

Geologic Hazard Plan for Windom 5N67W24 1-46

PDC Energy Inc. is proposing the construction and development of an Oil and Gas Location, Windom 5N67W24 1-46, located in the southeast quarter of Section 24 in Township 5 North, Range 67 West, in Weld County, Colorado. Per Colorado Oil and Gas Conservation Commission (COGCC) Rule 304.b.(7).I., a Geologic Hazard Map was created to identify Geologic Hazards within a one-mile radius of the proposed working pad surface. Per COGCC Rule 304.c.(21), this Geologic Hazard Plan was developed to describe the hazards and proposed mitigation measures.

Site Characteristics

Research and investigations related to Geologic Hazards were completed for the Oil and Gas Location and surrounding areas. As defined by the State of Colorado, a Geologic Hazard means a geologic phenomenon which is so adverse to past, current, or foreseeable construction or land use as to constitute a significant hazard to public health and safety or to property. The term includes but is not limited to: avalanches, landslides, rock falls, mudflows, and unstable or potentially unstable slopes; seismic effects; radioactivity; and ground subsidence.

According to the Federal Emergency Management Agency (FEMA) floodplain data (preliminary study released for review in 2020), there is a Zone AE floodplain and floodway to the northwest along Sheep Draw. The floodplain location is within one mile of the proposed working pad surface as shown on the Geologic Hazard Map.

Mitigation Measures

Although there is a floodplain and floodway within one mile of the proposed working pad surface, these geologic features do not pose a risk to past, current, or future construction operations or land use at the Oil and Gas Location. Even so, standard mitigation measures will be in place including site stabilization, onsite and offsite stormwater controls, water quality BMPs, and site inspections following rain or snowmelt events. Additionally, the following may be implemented during the construction and drilling phases:

Construction Phase

- Pad stabilization options in the event of found subsidence during construction.
 - Cement stabilization to be used as needed.
- Standard practice is to utilize cement stabilization under the rig footprint and around each well head.
- If no subsidence issues occur during drilling with the conductor, this is indication that there should be no further issues during well development.
- Permitted storm water designs will also act as BMPs to help control, filter, and slowly discharge runoff.
- Locations are graded to 0.5% slope to slow the rate of runoff and channel the storm water toward a collection point for detention and settlement before discharge.

Drilling Phase

- If losses occur during Drilling:
 - LCM will be utilized to immediately stop losses.
 - Mud weight will be lightened to regain circulation, but not light enough to encounter any formation problems.
- If losses occur during Cementing:
 - Excess cement volume will be utilized.
 - LCM will be included in the cement.
 - If deemed necessary, a DV tool will be utilized to circulate cement above the lost zone on a second stage of cementing.
- Site Stabilization:
 - Rig mats will be used to help evenly distribute weight.
 - Soil cementation around the substructure of the rig will also stabilize the weight.

Summary

Geologic Hazards were reviewed for the proposed Windom 5N67W24 1-46 Oil and Gas Location and surrounding areas. FEMA identifies one floodplain and floodway within one mile of the proposed working pad surface. The floodplain and floodway do not pose a risk to past, current, or future construction or land use operations at the proposed Oil and Gas Location which would constitute significant hazards to public health, safety, or property.

References

Floodplain

- National Flood Hazard Layer FIRMette. Federal Emergency Management Agency. https://cogccmap.state.co.us/cogcc_gis_online/
- Weld County Floodplain Management. <https://www.weldgov.com/Government/Departments/Planning-and-Zoning/Floodplain-Management>

Surface Mines

- Colorado Oil and Gas Conservation Commission. DRMS Mine. https://cogccmap.state.co.us/cogcc_gis_online/

Earthquakes

- Colorado Geologic Survey. https://cogccmap.state.co.us/cogcc_gis_online/
- United States Geological Survey. <https://www.usgs.gov/programs/earthquake-hazards/science>
- United States Geological Survey. <https://earthquake.usgs.gov/earthquakes/map/>

Landslides

- Colorado Geologic Survey. <https://cologeosurvey.maps.arcgis.com/apps/webappviewer/>

Sub-Surface Mines

- Colorado Oil and Gas Conservation Commission. Coal Mine. https://cogccmap.state.co.us/cogcc_gis_online/
- Roberts, S.B., Hynes, J.L., and Woodward, C.L. Maps Showing the Extent of Mining, Locations of Mine Shafts, Adits, Air Shafts, and Bedrock Faults, and Thickness of Overburden above Abandoned Coal Mines in the Boulder-Weld Coal Field, Boulder, Weld and Adams Counties, Colorado. 1:48:000. Denver, CO: US Geological Survey: 2001
- Ivery, J.B., and Hynes, J.L., Subsidence Hazard Map Boulder-Weld Coal Field Boulder and Weld Counties, Colorado. Map No. 7361-6 1:24,000. Colorado Geological Survey: 1974

Soils

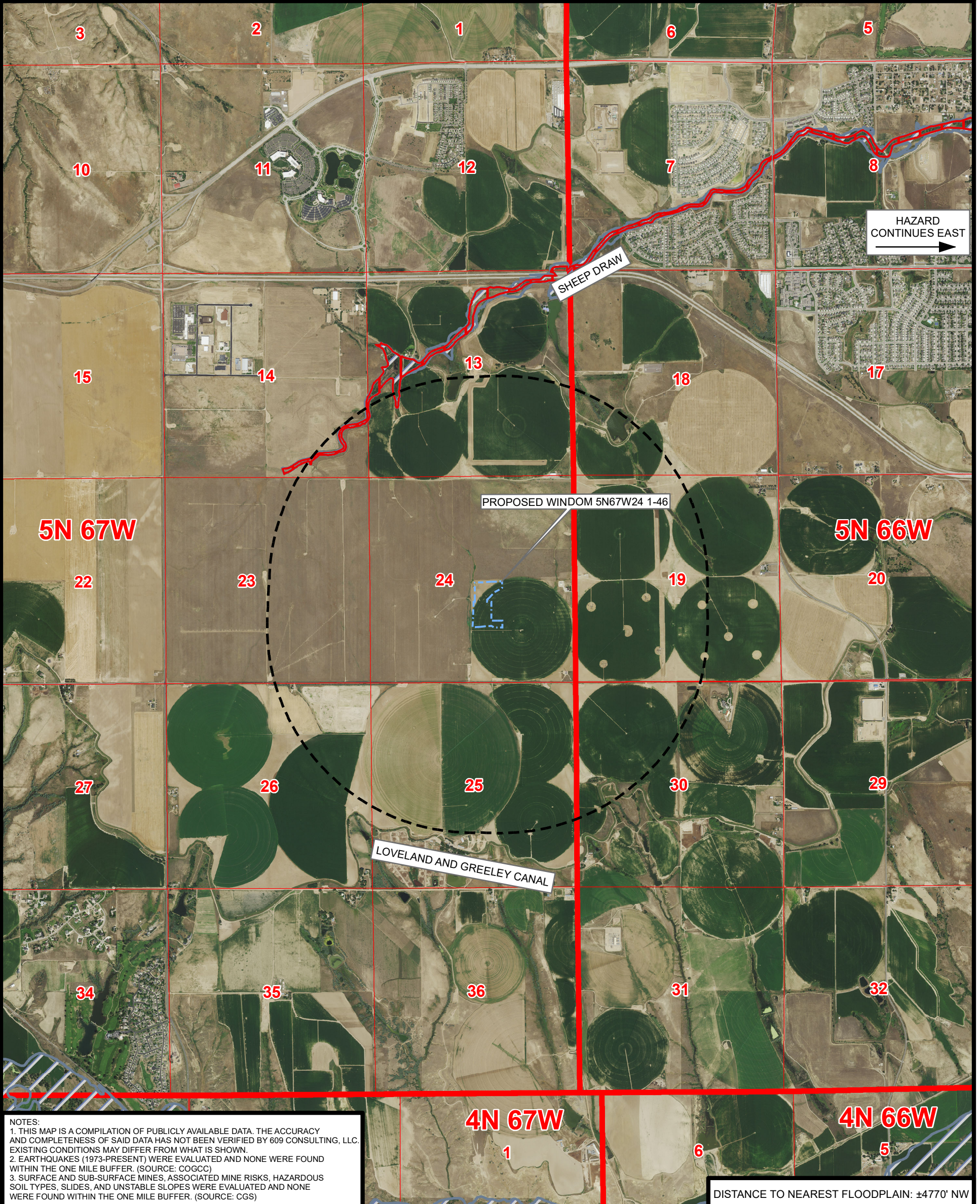
- United States Department of Agriculture. Natural Resources Conservation Service Soil Survey. <https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx>
- Colorado Geologic Survey. Collapsible Soils. <https://cologeosurvey.maps.arcgis.com/apps/webappviewer/>
- Crab, J.A., Soil Survey of Weld County, Colorado, Southern Part., USDA Soil Conservation Service, 1980.

Weld County

- Weld County Property Portal. Weld County, Colorado. <https://www.co.weld.co.us/maps/propertyportal>

GEOLOGIC HAZARD MAP WINDOM 5N67W24 1-46

SECTION 24, TOWNSHIP 5 NORTH, RANGE 67 WEST, 6TH P.M., WELD COUNTY, COLORADO



NOTES:
 1. THIS MAP IS A COMPILATION OF PUBLICLY AVAILABLE DATA. THE ACCURACY AND COMPLETENESS OF SAID DATA HAS NOT BEEN VERIFIED BY 609 CONSULTING, LLC. EXISTING CONDITIONS MAY DIFFER FROM WHAT IS SHOWN.
 2. EARTHQUAKES (1973-PRESENT) WERE EVALUATED AND NONE WERE FOUND WITHIN THE ONE MILE BUFFER. (SOURCE: COGCC)
 3. SURFACE AND SUB-SURFACE MINES, ASSOCIATED MINE RISKS, HAZARDOUS SOIL TYPES, SLIDES, AND UNSTABLE SLOPES WERE EVALUATED AND NONE WERE FOUND WITHIN THE ONE MILE BUFFER. (SOURCE: CGS)


Legend

- PROPOSED WORKING PAD SURFACE
- ONE MILE BUFFER - WORKING PAD SURFACE
- 100-YEAR FLOODPLAIN (PRELIMINARY, 2020) (SOURCE: FEMA)
- 100-YEAR FLOODWAY (PRELIMINARY, 2020) (SOURCE: FEMA)
- RADIOACTIVITY (SOURCE: CGS)
- EARTHQUAKES (1973-PRESENT) (SOURCE: CGS)
- CGS LANDSLIDES (SOURCE: CGS)
- COAL MINES SUBSIDENCE HAZARD (SOURCE: CGS)
- LOW
- MODERATE
- SEVERE

CGS
 RADIOACTIVITY: <https://cologeosurvey.maps.arcgis.com/apps/webappviewer/index.html?id=c5381e1335284d63bfa5d4b018b3372f>
 EARTHQUAKES: <https://cgsarcimage.mines.edu/ON-001/>
 LANDSLIDES: <https://cologeosurvey.maps.arcgis.com/apps/webappviewer/index.html?id=9dd73db7bc34139abe51599396e2648>
 COAL MINES: <https://cologeosurvey.maps.arcgis.com/apps/webappviewer/index.html?id=1891e3149eda44af9dc8af81c4dc58a8>

COGCC
 GIS ONLINE: https://cogccmap.state.co.us/cogcc_gis_online/

FEMA
 FLOOD ZONES: <https://msc.fema.gov/portal/advanceSearch>



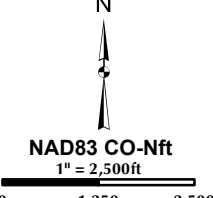
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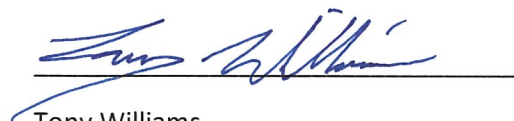


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 NAD83 CO-Nft
 1" = 2,500ft
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Drawn by: BB Date: 5 Nov 2021
 Revised: AK Date: 15 Mar 2023

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I certify that I am a Professional Geologist, having met the educational 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 Geologic Hazards within a one mile radius.

A handwritten signature in blue ink, appearing to read "Tony Williams", is written over a solid horizontal line.

Tony Williams
Senior Development Geologist
PDC Energy Inc.