket exit counts. (See EXHIBIT B). 7. Removed non-native invasive plants. 8. New fencing was installed by TCMA. 9. Formal management agreement with AW BCP to ensure permit compliance was signed by all parties on May 4, 2021
Lost Gold Cave Private 1. The owner of the lot removed the fence for the buffer lot, cleared vegetation within the surface catchment up to the entrance of Lost Gold Cave, placed mulch and a playscape in the preserve buffer lot, WP staff attempted to work with the owner to restore the site, however, at some point gave the property owner a variance to allow the encroachment to stay in place.
Maple Run Cave City of Austin 1. Conducted bi-annual cave faunal survey (See EXHIBIT A). 2. Conducted bi-annual cave cricket exit counts. (See EXHIBIT B). 3. COA BCP staff conducted quarterly site inspections and removed trash from preserve area. 4. Permitted access to this cave is allowed. 5. An interdepartmental agreement between PARD and AW BCP is being sought to establish formal BCCP karst preserve management.
McDonald Cave Travis County 1. Performed periodic surface inspections with no signs of vandalism to the cave entrance or in the cave. 2. Maintained fencing and signage to protect this area from unauthorized access and dumping. 3. Surveyed site for RIFA but no mounds were found. 4. Conducted annual cave faunal surveys (see EXHIBIT A).
McNeil Bat Cave Private
Midnight Cave City of Austin 1. Conducted quarterly site inspections; on multiple occasions in the past vandals cut the chain to the gate. Staff continue to monitor a cellular game camera and continue to make improvements to the gate and fence to better secure the site. 2. Conducted bi-annual cave faunal surveys. (See EXHIBIT A). 3. Conducted bi-annual cave cricket exit counts. (See EXHIBIT B). 4. Permitted access to this cave is allowed, though no access permits were granted this fiscal year. 5. Zara Environmental continued to monitor dye trace packets as part of the area hydrological study, the study was

Table 10. FY21 BCCP Karst Feature Monitoring and Management Activities.
completed in FY 21 and the equipment has been removed 6. An interdepartmental agreement between PARD and AW BCP is being sought to establish formal BCCP karst preserve management.
M.W.A. Cave Private 10a Permit: PRT-808694
Moss Pit Cave Private
New Comanche Trail Cave Travis County 1. Performed periodic surface inspections with no signs of vandalism to the cave entrance or in the cave. 2. Maintained fencing and signage to protect this area from unauthorized access and dumping. 3. Surveyed site for RIFA. A total of 14 were treated within the 80 m buffer and none outside of it in Spring 2021. 4. TC conducted annual cave faunal survey (see EXHIBIT A). 5. TC conducted annual cave cricket exit survey. (See EXHIBIT B).
No Rent Cave Travis County 1. TC acquired No Rent Cave and surrounding land that protects a portion of the cave cricket foraging area and surface/subsurface drainage basins in FY19. 2. Zara Environmental installed an elevated cave gate in FY19. 3. TC performed surface inspections with no current signs of vandalism to the cave entrance or in the cave. 4. TC conducted bi-annual cave faunal surveys (see EXHIBIT A). 5. TC conducted bi-annual cave cricket exit surveys. (See EXHIBIT B).
North Root Cave Travis County 1. Performed periodic surface inspections with no signs of vandalism to the cave entrance or in the cave. 2. Maintained fencing and signage to protect this area from unauthorized access and dumping. 3. Surveyed site for RIFA. A total of 16 were treated within the 80 m buffer and none outside of it in Spring 2021. 4. TC conducted an annual cave faunal survey (see EXHIBIT A).
Pennie's Cave Private 1 The entrance was re-excavated in 2012, providing access to the cave. 2.The cave entrance has been gated and fenced; boulders were also placed around the cave at the edge of a 300-ft buffer to better define the protected area. 3. Zara Environmental has continued to secure one-year contracts to conduct cave faunal surveys, map the interior of the cave and treat the site for RIFA. Although only a one-year contract, it is hoped that the owner will extend the contract for multiple years. 4. Zara Environmental provided an annual report to the BCP on all monitoring and management activities.
Pickle Pit Cave Private USFWS Section 7 Permit 2-15-93-F-075

Table 10. FY21 BCCP Karst Feature Monitoring and Management Activities.
1. A volunteer neighbor occasionally monitors the cave entrance/ gate monthly; no problems noted.
Pipeline Cave Private 1. A 2004 agreement between COA and Stratus set aside an approximately 8-acre buffer around Pipeline Cave that varies from 100 feet to the east and up to 300 feet west of the cave and an additional setback of 300 feet to the north and west; 150 ft. to east and south for the adjacent feature known as Confusion Sink. 2. Developer installed cave gate (including a gate on the nearby "Confusion Cave." 3. In August 2018, COA BCP staff met with the property manager and obtained provisional access to begin monitoring and management of Pipeline and the adjacent Confusion Cave according to the Tier II karst land management plan. 4. Conducted bi-annual cave faunal surveys. (See EXHIBIT A). 5. Conducted bi-annual cave cricket exit counts. (See EXHIBIT B). 6. COA BCP provided a monitoring and management report to the property manager. 7. Staff has removed trash fill from the cave on multiple occasions, which is initially dated to late 1950's and early 1960's. 8. COA and Zara Environmental completed a hydrological study which included monitoring several other nearby caves.
Rolling Rock Cave City of Austin 1. Inspected quarterly and no sign of human visitation or vandalism was found. 2. Conducted one cave faunal survey. (See EXHIBIT A).
Root Cave Travis County 1. Performed periodic surface inspections with no signs of vandalism to the cave entrance or in the cave. 2. Maintained fencing and signage to protect this area from unauthorized access and dumping. 3. Surveyed site for RIFA. A total of 21 were treated within the 80 m buffer and 6 outside of it in Spring 2021.
Slaughter Creek Cave City of Austin 1. Conducted quarterly site inspections. 2. Conducted one cave faunal survey. (See EXHIBIT A) 3. Zara Environmental continued to monitor dye trace packets as part of the area hydrological study. Study was completed in FY 21 and all equipment was removed from the cave. 4. An interdepartmental agreement between PARD and AW BCP is being sought to establish formal BCCP karst preserve management.
Spanish Wells Cave Travis County 1. TC acquired Spanish Wells Cave and surrounding land that protects the cave cricket foraging area and surface/subsurface drainage basins in FY15. 2. Performed surface inspections with no signs of trespass or vandalism to the cave entrance or in the cave. 3. Surveyed site for RIFA. A total of 16 were treated within the 80 m buffer and 3 outside of it in Spring 2021 4. Conducted bi-annual cave faunal surveys (See EXHIBIT A). 5. Conducted bi-annual cave cricket exit count. (See EXHIBIT B).
Spider Cave

Table 10. FY21 BCCP Karst Feature Monitoring and Management Activities.
City of Austin 1. Conducted four site visits, and no sign of human access or vandalism was found. 2.Conducted bi-annual cave faunal surveys (See EXHIBIT A). 3. Conducted bi-annual cave cricket exit counts. (See EXHIBIT B). 4. Treated site for RIFA with boiling water. 5. As part of the new adjacent highway expansion work, TXDOT has provided funds for hydrological studies, which includes excavation of features adjacent to spider cave, the ultimate goal of finding active drips which would allow for dye trace studies that would accurately determine the subsurface drainage basin.
Stark's North Mine Travis County 1. TC acquired this cave and 0.8 acres surrounding it in FY12. The area surrounding the cave is all previously developed. 2. TC acquired a conservation easement on the adjacent 0.38 acres which contains much of the cave cricket foraging area. 3. Performed surface inspections and detected signs of vandalism to the cave entrance and inside the cave. Cave gate was subsequently repaired by Zara Environmental. 4. Surveyed site bi-annually for RIFA. No mounds found within 80 m of cave. 5. Conducted bi-annual cave faunal surveys (See EXHIBIT A). 6. Conducted bi-annual cave cricket exit counts (See EXHIBIT B).
Stovepipe Cave 1. Conducted 6 site inspections and continued to remove new and old trash from the preserve. 2. Repaired perimeter fence. 3. Conducted bi-annual cave faunal surveys (See EXHIBIT A). 4. Conducted bi-annual cave cricket exit counts (See EXHIBIT B). 5. Surveyed site for RIFA; no mounds were discovered within the cave's treatment area. 6. Continued karst assessment of site in FY20. 7. As part of the new adjacent highway expansion work, TXDOT has provided funds for hydrological studies, which includes excavation of features adjacent to stovepipe cave, the ultimate goal of finding active drips which would allow for dye trace studies that would accurately determine the subsurface drainage basin. 8. As part of a hydrological study, the drip gauge that was installed in FY 20 was continued to be monitored in FY21.
Talus Spring Cave Private 1. The USFWS 10a permit PRT 815447 mitigation requirement intended this cave to go to TC, however, the cave is located on private land just outside of the mitigation area. TC has continued requesting that the homeowner's association donate the land to TC. 2. Performed surface inspections with no signs of vandalism to the cave entrance or in the cave. 3. Conducted annual cave faunal survey (see EXHIBIT A). 4. Performed a non-native plant removal project on tract to increase native plant diversity.
Tardus Hole Cave Travis County 1. Performed periodic surface inspections with no signs of vandalism to the cave entrance or in the cave. 2. Maintained fencing and signage to protect this area from unauthorized access and dumping. 3. Surveyed site for RIFA. A total of 21 were treated within the 80 m buffer and 1 outside of it in Spring 2021. 4. Conducted annual cave faunal survey (see EXHIBIT A).
Tooth Cave Travis County

Table 10. FY21 BCCP Karst Feature Monitoring and Management Activities.
1. Performed periodic surface inspections with no signs of vandalism to the cave entrance or in the cave. However, a homeless camp was found onsite in the Fall of 2108 and was removed. 2. Maintained fencing and signage to protect this area from unauthorized access and dumping. 3. Zara Environmental replaced old cave gate with a newer elevated gate in FY18. 4. Surveyed site for RIFA. A total of 18 were treated within the 80 m buffer and 7 outside of it in Spring 2021. 5. Conducted bi-annual cave faunal surveys (see EXHIBIT A). 6. Conducted bi-annual cave cricket exit surveys. (See EXHIBIT B).
<u>Weldon Cave</u> Travis County 1. TC acquired Weldon Cave and surrounding land that protects a portion of the cave cricket foraging area and surface/subsurface drainage basins in FY19. 2. Zara Environmental install a cave gate in FY19. 3. TC performed surface inspections with no current signs of vandalism to the cave entrance or in the cave. 4. TC conducted bi-annual cave faunal surveys (see EXHIBIT A). 5. TC conducted bi-annual cave cricket exit surveys. (See EXHIBIT B).
<u>Whirlpool Cave</u> TCMA 1. Formal management agreement with AW BCP to ensure permit compliance was signed by all parties on May 4, 2. TC/COA conducted bi-annual cave faunal surveys (see EXHIBIT A). 3. TC/COA conducted bi-annual cave cricket exit surveys. (See EXHIBIT B). 4. TCMA continued to allow permitted access to the cave; however, in an effort to limit access and to raise funds for cave management, they are now charging a fee for access. 5. Continuous monitoring of CO_2, humidity, and airflow is being conducted in the East caverns passage by Zara Environmental on behalf of COA BCP.

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EXHIBIT A:

KARST FAUNAL SURVEY REPORTS

FY21 City of Austin/Travis County Karst Faunal Surveys[1, 2]

			Endangered Species						Species of Concern										Other Significant Troglobites							
Cave	**Survey Date**	**Monitoring Agency**	***Rhadine persephone***	***Tartarocreagris texana***	***Tayshaneta myopica***	***Texamaurops reddelli***	***Texella reddelli***	***Texella reyesi***	***Caecidotea reddelli***	***Cicurina bandida***	***Cicurina travisae***	***Eidmannella reclusa***	***Rhadine austinica***	***Rhadine subterranea***	***Sphalloplana mohri***	***Tartarocreagris comanche***	***Tayshaneta concinna***	***Tayshaneta devia***	***Texella spinoperca***	***Cicurina bawata***	***Speodesmus bicornourus***	***Speodesmus sp.***	***Tartarocreagris attenuata***	***Tartarocreagris infernalis***	***Tayshaneta sp.***	***Texella mulaiki***	**Other notable species detected**
Adobe Springs Cave	12/1/2020	TC																									
Adobe Springs Cave	5/17/2021	TC																									*Cicurina* sp. eyeless (1)
Airman's Cave	2/2/2021	COA								14									2		9					2	*Cambala speobia* (7) *Perimyotis subflavus* (2)
Airman's Cave	8/5/2021	COA								18									4		6						*Cambala speobia* (8) *Texoreddellia texensis* (2)
Another Cave	3/10/2021	COA																									
Ants in the Pants Cave	11/2/2020	COA																				3					*Tayshaneta sandersi* (5)
Arrow Cave	10/4/2020	COA								5												1					*Cambala speobia* (2) *Tayshaneta sandersi* (5) Texoreddellia sp. (1)
Arrow Cave	9/29/2021	COA								6			1									2				3	*Cambala speobia* (1)
Beard Ranch Cave	8/25/2021	COA						8			3																*Cambala speobia* (7)
Big Woof Cave	11/1/2020	COA								3												2				1	*Cambala speobia* (2)
Black-cap Cave	8/4/2021	COA									3	2															
Blowing Sink Cave	9/29/2021	COA								22			1									9				1	*Batrisodes* sp. (1) *Cambala speobia* (6)
Broken Arrow Cave	11/10/2020	COA	1						45											6	2						*Cambala speobia* (96)
Broken Arrow Cave	5/4/2021	COA							40											6	1						*Cambala speobia* (34)
Cave Y	1/27/2021	COA								1																	*Perimyotis subflavus* (24) *Texella grubbsi* (1)
Cave Y	8/27/2021	COA								16												10					*Texella grubbsi* (10)
Caverns of Sweet Nora	2/4/2021	COA									6																
Cold Cave	2/8/2021	TC						4												12		4					*Cambala speobia* (25) *Texoreddellia* sp. (2)
Cold Cave	8/31/2021	TC												1						2		3					*Batrisodes* sp. (3) *Cambala speobia* (3,251) *Perimyotis subflavus* (2) *Texoreddellia* sp. (1)
Cortana Cave	1/26/2021	COA			34			10			5	38										6					

			Endangered Species						Species of Concern											Other Significant Troglobites							
Cave	Survey Date	Monitoring Agency	*Rhadine persephone*	*Tartarocreagris texana*	*Tayshaneta myopica*	*Texamaurops reddelli*	*Texella reddelli*	*Texella reyesi*	*Caecidotea reddelli*	*Cicurina bandida*	*Cicurina travisae*	*Eidmannella reclusa*	*Rhadine austinica*	*Rhadine subterranea*	*Sphalloplana mohri*	*Tartarocreagris comanche*	*Tayshaneta concinna*	*Tayshaneta devia*	*Texella spinoperca*	*Cicurina bawata*	*Speodesmus bicornourus*	*Speodesmus* sp.	*Tartarocreagris attenuata*	*Tartarocreagris infernalis*	*Tayshaneta* sp.	*Texella mulaiki*	Other notable species detected
Cortana Cave	8/13/2021	COA			19			4			8	51										3					*Cambala speobia* (7)
Cotterrell Cave	1/262021	COA						7			50										10						
Cotterrell Cave	8/5/2021	COA						10			62			2							15			4			*Cambala speobia* (10)
District Park Cave	11/24/2020	COA								22												1				2	*Cambala speobia* (13) *Tayshaneta sandersi* (1)
District Park Cave	6/10/2021	COA								16																	*Cambala speobia* (55)
Flint Ridge Cave	11/30/2020	COA								17												10				1	*Batrisodes* sp. (1)
Flint Ridge Cave	6/4/2021	COA								15												6					Japigidae (3) *Texoreddellia* sp. (3)
Gallifer Cave	8/19/2021	TC	2		38			11			179																*Cambala speobia* (190) *Tartarocreagris* sp. (1) *Texoreddellia* sp. (1)
Gallifer Cave	1/28/2021	TC	1		43			11			50											2					*Cambala speobia* (5) *Perimyotis subflavus* (1)
Geode Cave	8/17/2021	TC	1		28			2			6	2										2					*Cambala speobia* (5) *Tartarocreagris* sp. (2)
Geode Cave	1/29/2021	TC			78						1	4															
Goat Cave	9/26/2021	COA								4												1					*Cambala speobia* (1) *Speodesmus* NS (1)
Grassy Cove Cave	2/9/2021	COA								17			4														*Cambala speobia* (10) *Stygobromus* sp. (3) *Texoreddellia* sp. (10)
GCWA Cave	12/3/2020	COA																				1					
Hammett's Cave	6/24/2021	TC					12															3		13			*Cambala speobia* (6)
Ireland's Cave	2/4/2021	TC								5			11														*Cambala speobia* (12)
Jester Estates Cave	11/17/2020	COA		4	8			42			2											1					*Cambala speobia* (2)
Jester Estates Cave	5/21/2021	COA		3	14			39			3											1					*Cambala speobia* (1)
Kretschmarr Cave	11/18/2020	TC				1					12										1						*Cambala speobia* (15)
Kretschmarr Cave	5/17/2021	TC				2					26																*Cambala speobia* (7) *Tartarocreagris* sp. (2)

			Endangered Species						Species of Concern											Other Significant Troglobites							
Cave	Survey Date	Monitoring Agency	*Rhadine persephone*	*Tartarocreagris texana*	*Tayshaneta myopica*	*Texamaurops reddelli*	*Texella reddelli*	*Texella reyesi*	*Caecidotea reddelli*	*Cicurina bandida*	*Cicurina travisae*	*Eidmannella reclusa*	*Rhadine austinica*	*Rhadine subterranea*	*Sphalloplana mohri*	*Tartarocreagris comanche*	*Tayshaneta concinna*	*Tayshaneta devia*	*Texella spinoperca*	*Cicurina bawta*	*Speodesmus bicornourus*	*Speodesmus* sp.	*Tartarocreagris attenuata*	*Tartarocreagris infernalis*	*Tayshaneta* sp.	*Texella mulaiki*	Other notable species detected
Kretschmarr Double Pit	11/18/2020	TC									1																
Little Bee Creek Cave	11/20/2020	COA					8																			*Cambala speobia* (14)
Little Bee Creek Cave	5/26/2021	COA					5			2												1				*Cambala speobia* (46)
Lost Oasis Cave	12/3/2020	COA								11												1				*Cambala speobia* (21)
Lost Oasis Cave	6/4/2021	COA								28												22				*Batrisodes* sp. (1) *Cambala speobia* (76) *Texoreddellia* sp. (3)
Maple Run Cave	1/18/2021	COA								6															1	
Maple Run Cave	8/18/2021	COA								8												5			1	
McDonald Cave	8/26/2021	TC						7			113							14			30			10			*Cambala speobia* (107)
Midnight Cave	1/7/2021	COA								7												1				*Batrisodes* sp. (1) *Cambala speobia* (29)
Midnight Cave	8/18/2021	COA								14																*Batrisodes* sp. (1) *Cambala speobia* (14)
Millipede Annex Cave	12/1/2020	COA			7			4												2						*Cambala speobia* (1)
Millipede Annex Cave	5/12/2021	COA			8			7												5						*Cambala speobia* (1)
Millipede Cave	12/1/2020	COA			4															5						
Millipede Cave	5/12/2021	COA			3			1												5						*Cambala speobia* (2)
New Comanche Trail Cave	8/17/2021	TC			3						19															
No Rent Cave	2/2/2021	TC																		21						*Cambala speobia* (21)
No Rent Cave	8/23/2021	TC						3												26		1				*Cambala speobia* (64) *Texoreddellia* sp. (5)
North Root Cave	6/16/2021	TC																								*Cambala speobia* (1)
Persephone Caverns	2/10/2021	COA						2			35	2										4				*Cambala speobia* (16)
Persephone Caverns	2/25/2021	COA						1			24	5										13	1			*Cambala speobia* (14) *Texoreddellia* sp. (1)
Persephone Caverns	2/28/2021	COA	1					4			2	7										5	2			*Cambala speobia* (4) *Texoreddellia* sp. (2)
Persephone Caverns	5/14/2021	COA				2		3			48	8										3				*Cambala speobia* (29) *Texoreddellia* sp. (1)
Persephone Caverns	8/19/2021	COA	3			1		7			45	14		1								6				*Batrisodes* sp. (5) *Cambala speobia* (42)

			Endangered Species						Species of Concern											Other Significant Troglobites							
Cave	Survey Date	Monitoring Agency	*Rhadine persephone*	*Tartarocreagris texana*	*Tayshaneta myopica*	*Texamaurops reddelli*	*Texella reddelli*	*Texella reyesi*	*Caecidotea reddelli*	*Cicurina bandida*	*Cicurina travisae*	*Eidmannella reclusa*	*Rhadine austinica*	*Rhadine subterranea*	*Sphalloplana mohri*	*Tartarocreagris comanche*	*Tayshaneta concinna*	*Tayshaneta devia*	*Texella spinoperca*	*Cicurina bowata*	*Speodesmus bicornourus*	*Speodesmus* sp.	*Tartarocreagris attenuata*	*Tartarocreagris infernalis*	*Tayshaneta* sp.	*Texella mulaiki*	Other notable species detected
Pipeline Cave	11/24/2020	COA								25			1													6	*Batrisodes* sp. (1) Speodesmus NS (27) *Texoreddellia* sp. (4)
Pipeline Cave	5/25/2021	COA								41																5	*Batrisodes* sp. (4) *Cambala speobia* (4) Japygidae (1) Speodesmus NS (10) *Texoreddellia* sp. (1)
Pond Party Pit	1/14/2021	COA						12														10		5			*Cambala speobia* (7)
Pond Party Pit	8/25/2021	COA	2					17			8											7		7			*Cambala speobia* (21)
Rolling Rock Cave	11/10/2020	COA																		12	1						*Cambala speobia* (1)
Seibert Sink	1/27/2021	COA								1																	*Texoreddellia* sp. (1)
Seibert Sink	8/25/2021	COA								2							4		4			2					*Cambala speobia* (1)
Slaughter Creek Cave	9/29/2021	COA								21												57					*Batrisodes* sp. (1) *Cambala speobia* (6)
Spanish Wells	2/1/2021	TC													14												
Spanish Wells	8/16/2021	TC													14												
Spider Cave	11/12/2020	COA						3			12											2					*Batrisodes* sp. (2)
Spider Cave	5/20/2021	COA	1								31											1					*Batrisodes* sp. (1) *Cambala speobia* (5)
Stark's North Mine	11/17/2020	TC																									*Perimyotis subflavus* (11)
Stark's North Mine	5/18/2021	TC															2										*Perimyotis subflavus* (1)
Stovepipe Cave	1/19/2021	COA	1			6		29			7	16		1								52	2				*Cambala speobia* (26)
Stovepipe Cave	8/17/2021	COA	3			9		28			4	12										87	7				*Cambala speobia* (60)
Talus Spring Cave	8/17/2021	TC																									*Cambala speobia* (2)
Tardus Hole	11/18/2020	TC																									
Testudo Tube Cave	1/21/2021	COA	2												20					17		14					*Batrisodes* sp. (3) *Cambala speobia* (116) *Eurycea tonkawae* (16) *Stygobromus* sp. (20)

			Endangered Species						Species of Concern											Other Significant Troglobites							
Cave	Survey Date	Monitoring Agency	*Rhadine persephone*	*Tartarocreagris texana*	*Tayshaneta myopica*	*Texamaurops reddelli*	*Texella reddelli*	*Texella reyesi*	*Caecidotea reddelli*	*Cicurina bandida*	*Cicurina travisae*	*Eidmanella reclusa*	*Rhadine austinica*	*Rhadine subterranea*	*Sphalloplana mohri*	*Tartarocreagris comanche*	*Tayshaneta concinna*	*Tayshaneta devia*	*Texella spinoperca*	*Cicurina bunvata*	*Speodesmus bicornuatus*	*Speodesmus* sp.	*Tartarocreagris attenuata*	*Tartarocreagris infernalis*	*Tayshaneta* sp.	*Texella mulaiki*	Other notable species detected
Testudo Tube Cave	8/13/2021	COA	1												20					26		5					*Cambala speobia* (391) *Eurycea tonkawae* (11) *Stygobromus* sp. (30)
Tooth Cave	11/24/2020	TC	1	1	6			39			88	3									1						*Cambala speobia* (17) *Perimyotis subflavus* (7)
Tooth Cave	5/19/2021	TC	2	2	23			23			122	15									2						*Cambala speobia* (37) *Texoreddellia* sp. (6)
Weldon Cave	2/2/2021	TC												10													*Cambala speobia* (9) *Perimyotis subflavus* (5)
Weldon Cave	8/23/2021	TC						3						7						5	3						*Cambala speobia* (6) *Perimyotis subflavus* (1)
Whirlpool Cave	1/22/2021	COA								7			3									1					*Batrisodes* sp. (1) *Speodesmus* NS (1)
Whirlpool Cave	8/10/2021	COA								40												1					*Speodesmus* NS (1)

[1] All survey data and full species lists available by request through COA and TC.

[2] Surveyors in FY21 include: Samuel Berg, Cristina Campbell, Travis Clark, Paul Fushille, Devin Grobert, Darrell Hutchinson, Annalily Lopes, David Morgan, Mark Sanders, Nancy Sandoval, Jonny Scalise, Blake Sissel, Colin Strickland, and Drew Thompson

EXHIBIT B:

CAVE CRICKET EXIT COUNT DATA REPORTS

FY21 COA/TC CAVE CRICKET EXIT COUNT DATA REPORTS

Surveyed Caves	Fall 2020 (November/ December)				Winter 2021 (January/February/ March)				Spring 2021 (May/ June)				Summer 2021 (August/ September)			
	N:	J:	A:	TI:	N:	J:	A:	TI:	N:	J:	A:	TI:	N:	J:	A:	TI:
Adobe Springs Cave	5	189	240	434					58	174	527	759				
Airman's Cave					349	518	71	938					293	51	10	354
Black-cap Cave													8	16	61	85
Broken Arrow Cave	150	59	92	301					334	147	337	818				
Cave Y					5	2	0	7					19	20	56	95
Cold Cave					2294	765	20	3079					817	291	2912	4020
Cortana Cave					5	1	3	9					55	53	97	205
Cotterell Cave					274	48	19	341					871	168	59	1098
District Park Cave	145	109	93	347					427	606	1275	2308				
Flint Ridge Cave	23	15	0	38					15	46	159	220				
Gallifer Cave					34	11	0	45					9	37	519	565
Geode Cave					24	24	9	57					9	37	519	565
Jest John Cave													114	100	590	804
Jester Estates Cave	282	280	462	1024					800	105	41	946				
Kretschmarr Cave	29	36	44	109					192	230	399	821				
Little Bee Creek Cave	1	0	1	2					0	0	6	6				
Lost Oasis Cave	322	86	19	427					N/A	N/A	N/A	N/A				
Maple Run Cave					1490	112	14	1616					1392	392	279	2063
Midnight Cave					9867	10006	2422	22295					7628	3561	10029	21218
New Comanche Trail Cave													2	2	308	312
No Rent Cave					390	42	1	433					81	154	273	508
Persephone Caverns					101	113	14	228	57	55	94	206	27	32	309	368
Pipeline Cave	203	44	2	249					692	627	732	2051				
Pond Party Pit					55	15	1	71					83	45	247	375
Seibert Sink					94	112	119	325					350	67	84	501

Surveyed Caves	Fall 2020 (November/December)				Winter 2021 (January/February)				Spring 2021 (May/ June)				Summer 2021 (August/ September)			
Spanish Wells Cave					107	147	46	300					112	126	1950	2188
Spider Cave	18	14	36	68					69	30	38	137				
Stark's North Mine	9	17	46	72					3	52	117	170				
Stovepipe Cave					144	42	14	200					171	81	941	1193
Testudo Tube					77	109	64	250					31	30	61	122
Tooth Cave	1	1	28	30					28	78	75	181				
Weldon Cave					423	98	0	521					600	82	435	1117
Whirlpool Cave					3405	1554	255	5214					3626	3476	3526	10628

N= nymphs; J= juveniles; A= adults; TI= total individuals.