December 16, 2021
Project No. 20221930.001A

Ms. Lindsey Rider
EHS Manager
Caerus Operating, LLC
143 Diamond Ave. Parachute, CO 81635

TECHNICAL MEMO: Soil Sample Assessment of G21 Well Pad Reclamation Area
Caerus Operating, LLC, Garfield County, Colorado

At the request of Caerus Operating, LLC (Caerus), Kleinfelder completed a comparative review of topsoil chemical composition at the G21 well pad area in Garfield County, Colorado to an adjacent reference site located directly southeast of the pad disturbance area. Kleinfelder's assessment included a review of publicly available data for the Project area and an examination of soil analysis information provided by Caerus. Under this project, Kleinfelder was requested by Caerus to evaluate whether the surface soil of the G21 well pad reclamation area, directly south of the well pad, demonstrates characteristics that make it more or less suitable to support vegetative growth than topsoil at the reference site directly southeast of the pad disturbance area.

Review of Available Information

Kleinfelder was provided the following information by Caerus in an email dated December 8, 2021 for review:

- Photographs, figures, a site assessment, and laboratory soil data of the reclamation area (G21YD)
- Photographs, figures, a site assessment, and laboratory soil data of the adjacent undisturbed area (G21ND)
- Timeline of approximate initial reclamation date and subsequent reclamation actions

Prior to analyzing the soil data, Kleinfelder reviewed publicly available soil information within the Project area and consulted with local agricultural and rangeland specialists from the Colorado State University Extension (CSU Extension) to better understand the composition and constraints of topsoil in the region. In addition to consultation with local soil conservation specialists, the Colorado Department of Transportation (CDOT) Topsoil Specification (Spec 207 – July 2020) was reviewed to confirm local recommendations on the chemical and organic composition of the sample.

Soil sample information provided by Caerus was obtained from two locations, one of which is inside the G21 well pad reclamation area and one of which is outside the reclamation area, on an adjacent undisturbed rocky ridge as shown in **Figure 1** attached to this technical memorandum. These samples are labeled G21YD and G21ND, respectively. Each of the two samples were collected in the Parachute-Irigul-Rhone association, an NRCS-designated soil unit that is

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characterized as a well draining loam overlying weathered sandstone and shale at shallow depths. No detailed physical analysis of the soil was conducted. However, Caerus provided a field evaluation of the topsoil layer at G21YD and G21ND. The texture at each of the sample locations was informally classified as silt loam with fragmented shale bedrock at or near the surface.

Analysis of Sample Data

Kleinfelder discussed the soil analysis results from the sample points with local CSU Extension specialists to determine topsoil quality related to each of the soil characteristics measured during the soil analysis as shown in **Attachment 1** attached to this technical memorandum. **Attachment 2** includes the topsoil laboratory data provided by Caerus.

Attachment 1 presents the soil analysis results summarized from the lab output provided by Caerus for each of the samples. A discussion of the most important soil characteristics for soil fertility and a comparison of the two samples, is presented below:

Organic Matter – There is less organic matter within the topsoil at G21YD in comparison to the reference point. However, the percent organic matter by weight, is within range for this type of soil.

Nutrient Concentrations – In general, the nutrients analyzed for G21YD are within typical ranges for local soils.

- **Phosphorus** – There is a significant difference between sample sites, with phosphorous levels at G21YD measuring 17 ppm above the reference site. The higher phosphorus value indicates higher fertility. Therefore phosphorus should not be a limiting factor to vegetative growth at G21YD.

pH and Excess Carbonate - Soils with a higher pH and containing free lime (excess carbonate) are typical of soils in the Project area. The elevated pH would limit the type of vegetation at the reclamation area. G21YD demonstrated better pH values to support plant growth (slightly lower pH) than the reference site.

Total Cation exchange capacity (CEC) – G21YD is within in typical range for local soils.

Soluble Salts – G21YD is within in typical range for local soils.

Soil Compaction –The bulk density measured at G21YD is lower than the reference site.

Conclusion

When compared to analytical results of the G21 well pad reference site (G21ND) and supplementary information for surrounding soils, the chemical composition of topsoil within the G21 well pad reclamation area (G21YD) is not notably different from soils within the surrounding undisturbed area. Additionally, the soil properties identified during Caerus' field assessment at each sample location indicate that the physical composition of the soil is similar for both the G21 well pad reclamation area and reference site.

Given the chemical analysis provided for our review, there is no indication that chemical properties are the root cause of poor soil fertility. Soil compaction is also not the likely cause, as the bulk density at the reclamation area was measured lower than the reference site. Additional detailed physical analysis (soil texture, structure, pore size distribution, etc.) could provide additional insight into topsoil quality; however, other environmental variables could also potentially be contributing to spotty revegetation include soil moisture availability and retention, slope/aspect

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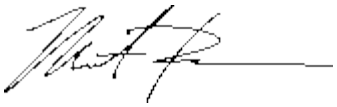
variability, suitable seed sources, and the microbial/fungal composition of the soil. Furthermore, site potential for vegetative growth may be inherently low, as compared to the reference site that includes extensive bare ground. Let us know if you have any questions or if we can provide further assistance with this project.

Sincerely,
KLEINFELDER, INC.

Prepared by:



Mitchell Reese
Natural Resources Specialist

Reviewed by:

Vince DeCianne
Senior Principal Professional

Attachments

- Figure 1 – Topsoil Sample Locations
- Attachment 1 – Soil Composition Comparison Table
- Attachment 2 – Topsoil Laboratory Data

References

Bruegger, R. 2021. Discussion and email response from Retta Bruegger Walters, Colorado State University Extension Regional Rangeland Specialist to Mitch Reese – Kleinfelder Natural Resources Specialist, December 15.

Colorado Department of Transportation (CDOT). 2020. Standard Specifications for Road and Bridge Construction. Specification 207 – Topsoil. June 2020

Harmon, J. and Murray, D. 1985. Soil Survet of Rifle Area, Colorado Parts of Garfield and Mesa Counties. United States Department of Agriculture, Soil Conservation Service, in cooperation with the Colorado Agricultural Experiment Station. May 1985.

United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS). 2018. Soil Resource Report. Available at: http://websoilsurvey.nrcs.usda.gov. Accessed May 2021.

Walters, D. 2021. Discussion and email response from Drew Walters, Colorado State University Extension – Garfield County Natural Resources and Agricultural Specialist to Mitch Reese – Kleinfelder Natural Resources Specialist, December 14.

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Figure 1
Topsoil Sample Locations

NO.	REVISIONS	BY	DATE

CAERUS OIL AND GAS LLC

Caerus G21-596

12/9/2021
Sample Grab Date
11/19/2021
Aerial Imagery Date
4/5/2006

Scaled Aerial Photograph
Pre-Disturbance Conditions

SHEET REFERENCE NUMBER:

Sheet 1 of 2

NO.	REVISIONS	BY	DATE

CAERUS OIL AND GAS LLC

Caerus G21-596

12/9/2021
Sample Grab Date
11/19/2021
Aerial Imagery Date
2021

Scaled Aerial Photograph of Topsoil Sample Locations

SHEET REFERENCE NUMBER:

Sheet 2 of 2

Attachment 1
Soil Composition Comparison Table

Table 1
Soil Composition Comparison

	G21 Site (G21YD)	Adjacent Reference Site (G21ND)	Range	Comments
Organic Matter (percent)	3.3	4.4	3 – 5 [1]	Methods of Soil Analysis, Part 3, Method 34
Nitrate (ppm)	1.9	2.0	--	
Phosphorus (ppm)	23	6	≥ 13.0 [1]	ASA Mono. #9, Part 2, Method 24-5.4 or others as required based on soil pH
Potassium (ppm)	148	102	≥ 80 [1]	ASA Mono. #9, Part 2, Method 13-3.5
Magnesium (ppm)	588	438	--	
Calcium (ppm)	5045	6780	--	
Sulfur (ppm)	8.6	3.8	--	
Zinc (ppm)	2.5	0.2	--	
Manganese (ppm)	1.3	0.4	--	
Copper (ppm)	1.6	2.1	--	
Iron (ppm)	11.9	8.5	--	
Boron (ppm)	0.5	1.5	--	
pH	7.9	8.1	5.6 – 7.5 [1]	ASA Mono. #9, Part 2, Method 10-3.2
Excess Carbonate	H – 2.6%	H – 2.9%	--	Typical for local soils[2]
Soluble Salts (mmhos/cm)	0.41	0.48	Max 1.60 [1]	ASA Mono. #9, Part 2, Method 10-3.3
Sodium (ppm)	51	54	--	
Bulk Density	1.14	1.16	--	
CATION EXCHANGE CAPACITY				
% K	1.2	0.7	--	
% Mg	15.9	9.6	--	
% Ca	82.1	89.1	--	
% Na	0.7	0.6	--	
% H	0.0	0.0	--	
Total CEC	30.7	38.1	--	Typical for local soils[2]

1. Obtained from CDOT Specification 207 (Topsoil – July 2020)
2. Discussion with D. Walter and R. Bruegger (Colorado State University Extension)

Attachment 2
Topsoil Laboratory Data

SOIL ANALYSIS

Submitted by **8001106**
Summit Services Group, LLC
15690 E 33rd Ave
Unit A
Aurora, CO 80011-1322

Date Received
23-Nov-2021

Submitted for
CAERUS G21-596
1226 Q RD
LOMA, CO 81524

Date Reported
29-Nov-2021

Laboratory Sample #
CF25689 - CF25690
Information Sheet #
127870

Laboratory Turnaround **6 Days**

Samples Will Be Stored Until **08-Dec-2021**

SUMMARY REPORT OF ANALYTICAL RESULTS

Sample Number	% Organic Matter	Nitrate N ppm	Phosphorus ppm IF pH < 7.1	Phosphorus ppm IF pH > 7.1	Potassium ppm	Magnesium ppm	Calcium ppm	Sulfur ppm	Zinc ppm	Manganese ppm	Copper ppm	Iron ppm	Boron ppm
G21YD	3.3	1.9	----	23	148	588	5045	8.6	2.5	1.3	1.6	11.9	0.5
G21ND	4.4	2.0	----	6	102	438	6780	3.8	0.2	0.4	2.1	8.5	1.5
Average	3.9	2.0		14	125	513	5913	6.2	1.3	0.9	1.9	10.2	1.0

SUMMARY OF ANALYTICAL RESULTS

Sample Number	Soil pH	Buffer Index	Excess Carbonate	Soluble Salts mmhos/cm	Sodium ppm	Bulk Density
G21YD	7.9	----	H - 2.6%	0.41	51	1.14
G21ND	8.1	----	H - 2.9%	0.48	54	1.16
Average	8.0		H - 2.7%	0.45	53	1.15

CATION EXCHANGE CAPACITY

Sample Number	ACTUAL % OF TOTAL CEC % K	% Mg	% Ca	% Na	% H	Total CEC
G21YD	1.2	15.9	82.1	0.7	0.0	30.7
G21ND	0.7	9.6	89.1	0.6	0.0	38.1
Average	1.0	12.8	85.6	0.7	0.0	34.4

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SOIL ANALYSIS

Submitted by **8001106**
Summit Services Group, LLC
15690 E 33rd Ave
Unit A
Aurora, CO 80011-1322

Date Received
23-Nov-2021

Submitted for
CAERUS G21-596
1226 Q RD
LOMA, CO 81524

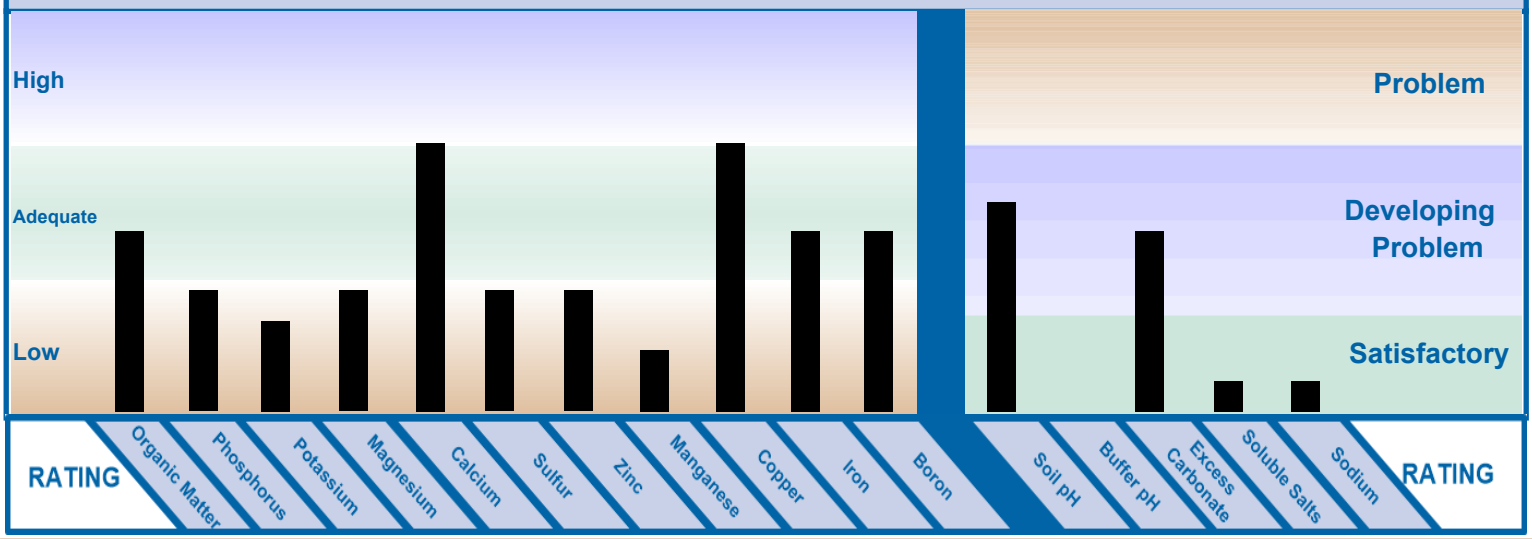
Date Reported
29-Nov-2021

Laboratory Sample #
CF25689 - CF25690
Information Sheet #
127870

Laboratory Turnaround **6 Days**

Samples Will Be Stored Until **08-Dec-2021**

GRAPHIC SUMMARY OF WEIGHTED AVERAGE TEST RESULTS



SUMMARY OF SOIL FERTILITY AND PLANT NUTRIENT GUIDELINES

Sample Number	Crop Yield or Turf/Ornamental Code	Lime Gypsum Sulfur	PLANT FOOD NEED IN: N	P_2O_5	K_2O	MgO	S	Zn	Mn	Cu	Fe	B
G21YD												
G21ND												
Average												

DISCLAIMER: Data and information in this report are intended solely for the individual(s) for whom samples were submitted. Reproduction of this report must be in its entirety. Levels listed are guidelines only. Data was reported based on standard laboratory procedures and deviations.

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Soil Analysis

Date Received: **23-Nov-2021**

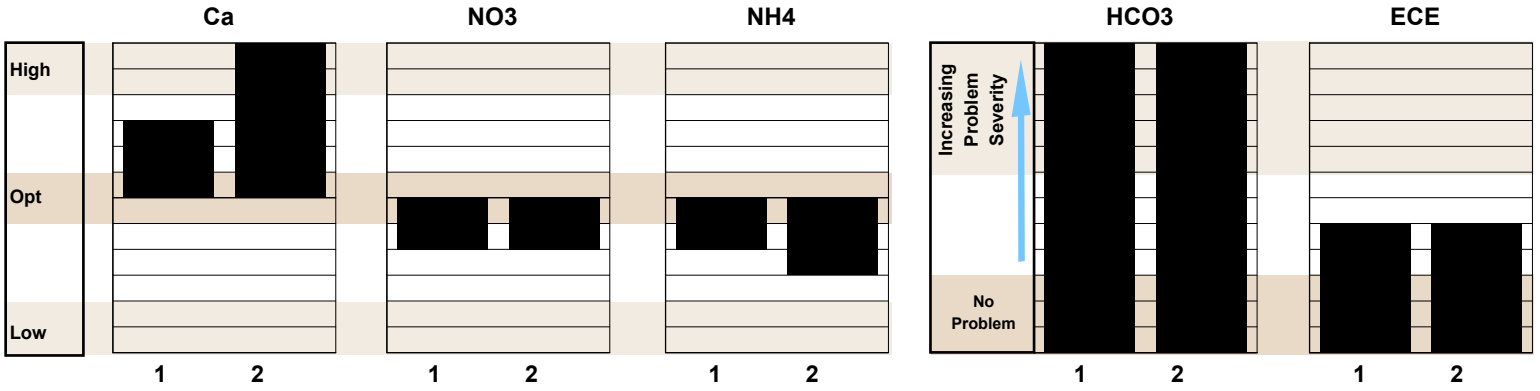
Date Processed: **29-Nov-2021**

Information Sheet # **127870**

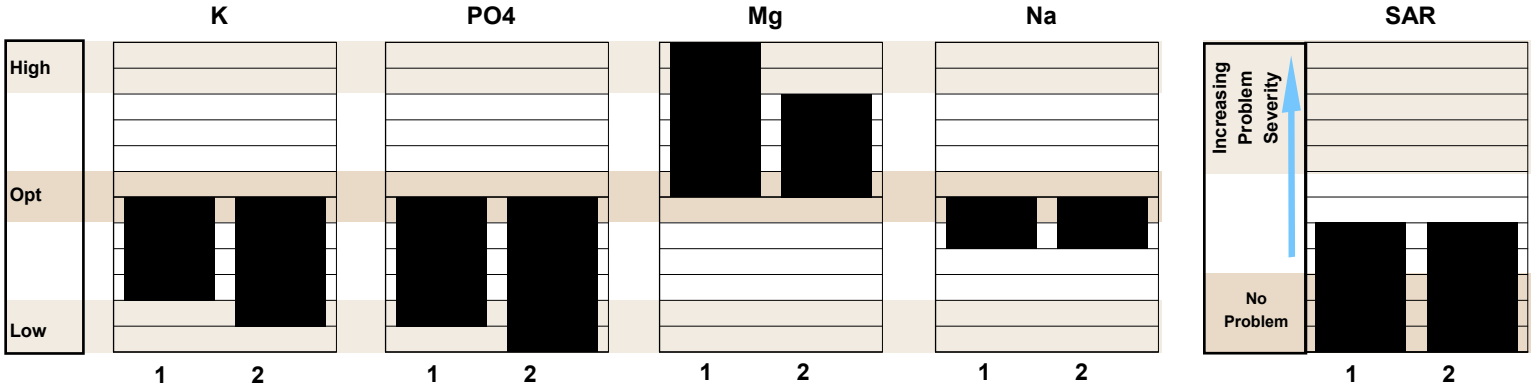
AgSource LABORATORIES

Submitted for **CAERUS G21-596**

Sample ID	Ca ppm	Ca Target Range	NO3 ppm	NO3 Target Range	NH4 ppm	NH4 Target Range	HCO3 ppm	HCO3 Target Range	ECE mmhos/cm	ECE Target Range
G21YD	44	23 - 29	4	5 - 10	4	5 - 9	145	20 - 36	0.3	0 - 2
G21ND	47	16 - 20	4	3 - 7	2	3 - 6	178	15 - 26	0.2	0 - 2



Sample ID	K ppm	K Target Range	PO4 ppm	PO4 Target Range	Mg ppm	Mg Target Range	Na ppm	Na Target Range	SAR	SAR Target Range
G21YD	5	12 - 19	1	4 - 8	20	6 - 8	7	8 - 15	0	0 - 6
G21ND	2	8 - 14	1	3 - 5	9	4 - 6	5	6 - 11	0	0 - 6



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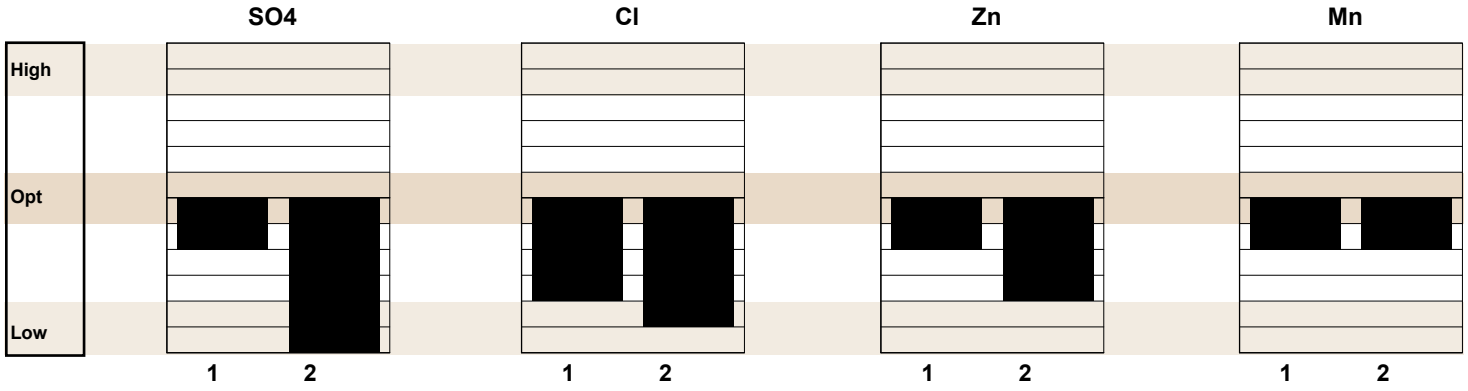
Information Sheet # **127870**

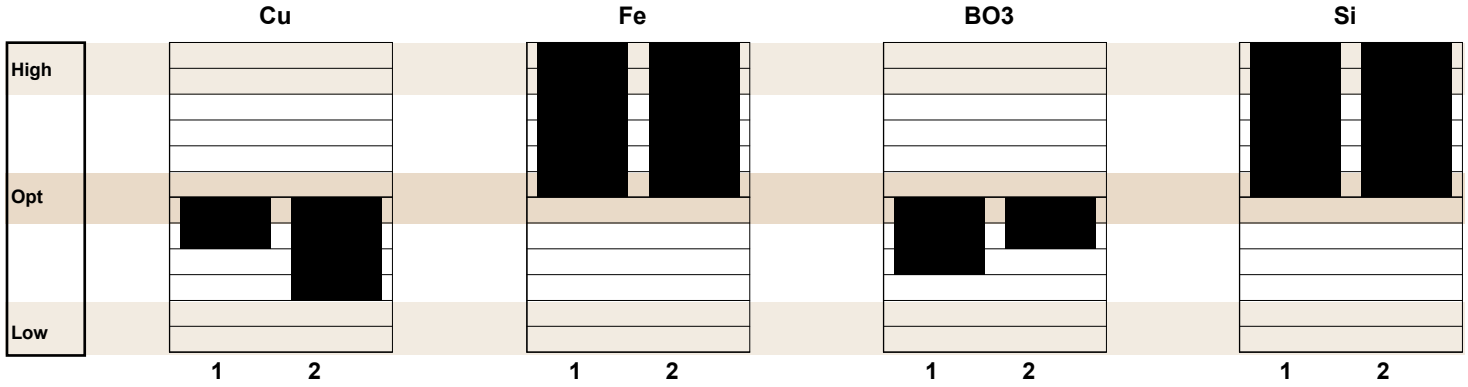
AgSource LABORATORIES

Submitted for **CAERUS G21-596**

Sample ID	SO4 ppm	SO4 Target Range	Cl ppm	Cl Target Range	Zn ppm	Zn Target Range	Mn ppm	Mn Target Range
	----------Salinity----------							
G21YD	43	38 - 57	9	17 - 26	0.02	0.02 - 0.03	0.04	0.04 - 0.08
G21ND	5	27 - 40	4	12 - 18	0.01	0.02 - 0.02	0.04	0.03 - 0.06



Sample ID	Cu ppm	Cu Target Range	Fe ppm	Fe Target Range	BO3 ppm	BO3 Target Range	Si ppm	Si Target Range	Moisture %
	----------Salinity----------								
G21YD	0.03	0.02 - 0.03	3.0	0.3 - 0.6	0.03	0.04 - 0.07	19.6	2.1 - 3.9	58
G21ND	0.01	0.02 - 0.02	3.0	0.2 - 0.4	0.05	0.03 - 0.05	17.8	1.5 - 2.8	68



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