

St, Croix Operating, Inc.
Longknife #3 SWD
NE/4 NW/4 Section 6, T3S R50W
Washington County, Colorado

SEISMICITY ANALYSIS

Pursuant to Energy and Carbon Management Commission (ECMC) Rule 803 g.(6), this report provides a geologic and geophysical review of known faults/shear zones within 12 miles of the subject proposed Class II UIC well. In addition, this report provides an analysis of historical seismicity in the area, as well as the potential for future seismicity, including induced seismicity, within 12 miles of the proposed SWD well. This report has been prepared on behalf of St. Croix Operating, Inc. by Slick Oil Limited, a Colorado LLC.

My name is Michael A. Domenick, sole proprietor of Slick Oil Limited; I am a professional geologist in Wyoming (PG-299) and Idaho (PG-861), and have provided geologic services in Colorado and elsewhere. I received a Bachelor of Science in Geology and Biology from the University of Rochester in 1979 and a Master of Science in Geology from the University of Rochester in 1981. I have over 35 years of experience in geology and related matters, including more than 10 years in environmental and regulatory compliance, as well as over 25 years in oil and gas exploration, development, and operations.

Known Faults and Shear Zones

As seen in Figure 1, the proposed Longknife #3 SWD is located in Section 6 – T3S – R50W, Washington County, Colorado, approximately 0.8 miles north of County Road 17 and approximately 2.6 miles west of County Road RR. The proposed injection location (NE/4 NW/4 Section 6) is approximately 8 miles north of US Highway 36, and the town of Arikaree, Colorado.

Figure 2 is a representation of Colorado Magnetic Field Intensity (USGS, 2008) with overlays of interpreted faults and large-scale lineaments (Simms et al, 2008). Niobrara outcrops (blue), as well as a 24-mile diameter circle centered on the Longknife #3 SWD, are also depicted and labeled. Figure 2 illustrates the relative distribution of Pre-Cambrian basement rocks which possess high concentrations of magnetic minerals (relative to overlying sedimentary rock and adjacent, less magnetic, crystalline basement rock). The magnetic field intensity relates to interpreted faults and lineaments in that together they define a northeast-southwest trend through Eastern Colorado. The Colorado Mineral Belt and Wattenberg High, as well as other, parallel trends, are considered shear zones along which dextral offset has episodically occurred in response to generally east-west crustal compression. Dashed black lines define general regional fault trends but do not correspond exactly to the loci of basement fault traces.

General observations and conclusions are: a) The Longknife #3 SWD is located in a magnetic intensity low between the Colorado Mineral Belt, to the north, and parallel lineaments to the south; b) High magnetic intensity is also associated with emplaced plutons, not simply long continuous uplifted basement block edges. It is not uncommon to see relatively circular magnetic anomalies aligned orthogonal (~NW-SE) to basement block lineaments, as is the case east-southeast of the Longknife #3 SWD location, in southwestern Yuma County, and west-northwest of the Longknife #3 SWD location, in western Washington County; and c) It can be surmised that fault movement (and magma emplacement), along orthogonal lineaments, when it occurs, is most likely during periods of 'relaxation' of east-west compression.

Figures 3 and 4 are structural elevation maps at the top of the Niobrara and J-Sand, respectively. Based on elevation contrasts in relatively linear patterns, both maps appear to show minor faulting oriented approximately northeast-southwest, as well as northwest-southeast, within the 12-mile radius around the Longknife location. While both trends are similar to those seen from magnetic field intensity (Figure 2), it is atypical for Cretaceous faulting in this area to be directly connected to the Pre-Cambrian basement rocks. Furthermore, insufficient well penetrations to the Permian and deeper are available to assess the potential presence of deep faults with existing well control. Limited deep well penetrations in the area do not appear to encounter, or otherwise suggest, deep-seated faulting within the 12-mile radius. Without seismic data, this hypothesized faulting in the Niobrara and J-Sand, its orientation, and whether basement is penetrated, cannot be verified.

Historical Seismicity and Potential for Future Seismicity

Figure 5 is a map showing historical earthquakes, from December 1870 to August 2016, compiled by the Colorado Geological Survey. The map also includes traces of Cenozoic (light purple) and Quaternary (all other colors) faults. As seen on Figure 5, no historical earthquake epicenter is located within, or even near, the 12-mile radius around the Longknife #3 SWD location. Earthquake clusters in the Front Range area near Denver and Greeley are mostly associated with induced seismicity at the Rocky Mountain Arsenal in the 1960s near Denver, and with more recent oil field activity in Weld County.

Figure 6 shows earthquake and "non-earthquake" seismic events for the period from October 1960 to December 2022. Figure 6 is an earthquake hazard map from the U.S. Geological Survey which factors population density in with earthquake probability to derive earthquake hazard zones. Figure 6 places the Longknife #3 SWD location in a "less" seismic hazard area. While more events are shown on Figure 6 than on Figure 5, it is clear that the former is similar to Figure 5 in confirming that no historical seismicity occurs within the 12-mile radius around the Longknife #3 SWD location.

Given the distance of the Longknife location from any historical seismic activity, and that relevant large, basement-penetrating faults are unlikely, it is likely that future seismicity can be considered very low probability. However, induced earthquakes are possible and the probability of inducing movement along stressed fault zones increases with the

increase in pore pressure in bisected reservoirs, particularly if the faults are rooted in Pre-Cambrian basement rock.

Figure 7 shows a cross-section and wellbore diagram illustrating the vertical separation between the Lyons Sandstone injection zone (bottom-hole location), and the underlying Pre-Cambrian basement. As seen in Figure 7, the base of the Lyons is approximately 2,300' above the Pre-Cambrian basement rock. In addition, the Lyons is surrounded, top and bottom, by hundreds of feet of plastic evaporite and shale deposits. A structure map of the Wolfcamp anhydrite marker is inset in the middle of the cross-section. This map, based on Permian well penetrations of approximately 1 well per township, shows no indication of deep faulting, but a gradual dip to the northwest at about 0.35 degrees. In addition, the mapped formations between the injection zone and basement would tend to anneal otherwise through-going faults. The isolation of the injection zone in this way thus also protects against non-basement involved induced seismicity in the underlying (and overlying) sedimentary layers.

Summary and Conclusions

1. Magnetic field intensity in eastern Colorado indicates the presence of northeast-southwest oriented shear zones in the Pre-Cambrian basement. In addition, secondary lineaments, orthogonal to the shear zones, are also identified. However, there is no evidence from wells that the proposed Longknife #3 SWD injector is located in an area of active basement faulting.
2. Structural elevation in the overlying Cretaceous Niobrara and J-Sand layers suggests possible local faulting within the 12-mile radius around the Longknife #3 SWD location. Insufficient data are available to determine whether these potential small faults, undetectable with regional potential field data, actually exist (above or below the proposed Lyons injection zone) or are merely mapping artifacts. In addition, connection of shallow faults, if present, to basement is deemed low probability in this tectonic environment
3. Historical earthquake data indicate no measured seismicity within 12 miles of the proposed Longknife #3 SWD location. These data have been collected since the year 1870 and run through December 5, 2022.
4. Future 'natural' seismicity is deemed highly unlikely, based on the historical earthquake record. Injection into the Lyons Sandstone, given the barrier layers above and below, and given the 2,300' of vertical between it and the underlying Pre-Cambrian basement, minimizes the possibility of inducing seismicity from injection operations.

CERTIFICATION:

I certify that I am a Professional Geologist, having met the relevant education requirements and professional work experience required by C.R.S. 23-41-208(b). I have reviewed information pertaining to this Oil and Gas Location and the surrounding area and have identified no seismic hazards within a twelve-mile radius which would pose a significant risk to the proposed Oil and Gas Operations or Location Area.



Michael A. Domenick, P.G.



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Yuma County
Washington County

Application Lands

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CR-19

CR-20

CR-21

CR-22

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Application Lands

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Scope

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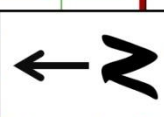
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Fig 1 - Location Map

Longknife #3 SWD; Washington County, CO

May 30, 2024

St. Croix Operating, Inc.



Map Scale

6 mi

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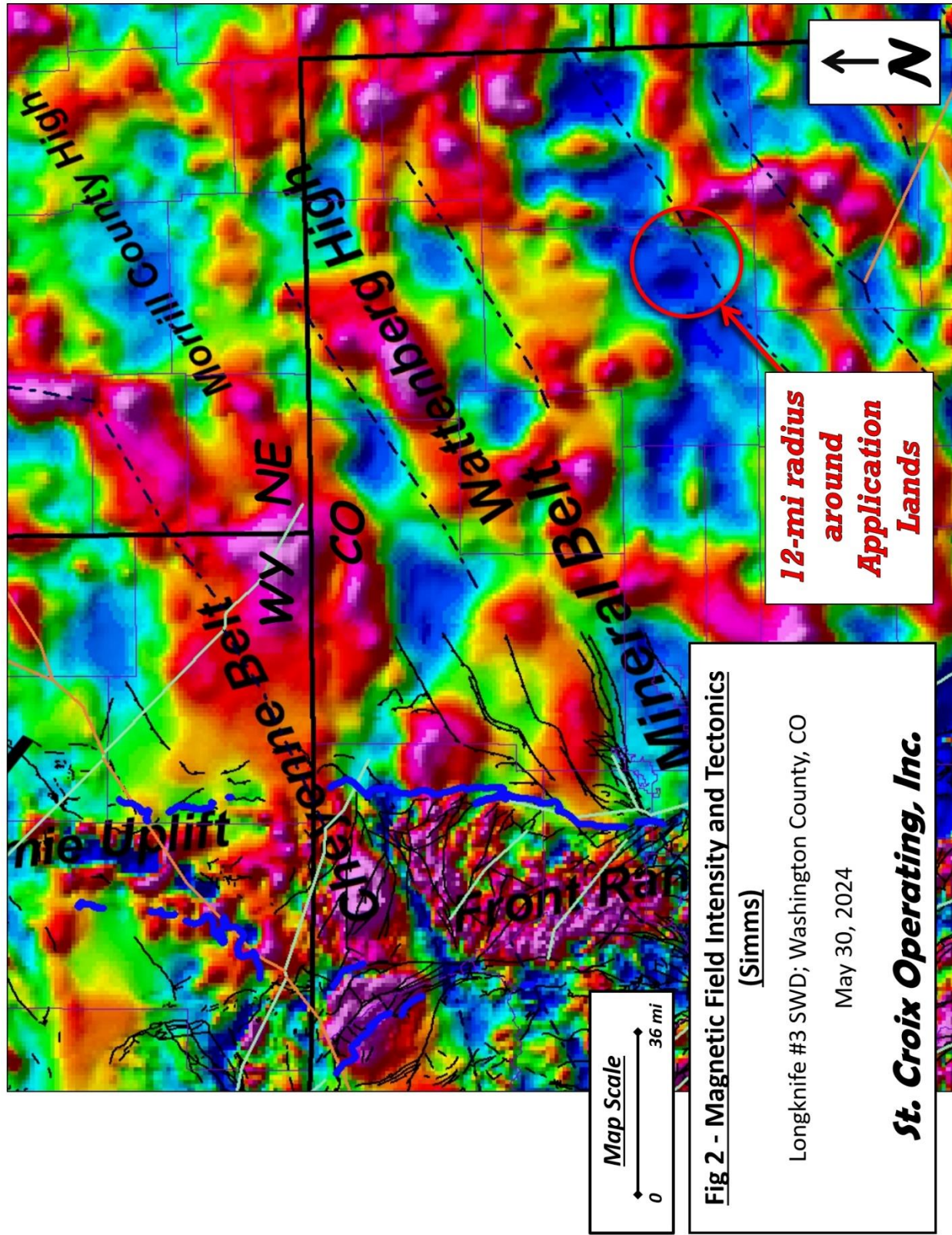


Fig 2 - Magnetic Field Intensity and Tectonics
(Simms)

Longknife #3 SWD; Washington County, CO

May 30, 2024

St. Croix Operating, Inc.

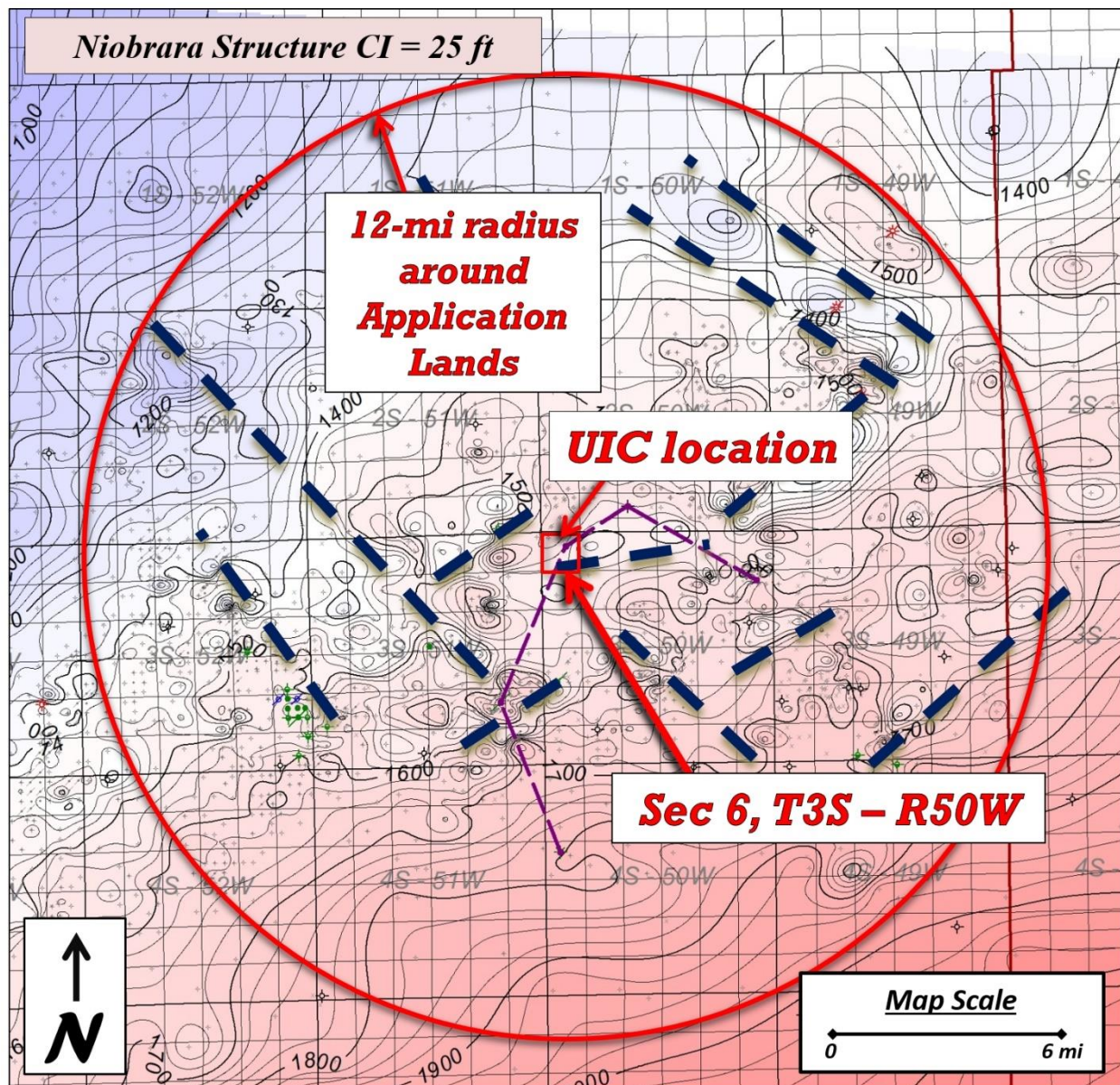
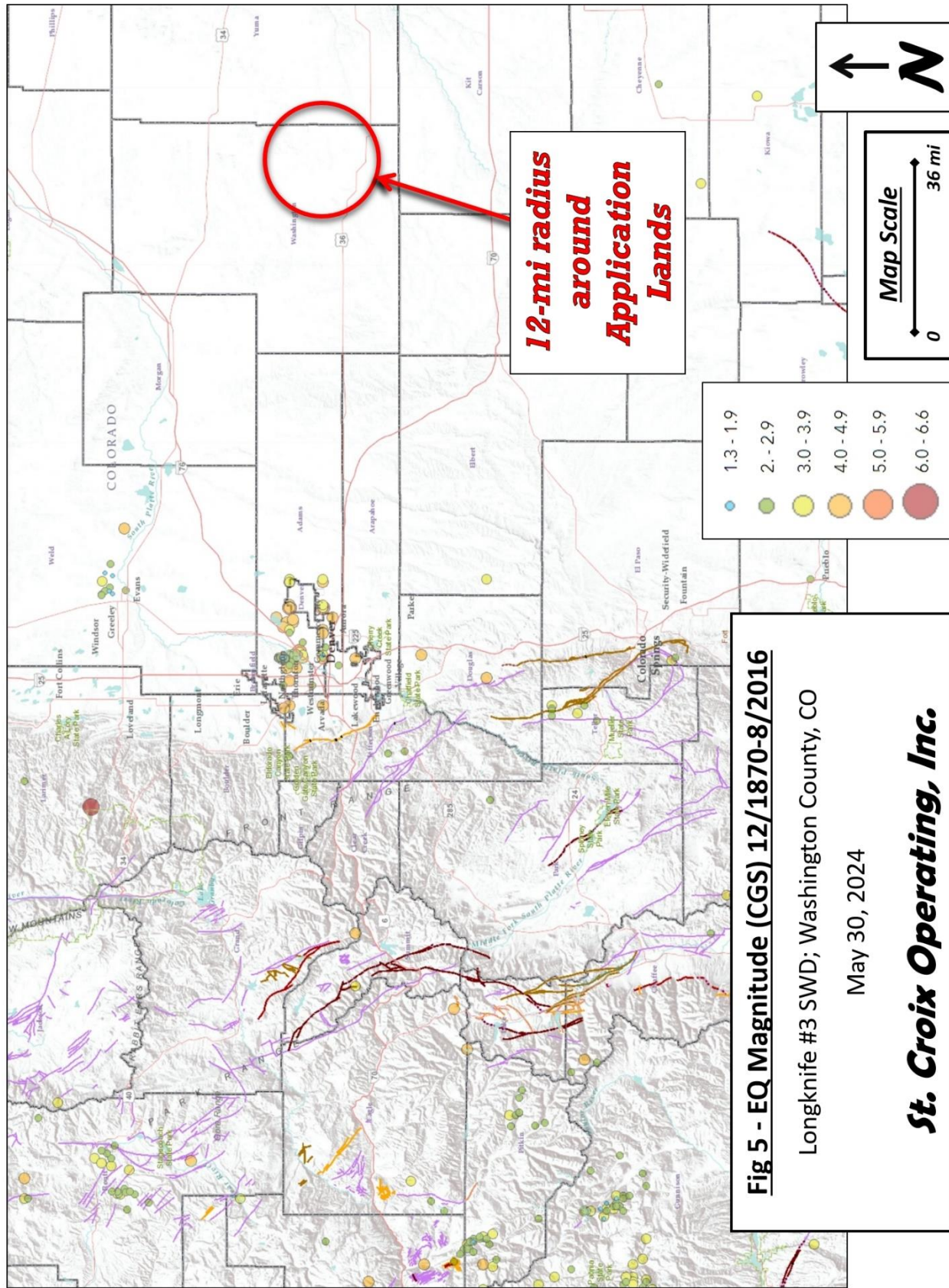


Fig 3 - Niobrara Structure

Longknife #3 SWD; Washington County, CO

May 30, 2024

St Croix Operating, Inc.



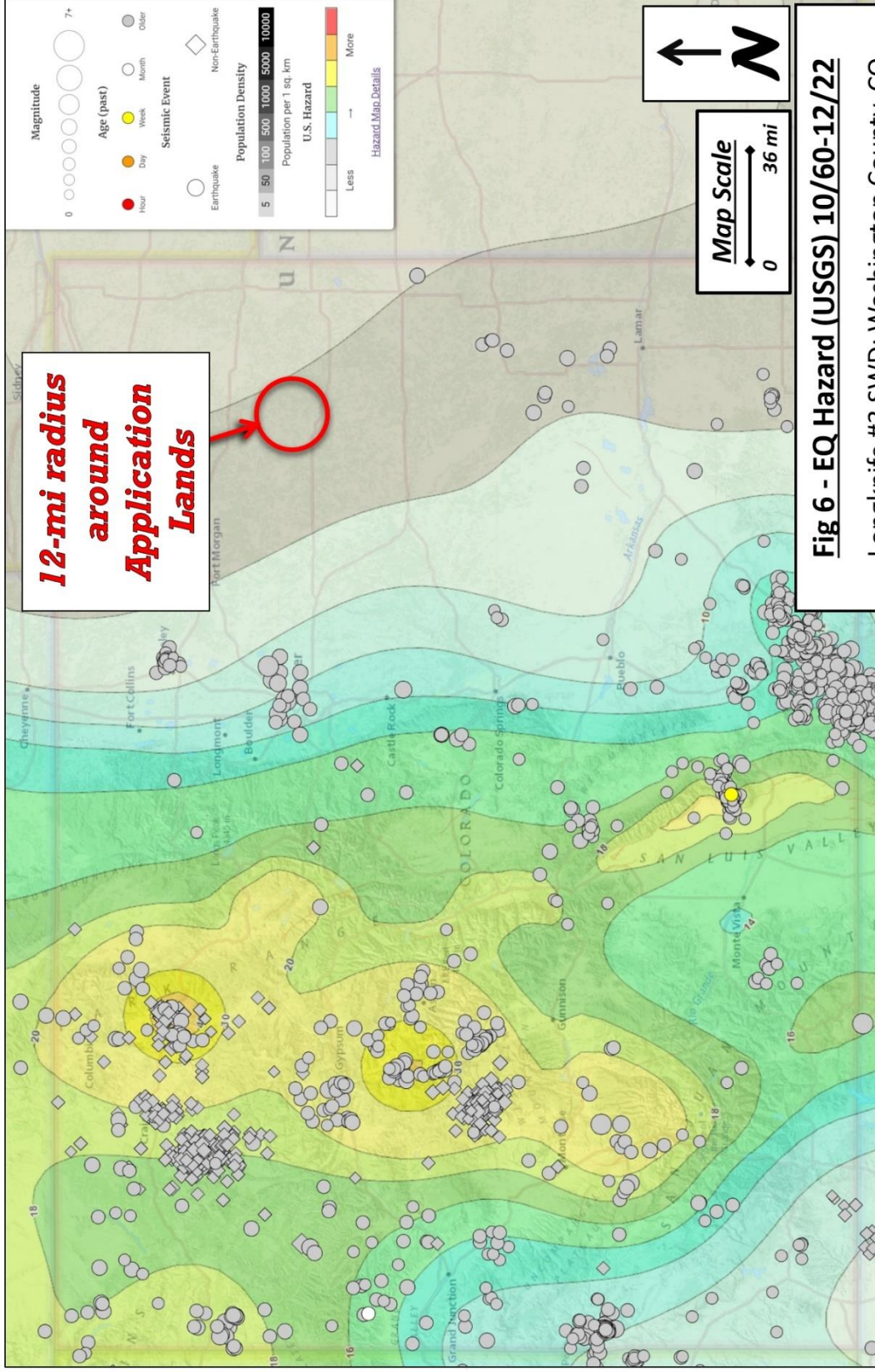


Fig 6 - EQ Hazard (USGS) 10/60-12/22

Longknife #3 SWD; Washington County, CO

May 30, 2024

St. Croix Operating, Inc.

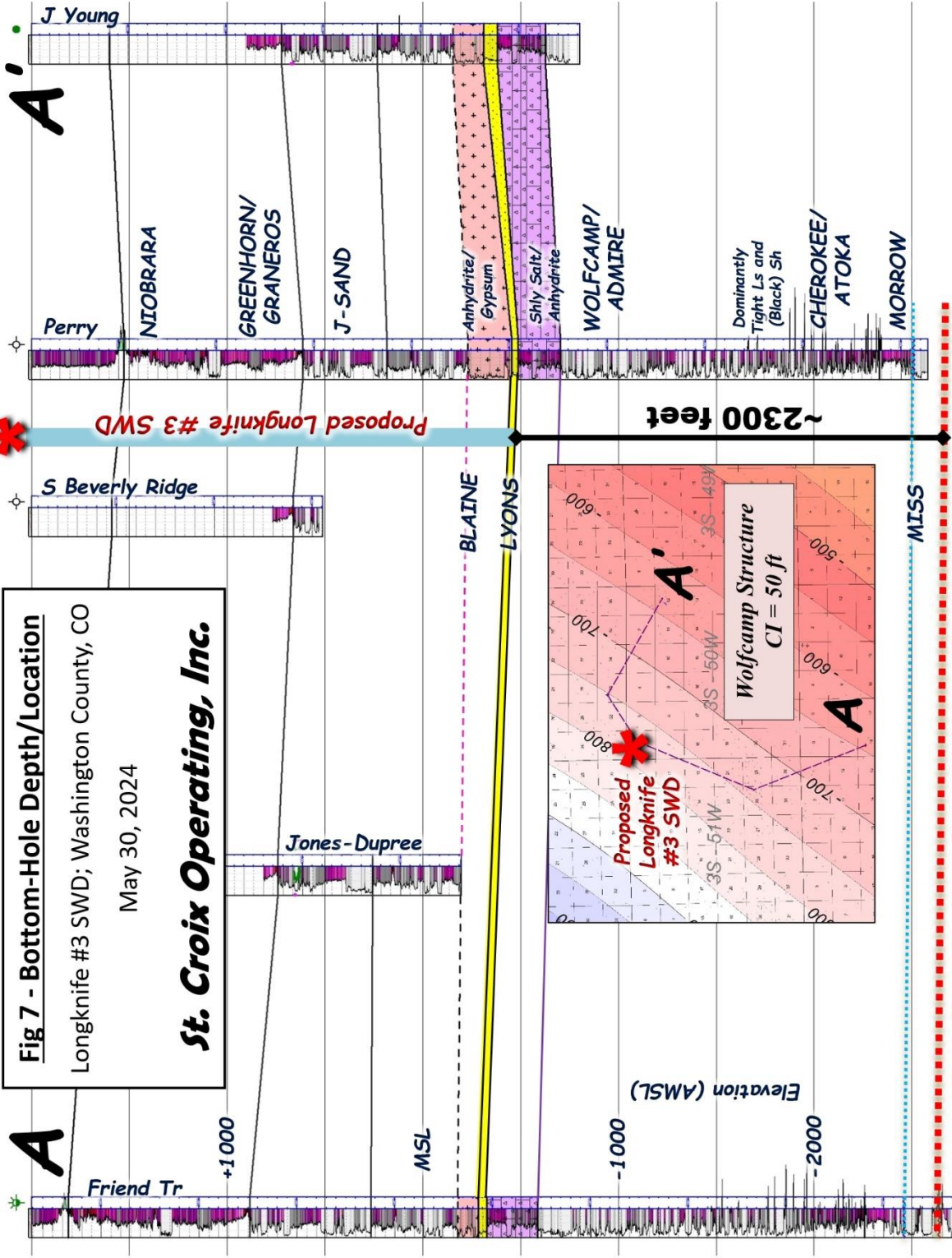


Fig 7 - Bottom-Hole Depth/Location
 Longknife #3 SWD; Washington County, CO
 May 30, 2024
St. Croix Operating, Inc.

PreCambrian Crystalline Rock