

**Terrestrial Species of Concern Study for the
Pensacola Hydroelectric Project (Project; FERC
[Federal Energy Regulatory Commission] No. 1494);
Craig, Delaware, Mayes and Ottawa Counties,
Oklahoma**

Prepared for:



Grand River Dam Authority

Prepared by:



Horizon Environmental Services, Inc.

TABLE OF CONTENTS

Chapter		Page
1.0	INTRODUCTION AND BACKGROUND	1
2.0	STUDY YEAR ONE ACTIVITIES	3
2.1	American Burying Beetle Survey	3
2.2	Gray Bats.....	5
3.0	STUDY YEAR TWO ACTIVITIES	7
3.1	Impact Analysis	7
4.0	REFERENCES CITED	9
	APPENDIX A: American Burying Beetle Pensacola Hydroelectric Project Survey Report	
	APPENDIX B: Monitoring Patterns and Use by Gray Bat Populations in Caves DL-2 and DL-91 in Delaware County, Oklahoma Governmental Interagency Agreement Contract No.43337	

LIST OF FIGURES

	Page
Figure 1. ABB Survey Trap Locations.....	4

LIST OF TABLES

	Page
Table 1. Records of highwater events where the elevation of Grand Lake exceeded elevation 750.00 feet PD from 2005-2019. At elevation 752 feet PD, the existing flyway inside cave DL-2 is completely inundated preventing colony exit and re-entry.	5

1.0 INTRODUCTION AND BACKGROUND

Grand River Dam Authority (GRDA, Licensee) holds a license issued by the Federal Energy Regulatory Commission (FERC, Commission) to operate and maintain the Pensacola Hydroelectric Project (Project). The Project is owned, operated, and maintained by the Licensee. The current license, which designates the Project as FERC No. 1494, expires on May 31, 2025 (FERC, 2018a).

As part of the relicensing of the Project, GRDA filed a Pre-Application Document (PAD) with FERC on February 1, 2017 (GRDA 2017). The GRDA filed its Proposed Study Plan (PSP) for the relicensing on April 27, 2018 (GRDA 2018a). Also, on April 27, 2018, FERC released its Scoping Document 2 for the relicensing of the Project (FERC 2018b). In its PSP, GRDA did not include a specific study to investigate potential Project effects on terrestrial species of concern. Based on comments received from federal and state resource agencies and other stakeholders, GRDA's Revised Study Plan (RSP), filed on September 24, 2018, proposed a Terrestrial Species of Concern Study (Study) to provide further details regarding how potential impacts to these species related to changing water levels due to Project operations will be assessed during the relicensing process.

This Study proposed to collect information to support an assessment of the effects of the Project, if any, on terrestrial species of concern as part of FERC's National Environmental Policy Act (NEPA) analysis for the relicensing of the Project. According to the approved study plan, three Rare, Threatened, and Endangered (RTE) species require analysis: the gray bat, and American burying beetle ("species of concern"). To provide the information needed by FERC to fulfill its requirements under NEPA, GRDA will complete a "desktop" evaluation of the changes due to Project operations, if any, on the two species of bat and field surveys and associated analysis to assess possible impacts on the American burying beetle. The analysis will be based on output from the Comprehensive Hydraulic Model (CHM) that will be developed as part of the Hydrologic and Hydraulic Modeling Study (H&H Study) combined with existing information on the bat species, and data derived from surveys of the American burying beetle in the study area.

Continued operation of the Project will influence water levels of Grand Lake. These water level fluctuations may have the potential to alter the habitat of the species of concern. Understanding the magnitude, duration, and frequency of operational effects on habitat will allow

for a characterization of potential impacts, if any, on the terrestrial species of concern and provide information needed by FERC to fulfill its requirements under NEPA.

2.0 STUDY YEAR ONE ACTIVITIES

2.1 AMERICAN BURYING BEETLE SURVEY

Horizon coordinated with the United States Fish and Wildlife Service (USFWS) to ensure sufficient Project Area coverage with respect to habitat types across the entire Project Area as well as greatest surface area coverage in areas of potential impacts based on the Upland Model extents associated with the H&H Study. Six baited pitfall bucket traps were deployed within suitable, representative terrain on 18 July 2021 in Delaware and Ottawa Counties (Figure 1). This presence/absence survey was conducted as an early season survey in accordance with the approved study plan. The survey was conducted in accordance with the United States Fish and Wildlife Service American Burying Beetle (*Nicrophorus americanus*; ABB) Range-Wide Presence/Absence Survey Guidance dated May 2018 (Guidance).

The survey continued with five nights of valid weather parameters. Guidance defines valid weather parameters as:

1. Nighttime temperature during the survey period above 60° F (15.5 C)
2. Wind speeds no greater than 10 mph in excess of 20% of the time (1 hour 24 minutes) between 9:00 p.m. and 4:00 a.m.,
3. Precipitation less than 0.5 inches between 9:00 p.m. and 4:00 a.m.

No ABBs were captured or observed during this survey effort. For full details of the survey effort, please refer to the American Burying Beetle Pensacola Hydroelectric Project Survey Report in Appendix A.

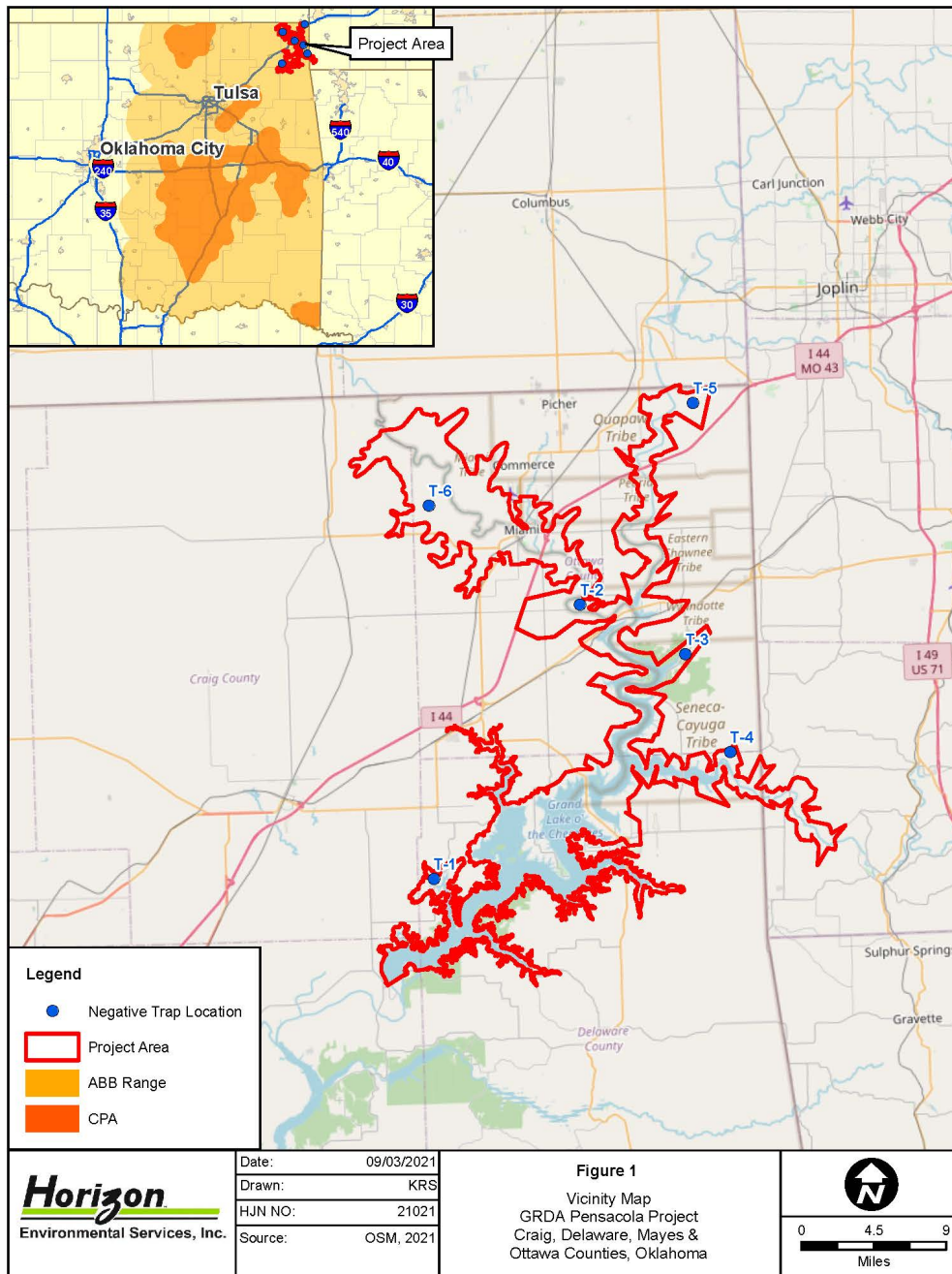


Figure 1. ABB Survey Trap Locations

2.2 GRAY BATS

The approved study plan states that GRDA will assess the degree to which Project operations would inundate the main entrance to Beaver Dam Cave and compare the frequency of inundation with that associated with existing operations. GRDA will determine whether the secondary exit suffices to provide an alternative access by gray bats to the cave (during times of inundation).

Observations from previous exit surveys support historical evidence that during high water or flood events during the maternity season, a maternity colony of the endangered gray bat vacates cave DL-2 (Beaver Dam Cave) —whose passage lies within the flood pool of Grand Lake—and migrates to an alternative cave. Persistent threat of inundation increases the likelihood of “take” of adult females and young. Complete inundation of the cave passage of DL-2 occurs at about elevation 752 feet Pensacola Datum (PD). When Grand Lake is at about elevation 751 feet PD, only about one foot of flyway exists between the top of the water in the cave and the rock ceiling of the flyway, forcing evacuation of the colony. In October 2008 a small, high passage within cave DL-2 was identified and minimally excavated and enlarged. Enlarging this passage was suspected to provide an alternative escape route for exiting bats, particularly during high water. Additional excavation and enlargement of this second-high passage was completed in October 2013. The length of the high passage was about 5m and was widened to about 0.40 meters wide by 0.50 meters tall. An inspection of the passage following flood events since 2011 revealed scattered guano in the enlarged passage indicating use by bats. A post-inundation monitoring visits to the cave following a flood event in 2019 failed to give any indication that take had occurred as a result of inundation, and that the colony had successfully vacated to another location (Table 1).

Table 1. Records of highwater events where the elevation of Grand Lake exceeded elevation 750.00 feet PD from 2005-2019. At elevation 752 feet PD, the existing flyway inside cave DL-2 is completely inundated preventing colony exit and re-entry.

Year	Date Beginning	Date Ending	Maximum Elevation (ft)	Total Duration	Effect on Colony
2011	27-Apr	28-Apr	750.80	2 days	Successfully Vacated
2011	25-May	26-May	751.71	2 days	Successfully Vacated
2015	27 May	22 June	754.89	27 days	Successfully Vacated
2017	30 April	25 May	754.77	26 days	Successfully Vacated

2019	14 May	15 July	755.02	63 days	Successfully Vacated
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The full 2021 Summer Report on Monitoring Patterns and Use by Gray Bat Populations in Caves DL-2 and DL-91 in Delaware County, Oklahoma is located in Appendix B. This report (as well as the previous discussion) was generated Dr. Keith W. Martin, Dean and Professor of Biology School of Arts and Sciences Rogers State University Claremore, Oklahoma as part of an ongoing monitoring program incidental to the approved study plan. These baseline data will be used to inform the analysis portion of this Study.

3.0 STUDY YEAR TWO ACTIVITIES

3.1 IMPACT ANALYSIS

The results of the H&H Study demonstrate that future operational changes that may be implemented by GRDA within the conservation pool of Grand Lake will not appreciably influence water levels beyond the current Project boundary (elevation of 750 feet Pensacola Datum). Thus, the areas that may be affected due to future operational changes are limited to a relatively narrow band of terrestrial habitat of a few feet of varying range from the shoreline.

The ABB will only use areas with a soil and/or leaf litter substrate and vegetated cover (as opposed to bare rocky or sandy shorelines) so suitable habitat within the project boundary is limited. The effective survey radius for each trap is 0.5 mile (0.8 km) based on ABB mobility, size, recorded movement distances, and the distance from which ABBs can detect carrion (Guidance). ABBs fly and have been reported moving nightly distances ranging from 0.16 to 30 kilometers (km) (0.10 to 18.6 miles) in various parts of their range (Bedick et al. 1999, Creighton and Schnell 1998, Schnell et al 2011).

In Oklahoma, ABBs have been recorded to move approximately 10 km (6.2 miles) in 6 nights (Creighton and Schnell 1998). With respect to these species' habits, traps would have to be placed within the narrow band of sparsely existing suitable habitat between the shoreline and the 750-foot elevation mark to cover the potentially affected area, and due to the imprecise nature of the survey model, the majority of the effective radius would cover unsuitable habitat (water surface) and potentially preferable habitat outside of the potentially affected area (above 750-foot elevation).

Considering the distance ABBs can travel and the limited terrestrial area potentially affected by future project operations, any ABBs captured could represent ABBs lured from the larger terrestrial area within the effective survey radius but outside of the area potentially affected by future Project operations project area and thus not representative of the species' actual habitat use or occupancy within the Project area as a whole. Positive ABB findings could thus incorrectly be identified as Project effects. Coupled with the negative findings of the 2021 ABB surveys, GRDA proposes to forego the second year survey as the results would not be representative of Project effects.

For gray bats, water levels in cave DL-2 (Beaver Dam Cave) and cave DL-91 (Twin Cave) have the potential to be affected by future operations. However, results from monitoring visits to

the cave following a flood event in 2019 demonstrate that such water levels do not result in any take of the species, and that the colony had successfully vacated to another location.

If it is found anticipated future operations according to the H&H Study will impact cave DL-2, the success of enlarging the passage in cave DL-2 to provide an alternative escape route for exiting bats in avoiding take will again be reviewed in 2022.

4.0 REFERENCES CITED

- (FERC, 2018a) Federal Energy Regulatory Commission. 2018. *Study Plan Determination for the Pensacola Hydroelectric Project*. November 8, 2018.
- (GRDA, 2017) Pensacola Hydroelectric Project, P-1494, Pre-Application Document. February 2017.
- (GRDA, 2018a) Pensacola Hydroelectric Project, P-1494, Proposed Study Plan. April 2018.
- (FERC, 2018b) Scoping Document 2, Pensacola Hydroelectric Project No. 1494-438. April 27, 2018.
- (Bedick et al. 1999) Bedick, J.C., B.C. Ratcliffe, W.W. Hoback, and L.G. Higley. 1999. Distribution, ecology and population dynamics of the American burying beetle *Nicrophorus americanus* Olivier (Coleoptera, Silphidae) in South-central Nebraska, USA. *Journal of Insect Conservation* 3(3):171-181.
- (Creighton and Schnell 1998) Creighton, J.C. and G. Schnell. 1998. Short-term movement patterns of the endangered American burying beetle *Nicrophorus americanus*. *Biological Conservation* 86:281-287.
- (Schnell et al 2011) Schnell, G. D., A.H. Hiott and V. Smyth. 2011. Evaluation of American burying beetles on the Weyerhaeuser Habitat Conservation Plan Area: 10-year assessment (1997-2006). Final report to Weyerhaeuser Company. Unpublished. MS.

APPENDIX A:

American Burying Beetle Pensacola Hydroelectric Project Survey Report



Environmental Services, Inc.

15 September 2021

Jacklyn Jaggars
Director of Hydropower Projects
Grand River Dam Authority
420 OK-28
Langley, OK 74350
918-981-8473 Office
Jacklyn.Jaggars@grda.com

RE: American Burying Beetle Presence/Absence Survey for the Pensacola Hydroelectric Project (Project; FERC [Federal Energy Regulatory Commission] No. 1494); Craig, Delaware, Mayes and Ottawa Counties, Oklahoma

Dear Ms. Jaggars:

Horizon Environmental Services, Inc. (Horizon) appreciates the opportunity to provide environmental support services to the Grand River Dam Authority (GRDA) for the Pensacola Hydroelectric Project (Project; FERC [Federal Energy Regulatory Commission] No. 1494), spanning Craig, Delaware, Mayes & Ottawa Counties, Oklahoma (Project Area).

As part of the relicensing of the Pensacola Hydroelectric Project the GRDA filed a preapplication document with FERC on February 1, 2017 (GRDA 2017). The GRDA filed its Proposed Study Plan (PSP) for the relicensing on April 27, 2018 (GRDA 2018a). Also, on April 27, 2018, FERC released its Scoping Document 2 for the relicensing of the Project (FERC 2018).

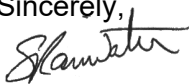
In support of the relicensing effort, Horizon was contracted to conduct a presence/absence survey for the American burying beetle (*Nicrophorus americanus*; ABB) to determine whether the ABB, a federally threatened species, may be present within the proposed Project Area. The Project Area is located within the ABB's current range, but outside of any conservation priority area (CPA) as defined by the US Fish and Wildlife Service (USFWS) (see attached Vicinity Map).

On 18 July 2021, Horizon ABB Specialist Stephanie Rainwater (permit number TE-00284A) placed six (6) traps to cover a representative sample of all suitable habitat types within the Project Area (see attached Trap Maps), as well as covering the largest surface areas of potential terrestrial impact from potential water level fluctuations determined by the output from the Comprehensive Hydraulic Model (CHM) developed from as part of the Hydrologic and Hydraulic Modeling Study (H&H Study) associated with this project. The traps were designed, baited and checked following the guidelines of the *American Burying Beetle Range-wide Presence/Absence Survey Guidance* (USFWS, 2018). Trap locations were oriented in Delaware and Ottawa Counties only, but confirmed with Kevin Stubbs, USFWS National Species Lead via telephone conversation as sufficiently representative of the overall four county Project Area.

The six traps were checked daily for a total of five nights with valid weather parameters and yielded no positive ABB findings. The survey effort concluded on 23 July 2021 (see attached Data Collection Forms). The results of this survey will remain valid until the commencement of the 2022

ABB active season. These negative survey findings indicate that the ABB is not active within the Project Area; thus, take (defined by the Endangered Species Act [ESA] as “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect any threatened or endangered species”) is not expected as a result of this project.

If you have any questions or concerns, please do not hesitate to contact me.

Sincerely,


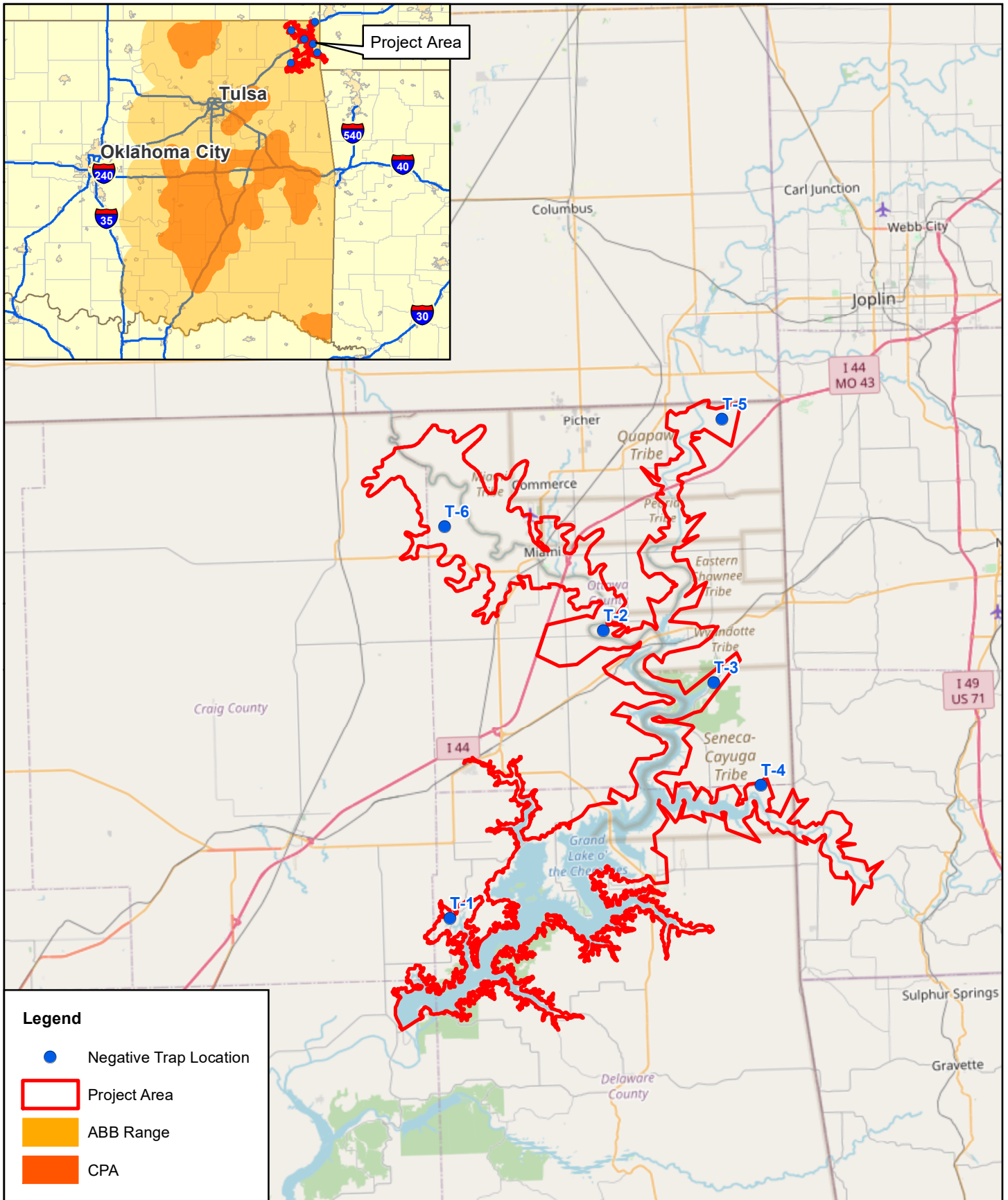
Stephanie Rainwater
Project Manager/Biologist (USFWS Permit Number TE-00284A)
Horizon Environmental Services, Inc.
321 S. Boston Ave., Suite 300
Tulsa, OK 74103
918-219-9951
srainwater@horizon-esi.com

Attachments:

1. Maps
2. Data Collection Forms

References:

- (Nearmap) Nearmap US, Inc. Nearmap Vertical™ digital orthographic photograph, <<https://go.nearmap.com>>. Imagery date 6 May 2021. Accessed 10 August 2021.
- (OSM) OpenStreetMap contributors. OpenStreetMap, <<http://www.openstreetmap.org>>. Available under the Open Database License (www.opendatacommons.org/licenses/odbl). Accessed 10 August 2021.
- (USFWS) US Fish and Wildlife Service. *American Burying Beetle (Nicrophorus americanus) Range-wide Presence/Absence Survey Guidance*, <https://www.fws.gov/southwest/es/oklahoma/Documents/ABB/Surveying%20final/ABB%20Rangewide%20Survey%20Guidance_Final8May2018.pdf>. Published May 2018.
- (USFWS) US Fish and Wildlife Service, Oklahoma Ecological Services Field Office. *American Burying Beetle: Additional Information*. ABB Range Map and Conservation Priority Area GIS Shapefiles, available at <https://www.fws.gov/southwest/es/oklahoma/ABB_Add_Info.htm>. Range Map updated 2016; CPA Map updated 14 April 2014. Accessed 10 August 2021.




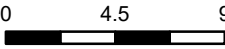
Legend

- Negative Trap Location
- Project Area
- ABB Range
- CPA

Horizon
Environmental Services, Inc.

Date:	09/03/2021
Drawn:	KRS
HJN NO:	21021
Source:	OSM, 2021

Figure 1
Vicinity Map
GRDA Pensacola Project
Craig, Delaware, Mayes & Ottawa Counties, Oklahoma


 0 4.5 9

 Miles




Legend


- Negative Trap Location
- Half-Mile Buffer
- Project Area

Horizon
Environmental Services, Inc.

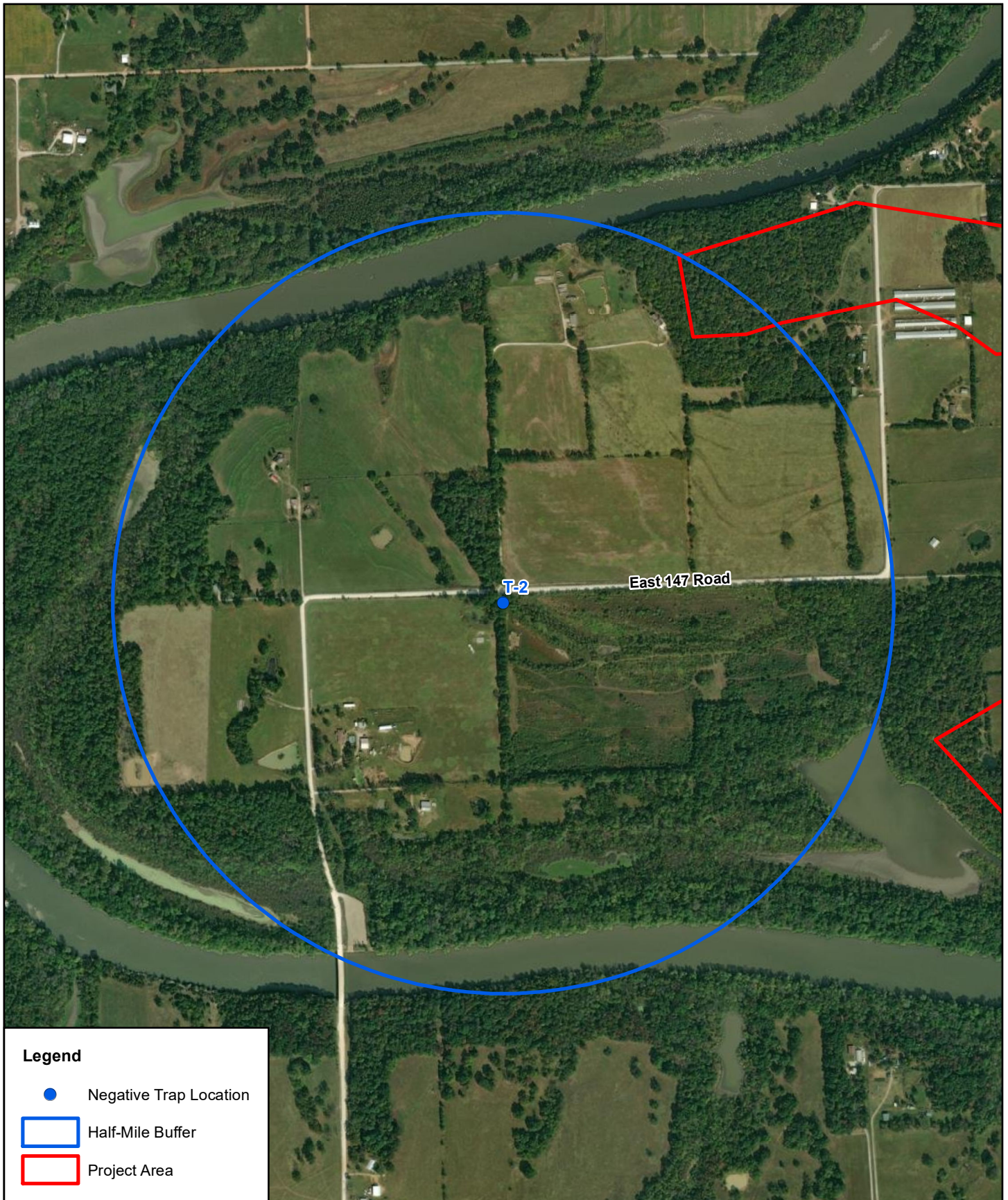
Date:	09/03/2021
Drawn:	KRS
HJN NO:	21021
Source:	Esri, 2020

Figure 2
Trap Location Map
GRDA Pensacola Project
Craig, Delaware, Mayes &
Ottawa Counties, Oklahoma





0 450 900
Feet




Legend


- Negative Trap Location
- Half-Mile Buffer
- Project Area

Horizon
Environmental Services, Inc.

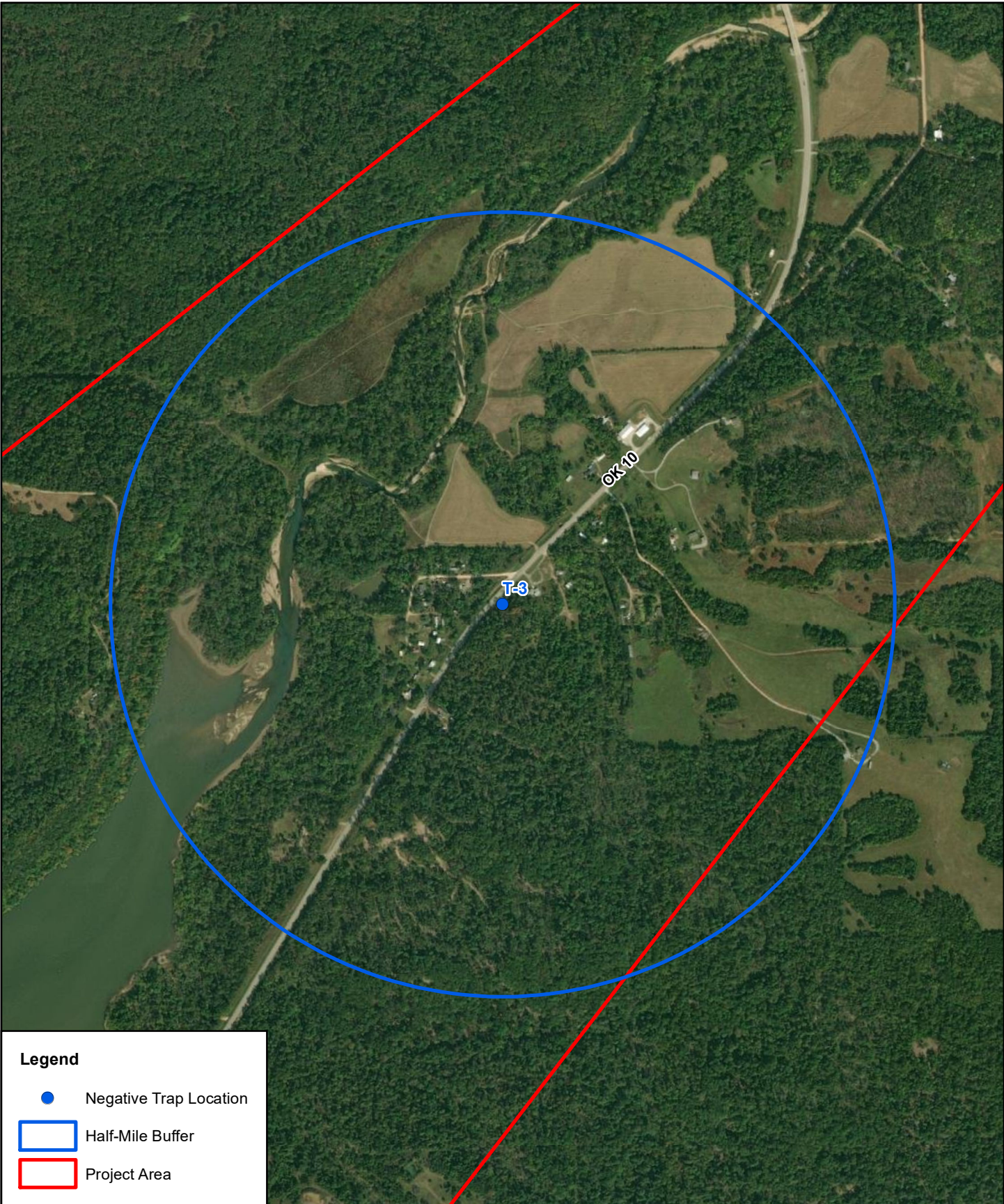
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HJN NO:	21021
Source:	Esri, 2020

Figure 3
Trap Location Map
GRDA Pensacola Project
Craig, Delaware, Mayes & Ottawa Counties, Oklahoma





0 450 900
Feet




Legend


- Negative Trap Location
- Half-Mile Buffer
- Project Area

Horizon
Environmental Services, Inc.

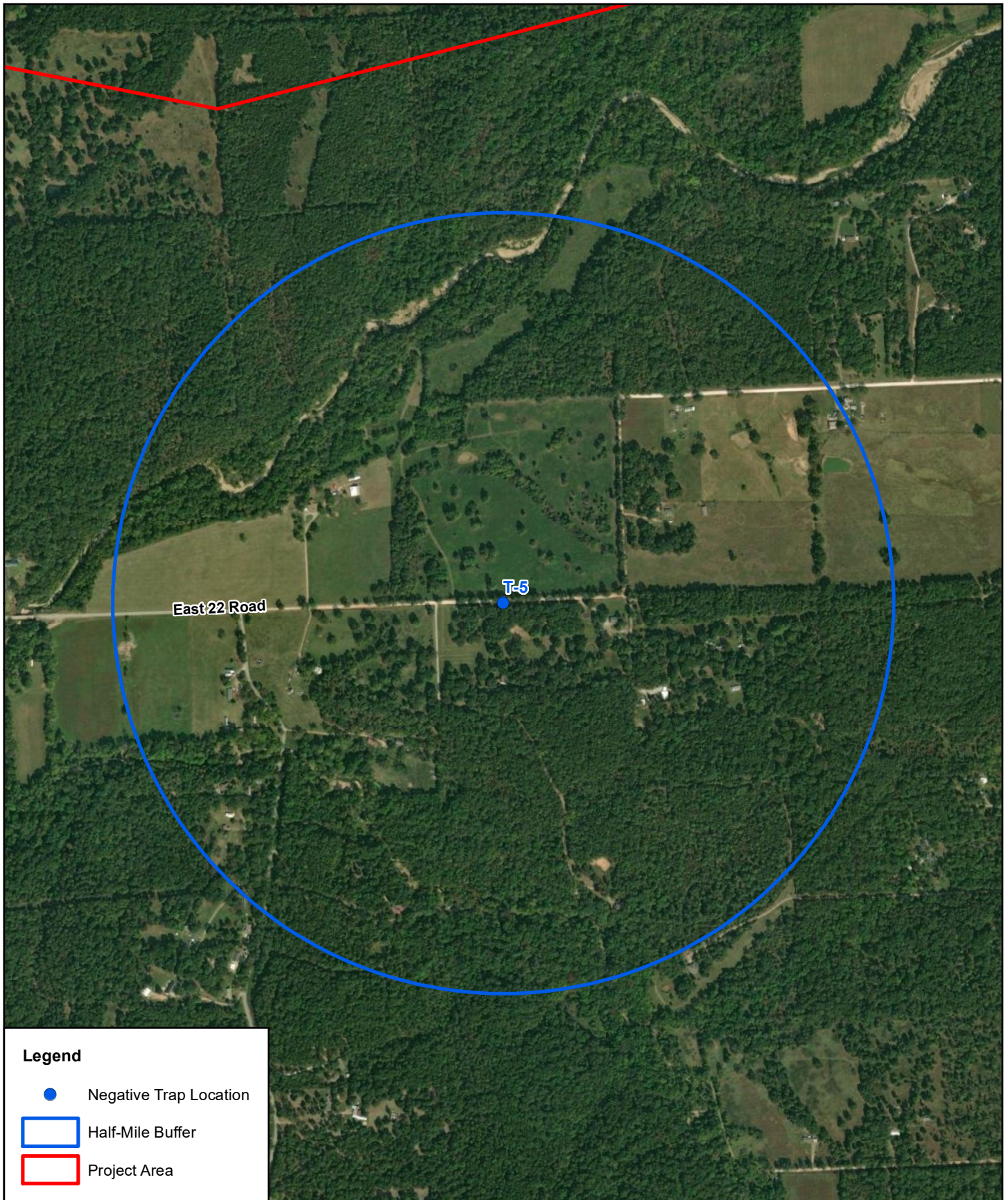
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HJN NO:	21021
Source:	Esri, 2020

Figure 4
Trap Location Map
GRDA Pensacola Project
Craig, Delaware, Mayes &
Ottawa Counties, Oklahoma





0 450 900
Feet




Legend


- Negative Trap Location
- Half-Mile Buffer
- Project Area

Horizon
Environmental Services, Inc.

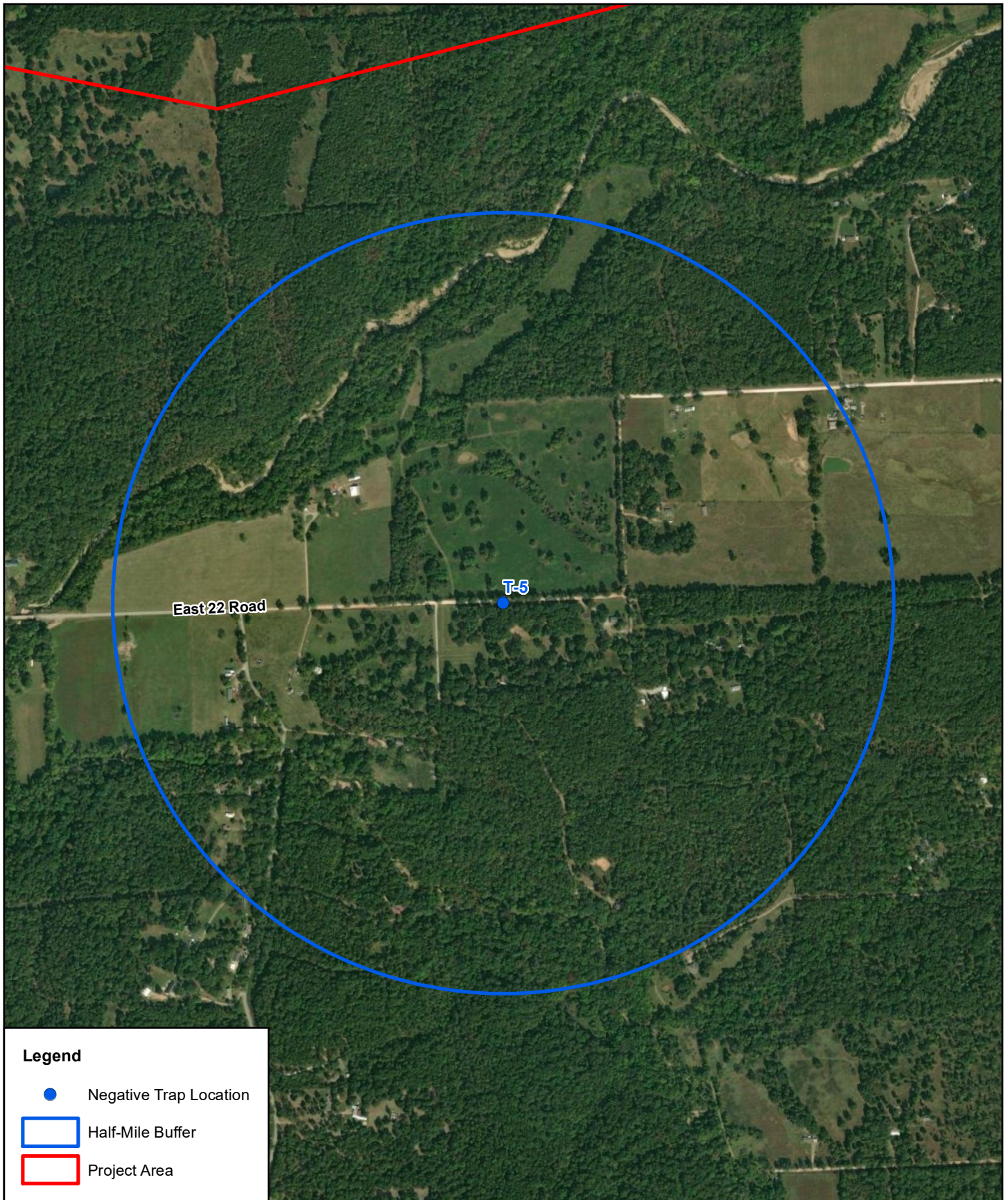
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HJN NO:	21021
Source:	Esri, 2020

Figure 7
Trap Location Map
GRDA Pensacola Project
Craig, Delaware, Mayes &
Ottawa Counties, Oklahoma





0 450 900
Feet




Legend


- Negative Trap Location
- Half-Mile Buffer
- Project Area

Horizon
Environmental Services, Inc.

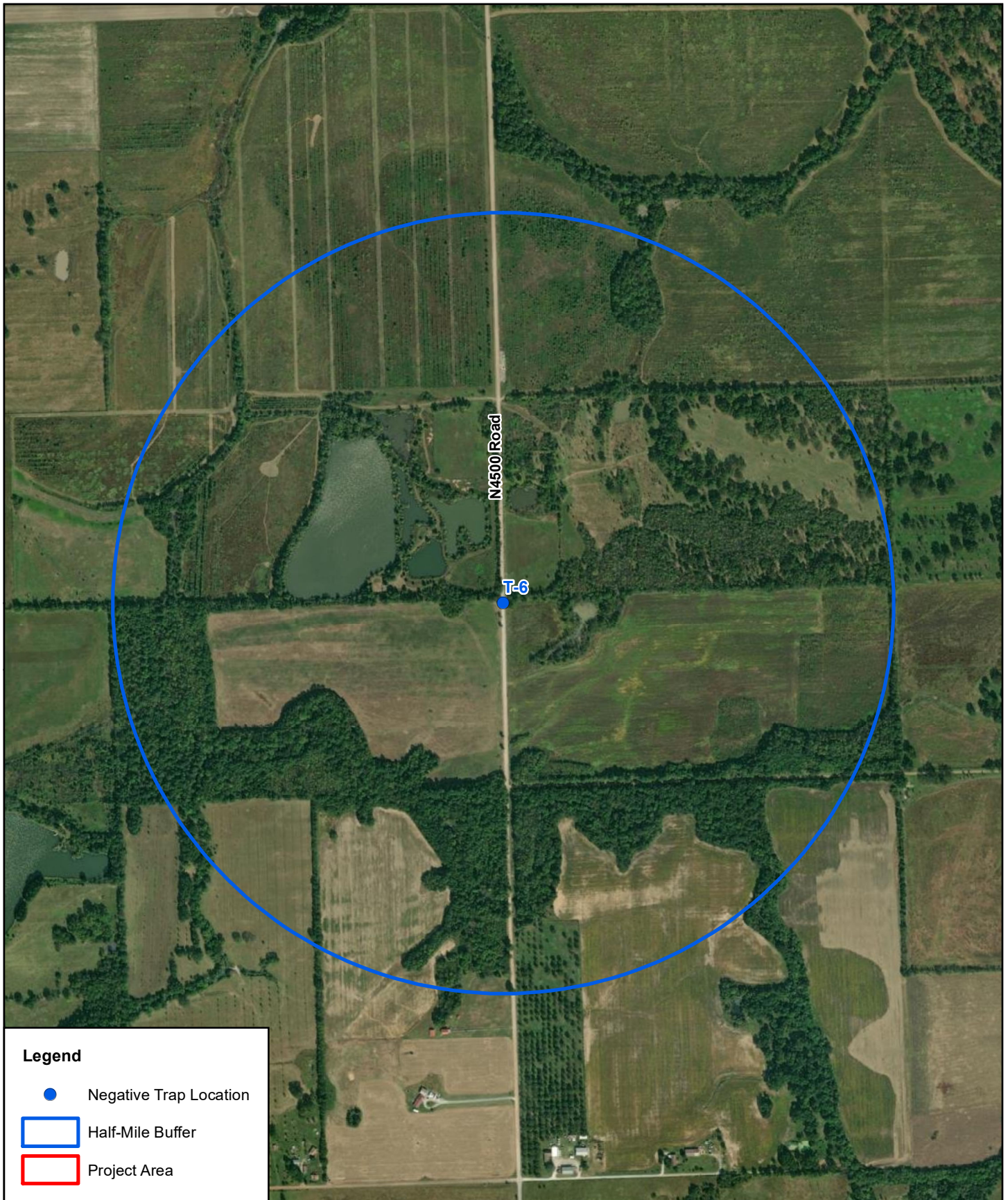
Date:	09/03/2021
Drawn:	KRS
HJN NO:	21021
Source:	Esri, 2020

Figure 7
Trap Location Map
GRDA Pensacola Project
Craig, Delaware, Mayes &
Ottawa Counties, Oklahoma





0 450 900
Feet




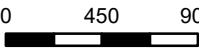
Legend

- Negative Trap Location
- Half-Mile Buffer
- Project Area

Horizon
Environmental Services, Inc.

Date:	09/03/2021
Drawn:	KRS
HJN NO:	21021
Source:	Esri, 2020

Figure 8
Trap Location Map
GRDA Pensacola Project
Craig, Delaware, Mayes &
Ottawa Counties, Oklahoma


 0 450 900

 Feet

AMERICAN BURYING BEETLE SURVEY DATA COLLECTION FORM

Project Name:	Pensacola Relicensing	Trap Type:	Above Ground	Survey Night:	2
Project Description:	Hydroelectric Relicensing	Bait Type:	Aged Chicken	Date Checked ¹ :	July 20, 2021
Action Agency/Proponent:	Grand River Dam Authority	Trap Cover Size:	24"	Permittee:	Stephanie Rainwater
				TE Permit #:	TE-00284A
				Survey Company:	Horizon Environmental Services, Inc.

Weather Data

Daytime Temps	65.5	83.71	Survey Period Temps	66.74	73.04	Humidity	-996	-996
	(min.)	(max.)		(min.)	(max.)		(min.)	(max.)
Wind>10mph? ⁶	No		Heavy Rain? ⁵	No		Soil Moisture ⁴	1.4758	
	(Yes/No)							

Capture Data		Nicrophorus species							Necrophilia	Necrodes	Other	Trap Night Valid	Time Checked ¹ :
Trap No.	Disturbed (Y=1/N=0) ⁶	americanus	orbicollis	tomentosus	pustulatus	marginatus	carolinus	sayi	americana	surinamensis		(No=0/Yes=1)	
1	0	0	0	0	0	0	0	0	3	1	1	1	6:30
Totals													
	0	0	0	0	0	0	0	0	3	1	1	1	

No. of disturbed traps and/or bait (D): Additional survey night required because of weather?⁸ # Valid Trap Nights:

(No=0/Yes=1)

List the individual ABB METRICS below and complete the appropriate columns. You will then COPY each row and PASTE into Individual ABB Capture Form on Pg 6.

ABB Number	Caught in Trap No.	Male	Female	Unknown Sex	Male New ⁹	Male Old ⁹	Female New ⁹	Female Old ⁹	Male Unknown Age ⁹	Female Unknown Age ⁹	Dead	Pronotum Width (mm)	Picture (Yes=1/No=0)	Recapture ¹⁰	Newly Marked ¹¹
Automated Tot.		0	0	0	0	0	0	0	0	0	0	NA	0		

Comments: _____

AMERICAN BURYING BEETLE SURVEY DATA COLLECTION FORM

Project Name:	Pensacola Relicensing	Trap Type:	Above Ground	Survey Night:	3
Project Description:	Hydroelectric Relicensing	Bait Type:	Aged Chicken	Date Checked ¹ :	July 21, 2021
Action Agency/Proponent:	Grand River Dam Authority	Trap Cover Size:	24"	Permittee:	Stephanie Rainwater
				TE Permit #:	TE-00284A
				Survey Company:	Horizon Environmental Services, Inc.

Weather Data

Daytime Temps	63.73	86.52	65.12	71.42	Humidity	-996	-996
	(min.)	(max.)	(min.)	(max.)		(min.)	(max.)
Wind>10mph? ⁶	No		Heavy Rain? ⁵	No		Soil Moisture ⁴	1.4773
	(Yes/No)						

Capture Data		Nicrophorus species							Necrophilia	Necrodes	Other	Trap Night Valid	Time Checked ¹ :
Trap No.	Disturbed (Y=1/N=0) ⁶	americanus	orbicollis	tomentosus	pustulatus	marginatus	carolinus	sayi	americana	surinamensis		(No=0/Yes=1)	
1	0	0	0	0	0	0	0	0	6	1	0	1	6:27
Totals													
	0	0	0	0	0	0	0	0	6	1	0	1	

No. of disturbed traps and/or bait (D): Additional survey night required because of weather?⁸ # Valid Trap Nights:

(No=0/Yes=1)

List the individual ABB METRICS below and complete the appropriate columns. You will then COPY each row and PASTE into Individual ABB Capture Form on Pg 6.

ABB Number	Caught in Trap No.	Male	Female	Unknown Sex	Male New ⁹	Male Old ⁹	Female New ⁹	Female Old ⁹	Male Unknown Age ⁹	Female Unknown Age ⁹	Dead	Pronotum Width (mm)	Picture (Yes=1/No=0)	Recapture ¹⁰	Newly Marked ¹¹
Automated Total		0	0	0	0	0	0	0	0	0	0	NA	0		

Comments: Bait refreshed _____

AMERICAN BURYING BEETLE SURVEY DATA COLLECTION FORM

Project Name:	Pensacola Relicensing	Trap Type:	Above Ground	Survey Night:	4
Project Description:	Hydroelectric Relicensing	Bait Type:	Aged Chicken	Date Checked ¹ :	July 22, 2021
Action Agency/Proponent:	Grand River Dam Authority	Trap Cover Size:	24"	Permittee:	Stephanie Rainwater
				TE Permit #:	TE-00284A
				Survey Company:	Horizon Environmental Services, Inc.

Weather Data

Daytime Temps	67.1 (min.)	87.49 (max.)	Survey Period Temps	67.46 (min.)	77.9 (max.)	Humidity	-996 (min.)	-996 (max.)
Wind>10mph? ⁶	No (Yes/No)		Heavy Rain? ⁵	No		Soil Moisture ⁴	1.5167	

Trap No.	Disturbed (Y=1/N=0)	<i>Nicrophorus</i> species							<i>Necrophilia americana</i>	<i>Necrodes surinamensis</i>	Other	Trap Night Valid (No=0/Yes=1)	Time Checked ¹ :
		<i>americanus</i>	<i>orbicollis</i>	<i>tomentosus</i>	<i>pustulatus</i>	<i>marginatus</i>	<i>carolinus</i>	<i>sayi</i>					
1	0	0	0	0	0	0	0	0	15	0	2	1	6:38
Totals		0	0	0	0	0	0	0	15	0	2	1	

No. of disturbed traps and/or bait (D): Additional survey night required because of weather?⁸ # Valid Trap Nights:

List the individual ABB METRICS below and complete the appropriate columns. You will then COPY each row and PASTE into Individual ABB Capture Form on Pg 6.

ABB Number	Caught in Trap No.	Male	Female	Unknown Sex	Male New ⁹	Male Old ⁹	Female New ⁹	Female Old ⁹	Male Unknown Age ⁹	Female Unknown Age ⁹	Dead	Pronotum Width (mm)	Picture (Yes=1/No=0)	Recapture ¹⁰	Newly Marked ¹¹
Automated Tot.	0	0	0	0	0	0	0	0	0	0	0	NA	0		

Comments: _____

AMERICAN BURYING BEETLE SURVEY DATA COLLECTION FORM

Project Name:	Pensacola Relicensing	Trap Type:	Above Ground	Survey Night:	5
Project Description:	Hydroelectric Relicensing	Bait Type:	Aged Chicken	Date Checked ¹ :	July 23, 2021
Action Agency/Proponent:	Grand River Dam Authority	Trap Cover Size:	24"	Permittee:	Stephanie Rainwater
				TE Permit #:	TE-00284A
				Survey Company:	Horizon Environmental Services, Inc.

Weather Data

Daytime Temps	68.27 (min.)	90.37 (max.)	Survey Period Temps	69.26 (min.)	76.81 (max.)	Humidity	55.35 (min.)	99.3 (max.)
Wind>10mph? ⁶	No (Yes/No)		Heavy Rain? ⁵	No		Soil Moisture ⁴	1.6729	

Trap No.	Disturbed (Y=1/N=0)	<i>Nicrophorus</i> species							<i>Necrophilia americana</i>	<i>Necrodes surinamensis</i>	Other	Trap Night Valid (No=0/Yes=1)	Time Checked ¹ :
		<i>americanus</i>	<i>orbicollis</i>	<i>tomentosus</i>	<i>pustulatus</i>	<i>marginatus</i>	<i>carolinus</i>	<i>sayi</i>					
1	0	0	0	0	0	0	0	0	6	2	1	6:45	
Totals		0	0	0	0	0	0	0	6	2	1		

No. of disturbed traps and/or bait (D): Additional survey night required because of weather?⁸ # Valid Trap Nights:

List the individual ABB METRICS below and complete the appropriate columns. You will then COPY each row and PASTE into Individual ABB Capture Form on Pg 6.

ABB Number	Caught in Trap No.	Male	Female	Unknown Sex	Male New ⁹	Male Old ⁹	Female New ⁹	Female Old ⁹	Male Unknown Age ⁹	Female Unknown Age ⁹	Dead	Pronotum Width (mm)	Picture (Yes=1/No=0)	Recapture ¹⁰	Newly Marked ¹¹
Automated Tot.	0	0	0	0	0	0	0	0	0	0	0	NA	0		

Comments: Survey concluded, trap pulled.

Appendix A: Data Collection Forms* American Burying Beetle *Nicrophorus americanus* Presence/Absence Live-trapping Survey Guidance**

ENTER DATA IN COLOR-SHADED CELLS ONLY IN CELLS THAT REQUIRE DATA ENTRY - DO NOT ENTER DATA IN WHITE CELLS OR HEADER ROWS

AMERICAN BURYING BEETLE SURVEY DATA COLLECTION FORM (April 2017)

Project Name: Pensacola Relicensing		No. of Transects Deployed: 6	Survey Night: 1						
Project Description: Hydroelectric Relicensing		Trap Type: Above Ground	Date Checked ¹ : July 19, 2021						
Action Agency/Proponent: Grand River Dam Authority		Bait Type: Aged Chicken	<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th>Month</th> <th>Date</th> <th>Year</th> </tr> <tr> <td>July</td> <td>23</td> <td>2021</td> </tr> </table>	Month	Date	Year	July	23	2021
Month	Date	Year							
July	23	2021							
Permittee: Stephanie Rainwater		Trap Cover Size: 24"							
TE Permit #: TE-00284A									
Survey Company: Horizon Environmental Services, Inc.									

Trap Location Data

Trap No.	Trap Coordinates		Legal Description			Gen Location	County	State	Vegetation Type	Primary Soil Name	Soil Description	Area	Weather Station
	Latitude	Longitude	Township	Range	Section								
2	36.805411	-94.815192	27N	23E	22	Ogeechee	Ottawa	OK	Pasture	Mayes silty clay loam	Clay loam	521	MIAM
3	36.757715	-94.69898	26N	34E	3	Wyandotte	Ottawa	OK	Forest	Clarksville stony silt loam	Silt loam	521	MIAM
4	36.667769	-94.69898	25N	25E	6	Tiff City	Ottawa	OK	Mixed	Clarksville stony silt loam	Silt loam	521	MIAM
5	36.983514	-94.680574	29N	24E	23	Baxter Springs	Ottawa	OK	Mixed	Clarksville stony silt loam	Silt loam	521	MIAM
6	36.898938	-94.981359	28N	22E	20	Miami	Ottawa	OK	Pasture	Verdigris silt loam	Silt loam	521	MIAM

Weather Data

Daytime Temps (min.)	68.23	(max.)	85.08	Survey Period Temps (min.)	69.08	(max.)	76.46	Humidity (min.)	53.61	(max.)	95.7
Wind>10mph? ⁶ (Yes/No)	No		Heavy Rain? ⁵	No		Soil Moisture ⁴	1.5867				

Capture Data

Trap No.	Disturbed (Y=1/N=0)	<i>Nicrophorus</i> species							<i>Necrophilia americana</i>	<i>Necrodes surinamensis</i>	Other	Trap Night Valid (No=0/Yes=1)	Time Checked ¹ :
		<i>americanus</i>	<i>orbicollis</i>	<i>tomentosus</i>	<i>pustulatus</i>	<i>marginatus</i>	<i>carolinus</i>	<i>sayi</i>					
2	0	0	1	0	0	0	0	0	0	0	1	7:32	
3	0	0	1	0	0	0	0	1	0	0	1	7:48	
4	0	0	1	0	0	0	0	1	0	2	1	8:02	
5	0	0	1	0	0	0	0	2	0	0	1	8:45	
6	0	0	0	0	0	0	0	0	0	0	1	9:48	
Totals	0	0	4	0	0	0	0	4	0	2	5		

No. of disturbed traps and/or bait (D):	0	Additional survey night required because of weather? ⁸	0	# Valid Trap Nights:	5
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List the individual ABB METRICS below and complete the appropriate columns. You will then COPY each row and PASTE into Individual ABB Capture Form BEGINNING at Cell A442 on Pg 6.

ABB Number	Caught in Trap No.	Male	Female	Unknown Sex	Male New ⁹	Male Old ⁹	Female New ⁹	Female Old ⁹	Male Unknown Age ⁹	Female Unknown Age ⁹	Dead	Pronotum Width (mm)	Picture (Yes=1/No=0)	Recapture ¹⁰	Newly Marked ¹¹
Automated Total	0	0	0	0	0	0	0	0	0	0	0	NA	0		

Comments: _____

APPENDIX B:

Monitoring Patterns and Use by Gray Bat Populations in Caves DL-2 and DL-91 in Delaware County, Oklahoma Governmental Interagency Agreement Contract No.43337

Monitoring Patterns and Use by Gray Bat Populations
in Caves DL-2 and DL-91 in Delaware County, Oklahoma
Governmental Interagency Agreement Contract No.43337

Prepared by:

Dr. Keith W. Martin
Dean and Professor of Biology
School of Arts and Sciences
Rogers State University
Claremore, Oklahoma

Submitted to:

Dr. Darrell Townsend
Director, Office of Ecosystems Management
Grand River Dam Authority

Project Period:

May 4, 2021 – August 31, 2021

INTRODUCTION:

Bats are considered by biologists as excellent indicators of general environmental health and integrity on many scales of habitat assessment. Their volant lifestyle allows them to utilize multiple community resources for their diversity of roosting and foraging habits, and a wide variety of ecological factors influence these life-history habits (Fenton 1997; Williams et al. 2006). The volant nature of their nightly and seasonal migratory movements, allows them access to multiple habitats, and in some cases multiple landscapes, decreasing their dependence on any single habitat (Findley 1993; Fenton 1997; Williams et al. 2006).

This study was an assessment of species utilization of colonies of the endangered gray bat (*Myotis grisescens*) in caves DL-2 and DL-91, in Delaware County, Oklahoma. In Oklahoma, gray bats represent a contingent in North America that are year-round, obligate cave dwelling species. All North American bats that are endangered or threatened can be classified as cave-dwelling species or subspecies (McCracken 1989, Harvey et al. 1999, Pierson 1999), and 13 are obligate cave-dwellers year-round (McCracken 1989).

Historical accounts of the cave-dwelling habits of the gray bat are well documented (Grigsby and Puckette 1984; U.S. Fish and Wildlife Service 1982; 1983; Grigsby et al. 1993; Martin et al. 2000, 2003). Since the gray bat is an obligate cave-dwelling species, its distribution is limited to karst-producing geographic regions of the southeastern and eastern U.S. Its prey consists mostly of night flying insects that have aquatic larval stages including mayflies, beetles, flies, stoneflies, and caddisflies (Best et al. 1997). Gray bats select foraging areas where these insects are abundant. Optimal foraging habitat includes open bodies of water such as a stream, river, or reservoir, with nearby wooded riparian areas. Gray bats forage over open water, and within the riparian areas near the water body. Based on recapture data, gray bats travel on average about 12.5-14.3 km each night while foraging (American Society of Mammalogists 1992).

STUDY AREA:

The study area in northeastern Oklahoma occurs within the Ozark Biotic District (Blair and Hubbell 1938) along the western limit of the Boston Mountains of the Ozark Plateau. The Plateau covers about 103,000 km² in the central United States; elevations are 260–460 m above mean sea level (Huffman 1959). The area is dominated by outcrops of alternating layers of limestone and flint and sandstone. Vegetation on mountain slopes is predominantly blackjack oak (*Quercus marilandica*), post oak (*Quercus stellata*), black hickory (*Carya texana*), and winged elm (*Ulmus alata*). Coralberry (*Symphoricarpus orbiculatus*) and sassafras (*Sassafras albidum*) comprise a sparse shrubby understory. Riparian areas occur in lowlands and are dominated by silver maple (*Acer saccharium*), river birch (*Betula nigra*), American elm (*Ulmus americana*), cottonwood (*Populus deltoides*), sycamore (*Platanus occidentalis*), and various oak species (*Quercus* spp.). Sporadic openings of managed grasslands are used for various types of agriculture (Blair and Hubbell 1938; Harvey et al. 1981).

Cave DL-2 is located in Section 17 of T23N R23E in Delaware County, OK adjacent to Drowning Creek, a tributary of Grand Lake. The cave passage is <65m long with a single historical roost site for gray bats located 4m above a persistent stream and about 5m inside the entrance to the cave. The floor of the vertical entrance to the cave is <745 ft elevation with backflow into the cave from Grand Lake at 746 ft elevation. Complete inundation of the cave passage occurs at 752 ft elevation. The roost was first documented as housing a colony of gray bats in 1981 when the colony was estimated to be 13,700 bats. Except during major flood events (Table 1), based on recent exit and capture surveys at the entrance, the size and status (lactating females) of the colony remains relatively constant for the past 25 years.

Cave DL-91 is located in the Section 13 of T23N R22E in Delaware County, OK. The cave’s location from Grand Lake (1 km) and elevation (840 ft) preclude any threat of inundation. The cave has a mapped passage of 803m and has historical records of nine roost sites for gray bats. Prior to 1973, DL-91 historically housed the largest colony of gray bats in Oklahoma estimated to be as many as 113,000 bats. Recent population estimates of the summer colony have been as high as 31,962 bats. Aquatic pools throughout the passage of the cave and provide documented habitat for the Ozark cavefish (*Troglichthys rosae*), and Delaware County cave crayfish (*Cambarus subterraneus*).

PROCEDURES:

IR-illuminated entrance and night vision optics were used to conduct non-intrusive exit surveys and population estimates of gray bat colonies exiting caves DL-2 and DL-91 in the 2021 summer maternity and post-maternity season. Such surveys are used to document habitation, assist in estimating colony size at the respective caves, and monitor movements of the colony during potential high water and flood events on Grand Lake.

Exit surveys were conducted at cave DL-2 on 22 June and at cave DL-91 on 24 June and again on 16 July 2021 (Table 1). The post-maternity colony population estimate at cave DL-91 during late summer 2021 (Table 1) was within the range of 10,000 to 29,905 bats (ave.=18,245) over the past decade (Table 2).

Table 1. Population estimates of gray bat colonies at caves DL-2 and DL-91 in Delaware County, OK. Gray bat colony size estimates are based on exit surveys using infrared-illuminated entrances and night vision optics during summer 2021.

Date	Survey Method	Population at Cave DL-2	Population at Cave DL-91
6/22/2021	Exit Survey	11,800	
6/24/2021	Exit Survey		510
7/16/2021	Exit Survey		20,440

Table 2. Population estimates of the colony of gray bats using caves DL-2 and DL-91 in Delaware County, Oklahoma. Average post-maternity colony size ranged from 15,200 to 29,905 bats, with an average colony size of 19,288 gray bats for the past 10 years.

Date	Population at Cave DL-2	Population at Cave DL-91
8/20/2012	1	18,000
8/22/2013	0	29,905
9/11/2014	0	18,015
8/5/2015	0	20,585
7/21/2016	0	16,520
9/12/2017	0	19,340
8/30/2018	NA	18,000
5/21/2019	NA	15,200
8/25/2020	NA	16,883
7/16/2021	NA	20,440

DISCUSSION:

Cave ecosystems harbor a variety of unique and sensitive organisms, many of which are cave obligates. Unique characteristics common to North American subterranean fauna render them vulnerable to anthropogenic activities and underscore the importance of monitoring sensitive populations. Subsurface habitats typically display decreased diversity in community complexity and reduced species abundance relative to above ground ecosystems translating to fewer species and individuals in subterranean habitats than in surface habitats (Holsinger 1988). Processes that isolate subterranean populations of organisms, and evolutionary adaptation of those species to their environments, can produce extreme patterns of endemism (Barr and Holsinger 1985; Culver et al., 2000). Within the United States, subterranean fauna constitutes more than 50% of the G1-G2 species recorded in the Natural Heritage Program; however, less than 4% have received federal protection (Culver et al. 2000).

Cave abandonment may result from high water events, or late-season migration after young become volant as often occurs in other areas of the species' range. Under favorable conditions, the colony ultimately vacates the maternity cave at DL-2 entirely in late summer and migrates to cave DL-91 located <5 km away (Grigsby et al. 1993; Martin et al. 2000) where the colony tends to remain until migration to hibernacula in November. Although cave DL-91 has intermittently served as a favorable maternity location, it is possible that it provides suboptimal climate conditions for a maternity colony compared to cave DL-2 with respect to microclimate and proximity to an abundant food source for developing young. Annual late-summer migration phenomena are intriguing because migration of any type elicits its own inherent effects on animal populations that are exacerbated in young and

reproductive adults. Observations from previous exit surveys support historical evidence that during high water or flood events during the maternity season, a maternity colony of the endangered gray bat vacates cave DL-2—whose passage lies within the flood pool of Grand Lake—and migrates to cave DL-91.

Persistent threat of inundation increases the likelihood of “take” of adults and young. The U. S. Fish and Wildlife Service defines take as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct. The determination of take was first made in their March 26, 1992, Biological Opinion prepared for the Federal Energy Regulatory Commission for the proposed re-licensing of the Pensacola Hydropower Project. Complete inundation of the cave passage of DL-2 occurs at about elevation 752 feet Pensacola Datum (PD). When Grand Lake is at about elevation 751 feet PD, only about one foot of flyway exists between the top of the water in the cave and the rock ceiling of the flyway, likely resulting in a significant disruption to normal behavior including feeding, rearing of young, and sheltering, and possibly forcing evacuation of the colony to the alternative cave (Table 3).

Forcing the colony to vacate during critical maternity periods (March through July) likely adversely affects pregnant or lactating females, and non-volant or newly volant young. If bats become trapped in cave DL-2, they could survive only a limited amount of time due to the high energy demands of raising young. Other potential adverse effects include the stress of being trapped, drowning, and, if adults are trapped outside the cave, stress and mortality of non-volant young.

In October 2008 a small, high passage within cave DL-2 was identified and minimally excavated and enlarged. Enlarging this passage was suspected to provide an alternative escape route for exiting bats, particularly during high water. Additional excavation and enlargement of this second-high passage was completed in October 2013. The length of the high passage was about 5m and was widened to about 0.40 meters wide by 0.50 meters tall. An inspection of the passage following a flood event in summer 2015 revealed scattered guano in the enlarged passage indicating use by bats. The post-inundation monitoring visit to the cave on 30 July 2019 failed to give any indication that take had occurred as a result of inundation.

Table 3. Records of highwater events where the elevation of Grand Lake exceeded elevation 750.00 feet PD from 2005-2019. At elevation 752 feet PD, the existing flyway inside cave DL-2 is completely inundated preventing colony exit and re-entry.

Year	Date Beginning	Date Ending	Maximum Elevation (ft)	Total Duration	Effect on Colony
2007	3-Jul	16-Jul	754.54	14 days	Successfully Vacated
2008	11-Apr	20-Apr	753.04	10 days	Successfully Vacated
2008	13-Jun	26-Jun	752.48	14 days	Successfully Vacated
2011	27-Apr	28-Apr	750.80	2 days	Successfully Vacated
2011	25-May	26-May	751.71	2 days	Successfully Vacated
2015	27 May	22 June	754.89	27 days	Successfully Vacated
2017	30 April	25 May	754.77	26 days	Successfully Vacated
2019	14 May	15 July	755.02	63 days	Successfully Vacated

SUMMARY/RECOMMENDATIONS:

Management efforts at cave DL-91 over the past 40 years have improved the security and potential for the colony’s persistence. The average post-maternity colony size illustrates relative consistency, ranging from 15,200 to 29,905 bats with an average colony size of 19,288 gray bats for the past 10 years. (Table 2). Efforts should be concentrated on maintaining strong ties with the landowner of cave DL-2 who owns the property access, so that similar security efforts can continue there for the long-term. To assist in the long-term management decisions for appropriate entities relative to gray bat conservation efforts at caves DL-2 and DL-91 the following recommendations are proposed:

- 1) Continue monitoring emergence surveys in caves DL-2 and DL-91 to maintain consistent data relative to habitation, population size, movement, and composition of bat colonies.
- 2) Considering the importance of site DL-91 as alternative and favorable habitat for a maternity colony of gray bats during flooding events of Grand Lake, and as a post-maternity colony during normal elevation, periodically inspect the structural integrity of respective gate/grill systems inside cave DL-91 to limit or prevent human entry.
- 3) Monitor elevation changes in Grand Lake during high water events and any subsequent movement of the gray bat colony in DL-2 to alternative habitable sites.
- 4) Continue to effectively engage with the current landowner of cave DL-2, maintaining current contact information and appropriate access to the cave for future monitoring.

In sum, the gray bat colony sharing caves DL-2 and DL-91 each summer appears to maintain a stable population size. Persistent protection is being afforded the internal habitat and other sensitive and imperiled species at cave DL-91 through the integrity of the internal gating system. Consistent and effective landowner engagement at cave DL-2 is appropriate at present.

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