ENVIROTECH
ENGINEERING

August 29, 2022

Ms. Victoria Venegas
New Mexico EMNRD
Oil conservation Division
811 S. First St.
Artesia, New Mexico 88210

RE: Rule 34 Variance Request –Produced Water Impoundment Construction on Unstable Area

Ms. Venegas:

WaterBridge Stateline, LLC (WaterBridge) is requesting a variance to Rule 34-Part 12(A)(8) construction on an unstable area. According to Bureau of Land Management guidelines and maps, this area is classified as a "Area of High Karst Potential" a site-specific karsting evaluation was conducted by Southwest Geophysical Consulting at this location. During this investigation, it was concluded that there are no areas of "high likelihood of karsting features." A copy of the full report is attached. Even though risk of karsting in this area is low, WaterBridge will still use best engineering practices and best management practices to ensure no undo risk is posed to the preservation of fresh water, public health, and the natural environment.

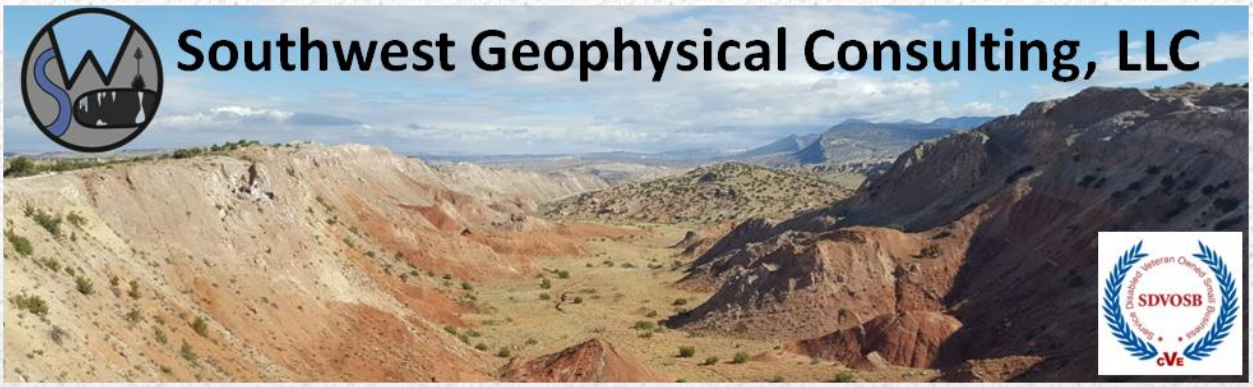
Should you have any questions or require additional information, please contact me by phone at 580-234-8780 or by email at twilliams@envirotechconsulting.com at your convenience.

Thank you for your consideration.
Best regards,

ENVIROTECH ENGINEERING & CONSULTING, INC.

Tyler Williams, P.E.
President and Principal Engineer

TYLER JOE WILLIAMS
NEW MEXICO
26432
PROFESSIONAL ENGINEER
8/29/2022



Cave and Karst Resource Inventory Report
WaterBridge Parkway Pond
Eddy County, New Mexico

Prepared for:

Permits West, Inc.

37 Verano Loop

Santa Fe, NM 87508

☐ **Positive**

- ☐ **Relocation/Realignment Recommended**
- ☐ **Construction Monitor Recommended**
- ☐ **Relocation/Realignment Not Required**

☑ **Negative**

July 20, 2022

PW-083B-20220512

Published by:
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1.0 INTRODUCTION

An aerial karst survey was commissioned by Permits West (hereinafter referred to as "the client") on May 12, 2022, for the purpose of determining the presence of karst-related surface features within the WaterBridge Parkway Pond project site (hereinafter termed “WBP”).

As indicated in section ***1.3 Affected Environment***, the bedrock and overlying soil at the survey site are susceptible to sinkhole development and karst features may be hidden beneath the existing soil stratum. Risk associated with sinkhole formation can be minimized during development with proper foundation design and construction, and the control of site hydrology. The owner/developer must recognize, however, that a risk of sinkhole-induced damage to infrastructure does exist. The owner/developer must evaluate the risks and attendant costs of not performing a geophysical survey prior to development and must be willing to accept these risks if it is decided that a surface karst survey is sufficient. Southwest Geophysical Consulting, LLC, can provide a geophysical survey. If the decision is made to conduct a geophysical survey, a cost estimate and timeline will be provided upon request.

1.1 Goals of this Study

To provide the client with the location, description, photos, and boundaries of any surface karst-related features within the boundary of the WBP right-of-way and pond boundaries as provided by the client via e-mail (**WB_Parkway_karst_review_area_051722.shp**) on May 17, 2022.

1.2 Summary of Findings

No surface karst features are located within the aerial survey area.

The lack of surface karst features does not mean the area is not karstified and the survey area may still contain buried karst features. Caution should be exercised while clearing brush and during any excavation, trenching, or construction operations. Employing a karst monitor on-site during these operations should be considered.

1.3 Affected Environment

The proposed WBP project is located in evaporite karst terrain, a landform that is characterized by underground drainage through solutionally enlarged conduits. Evaporite karst terrain may contain sinkholes, sinking streams, caves, and springs. Sinkholes leading to underground drainages and voids are common. These karst features, as well as occasional

fissures and discontinuities in the bedrock, provide the primary sources for rapid recharge of the groundwater aquifers of the region.

Karst features are delicate resources that are often of geological, hydrological, biological, and archeological importance, and should be protected. The three primary concerns in these types of terrain are environmental issues, worker safety, and infrastructure integrity.

The Bureau of Land Management (BLM) categorizes all areas within the Carlsbad Field Office (CFO) zone of responsibility as having either low, medium, or high cave potential based on geology, occurrence of known caves, density of karst features, and potential impacts to freshwater aquifers[1]. These designations are also recognized by the New Mexico State Land Office (NMSLO). This project occurs within a **HIGH** karst occurrence zone (**HKOZ**, **Figure 1**).

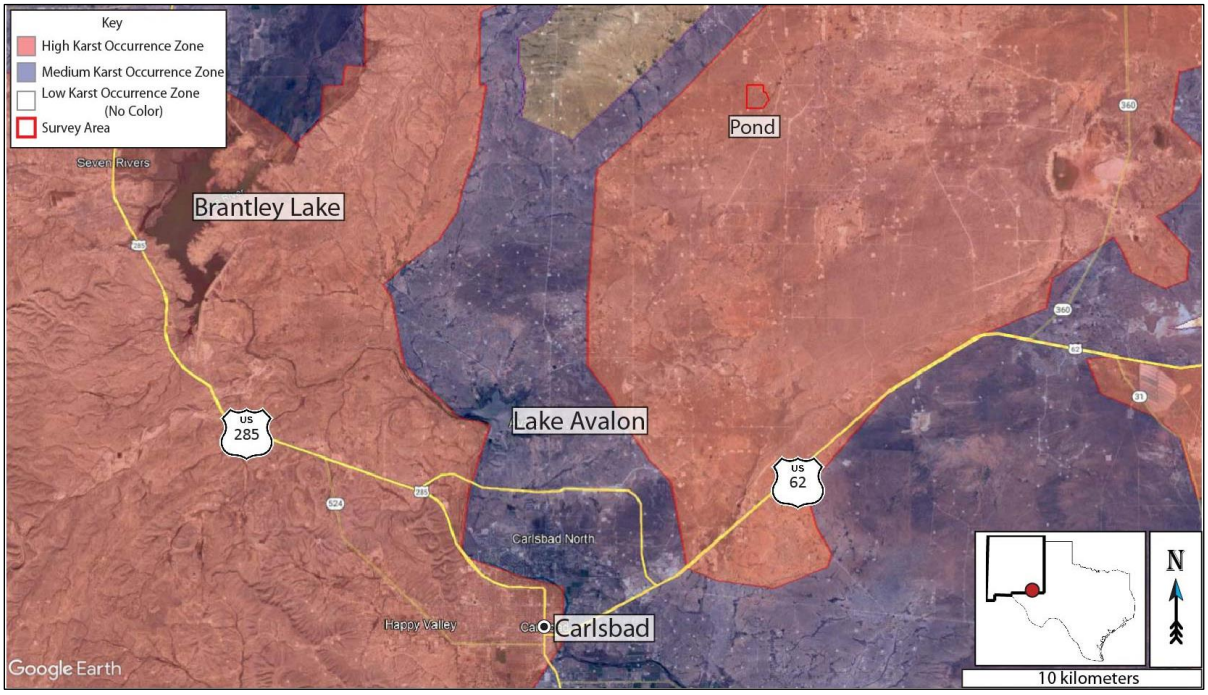

Figure 1: Karst occurrence overview. Background image: Google Earth. Image date: December 21, 2019. Datum: WGS-84.

A high karst occurrence zone is defined as an area in known soluble rock types that contains a high frequency of significant caves and karst features such as sinkholes, bedrock fractures that provide rapid recharge of karst aquifers, and springs that provide riparian habitat[2].

2.0 LOCATION AND DESCRIPTION OF STUDY AREA

2.1 Description of Site

The WBP project site is located in Eddy County, New Mexico, 26.1 kilometers (16.2 miles) northeast of Carlsbad, New Mexico, south of Curry Comb Road. The site is located west of Buckskin Road and south of Curry Comb Road within the NW ¼ of section 36, NM T19S R28E[3] (**Figure 1** and **Figure 2**). The region is semi-arid with an average annual precipitation of approximately 13 inches, of which about two-thirds falls as rain during summer thunderstorms from June to October. Summers are hot and sunny while winters are generally mild, with an average maximum temperature of 96°F in July and an average minimum temperature of 28°F in January[4]. This area is within the Chihuahuan Desert Thornscrub as defined by the Southwestern Regional ReGAP Vegetation map[5] and the vegetation consists mostly of areas of grass, sparse creosote, and sparse yucca, with very good visibility in most locations. See section ***2.2 Local Geology*** for the geology of the area. Both project sites are located entirely within an HKOZ[1] (**Figure 1**). The pond project site is located entirely within privately managed (fee surface) land and the parkway project site is located entirely within NMSLO managed land[6] (**Figure 2**).

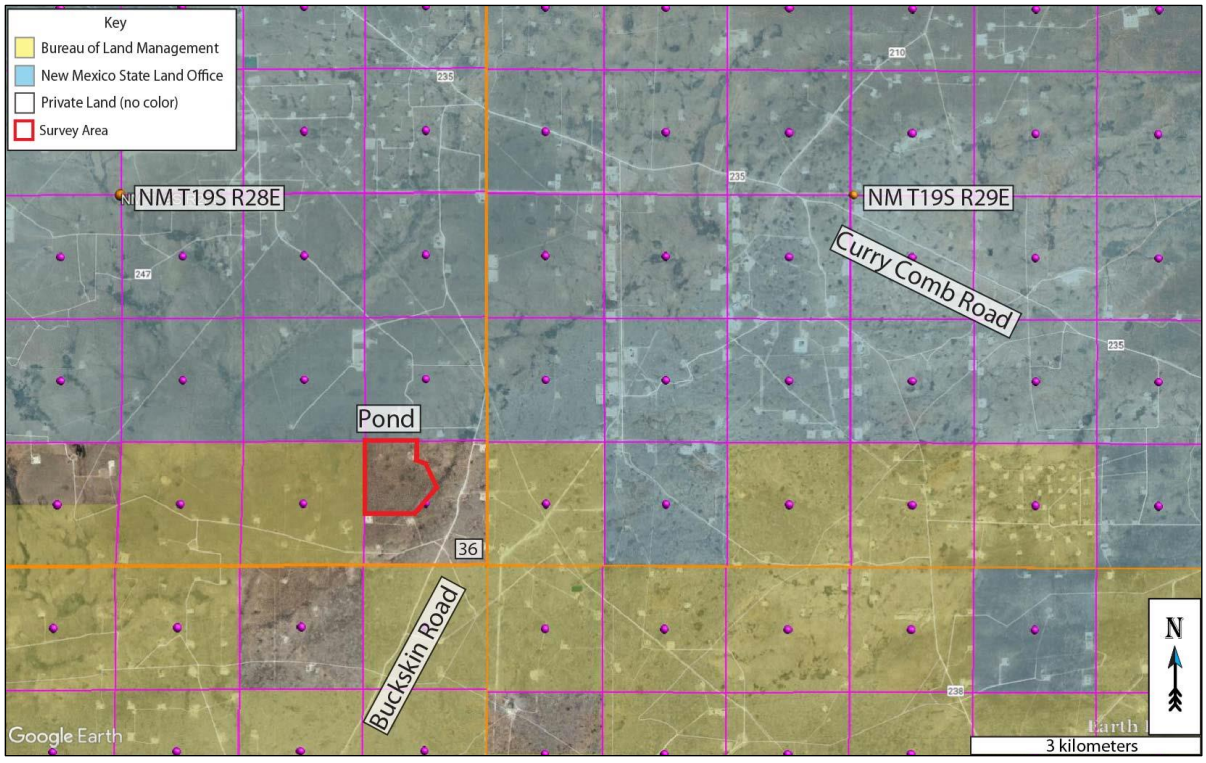

Figure 2: Land ownership overview[3,6]. Background image credit: Google Earth. Image date: December 21, 2019. Datum: WGS-84.

2.2 Local Geology

The area surveyed for the WBP project is located in a region locally known as Burton Flats at an elevation of 1,012 meters (3,319 feet), ± 12 meters (39 feet), and is underlain by the Permian Rustler (Pru) and Salado (Psl) Formations. The area is mantled by thin gypsiferous soils and Quaternary aeolian sands (Qal) and alluvial sands and gravels (Qp)[7] between 0 and 6 meters in depth (**Figure 3**).

The Rustler Formation is composed mainly of thin siltstones and sandstones interbedded with claystones, dolomite, and gypsum, and contains both karst-forming strata (the Forty-niner and Tamarisk members) and two shallow aquifers (the Magenta and Culebra Dolomite members)[8].

The Salado contains a layer of extremely soluble halite which can readily dissolve to create caves, sinkholes and other karst features; however, due to its extremely soluble nature, only non-soluble silt and sand remain from the dissolution of this layer at the surface[8]. The Rustler Formation may be subject to collapse if a void has developed beneath it in the Salado Formation[9].

This area is heavily karstified and has numerous sinkholes, swallets, caves, and other karst features within the survey area. Extreme caution is recommended during any surface activities including surface inspection, brush clearing, and trenching. The survey area is covered by the easily accessible Geologic Map of New Mexico (2003) at 1:500,000 scale[5].

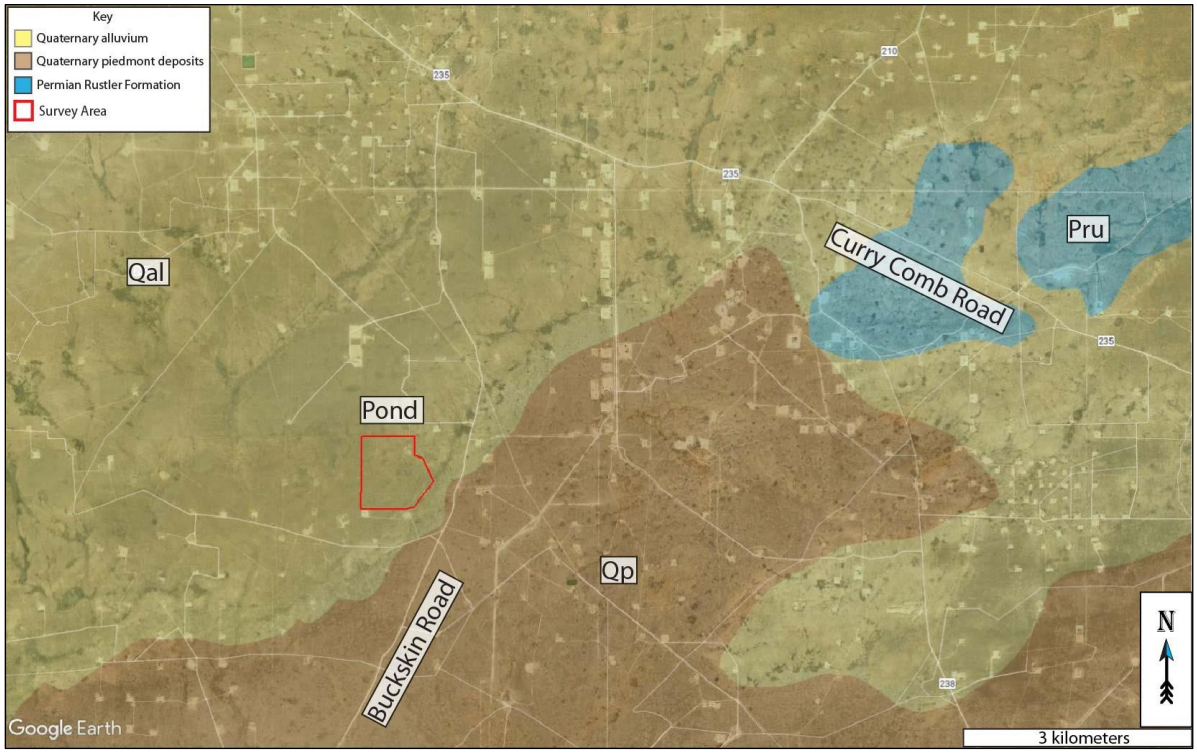

Figure 3: Geology overview. Map credit: The Digital Geologic Map of New Mexico in ARC/INFO Format[10], and Google Earth. Image date: December 21, 2019. Datum: WGS-84.

2.3 Description of Survey

Southwest Geophysical Consulting, in partnership with SWCA Environmental Consultants, provides aerial karst surveys using drones that are flown by qualified, FAA licensed drone pilots and that meet the stringent Bureau of Land Management – Carlsbad Field Office requirements for both pedestrian and aerial karst surveys. The BLM-CFO requirements are recognized by the NMSLO for aerial karst surveys.

Aerial karst surveys are conducted at low elevation following a preplanned raster pattern flightpath designed for the purpose of generating at least 75% imagery overlap. The collected high-resolution, georeferenced imagery is stitched together to develop orthomosaic imagery which is further developed into a digital elevation model (DEM); the DEM is then processed into a local relief model (LRM). This LRM is color coded to enhance differences in elevation of as little as five centimeters. The orthoimagery, DEM, and LRM are uploaded to a server where they are analyzed by a highly qualified karst geologist. Finally, the data is reviewed by a senior karst geologist for quality assurance and downloaded into a table for inclusion in a written report[11].

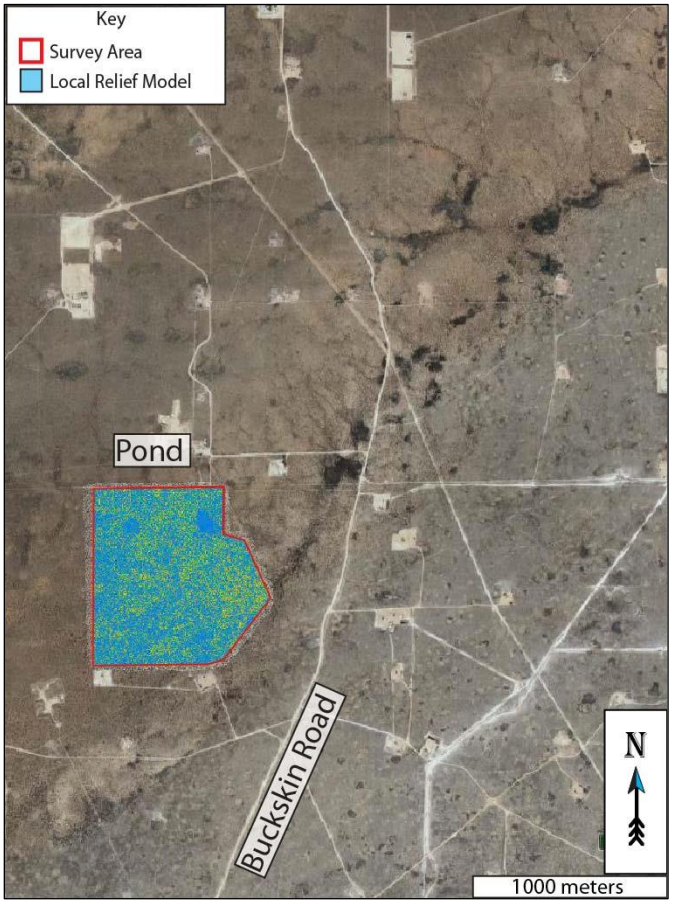

Figure 4: Survey overview. Background image credit: Google Earth. Image date: December 21, 2019. Datum: WGS-84.

Resolution of the orthoimagery is clear enough that features as small as 10 centimeters can be positively identified in most circumstances. Occasionally there are ambiguous features identified during an aerial survey that will need to be checked in the field if they impact the facility's location. Specifically, it is difficult to tell the difference between solution tubes, abandoned uncased well bores, and some burrows in drone imagery[12]. These features are marked with yellow dots in **Figure 4**. If a feature is subsequently verified in the field prior to publication of the report, the dot color will be changed to red if confirmed as a karst feature or deleted if not.

The imagery for this study was collected via aerial survey by Pat Lagodney of SWCA on June 3, 2022. Surface karst features may have developed after these dates and will not be noted in this report. Imagery analysis was completed by Dave Decker of Southwest Geophysical Consulting, LLC, on June 9, 2022.

2.4 Description of Karst Features

No surface karst features were located during this survey.

The lack of surface karst features does not mean the area is not karstified and the survey area may still contain buried karst features. Caution should be exercised while clearing brush and during any excavation, trenching, or construction operations. Employing a karst monitor on-site during these operations should be considered.

3.0 RECOMMENDATIONS

No surface karst features were located during this aerial survey.

The lack of surface karst features does not mean the area is not karstified and the survey area may still contain buried karst features. Caution should be exercised while clearing brush and during any excavation, trenching, or construction operations. Employing a karst monitor on-site during these operations should be considered.

This area may be prone to rapid karst formation in the underlying stratigraphy and warrants careful planning and engineering to mitigate karst-forming processes that could be accelerated by poor design considerations. Proper engineering of petroleum-related facilities following karst guidelines should be implemented during both excavation and construction. Mitigation measures for any karst features revealed during excavation shall be approved by the Bureau of Land Management – Carlsbad Field Office and follow the Natural Resources Conservation Service Conservation Practice Standard for Karst Sinkhole Treatment, Code 527, or the Bureau of Land Management Cave and Karst Management Handbook, H-8380-1.

Keep in mind that any flow of gypsum-undersaturated waters into a small crack or crevice can rapidly dissolve any underlying gypsum and cause failure of an impoundment or infrastructure within a matter of months to a few years. It is imperative that any dikes, buffers, or liners installed are checked regularly for integrity, with repairs made immediately upon discovery of failure.

Vigilance during construction is paramount. If voids are encountered during excavation, contact the Bureau of Land Management Karst Division at (575) 234-5972, the New Mexico State Land Office Surface Resources Division at (505) 827-5768, or a BLM-CFO-approved karst vendor and request an on-site investigation from a karst expert if one is not already on site. A karst consultant can generally be available in Eddy County within five hours.

Approved karst monitors should have karst feature identification training, at least two years of supervised experience identifying karst features, wilderness first aid training, SRT training, confined space training, gas monitor training, and a minimum of SPAR cave rescue training through NCRC. They should have with them the proper gear and be prepared both physically and mentally to enter a collapse feature within minutes to perform a rescue if needed. Monitoring services with qualified karst monitors, as well as cave surveys and geophysical surveys, are available from Southwest Geophysical Consulting.

Under no circumstances should an untrained, inexperienced person enter a cave, pit, sinkhole, or collapse feature. All field employees of Southwest Geophysical Consulting have extensive caving experience and the ability to determine whether entry into a karst feature is safe or presents a

hazard. In the event it is necessary to enter a karst feature, Southwest Geophysical Consulting can provide these services on request.

Cave and karst resource inventory reports for the BLM-CFO should be submitted to:

blm_nm_karst@blm.gov

Cave and karst resource inventory reports for the NMSLO should be submitted to the respective project manager.

4.0 REFERENCES

1 Rybacki, K. (Bureau of Land Management - Carlsbad Field Office, 2020).

2 Goodbar, J. R. Vol. BLM Management Handbook H-8380-1 (ed Carlsbad Field Office) 59 (Bureau of Land Management, Denver, CO, 2015).

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4 Center, W. R. C. *National Climate Data Center 1981-2010 Normal Climate Summary for Carlsbad, New Mexico (291469)*, 2010).

5 Whitehead, W. & Flynn, C. *Plant Utilization in Southeastern New Mexico: Botany, Ethnobotany, and Archaeology*. (Bureau of Land Management, Carlsbad Field Office, 2017).

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9 Martinez, J. D., Johnson, K. S. & Neal, J. T. Sinkholes in Evaporite Rocks. *American Scientist* **86**, 38-51 (1998).

10 Green, G. N. & Jones, G. E. *The Digital Geologic Map of New Mexico in ARC/INFO Format*, <https://mrdata.usgs.gov/geology/state/state.php?state=NM> (1997).

11 Whitehead, W., Bandy, M. & Decker, D. Protocol for Using UAV Photography for Rapid Assessment of Karst Features in Southeast New Mexico. *Proceedings of the 2022 Cave and Karst Management Symposium* (2022).

12 Decker, D. D. & Jorgensen, G. L. (ed LLC Southwest Geophysical Consulting) (Private Correspondence, 2020).

5.0 GLOSSARY OF TERMS AND ABBREVIATIONS

BLM-CFO	Bureau of Land Management - Carlsbad Field Office
caprock-collapse sinkhole	Collapse of roof-spanning rock into a cave or void.
cave	Natural opening at the surface large enough for a person to enter.
cover-collapse sinkhole	Collapse of roof-spanning soil or clay ground cover into a subsurface void.
GPS	Global Positioning System
(H)	High confidence modifier for a PKF. This is typically reserved for a feature that is definitely karst, but has not been confirmed in the field.
HKOZ	High Karst Occurrence Zone
(L)	Low confidence modifier for a PKF. This is typically a feature that cannot be ruled out as karst but is most likely NOT karst related. This modifier may also be used for pseudokarst features.
LED	Locally enclosed depression. A natural depression on the surface that collects rainwater. Some contain swallets and/or caves, others do not.
LKOZ	Low Karst Occurrence Zone
(M)	Medium confidence modifier for PKF. This is an ambiguous feature that can't be positively identified as karst without a field visit (e.g., burrows, abandoned unlined wells, solution tubes).
MKOZ	Medium Karst Occurrence Zone
NCRC	National Cave Rescue Commission
NKF	Non-karst feature. Used for features originally identified as PKF that have been subsequently identified in the field as non-karst related. This term may also be used for pseudokarst features.
NMSLO	New Mexico State Land Office
Pdl	Permian Dewey Lake Formation
PKF	Possible karst feature. This term is reserved for features identified in satellite or aerial imagery that have NOT been visited in the field. Further modifiers include (H) for high confidence, (M) for medium confidence, and (L) for low confidence. These confidence levels are based on field experience.
Pr	Permian Rustler Formation
Psl	Permian Salado Formation
pseudokarst	Karst-like features (sinkholes, conduits, voids etc.) that are not formed by dissolution. These types of features include soil piping, lava tubes, and some cover-collapse and suffosion sinkholes.
Qal	Quaternary alluvium

Qp	Quaternary piedmont deposits
Qpl	Quaternary playa lake deposits
RKF	Recognized karst feature. This term is reserved for karst features that have been physically verified in the field.
SKF	Surface Karst Feature
SPAR	Small Party Assisted Rescue
suffosion sinkhole	Raveling of soil into a pre-existing void or fracture.
swallet	A natural opening in the surface, too small for a person, that drains water to an aquifer. Some are "open," meaning a void can be seen below; some are "closed, "meaning they are full of sediment.
SWG	Southwest Geophysical Consulting, LLC
UTM	Universal Transverse Mercator (projected coordinates)
WGS	World Geodetic System (geographic coordinates)

6.0 ATTESTATION

David D. Decker, PhD, PG, CPG
Chief Executive Officer, Principal Geologist
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dave@swgeophys.com
(505) 585-2550

CERTIFICATE OF AUTHOR

I, David D. Decker, a Licensed Professional Geologist and a Certified Professional Geologist, do certify that:

- I am currently employed as a consulting geologist in the specialty of caves and karst with an office address of 5117 Fairfax Dr. NW, Albuquerque, NM, USA, 87114.
- I graduated with a Master of Science in Applied Physics with a specialization in Sensor Systems from the Naval Post Graduate School in Monterey, California, in 2003, and a Doctor of Philosophy in Earth and Planetary Sciences from the University of New Mexico, Albuquerque, New Mexico, in 2018.
- I am a Licensed Professional Geologist in the State of Texas, USA (PG-15242) and have been since 2021. I am a Certified Professional Geologist through the American Institute of Professional Geologists (CPG-12123) and have been since 2021.
- I have been employed as a geologist continuously since 2016. I was previously employed as a Fire Controlman, Naval Flight Officer, and Aerospace Engineering Duty Officer in the U.S. Navy and operated, maintained, and installed various sensor systems including magnetic, electromagnetic, radar, communications, and acoustic systems in various capacities from 1986 through 2010.
- I have been involved in various aspects of cave and karst studies continuously since 1985, including exploration, mapping, and scientific studies.
- I have read the definition of “qualified karst professional” set out in the ASTM Standard (currently in review). I meet the definition of “qualified professional” for the purposes of ASTM E-1527.
- I am responsible for the content, compilation, and editing of all sections of the report entitled “PW-083B-20220512 Cave and Karst Resource Inventory Report, WaterBridge Parkway Pond, Eddy County, New Mexico.” I or a duly authorized and qualified representative of Southwest Geophysical Consulting, LLC, have personally visited this site on the date or dates mentioned in section ***2.3 Description of Survey***.

- I have no prior involvement nor monetary interest in the described property or project, save for my fee for conducting this investigation and providing the report.

Dated in Albuquerque, New Mexico, July 20, 2022.

David D. Decker
PhD, CPG-12123

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State of New Mexico
Energy, Minerals and Natural Resources
Oil Conservation Division
1220 S. St Francis Dr.
Santa Fe, NM 87505

CONDITIONS

Action 140873

CONDITIONS

Operator: WaterBridge Stateline LLC 5555 San Felipe Houston, TX 77056	OGRID: 330129
	Action Number: 140873
	Action Type: [C-147] Water Recycle Long (C-147L)

CONDITIONS

Created By	Condition	Condition Date
vvenegas	None	9/14/2022