

Vulnerability of Rattlesnake Springs to Contamination from Nearby Agricultural Activity and Oil and Gas Development, Carlsbad Caverns National Park, New Mexico

Project Category: Technical Assistance

Funding Request: \$50,000 over 1 year

NPS Park Unit or Network: Carlsbad Caverns National Park (CAVE)

USGS Lead Contact: Kimberly Beisner, Research Hydrologist, New Mexico Water Science Center, (505) 584-9667, kbeisner@usgs.gov and Jorge Gonzalez, Hydrologic Technician, New Mexico Water Science Center, (575) 294-0432, jorgegonzalez@usgs.gov

NPS Lead Contact: Paul Burger, Hydrologist, Acting Resource Chief, Carlsbad Caverns National Park, (907) 644-3577, paul_burger@nps.gov

Introduction and Problem Statement

Carlsbad Caverns National Park (CAVE) in southern New Mexico manages a separate unit from the main park, Rattlesnake Springs which is an area that provides visitors with a day use picnic area as well as a rich cultural experience. Rattlesnake Springs is a unique feature in the surrounding desert environment and is considered sacred to the Mescalero Apache who have utilized the site since at least the 1400s (NPS, 2016). Modern settlement at Rattlesnake Springs predates the discovery of Carlsbad Caverns. Rattlesnake Springs has served as an important recreation area and is included on the National Register of Historic Places. The riparian area is home to the native roundnose minnow (fig. 1) (*Dionda episcopa*) and greenthroat darter (*Etheostoma lepidum*, New Mexico threatened species) and the area provides critical habitat for a number of bird species including the Bell's vireo (*Vireo bellii*, New Mexico threatened species), yellow-billed cuckoo (*Coccyzus americanus*, Federal threatened species), and southwestern willow flycatcher (*Empidonax trailii*, Federal endangered species).



Figure 1. Roundnose minnows (*Dionda episcopa*) from Rattlesnake Springs (NPS, 2017).

Rattlesnake Springs is the only water source for nearly 400,000 visitors to Carlsbad Caverns National Park each year. Spring water is also provided to nearby Washington Ranch, a non-profit dedicated to serving people with developmental disabilities through group homes, respite care, and employment. The park is located in the midst of active oil and gas development in the Permian Basin (fig. 2) and nearby irrigated agricultural lands. The park is concerned about how this human development could potentially affect both the water quality and quantity available at Rattlesnake Springs, especially as the effects of climate change continue to impact this desert environment. Southwestern United States is in a prolonged period of drought and discharge from Rattlesnake Springs hit a historic recorded low in 2006 (NPS, 2006). The spring continues to be vulnerable to low flow conditions. Algal blooms have increased in recent years at the pond supplied by Rattlesnake Springs (fig. 3) and there is concern that upgradient agricultural development is contributing excess nutrients to the spring (fig. 4).

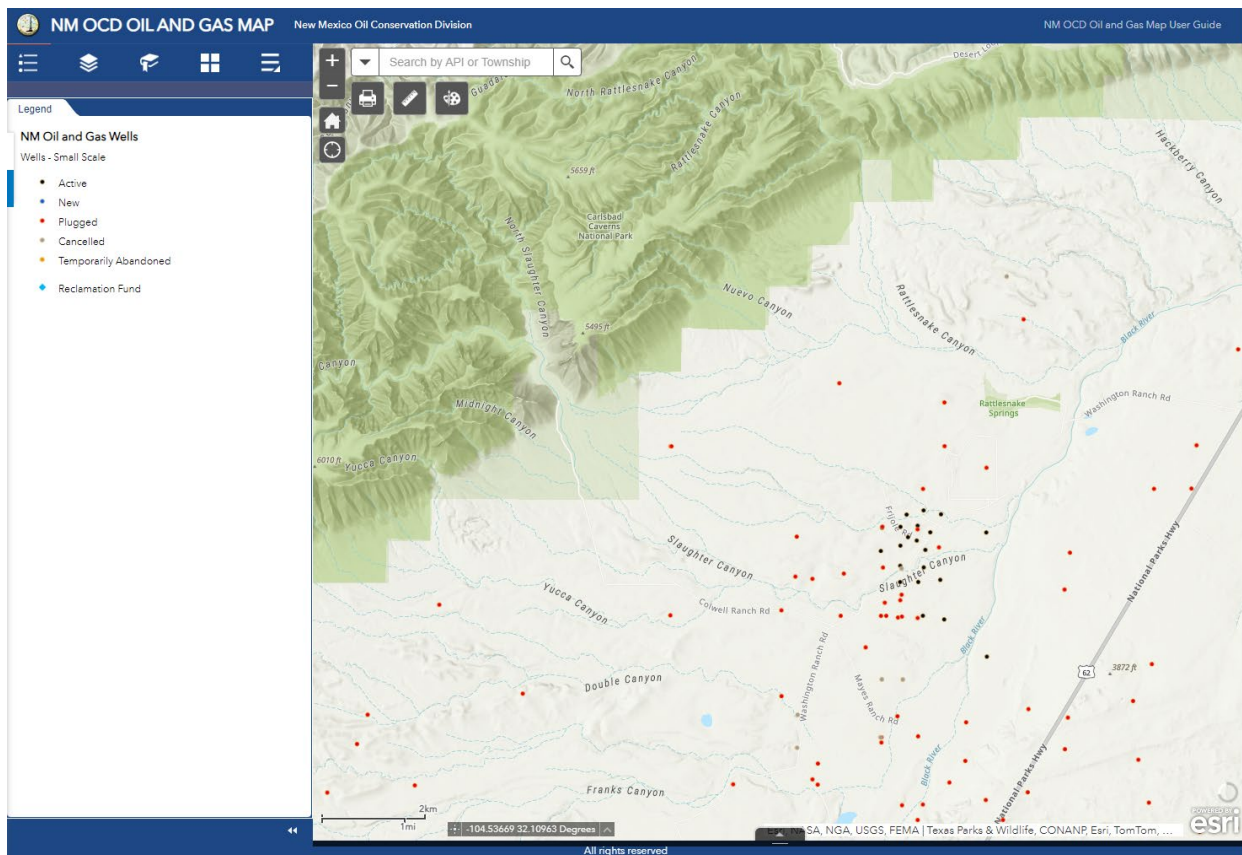


Figure 2. Rattlesnake Springs unit location relative to larger main Carlsbad Caverns National Park unit. Oil and gas well locations in proximity to the Rattlesnake Springs unit are shown as black circles for active sites and red for plugged sites (Oil Conservation Division Geospatial Hub, 2024).

Previous investigations by Hale (1955) and Cox (1963) found pumping of nearby agricultural irrigation wells affected flow at Rattlesnake Springs. The relation of pumping effects from nearby irrigation wells on flow at Rattlesnake Springs suggests they share the same alluvial aquifer. Groundwater generally flows north towards Rattlesnake Springs (fig. 5) in the alluvial aquifer from the agricultural areas. Geophysical research in the area around Rattlesnake Springs suggests surficial drainage patterns mimic an underlying network of fractures related to dissolution structures within the gypsum bedrock (fig. 6) that may control preferential flow paths for groundwater (Boykov, 2009). A structural feature and associated fine-grained material was also observed just east of Rattlesnake Springs

that could provide a barrier to groundwater flow responsible for spring discharge to the surface (Santiago, 2009).



Figure 3. Algal growth at Rattlesnake Springs [Rattlesnake Springs – Carlsbad Caverns National Park, New Mexico – The Trek Planner](#).

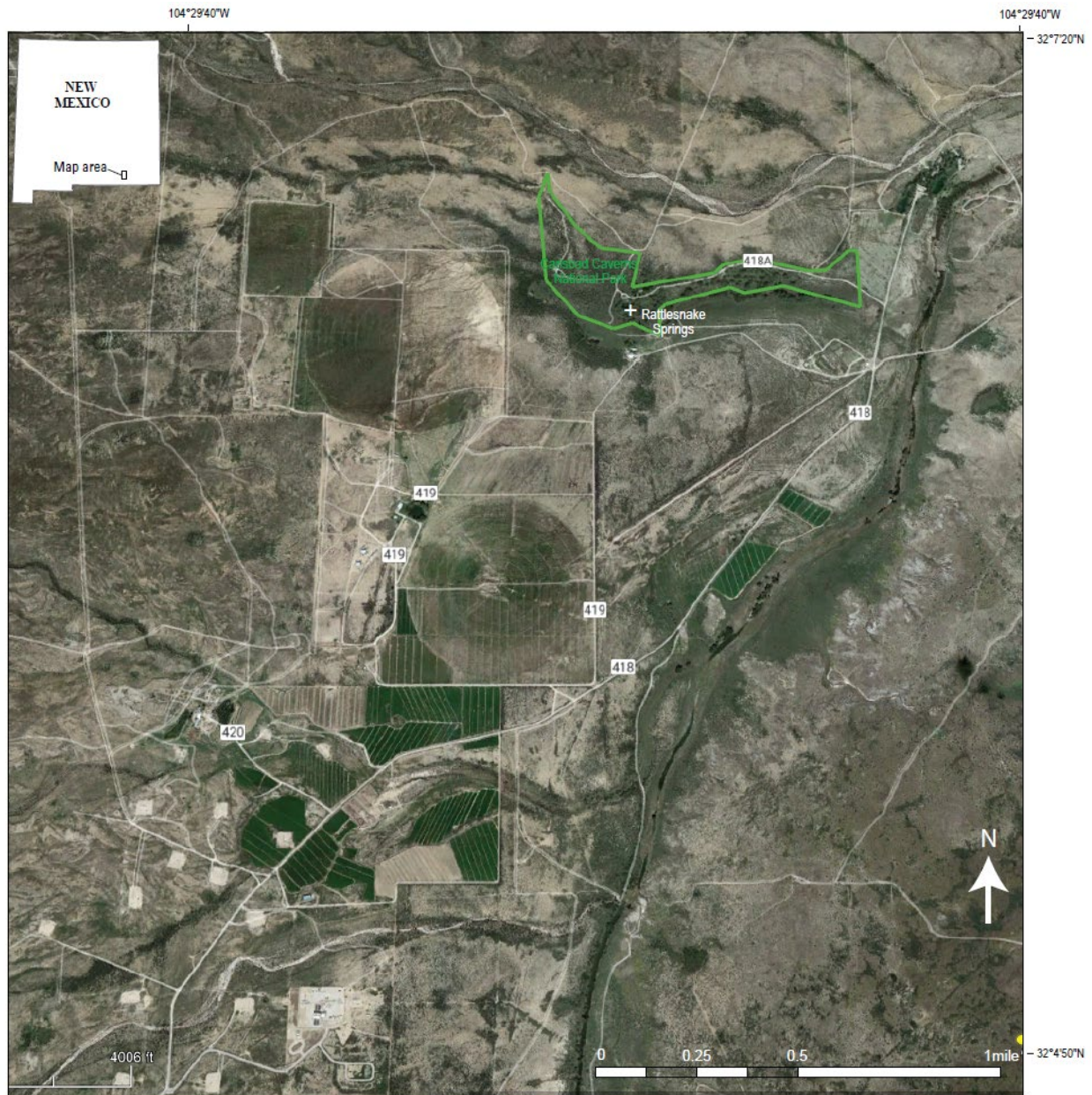


Figure 4. Aerial image of Rattlesnake Springs area and surrounding agricultural and oil and gas development. Three digit road numbers are included on the map.

Additionally, there are oil and gas extraction wells upgradient of Rattlesnake Springs (figs. 2 and 4). The area south and southwest of Rattlesnake Springs was a natural gas field in the 1970s, then housed a natural gas reinjection and storage facility in the 1980s with 23 wells within 2 miles of Rattlesnake Springs (Richard and Boehm, 1989). Groundwater contamination of several water wells southwest of Rattlesnake Springs occurred in the early 1980s due to gas well leakage (Richard and Boehm, 1989). Investigation is needed to understand the influence of human development including both agricultural and oil and gas development on the water quality of Rattlesnake Springs.

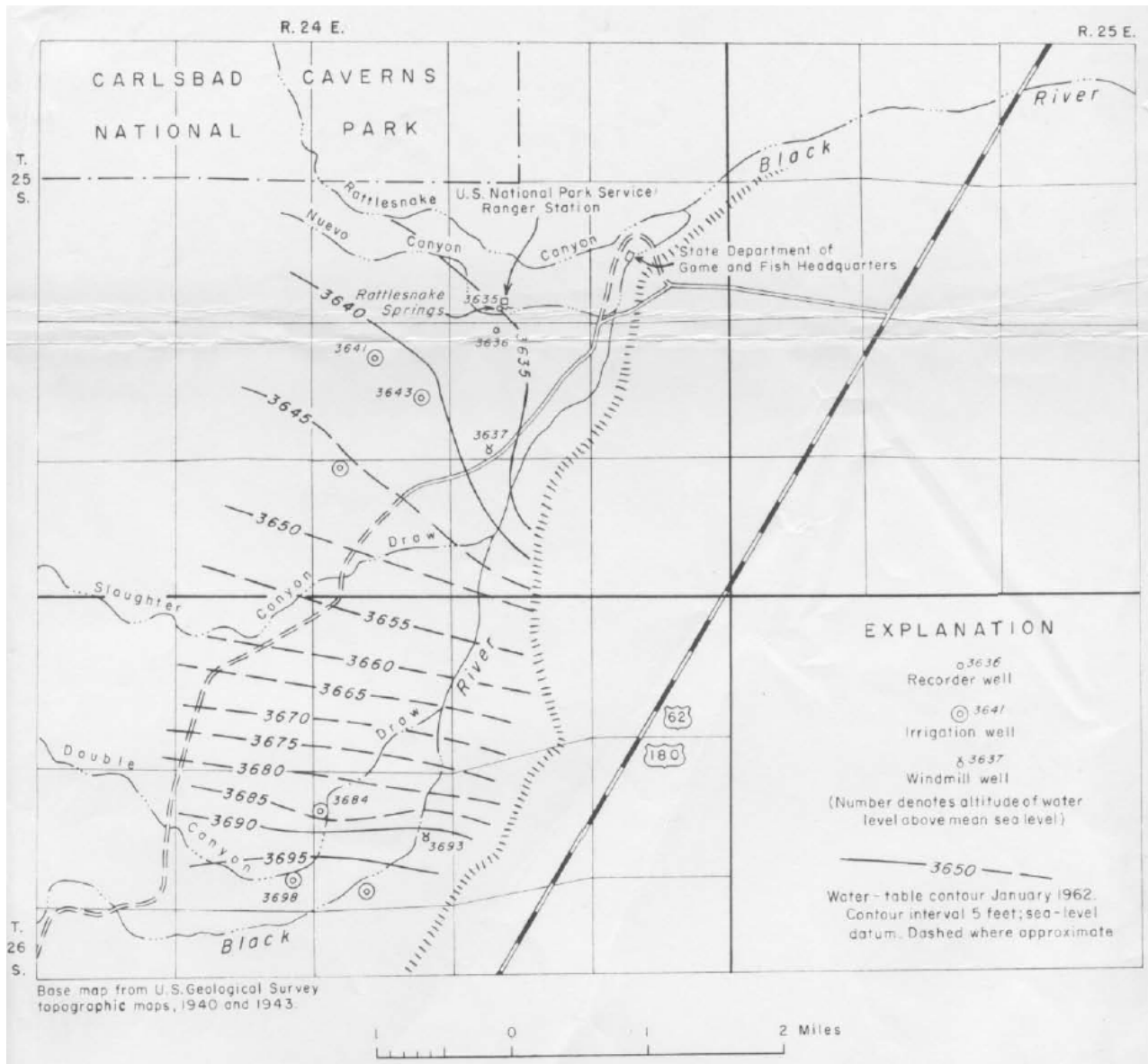


Figure 5. Map showing spring and well locations and water-table contours in part of the upper Black River valley, Eddy County, New Mexico (from Cox, 1963).

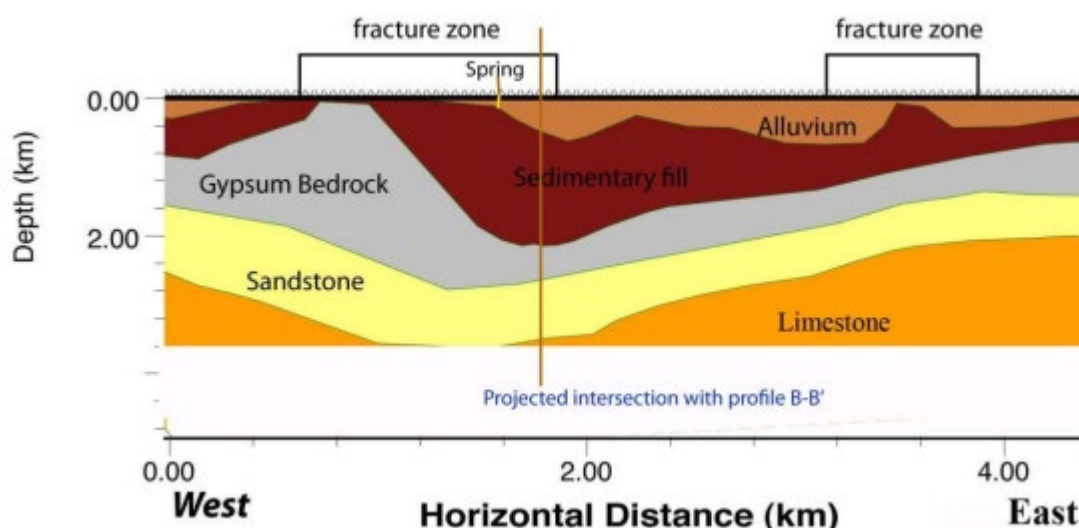


Figure 6. Bedrock and fracture control on location of Rattlesnake Springs (Boykov, 2009).

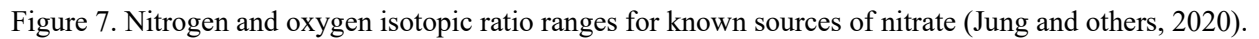
Objective

The purpose of this proposed investigation is to characterize potential contamination of water quality at Rattlesnake Springs, managed by Carlsbad National Park. Several oil and gas well pads and agricultural lands are located in areas upgradient and surrounding the spring. An investigation is necessary to properly assess any contributing impacts to water quality that may be caused by surrounding human development. With increasing algal blooms in recent years, there is concern of contamination influencing water quality. Water quality is vital to maintaining a healthy ecosystem, analyzing the constituents proposed in this project will support the park's mission to preserve and maintain its natural and cultural resources.

Methods

Discrete samples will be collected according to the USGS National Field Manual (U.S. Geological Survey, variously dated) at Rattlesnake Springs and a nearby well in the same aquifer. Samples will be collected in collaboration with a water quality project at the New Mexico Water Science Center planned for October 2024 to leverage travel and staff time. This proposed project would also pay for the additional analytes and staff time to review and approve the data. Additional samples will be collected in the following months (October, February, and June) from Rattlesnake Springs and at a nearby well for a total of 3 sampling events in water year 2025.

Each site will be sampled and analyzed for major ions, trace elements, nutrients, nitrogen isotopes, pesticides, and volatile organic compounds. Major ion and trace element analysis has been occurring at this site as part of another USGS project assessing water quality in the Permian Basin (U.S. Geological Survey, 2024). These parameters serve as indicators of the presence of produced water associated with oil and gas extraction as well as differentiation of water-rock interactions. Excess nutrients can be related to fertilizers or manure applied to agricultural fields and nitrogen and oxygen isotopes of nitrate provide a valuable tool to differentiate nutrient sources (Linhoff, 2022). Nitrate that originates from fertilizer falls within a known range of values for $\delta^{15}\text{N}$ and $\delta^{18}\text{O}$ which are distinct compared with atmospheric sources and manure and septic wastes (Jung and others, 2020). Comparing values from Rattlesnake Springs and nearby groundwater with known source isotopic ranges will help differentiate the source of nitrate (fig. 7). Volatile organic compounds are associated with oil and gas extraction activities (Linhoff and others, 2023) and can provide valuable indicators of interaction with oil and gas wells upgradient of Rattlesnake Springs in addition to the other water quality parameters proposed for this study.



Project Timeline

[illegible]

Itemized Budget

Personnel	Cost Item	FY25		
		Hours	Requested \$	Supported \$
Jorge Gonzalez	Hydrologic Technician	170	\$ 9,099	\$ 856
Efren Alvarado	Hydrologic Technician	170	\$ 9,289	\$ 874
Kimberly Beisner	Research Hydrologist	40		\$ 5,202
TOTAL			\$ 18,389	\$ 6,933

Type	Description	FY25			
		Cost	#	Requested \$	Supported \$
Travel	Lodging and Per Diem for 2 overnights for 2 staff per visit	\$ 1,752	3	\$ 5,256	
Field Supplies	Filters, Acid, Bottles, Blank Water	\$ 1,270	1	\$ 1,270	\$ 420
	In-Situ Aqua Troll 600	\$ 6,905	1		\$ 6,905
	Vehicle			\$ 1,710	\$ 298
Lab analyses	USGS National Water Quality Lab				
	Major ions and trace elements (Schedule 2069)	\$ 342	10	\$ 3,416	
	Nutrients (Schedule 101)	\$ 92	10	\$ 918	
	Pesticides (Schedule 2447)	\$ 890	10	\$ 8,904	
	Volatile organic compounds (Schedule 1388)	\$ 706	10	\$ 7,056	
	USGS Reston Stable Isotope Laboratory				
	Nutrient isotopes	\$ 277	10	\$ 2,766	
Shipping	Samples in Coolers to CO, VA	\$ 52	6	\$ 312	
TOTAL				\$ 31,609	\$ 7,623
GRAND TOTAL				\$49,997	\$14,556

Note: overhead is factored into each budget line item.

Outcome and Products

The information collected by this study will provide CAVE with a much-needed understanding of the contribution of water to Rattlesnake Springs that may have been contaminated from agricultural and or oil and gas activities upgradient of Rattlesnake Springs. This study will help the park understand the nutrient levels at Rattlesnake Springs over a range of hydrologic conditions to manage the spring waters for the native roundnose minnow and greenthroat darter and protected bird species Bell's vireo, yellow-billed cuckoo, and southwestern willow flycatcher. The Southwest is in a prolonged period of drought and the threat that human activities such as agricultural and oil and gas development pose to the water quality of Rattlesnake Springs needs to be understood.

This project provides a unique opportunity to mentor early career staff hydrologic technicians and CAVE staff that have been sampling Rattlesnake Springs and nearby groundwater and are eager to learn more about the hydrologic system. The deliverable from this study will be the water-chemistry data which will be entered into the USGS National Water Information System (NWIS) database that is publicly available. Additionally, Rattlesnake Springs is planned to be sampled as part of a larger project with the Bureau of Land Management to assess baseline conditions in the Permian Basin for a limited group of analytes including major ions and trace elements related to oil and gas development and will result in a report. The sampling with the related project will occur once at the start of our proposed project and the additional water quality analytes such as volatile organic compounds collected in this project will help better characterize the influence of oil and gas development on water quality at Rattlesnake Springs. These data and associated regional Permian Basin investigation will be provided to and discussed with NPS staff. Information learned from the study would help the park determine management actions to improve water quality at Rattlesnake Springs, such as purchasing additional water rights in the area and discussing management changes with neighboring landowners.

This project would also provide a valuable opportunity to engage with the Mescalero Apache Tribe Youth Development program. The Youth Development program involvement with our project would help reestablish tribal connection with Rattlesnake Springs, as well as provide an opportunity to

learn about water quality sample collection and gain experience with earth science careers.

References Cited

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Project ranking criteria for the national evaluation panel
USGS National Park Service Water Quality Partnership for the proposed project:

Vulnerability of Rattlesnake Springs to Contamination from Nearby Agricultural Activity and Oil and Gas Development, Carlsbad Caverns National Park, New Mexico

1. **Significance of the resource or issue to the park:** Rattlesnake Spring has been utilized by the Mescalero Apache since the 1400s and by U.S. Cavalry patrols in the 1880s, providing historical/cultural significance to the park and the surrounding communities. The spring and associated riparian area it supports has been designated as an “Important Bird Area” by the National Audubon Society (National Audubon Society, 2024). The spring supports a number of Threatened and Endangered (T&E) fish and bird species greenthroat darter, Bell’s vireo, yellow-billed cuckoo, and southwestern willow flycatcher. Rattlesnake Springs also supports a unique riparian area and remains the sole source of water to Carlsbad Caverns National Park with no viable alternatives. The park utilizes the water on a daily basis, supplying water to operations such as the visitor center, NPS housing, offices throughout the park. The spring also serves as a picnic area for visitors.
2. **Severity of resource threat, problem, or need(s):** This spring remains the sole source of water for the park which not only supplies water to the park but to the threatened and endangered (T&E) species that rely on this spring. Degradation of spring could adversely impact the park by threatening loss of habitat for T&E species along with cultural resources associated with this spring. With frequent algal blooms and potential for contamination from surrounding agricultural and oil and gas resources, it is important to properly characterize water quality of the spring. Maintaining the quality of this spring helps maintain the ecology and water supply of the park, supporting its mission of persevering its resources.
3. **Diversity, equity, inclusion, and accessibility (DEIA):** Water from Rattlesnake Springs is also provided to nearby Washington Ranch, a non-profit dedicated to serving people with developmental disabilities through group homes, respite care, and employment. This project would serve as a great opportunity to mentor early career staff hydrologic technicians that are interested in being hydrologists to give them the opportunity to learn project management. This project would also provide a valuable opportunity to engage with the Mescalero Apache Tribe Youth Development program. The Youth Development program involvement with our project would help reestablish a tribal connection with Rattlesnake Springs, as well as provide an opportunity to learn about water quality sample collection and gain experience with earth science careers.
4. **Scientific merit:** The sampling collection methods used by this proposal will be performed by well-trained hydrologists or hydrologic technicians. The New Mexico Water Science Center has conducted several projects to assess anthropogenic contamination and has proven to be proficient at collecting the samples. Analytes proposed for this investigation provide several supporting lines of evidence using the best available chemical tools to characterize water quality at Rattlesnake Springs as well as assess human related changes to water quality.

5. **Problem resolution:** The information collected by this study will provide Carlsbad Caverns National Park with a much-needed understanding of the presence and concentration of anthropogenic compounds in water from Rattlesnake Springs. Once the park understands the extent of contamination, they can work with the landowners to improve the water quality at Rattlesnake Springs, such as purchasing additional water rights in the area and discussing management changes with neighboring landowners.

6. **Project support**

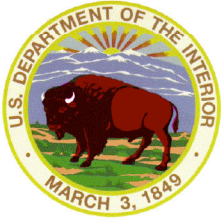
Project support is provided by the overlap with an existing project assessing water quality in the Permian Basin in collaboration with the Bureau of Land Management related to oil and gas development.

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TOTAL				\$ 31,609	\$ 7,623
GRAND TOTAL				\$49,997	\$14,556

Project Support Cost Estimate Totals: \$14,556

7. **Transferability:** The knowledge gained from this study will be applicable to understanding human activity development effects water quality which is applicable to many other parks and federal resources. Understanding how water quality changes related to human activities relate to algal blooms would also provide valuable information to others in the arid southwest managing water resources where algal blooms are becoming more common. The park has expressed interest in working with neighbors and the community to mitigate potential issues with water quality which could provide an opportunity for outreach/education for community/stakeholders.



United States Department of the Interior
NATIONAL PARK SERVICE
CARLSBAD CAVERNS NATIONAL PARK
3225 National Parks Highway
Carlsbad, NM 88220



06/11/2024

MEMORANDUM

To: Sarah Spaulding, Andrew Birch, and Panel Members, USGS-NPS Water Quality Partnership

From: Carmen T. Chapin, Superintendent, Carlsbad Caverns National Park

Subject: Support for technical assistance proposal “Vulnerability of Rattlesnake Springs to Contamination from Nearby Agricultural Activity and Oil and Gas Development, Carlsbad Caverns National Park, New Mexico.”

I am writing to express my strong support on behalf of Carlsbad Caverns National Park and the National Park Service for the proposal titled “Vulnerability of Rattlesnake Springs to Contamination from Nearby Agricultural Activity and Oil and Gas Development, Carlsbad Caverns National Park, New Mexico.”

Life here in the northern part of the Chihuahuan Desert is predicated upon access to clean water. Rattlesnake Springs is a major artesian spring located at the foot of the Guadalupe Mountains and is a protected part of Carlsbad Caverns National Park. The spring serves as an important desert oasis for a range of wildlife and is the park’s only source for drinking water for the nearly 400,000 visitors to the park each year. The spring also provides water to nearby Washington Ranch, a non-profit dedicated to serving people with developmental disabilities through group homes, respite care, and employment. The park is located in the midst of active oil and gas development in the Permian Basin and nearby irrigated agricultural lands. We are concerned about how these industries could potentially impact both the water quality and quantity available at Rattlesnake Springs, especially as the effects of climate change continue to impact this desert environment.

The information from this study would be critical in helping us make sound science-based management decisions to continue to protect this important natural resource.

Sincerely,

**CARMEN
CHAPIN**

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Carmen T. Chapin
Superintendent
Carlsbad Caverns National Park





United States Department of the Interior

U. S. GEOLOGICAL SURVEY

New Mexico Water Science Center
6700 Edith Blvd NE
Albuquerque, New Mexico 87113
(505) 830-7900 FAX (505) 830-7998
<http://nm.water.usgs.gov/>

MEMORANDUM

June 13, 2024

To: Sarah Spaulding, USGS National Program Manager
Andrew Birch, NPS National Program Manager

From: Justin Hagerty
Director, USGS New Mexico Water Science Center, Albuquerque, NM

This memorandum voices the support of the USGS New Mexico Water Science Center (NMWSC) for the USGS-NPS water-quality partnership proposal “Vulnerability of Rattlesnake Springs to Contamination from Nearby Agriculture Activity and Oil and Gas Development, Carlsbad Caverns National Park, New Mexico”

The USGS NMWSC fully supports the proposed work at Carlsbad Caverns National Park. Rattlesnake Springs is a major artesian spring located at the foot of the Guadalupe Mountains and is a protected part of Carlsbad Caverns National Park. The spring serves as an important desert oasis for a range of wildlife and is the park’s only source for drinking water for the nearly 400,000 visitors to the park each year. The spring also provides water to nearby Washington Ranch, a non-profit dedicated to serving people with developmental disabilities through group homes, respite care, and employment. The park is located in the midst of active oil and gas development in the Permian Basin and nearby irrigated agricultural lands. We are concerned about how these industries could potentially impact both the water quality and quantity available at Rattlesnake Springs, especially as the effects of climate change continue to impact this desert environment.

Kimberly Beisner has extensive previous experience in water quality projects with NPS partners throughout the southwest including previous water quality investigations. I have the highest level of confidence that she will productively and successfully manage and complete this project.

This study supports the USGS NMWSC mission to provide reliable, impartial scientific information to our sister Interior agencies so they can effectively manage the water resources within their jurisdiction. In this case, the information developed in the proposed study will characterize current site conditions and will help understand the potential for a management action.

Sincerely,

JUSTIN
HAGERTY

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JUSTIN HAGERTY
Date: 2024.06.13
14:27:02 -06'00'

Justin Hagerty