3.5 Geology, Soils, Seismic Hazards, and Hazardous Waste Sites

This section describes the geology, soils, and seismic hazards impacts that could result from construction and operation of the proposed rail line, as well as impacts related to hazardous waste sites that could result from construction and operation of the proposed rail line. The subsections that follow describe the study areas, data sources, methods OEA used to analyze the impacts, the affected environment, and the impacts of the Action Alternatives and No-Action Alternative. Section 3.2, *Rail Operations and Safety*, ~~and~~ Section 3.3, *Water Resources*, and Section 3.4, *Biological Resources*, discuss impacts related to the transportation of potentially hazardous materials, including the risk of accidents and spills.

3.5.1 Analysis Methods

This subsection identifies the study areas, data sources, and analysis methods used to analyze geology, soils, seismic hazards and hazardous waste conditions associated with the proposed rail line.

3.5.1.1 Study Areas

OEA delineated two study areas for the analysis of potential impacts related to geology, soils, seismic hazards, and hazardous waste sites.

- **Geology, soils, and seismic hazards**. OEA defined the study area for geology and soils as a 0.5-mile buffer surrounding the project footprint[1] for each Action Alternative and the study area for seismic hazards as a 60-mile buffer surrounding the project footprint for each Action Alternative.
- **Hazardous waste sites**. OEA defined the study area for hazardous waste sites to include a 2,000-foot buffer from the project footprint. The 2,000-foot study area is intended to identify hazardous waste sites in the vicinity of the proposed rail line, especially sites with potential groundwater contaminant plumes migrating toward (and with the potential of reaching) each Action Alternative. OEA provides a summary of all sites identified in the study area below.[2]

[1] The *rail line footprint* includes the area of the railbed, as well as the full width of the area cleared and cut or filled. The rail line footprint would also include other physical structures installed as part of the proposed rail line, such as fence lines, communications towers, siding tracks, relocated roads, and power distribution lines. The rail line footprint is the area where rail line operations and maintenance would occur. The area would be permanently disturbed. The *temporary footprint* is the area that would be temporarily disturbed during construction, including areas for temporary material laydown, staging, and logistics. The temporary footprint would be reclaimed and revegetated following construction. The *project footprint* is the combined area of the rail line footprint and temporary footprint, both of which would be disturbed during construction, comprise where construction and operations of the proposed rail line would occur.

[2] All sites within the project footprint (regardless of the database in which it was found) are described in detail due to the proximity of the hazardous waste sites. The only off-site locations (sites beyond the project footprint, but within the study area) discussed in detail are those with a potential of affecting an Action Alternative.

3.5.1.2 Data Sources

Geology, Soils, and Seismic Hazards

OEA reviewed the following data sources to determine the potential impacts related to geology, soils, and seismic hazards that could result from construction and operation of the Action Alternatives and the No-Action Alternative.

- Available data from applicable federal, state, and local agencies including reports on the geologic setting of the area (Leighty & Associates, Inc. 2001; Hintze 1988).
- Geologic mapping for the study area (Sprinkel 2018;[3] Bryant 2010; Sprinkel 2007; Weiss et al. 1990; Utah Geological Survey 2010a, 2010b).
- Physiography of the study area (Fenneman and Johnson 1946).
- Reports and mapping on seismic faults (Utah Geological Survey ~~2017~~2020c; Howe 2021).
- Information on geologic hazards, including landslide and rock fall (Utah Geological Survey n.d., 2005).
- Mapping for oil and gas fields, active and abandoned wells, and active and abandoned mines (Utah Division of Oil, Gas, and Mining 2020; Utah Geological Survey 2015, 2018; Utah Abandoned Mine Reclamation Program n.d.).
- Soil data from the Gridded Soil Survey Geographic (gSSURGO) database for Utah (NRCS 2018).
- Reporting on effects of invasive species on soil function (Norton et al. 2004).

Hazardous Waste Sites

OEA reviewed the following data sources to determine the potential impacts on hazardous waste sites that could result from construction and operation of the Action Alternatives and No-Action Alternative.

- Data from environmental databases obtained via EDR Lightbox in the EDR Area/Corridor Report (EDR 2020).[4]
- Data available from applicable state agencies, including the Utah Department of Environmental Quality to supplement environmental database information.
- The USEPA Envirofacts database (USEPA 2020).

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[3] Sprinkel 2018 is the most current geologic map for the northern portion of the study area. Because this geologic map covers only a portion of the proposed rail line and was not available in GIS format at the time this document was prepared, OEA based its analysis on the other geologic mapping (Bryant 2010; Sprinkel 2007; Weiss et al. 1990; Utah Geological Survey 2010a, 2010b), which was augmented by qualitative analysis based on review of Sprinkel 2018. According to the Utah Geological Survey through agency consultation with OEA, Sprinkel 2018 has been updated with revised geologic mapping, as well as new/revised mapping of the Duchesne-Pleasant Valley fault system, which will be published in the latter part of 2021.

[4] EDR Lightbox uses proprietary techniques to search federal, state, local, and other databases to obtain information on facilities that use, store, transport, or generate regulated substances. OEA obtained an EDR report of all sites within a 2,000-foot radius from the project footprint.

3.5.1.3 Analysis Methods

Geology, Soils, and Seismic Hazards

OEA used the following methods to analyze geology, soils, and seismic hazards in the study area. The methods included a combination of quantitative analysis (i.e., GIS mapping) and qualitative analysis (i.e., risk assessment).

- **OEA assessed the potential for landslide, debris flow, and rock fall**. OEA used GIS to overlay maps of the project footprint onto maps of landslide, debris flow, rock fall, and geologic unit data.
- **OEA assessed the potential for soil hazards, including expansiveness, erosion, and corrosivity**. OEA overlaid maps of the project footprint onto maps of soil data and analyzed the area of soil disturbance and the engineering properties of soils in the study area, including susceptibility to expansiveness during alternative periods of wet and dry, susceptibility to wind and water erosion, and corrosivity to concrete and steel.
- **OEA determined the potential for primary seismic hazards**. Primary seismic hazards include surface fault rupture and seismic ground shaking. To assess risks related to these hazards, OEA overlaid the project footprint onto maps of seismic faults that have been active in historic and Holocene times. The project footprint does not intersect an active fault; therefore, OEA did not assume a potential for surface fault rupture. OEA assumed a high potential for ground shaking within 20 miles of faults with potential for Magnitude 6.0 or greater.
- **OEA determined the potential for secondary seismic hazards**. Secondary seismic hazards include landslides and liquefaction. Liquefaction occurs when ground shaking causes soil that is saturated with water to temporarily lose strength and act like a liquid. This can cause structures and infrastructure built on the soil to collapse. Liquefaction is more likely to occur in areas where the groundwater is closer to the surface and where the soil is loose and sandy. OEA performed a qualitative analysis for risk of landslide based on areas where groundwater discharges to the surface and sediments are unconsolidated sand or sandy gravel.

Hazardous Waste Sites

OEA used the following methods to analyze hazardous waste sites in the study area. The hazardous waste sites analysis evaluates both the potential for hazardous waste sites to affect the proposed rail line and the potential for the proposed rail line to affect hazardous waste sites. As mentioned previously, Section 3.2, *Rail Operations Safety*, Section 3.3, *Water Resources*, and Section 3.4, *Biological Resources*, discuss impacts related to risk of accidents and spills of potentially hazardous materials during construction and operation of the proposed rail line.

- **OEA defined hazard waste sites**. USEPA defines hazardous waste as waste specifically listed as a known hazardous waste or that meets the characteristics of a hazardous waste. These include wastes from common manufacturing and industrial processes and from specific industries that generate waste from discarded commercial products. Hazardous wastes include wastes that exhibit any one or more of the following characteristics: ignitability, corrosivity, reactivity, or toxicity. For the purpose of OEA's analysis, a hazardous waste site is an area that has been affected by a release (e.g., a spill) of hazardous waste into soil, groundwater, surface water, sediments, and/or air.

- **OEA analyzed information on hazardous waste sites obtained via EDR Lightbox.** OEA used the EDR Lightbox data (EDR 2020) to identify sites where hazardous waste is stored or used, as well as the location of sites with a history of contamination and closed status sites where remediation has been performed (and closure has been granted by the applicable oversight agency). Handling hazardous waste alone does not constitute a potential impact in OEA's analysis. The EDR Area/Corridor Report is available to the public on the Board's website at www.stb.gov and the Board-sponsored project website at www.uintabasinrailwayeis.com.
- **OEA ranked hazardous waste sites based on the potential to affect or be affected by the proposed rail line**. Two criteria are particularly important when evaluating the risk associated with a hazardous waste site in the context of a rail line construction project. These are the history of the site and its proximity to the proposed rail line. OEA evaluated whether past releases from each hazardous waste site affected soil or groundwater by considering the type of contamination, the media (soil, air, or water) affected, the severity of release, the direction of groundwater flow and whether the release was effectively contained. OEA categorized hazardous waste sites as low risk, medium risk, or high risk based on the following criteria.
  - **Low risk**. A low-risk site is within or adjacent to the study area, has no known documented releases, and is not identified on databases indicative of environmental concern.
  - **Medium risk**. A medium-risk site is within or adjacent to the study area and may or may not have a known documented release. Its historical operations and information analyzed indicate a potential release(s) to the environment or it is identified on databases indicative of release(s) to the environment. A site involving a documented release(s) to soils outside of project soil disturbance areas would be considered a medium risk.
  - **High risk**. A high-risk site is within the study area, has a known active-status documented release or residual contamination that is situated within or adjacent to the study area, and is identified on databases indicative of release(s) to the environment. A site might also be considered high risk if limited information is available about the site, which creates greater uncertainty about the extent of contamination and the costs of remediation.

3.5.2 Affected Environment

This subsection identifies the existing environmental conditions related to geology, soils, seismic hazards, and hazardous waste sites in the study areas.

3.5.2.1 Geology

Physiography

The study area lies within the Uinta Basin section of the Colorado Plateau Physiographic Province (Fenneman and Johnson 1946). The Uinta Basin (the Basin) is a structural depression bounded by the Uinta Mountains to the north, the Douglas Creek Arch and Roan Plateau to the east, the Book Cliffs/Tavaputs Plateau to the south, and the Wasatch Range to the west (Leighty & Associates 2001:9). The geologic deposits within the Basin generally slope northward and are dissected by steep and narrow stream valleys (Cashion 1967:4). Streams in the study area drain into the Green River, located east of the study area, which flows from the Uinta Mountains across the Basin and south into Desolation Canyon. Elevations in the study area range from 4,930 feet above mean sea level in the northeast portion of the study area to 9,462 feet above mean sea level in the southwest portion of the study area. The terrain includes steep slopes, cliffs, and dissected uplands predominantly in the west, as well as areas of more moderate slope to the northeast.

Geologic Units

A geologic unit is a layer or layers of rocks that can be grouped together and mapped based on their characteristics. A geologic unit can be a single rock formation or layer, a group of many formations that are associated with each other, a subgroup or member of a larger formation, or a collection of loosely associated rocks and sedimentary deposits. Table 3.5-1 quantifies and Figure 3.5-1 shows the extent of geologic units in the study area. These geologic units encompass the Green River Formation (Eocene) and Uinta Formation (Eocene), Colton Formation and Flagstaff Limestone/North Horn Formation, and other geologic units (Bryant 2010; Sprinkel 2007, 2018; Weiss et al. 1990).

The Green River Formation is exposed at ground surface over approximately 40 to 50 percent of the surface in the study area (Cashion 1967: 8; Bryant 2010; Sprinkel 2007; Weiss et al. 1990). The formation consists of beds of oil shale, marlstone, shale, siltstone, sandstone, limestone and tuff deposited in a lacustrine environment (Cashion 1967: 7). The Green River Formation is exposed at ground surface throughout the western portion of the study area and underlies the Uinta Formation where it is exposed in the east (Sprinkel 2018: 10).

Table 3.5-1. Geologic Units in the Study Area by Action Alternative (acres in study area)

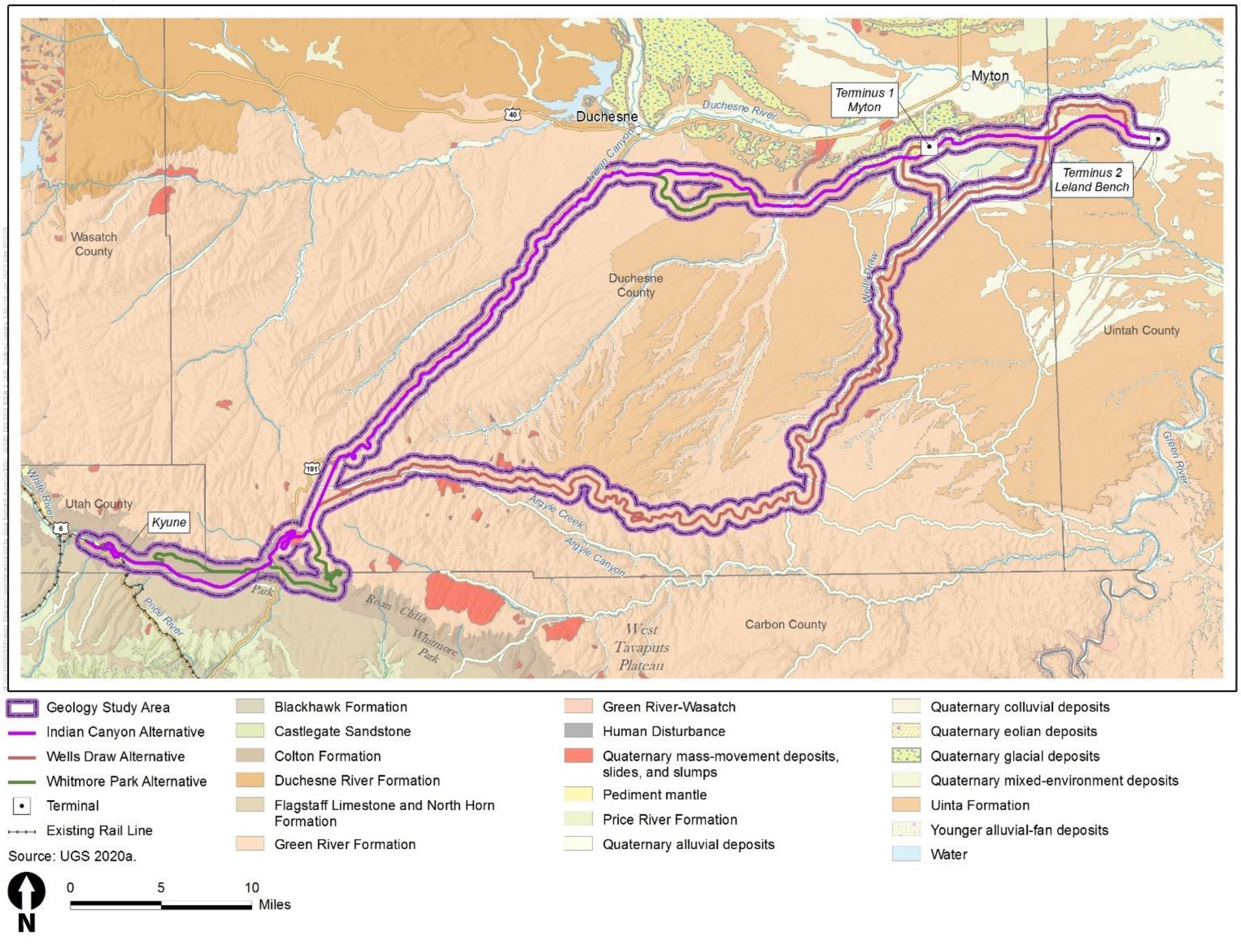
Geologic Unit	Indian Canyon Alternative	Wells Draw Alternative	Whitmore Park Alternative
Green River Formation	20,547	28,704	20,748
Uinta Formation	10,344	11,086	11,267
Colton Formation, Flagstaff Limestone/North Horn Formation	7,856	7,856	11,089
Other geologic units[a]	10,860	14,319	10,451

Notes:
[a] Including Quaternary alluvium, glacial, mass-movement, mixed-environment.
Sources: Bryant 2010; Sprinkel 2007, 2018; Weiss et al. 1990

The Uinta Formation is exposed at ground surface over approximately 20 percent of the surface in the study area (Bryant 2010; Sprinkel 2007; Weiss et al. 1990). The Green River Formation interfingers with and underlies fluvial deposits of the Uinta Formation (Cashion 1967: 21; Sprinkel 2018: 10). The Uinta Formation consists of claystone and sandstone. Most sediments in this formation were deposited in streams and on floodplains. The Uinta Formation is exposed at ground surface in the central and eastern portion of the study area.

The Colton Formation and Flagstaff Limestone/North Horn Formation are exposed at ground surface over approximately 10 to 20 percent of the surface in the study area (Bryant 2010; Sprinkel 2007; Weiss et al. 1990). The Colton Formation consists of mudstone and shaly siltstone interfingered with sandstone (Weiss et al. 1990). Flagstaff Limestone/North Horn Formation consist of mudstone with interbedded calcareous siltstone, sandstone, limestone conglomerate, and limestone, as well as some carbonaceous shale. All three of these formations are exposed at ground surface in the southwest portion of the study area.

Figure 3.5-1. Geologic Formations in the Study Area



Other geologic units are exposed at ground surface over 10 to 20 percent of the surface in the study area (Bryant 2010; Sprinkel 2007, 2018; Weiss et al. 1990). These deposits include alluvial deposits, colluvial, aeolian, glacial deposits, and mass-movement deposits, slides, and slumps (Sprinkel 2018: 2). These deposits are exposed at ground surface in the northeast portion of the study area. The study area includes geologic units that are prone to mass movement, particularly the Green River Formation. Mass movement refers to the downward movement of rocks and soils on hillsides and other slopes in response to the pull of gravity. Examples of mass movement in the study area include slope collapse (landslides), slumping and soil creep, debris flow, and rock falls. Soil erosion can increase the potential for and severity of mass movement (Subsection 3.5.2.2, *Soils*). Mass movement can, in turn, leave the land surface more prone to additional erosion as mass movement typically disturbs or removes vegetation and loosens soil.

Landslide Hazards

Landslides have several potential contributing causes such as weak, weathered, or sheared rock; changed morphology such as erosion at the toe of a slope; or human causes such as grading a slope (Beukelman and Hylland 2016: 63-64) (see also Subsection 3.5.2.2, *Soils*, *Soil Hazards*, for a discussion of factors that may contribute to erosion). Triggers that cause a landslide in slopes with such conditions include intense precipitation and earthquake. Seismic activity, particularly in areas with steep slopes, can cause a landslide through ground shaking and liquefaction. In some locations, the weak and weathered Green River Formation has failed, resulting in mass movement. Approximately 2,200 acres in the study area have been mapped as landslide, debris flow, and rockslide areas (Utah Geological Survey 2010a). These include deep or unclassified landslides that are generally more than 10 feet thick and deep, as well as shallow landslides from talus, colluvial, rock-fall, glacial, or soil-creep deposits (Utah Geological Survey 2010b) (Figure 3.5-2). Mapped landslides lie primarily in the southwestern portion of the study area underlain by the Green River Formation. However, this portion of Utah has not undergone an extensive landslide mapping; accordingly, this mapped acreage likely represents only a small proportion of areas affected by mass movement. Table 3.5-2 shows the mapped acreage in the study area with landslide, debris flow, and rockslide deposits by alternative. Figure 3.5-2 shows the areas in the study area mapped as affected by mass movement.

Table 3.5-2. Quaternary Mass Movement (Landslide, Debris Flow, and Rockslide) in the Study Area by Action Alternative

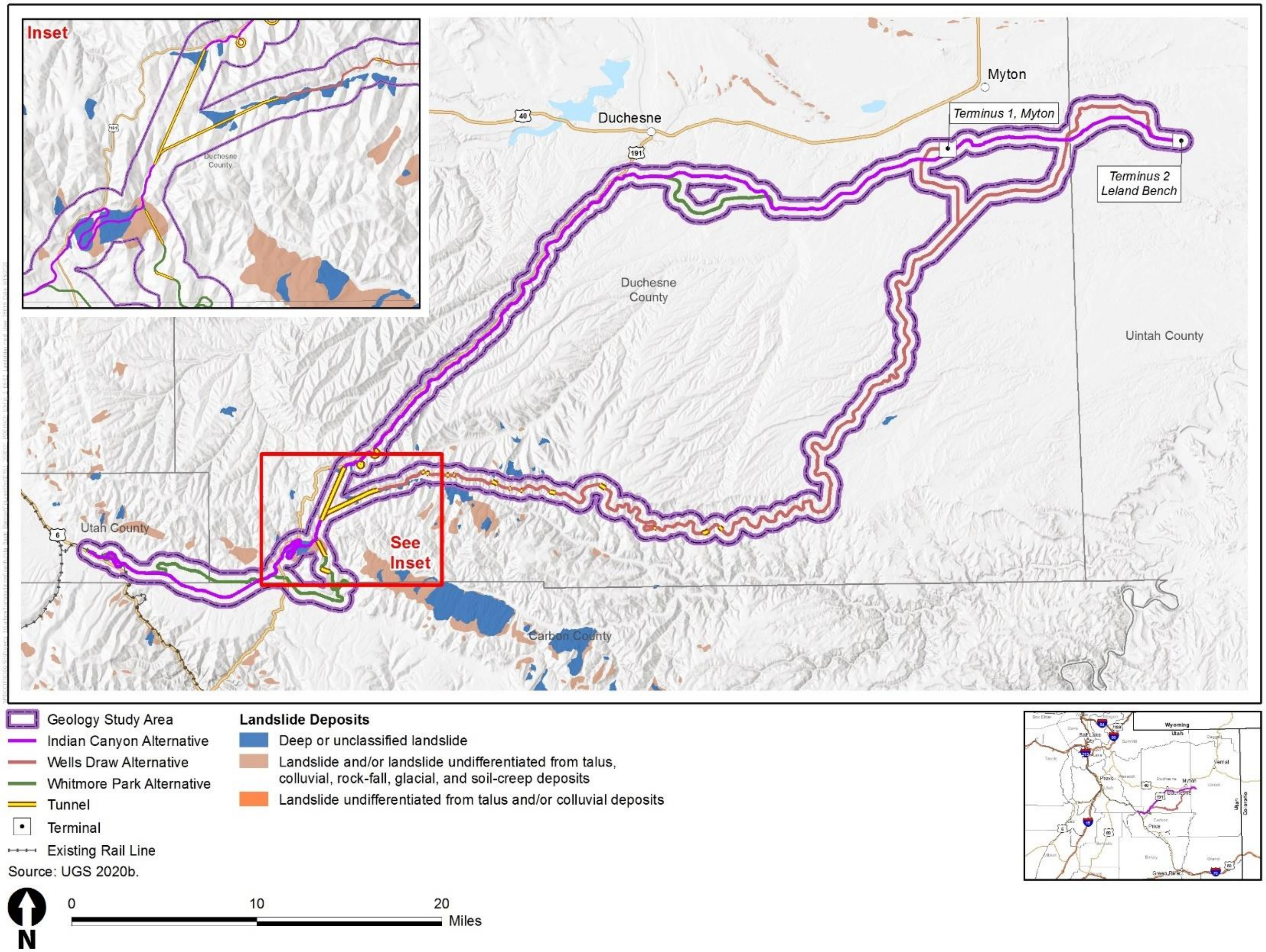
Geologic Unit	Indian Canyon Alternative	Wells Draw Alternative	Whitmore Park Alternative
Landslide, debris flow, and rockslide deposits (acres)	1,238	1,667	582

Notes:
Sources: Bryant 2010; Sprinkel 2007, 2018; Weiss et al. 1990

In addition, steep slopes (greater than 35 percent) can fail whether or not rocks are prone to slide if the angle of repose[5] is exceeded. The study area includes some areas of steep slopes in the southwest portion of the study area.

[5] The angle of repose is the steepest slope that a pile of material can have before the material starts to slide downward. Different types of soil and rocks can have different angles of repose depending on their structure and composition.

Figure 3.5-2. Landslide Deposits in the Study Area



Snow Avalanche Hazards

The two types of snow avalanches are loose snow slides and slab avalanches (Mock and Birkeland 2000). Loose snow slides, or sluffs, occur when loose snow on top of a snow pack slides down a mountainside. Because they are usually small and are made up of loosely consolidated snow, loose snow slides typically do not result in significant damage to property or injuries to people. Slab avalanches are more dangerous than loose snow slides because they involve more snow, traverse longer distances, and are more likely to result in death, injury, and damage to property. Slab avalanches occur in snowpacks in which a cohesive slab overlies a less-cohesive or weak slab. Added weight, such as new snow or a person on the slope, as well as loud noise and vibration, such as an explosion, can destabilize the layers and trigger a slab avalanche. Slab avalanches are common in the intermountain region because of climate. Specifically, continental climates have colder temperatures and more winter sun, characteristics that contribute to formation of weak layers.

The Utah Avalanche Center reports on snow avalanche occurrence in Utah; observations are tracked and show multiple slab avalanches each snow season (Utah Avalanche Center n.d.). The mountainous portion of the study area contains steep slopes and experiences climatic conditions that are conducive to formation of slab avalanches.

3.5.2.2 Soils

Soil Hazards

~~In general, soil hazards are not high throughout much of the study area.~~ Soil hazards in the study area include susceptibility to water and wind erosion and corrosivity to concrete and steel (NRCS 2018). Conditions in the study area that may contribute to erosion include unconsolidated deposits, high silt, and high carbonate contents. Conditions in the study area that may contribute to corrosivity include acidity (pH), moisture content, electrical resistivity of the soil, and temperature. Soils data indicate that mapped areas have low or moderate susceptibility to expansion and contraction (NRCS 2018).

Table 3.5-3 shows the acres and percentage of the study area with high and very high risk of soil hazards for each Action Alternative. These ratings are based on NRCS soil hazard ratings. Specifically, the values in the table for wind erosion correspond to a severe rating in the Gridded Soil Survey Geographic (gSSURGO) data; the values for water erosion correspond to the severe and very severe ratings; the values for corrosivity to concrete correspond to a high rating, and the values for corrosivity to steel correspond to a high rating. Figure 3.5-3 illustrates the regions of high and very high risk.

Table 3.5-3. High and Very High Risk of Soil Hazards by Action Alternative (acres in study area and percentage of study area)

Soil Risk	Indian Canyon Alternative		Wells Draw Alternative		Whitmore Park Alternative	
	Acres	Percent	Acres	Percent	Acres	Percent
Wind erosion	1,516	3.2	897	1.5	1,446	2.8
Water erosion	4,884	10.2	5,517	9.2	5,325	10.3
Corrosivity to concrete	1,364	2.8	1,767	2.9	1,386	2.7
Corrosivity to steel	5,393	11.3	9,320	15.5	5,460	10.6

Notes:
Source: NRCS 2018

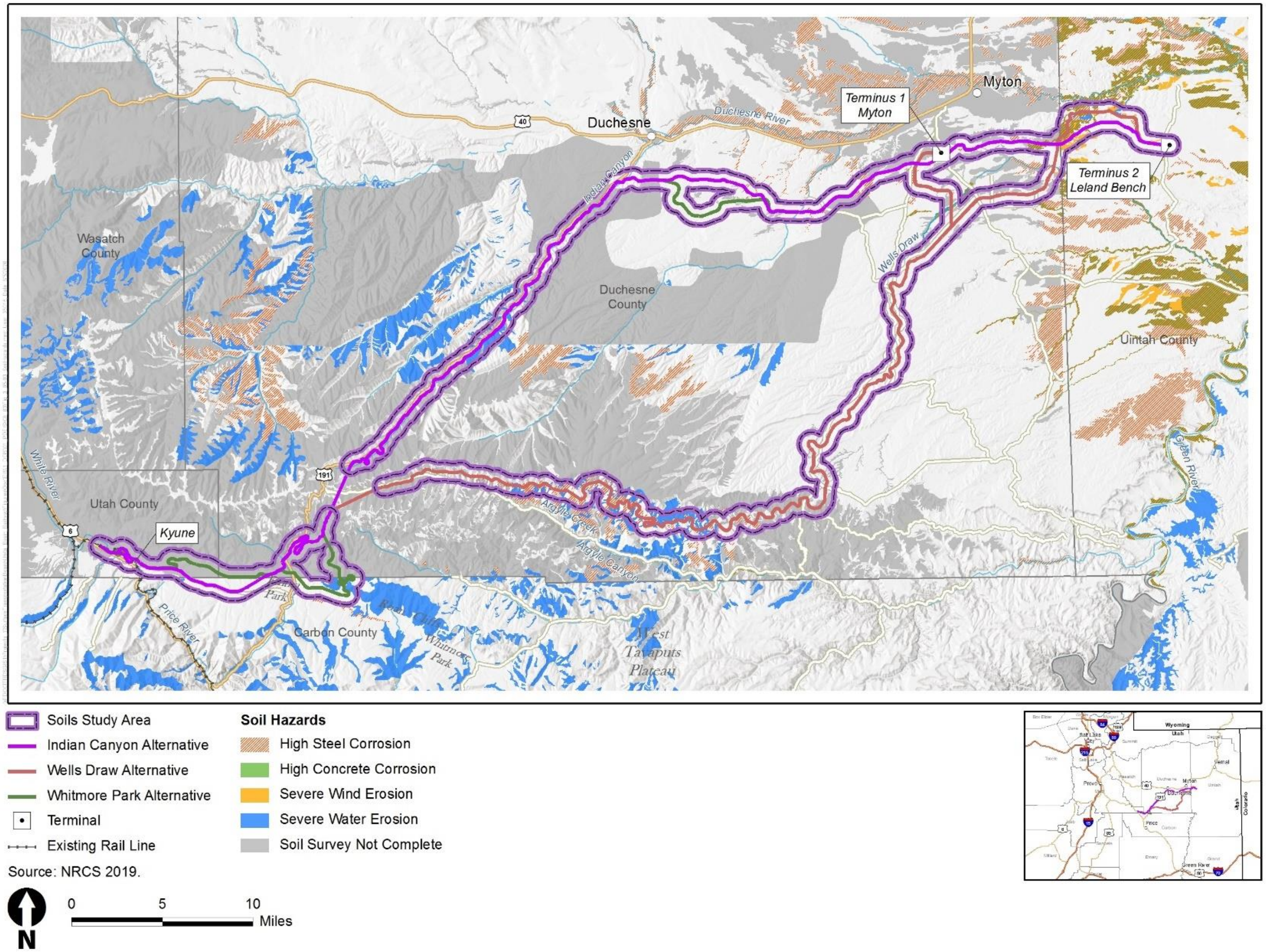
The areas with high and very high susceptibility to wind erosion are primarily in the northeast portion of the study area along the Indian Canyon Alternative and Whitmore Park Alternative (Figure 3.5-3). The areas with high susceptibility to water erosion are primarily in the western portion of the study area along all three Action Alternatives, with some areas in the northeast along all Action Alternatives (Figure 3.5-3).

The areas of high risk of susceptibility to corrosivity to concrete are primarily in the northern portion of the study area along the Indian Canyon Alternative and Whitmore Park Alternative and in the northeast along all Action Alternatives (Figure 3.5-3). The areas with high risk of susceptibility to corrosivity to steel are primarily in the southern portion of the study area along the Wells Draw Alternative and in the northeast portion of the study area along all Action Alternatives (Figure 3.5-3).

Soil Productivity

Soils perform multiple ecological services (Forest Service 2014~~2004~~). They promote and sustain biological and hydrologic functions and store carbon and water. Soil disturbance can disrupt the soils' ability to perform these services by causing wind and water erosion, compaction, and contamination. When disturbances occur, the likelihood that nonnative plants can move into an area is increased. Some of these nonnative plants can be noxious or invasive. The Utah Department of Agriculture and Food is responsible for designating the State of Utah Noxious Weed List, although counties may set priorities for responding to invasive plant threats.

Figure 3.5-3. Soil Hazards in the Study Area



3.5.2.3 Seismic Hazards

Earthquakes

The seismic hazards study area includes several faults that have been active in Holocene time[6] (Utah Geological Survey ~~2017~~2020c). Table 3.5-4 shows the earthquake scenario magnitude[7] and distance from the Action Alternatives to these faults. Figure 3.5-4 displays the faults in the study area, and Figure 3.5-5 depicts the named faults in proximity to the proposed rail line. Several of the faults are capable of generating a large earthquake (i.e., at least M 6.9) (Lund 2014:5-8). ~~The closest of these faults, the Strawberry fault, is approximately 19 miles away from all Action Alternatives, and its design earthquake for planning purposes is Magnitude 6.9. In addition, the~~ The Duchesne-Pleasant Valley fault system, which crosses the Indian Canyon and Whitmore Park Alternatives and lies within 0.4 mile of the Wells Draw Alternative, may have been active in the Holocene to the late Quaternary, between now and approximately 130,000 years ago (Howe 2021; Black and Hecker 1999a). The Towanta Flat graben, which lies approximately 20 miles north of the Action Alternatives, may also have been active in the late Quaternary (Black and McDonald 1999). The Pot Creek faults, which lie approximately 40 miles northeast of the Action Alternatives, was active during the Quaternary, but its history is poorly understood (Black and Hecker 1999b).

Table 3.5-4. Active Faults in the Study Area and Distance to Action Alternatives

Fault	Design Earthquake[a] (Magnitude)	Distance from Indian Canyon Alternative (miles)	Distance from Wells Draw Alternative (miles)	Distance from Whitmore Park Alternative (miles)
Bear River fault zone	6.9	53	60	53
Duchesne-Pleasant Valley fault[b]	N/A	0	0.4	0
Gunnison fault	7.0	39	39	39
Joe's Valley	6.7	23	23	23
Snow Lake graben	6.5	43	43	43
Strawberry fault	6.9	19	19	19
Utah Lake faults	6.8	47	47	47
Wasatch fault zone	6.9	36	36	36

Notes:

[a] Design earthquake for planning purposes.

[b] Design earthquake magnitude for the Duchesne-Pleasant Valley fault is not available.

Sources: Utah Geological Survey ~~2017~~2020c; Lund 2014

NA = not applicable

[6] Faults that have not moved in the Holocene epoch (the past 11,650 years) are not considered to be active.

[7] The earthquake scenario magnitude or design earthquake magnitude is the magnitude earthquake that a fault is thought to be capable of producing based on fault dimensions, slip rate, and other factors.

Figure 3.5-4. Active Quaternary Faults in the Study Area

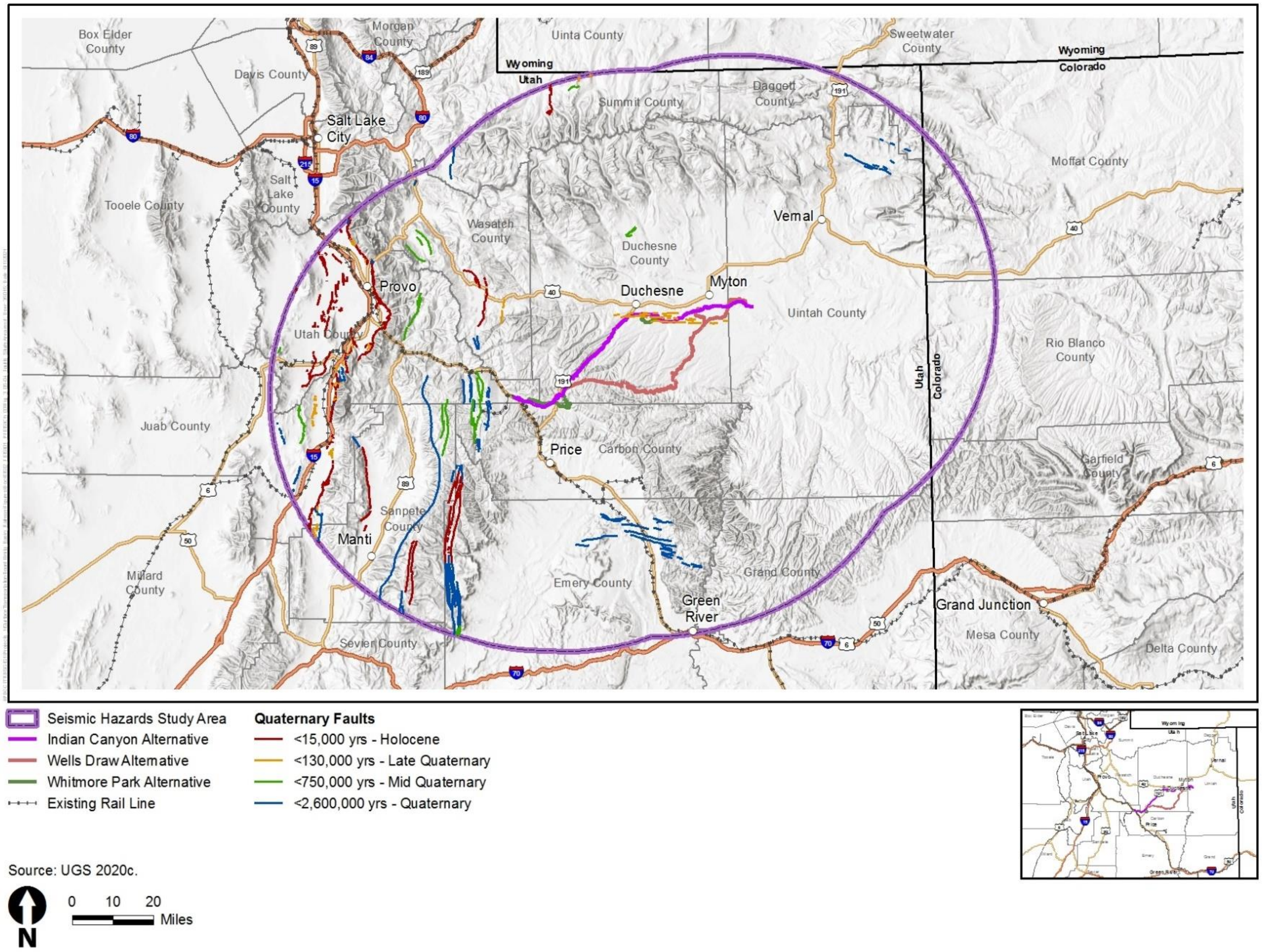
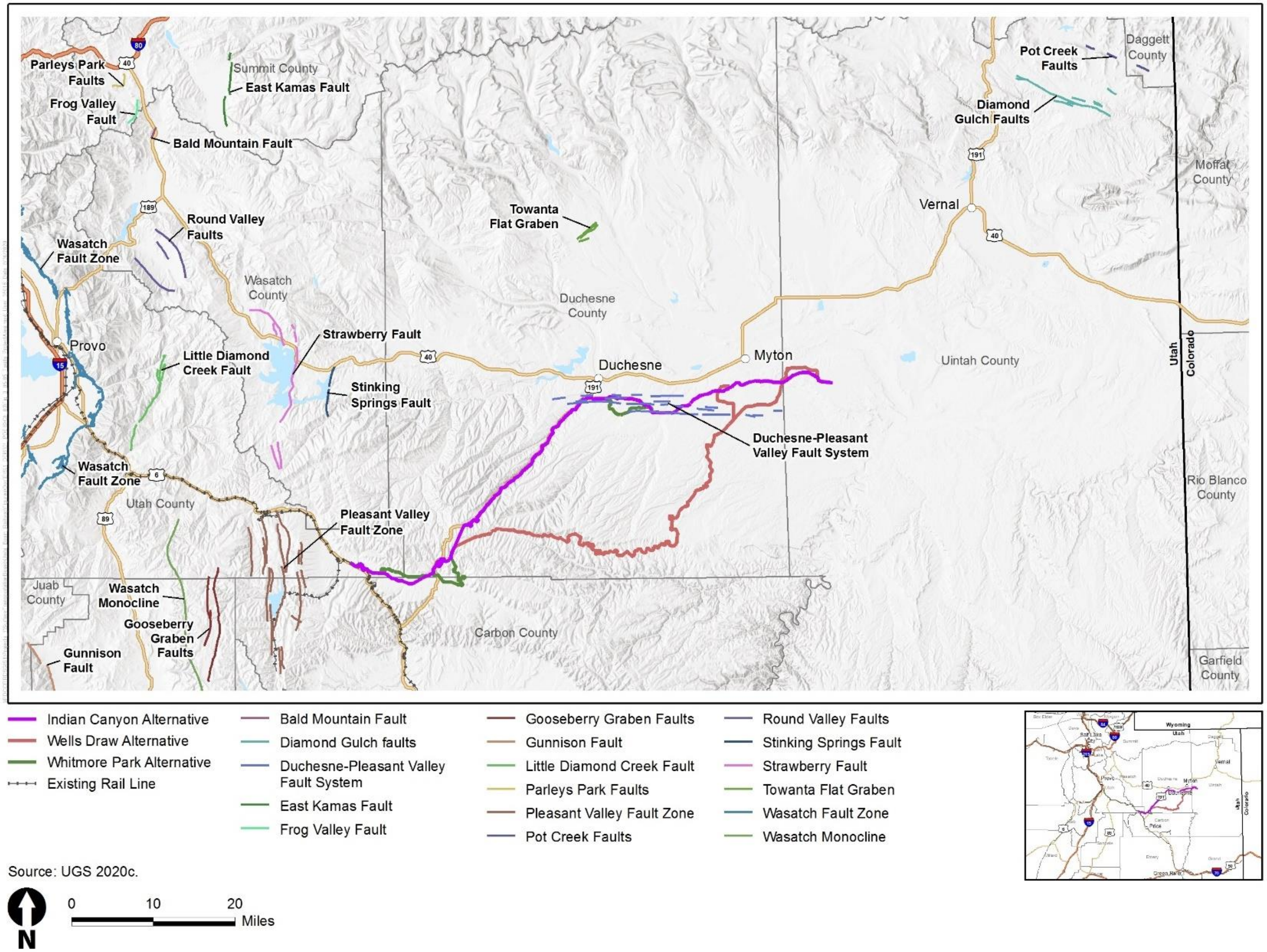


Figure 3.5-5. Named Faults in the Project Vicinity



Source: UGS 2020c.

Earthquakes can trigger liquefaction where sediments are unconsolidated and saturated. Unconsolidated sediments occur in the northeast portion of the study area where Quaternary alluvial deposits; colluvial, aeolian, glacial deposits, and mass-movement deposit; slides; and slumps predominate, as well as in the southwest area where landslides on the Green River Formation have occurred. Depth to groundwater varies considerably across the study area. Near stream beds where groundwater discharges into waterways, groundwater depth is shallow, but can be up to several feet below ground surface in areas between streams (Winter et al. 1998). As discussed in Section 3.3, *Water Resources*, the water rights details of groundwater wells in the vicinity (within approximately 2,000 feet) of tunnels proposed for the Action Alternatives indicate that groundwater depths typically range from 100 feet to 500 feet below the ground surface (UDWRi 2020). Because depth to groundwater is at least 100 feet in these areas, liquefaction is unlikely to occur. In lower-lying areas where groundwater discharges to the surface and unconsolidated granular soils are present, liquefaction could present a hazard.

Earthquakes can also trigger rockslides and landslides (Subsection 3.5.3, *Environmental Consequences*). Steep slopes and unconsolidated sediments can exacerbate risk of rockslide and landslide.

3.5.2.4 Mines, ~~and~~ Oil and Gas Fields, and Wells

Active and inactive mines occur in the study area. According to the Utah Mineral Occurrence System database, no mapped mines intersect the project footprint for any of the Action Alternatives, one inactive mine occurs in the temporary construction area for each Action Alternative, between six and eight active and inactive mines lie within the study area, depending on Action Alternative, and approximately 50 active and inactive mines lie within 5 miles of the study area (Utah Geological Survey 2015). Table shows the number of mines with respect to each Action Alternative.

Table 3.5-5. Active and Inactive Mines and Mine Prospects by Alternative

Fault	Indian Canyon Alternative	Wells Draw Alternative	Whitmore Park Alternative
Project footprint	0	0	0
Temporary construction area	1	1	1
Study area	6	8	7
Within 5 miles of study area	50	50	49

Notes:
Source: Utah Geological Survey 2015

These mines include sand and gravel and tar sands (within the temporary construction area) and also include limestone and sandstone (within the study area) and minerals and gilsonite[8] (within 5 miles of the study area).

[8] Gilsonite is a lightweight organic material that originates from the solidification of petroleum (Utah Geological Survey 2004). Gilsonite is soluble in organic solvents and has many industrial applications. The gilsonite deposits in Utah are unusually large; within the Uinta Basin, Gilsonite occurs in a 60-mile by 30-mile area in long, vertical veins ranging in width from a few inches to almost 18 feet (Utah Geological Survey 2004).

As a result of mining practices before 1975, when Utah passed the Utah Mining Reclamation Act making it illegal to abandon mines, there are an estimated 17,000 abandoned mine openings across the state (Utah Abandoned Mine Reclamation Program n.d.). Utah's Abandoned Mine Reclamation Program is working to seal off access to these old mine openings. Because mining has taken place in the study area, it is possible that unmapped mines could exist.

In addition to sandstone, limestone, and hydrocarbons including gilsonite, geologic units in the study area (particularly Green River Formation and Wasatch Formation) have yielded fossil fuels (Utah Geological Survey 2018). Oil and gas fields occur primarily in the north and east portion of the study area and do not intersect the proposed tunnels (Utah Division of Oil, Gas, and Mining 2017) (Section 3.15, *Cumulative Impacts*, Figure 3.15-1). As Table 3.5-6 shows, oil and gas wells also lie both within and near the study area.

Table 3.5-6. Oil and Gas Wells in the Study Area by Action Alternative

Well Type	Indian Canyon Alternative	Wells Draw Alternative	Whitmore Park Alternative
Producing wells (oil)	63	69	64
Plugged and abandoned wells (dry hole, gas, oil, test, and water injection)	14	14	10
Shut-in wells (gas and oil)	12	25	12
Total	**279**	**613**	**272**

Notes:
Source: Utah Division of Oil, Gas, and Mining 2020

3.5.2.5 Hazardous Waste Sites

Listed Hazardous Waste Sites

The EDR Area/Corridor Report (EDR 2020) identified 14 hazardous waste sites in the project footprint. However, two sites—Uintah and Ouray Reservation and Utah Department of Highways Pit 25104—were included multiple times, reducing the number of identified sites to 11. OEA identified an additional 195 sites in the study area outside of the project footprint (off-site locations). The EDR Area/Corridor Report (EDR 2020) identified eight "orphan" sites that have incomplete addresses and cannot be mapped. Because their locations are uncertain, OEA assumed that these orphan sites have not had significant releases subject to regulatory oversight and did not evaluate them further.

Table 3.5-7 lists the hazardous waste sites located in the project footprint (Figure 3.5-6). Because of their location, all sites in the project footprint were included in the table regardless of the database it was found in, along with the site's likelihood of affecting the proposed rail line. The sites are grouped by the database they were identified in (EMI/AIRS and Underground Injection Control [UIC] listings contain multiple sites). The table also includes the approximate distances of hazardous waste sites to large rivers in the study area for context. As denoted in Table 3.5-7, all sites located as being in the project footprint were identified as low-risk.

Table 3.5-7. Hazardous Waste Sites in the Project Footprint

Site	Distance to Nearest Large Rivers	Database(s)	Notes	Ranking and Reason for Ranking
Uintah and Ouray Reservation	Portions of Duchesne and Indian Canyon rivers within reservation footprint.	INDIAN RESERV	Indian reservation. No violations or releases associated with site.	Low. No violations or releases identified.
Newfield Production Company-Lamb 14-2-4-1W Oil & Gas Tank Battery Newfield Production Company-Ute Tribal 3-9-4-1e O Newfield Production Company-Ute Tribal 7-10-4-1e Newfield Production Company-Federal 7-8-9-16 Production Tank Battery Newfield Production Company-W Point 12-8-9-16 Oil & Gas Tank Battery	1.7 miles south of Duchesne River. 2.5 miles southeast of Duchesne River. 3.5 miles southeast of Duchesne River. 7.2 miles south of Duchesne River. 7.3 miles south of Duchesne River.	EMI/AIRS	Division of Air Quality Emissions inventory sites. All sites are associated with oil production and denoted as owned by Newfield Production Company. No violations or releases associated with the sites.	Low. No violations or releases identified.
Environmental Energy LLC Land Spreading	3 miles southeast of Duchesne River.	SWF/LF	Solid Waste Facilities /Landfill Sites. Facility noted as an open land treatment site. Owner listed as Environmental Energy Innovations, LLC. Land-spreading facilities are where solid waste is applied onto or incorporated into the soil surface for the purpose of biodegradation. No violations or releases associated with the sites.	Low. No violations or releases identified.
West Point 14-8-9-16 Nine Mile 16-7-9-16 Mon Fed 41-18-9-16yd	8.4 miles south of Duchesne River. 8.4 miles south of Duchesne River. 8.6 miles south of Duchesne River.	UIC	Underground injection control wells site location. Two sites are listed as active, one is inactive (MonFed 41-18-9-16YD). All water injection wells and operated by the Newfield Production Company. No violations or releases associated with the sites.	Low. No violations or releases identified.
Utah Department of Highways Pit 25104	Adjacent to Price River.	MINES MRDS	Mineral Resources Data System site. Primary commodities listed as sand and gravel for construction. No violations or releases associated with the site.	Low. No violations or releases identified.

Figure 3.5-6. Hazardous Waste Sites

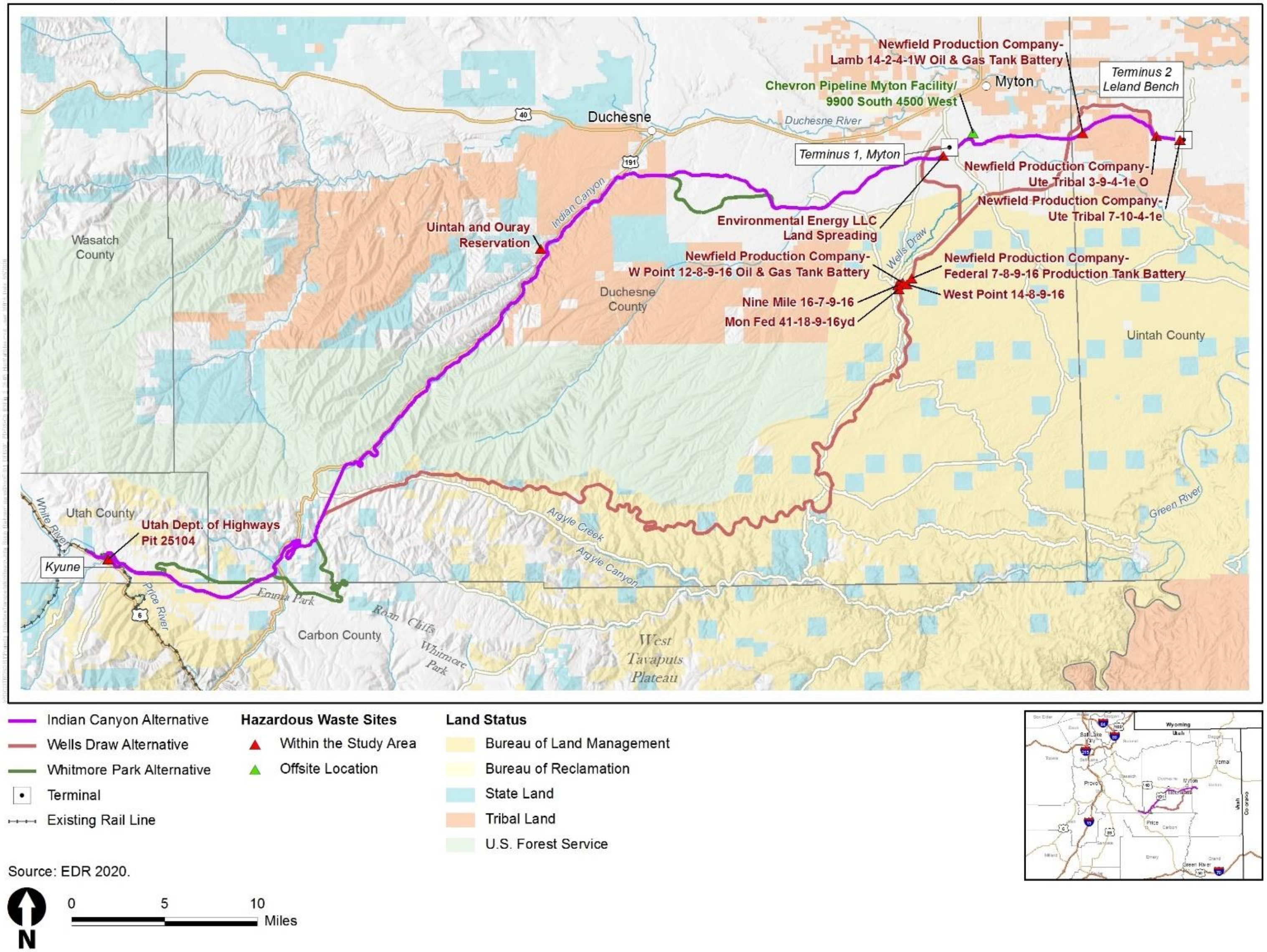


Table 3.5-8 reports the number of off-site locations identified in each of 10 databases that were included in the EDR Area/Corridor Report (EDR 2020). Because a single site can be included in multiple database listings, the number of sites is generally lower than the number of listings identified.

Table 3.5-8. Off-Site Locations Identified in the Database Search

Database	Database Description	Number of Sites Listed
UIC	Site location listing for underground injection control wells	129
EMI	Division of Air Quality Emissions inventory. Permitted sites	34
Tier 2	Tier 2 facilities under the Emergency Planning and Community Right-to-Know Act (EPCRA)	11
FINDS	Facility Index System/Facility Registry System	12
ECHO	Enforcement & Compliance History Information	10
MINES MRDS	Mineral Resources Data System. 8 listings	8
NPDES	Permitted Facilities Listing, Division of Water Quality	2
ICIS	Integrated Compliance Information System	2
ERNS	Emergency Response Notification System	1
RMP	Risk Management Plans	1
Total		**195**

With the exception of the ERNS listing Chevron Pipeline Myton Facility/9900 South 4500 West (Figure 3.5-6), none of the off-site locations had a known history of accidental hazardous materials releases into the environment, on-site contamination, or major violations that could indicate a release. The two listings under ICIS contained violations that were administrative in nature and therefore unlikely to involve a release of hazardous waste. Table 3.5-9 describes ERNS-listed Chevron Pipeline Myton Facility and evaluates the potential for the site to affect or be affected by the proposed rail line. OEA concluded that the potential for impacts related to the off-site locations would be negligible and did not evaluate them further.

Crude Oil and Natural Gas Pipelines

Pipelines in the study area include one natural gas pipeline operated by Dominion Questar and one crude oil pipeline operated by Chevron. The Chevron pipeline is associated with the site presented in Table 3.5-9. Additional details regarding these pipelines can be found in Section 3.8, *Energy*; pipeline locations can be found in Figure 3.8-1.

Table 3.5-9. Off-Site Locations with the Potential to Affect the Action Alternatives

Site	Distance from Study Area	Database	Notes	Ranking and Reason for Risk Class
Chevron Pipeline Myton Facility/ 9900 South 4500 West	1,421 feet to the north, northeast	ERNS	In June 2012, a release of 2,000 gallons of heavy crude was discovered just north of this location. At the time, the cause was under investigation. Diking and weirs were installed was conducted as mitigation. The responsible company is listed as Chevron Pipeline Company.	Medium. The release occurred in 2012 1,421 feet from the Indian Canyon Alternative and the Whitmore Park Alternative. The material was being contained at the time and it is expected that the area would have been remediated soon after. Therefore, because of the distance from the Action Alternatives and the containment of the release, the ranking is medium. Impacts on the proposed rail line associated with the Chevron Pipeline Myton Facility are considered unlikely.

3.5.3 Environmental Consequences

Construction and operation of the proposed rail line could result in impacts related to geology, soils, seismic hazards, and hazardous waste sites. This subsection first presents the potential impacts that would be the same for all three Action Alternatives and then compares the potential impacts that would be different for each Action Alternative. For comparison purposes, this subsection also describes geology, soils, seismic hazards and hazardous waste sites under the No-Action Alternative.

3.5.3.1 Impacts Common to All Action Alternatives

This subsection describes the potential impacts related to geology, soils, seismic hazards, and hazardous waste sites that would be the same across the three Action Alternatives.

Construction

Unstable Geologic Units

Each of the Action Alternatives would cross geologic units known to be susceptible to mass movement. In the study area, the geologic units that are most susceptible to mass movement are the Green River Formation (Table 3.5-1) and various Quaternary deposits where landslide, debris flow, and rock slide have occurred (Table 3.5-2). In addition to mapped landslide deposits, as stated in Subsection 3.5.2.1, *Geology*, unmapped landslide deposits are likely to occur in the study area. Construction activities that would create steep slopes or disturb the surface within unstable geologic units could cause geologic hazards such as landslides, slumping, debris flows, and rockslide. This is especially true for areas where excavations would occur for the construction of tunnels (discussed in more detail below under *Hazards Associated with Tunnel Construction*), bridges, embankments, culverts, retaining walls, and grade separations. If mass movement were to occur during or following construction, it could dislocate, damage, or destroy rail-related facilities and result in both environmental damage and potentially cause injury or death.

To address these potential impacts, OEA is recommending mitigation measures that would require the Coalition to conduct geotechnical investigations prior to construction to identify soils and bedrock in excavation areas that have the potential for mass movement, to implement engineering controls to prevent mass movement in those areas, and to institute immediate remedial actions in the event that mass movement occurs during construction (GEO-MM-2). If the Coalition were to implement these mitigation measures, OEA does not anticipate that construction would affect slope stability and result in landslide, slumping, rock fall, or debris flow that would affect the environment or the proposed rail line.

Snow Avalanche

Each of the Action Alternatives would traverse steep mountain terrain that could be susceptible to slab snow avalanches. If such an avalanche were to occur during or following construction, it could dislocate, damage, or destroy rail-related facilities and result in both environmental damage and potentially cause injury or death.

To address these potential impacts, OEA is recommending mitigation requiring the Coalition to consult with applicable land management agencies and other agencies with expertise in avalanche mitigation to identify areas with a high risk of snow slab avalanche, investigate the use of nonstructural and structural methods to control the effects of slab avalanches, and implement appropriate avalanche control methods (GEO-MM-7). Nonstructural methods could include artificial triggering of avalanche, and structural measures could include installing diversion structures, retarding structures, and avalanche sheds. Implementation of these mitigation measures would minimize the risk of damage created by snow avalanche.

Soil Disturbance

Construction of the proposed rail line would require moving and stockpiling soil, that would result in mixing soil layers and compaction. When soils are mixed and compacted, their biological productivity can be affected. Excavating and stockpiling soil damages soil quality and alters the physical, biological, and chemical properties of soil. Among the impacts would be the destruction of soil structure, which would reduce porosity, allow organic materials to decompose more readily, and damage the soil microbial community that cycles nutrients. To limit these impacts, the Coalition has committed to limit ground disturbance to only the areas necessary for project-related construction activities and to stockpile and reuse topsoil (VM-16, VM-17, VM-18). In addition, OEA is recommending additional mitigation requiring the Coalition minimize surface disturbance, ~~and~~ provide surface treatments to minimize soil compaction, and seed disturbed ground and stockpiled soil to stabilize soil and prevent erosion in accordance with land management agency requirements (WAT-MM-5, WAT-MM-6).

Soil that has lost some or all of its cover is more susceptible to wind and water erosion, which exacerbates the loss of soil productivity, creating a cycle of increasing loss of soil at the point of erosion. Soil erosion in turn can contribute to mass movement and other environmental impacts.

Disturbed soil, such as is created during excavation, grading, and cut-and-fill activities, is susceptible to wind and water erosion. Both types of erosion result in soil loss at the point of erosion and deposition at points distant from the erosion site. Loss of soil at the point of origin diminishes the ability for plants to grow. Offsite sedimentation can increase risk of flooding (and subsequent erosion) and damage plant life (resulting in further increased risk of erosion).

When soil is disturbed, the risk that invasive plant species can become established is increased. Research has demonstrated that some invasive species change soil chemistry and area ecological services (Norton et al. 2004), making it harder for established native plants to compete successfully with the invasive species and thus creating a downward cycle. Section 3.4, *Biological Resources*, provides additional discussion about the impacts of construction of the proposed rail line on invasive species establishment and spread.

Based on soil ratings, all of the Action Alternatives would have a similar susceptibility to wind and water erosion. Construction activities could increase erosion risk. Vegetation removal would expose the underlying soil to erosive forces of both wind and water. The use of heavy machinery during construction would compress soils, reducing the amount of water that can infiltrate. This could result in increased runoff, which would then increase erosion. Earth-moving machinery would change drainage patterns, potentially causing gullies to form as a result of increased runoff in new areas. All of these issues would be exacerbated by steep slopes and unstable geologic units. In the extreme case, excessive erosion could increase the risk of landslide.

The Coalition has proposed voluntary mitigation measures related to soil disturbance and OEA is recommending additional mitigation measures to address these potential impacts. If those mitigation measures are implemented, the Coalition would obtain an NPDES permit[9] prior to beginning construction activities and would implement an SWPPP during construction. The SWPPP would include limiting ground disturbance to only the areas necessary for project-related construction activities; implementing erosion control measures to minimize the potential for erosion of soil stockpiles until they are removed and the area is restored; and restoring disturbed areas as soon as practicable after construction ends on a particular stretch of rail line (VM-19, VM-20, VM-21, VM-22). OEA is also recommending additional mitigation measures (WAT-MM-6) requiring the Coalition coordinate with the appropriate land management agency, private landowner, or the Ute Indian Tribe to select seed mixes for use in restoration and reclamation activities that are appropriate to the ecological site and would avoid invasive species establishment and spread. In addition, OEA is recommending mitigation (GEO-MM-1) to minimize the quantities of materials required to be excavated, transported, or placed off site. These mitigation measures would prevent excessive construction-related erosion that could significantly affect the environment or create a hazard to the proposed rail line.

Collapse

No mapped mines intersect the project footprint under any of the Action Alternatives, and only one mapped inactive mine intersects the temporary footprint for each Action Alternative. Because the location of these mines is known and construction activities would consider these areas, OEA concludes that the risk of collapse due to the presence of known abandoned mines is minimal. Construction of any of the Action Alternatives would have similar risk.

Because unmapped abandoned mines could occur at any location in the study area, construction of all of the Action Alternatives would have a similar risk of collapse due to construction on unmapped abandoned mines. Construction of the proposed rail line over or near an abandoned mine would

[9] NPDES is the permit system mandated by Clean Water Act Section 402 to control pollutants in waters of the United States. With the exception of Tribal trust lands, the U.S. Environmental Protection Agency (EPA) has delegated authority to issue NPDES permits to the state of Utah, referred to as Utah Pollutant Discharge Elimination System (UPDES) permits. On Tribal trust lands, EPA retains authority to issue NPDES permits. NPDES refers to both UPDES and NPDES permits in this section.

present a risk of collapse. Heavy vehicles could overload the bearing capacity of the geologic units present and excavation could remove material that is currently providing stability. OEA is recommending mitigation (GEO-MM-4) requiring the Coalition conduct geotechnical studies prior to beginning construction and to take actions to appropriately stabilize areas where unmapped abandoned mines are identified. If the Coalition were to implement these mitigation measures, OEA concludes that collapse would not occur as a result of construction over abandoned mines.

Hazards Associated with Tunnel Construction

Each of the Action Alternatives would require construction of tunnels. Tunnel construction involves numerous potential geologic hazards, including collapse, water inrush, portal landslide, gas explosion, and avalanche (Wang et al. 2019: 767). Collapse and water inrush are the most common failures during project construction (Wang et al. 2019: 769). When in-situ stress (as on faults, weak rock features, and groundwater) is released, it can trigger collapse and, if groundwater is involved, an inrush of water into the tunnel (Li et al. 2010: 232). A tunneling-induced portal landslide can occur when unstable geologic units are further destabilized by excavation and other ground-moving activities and can be exacerbated by precipitation and water inrush (Wang et al. 2019: 770). Gas explosion occurs when explosive gases, such as methane, are encountered during tunneling when inadequate ventilation is provided (Wang et al. 2019: 768). Avalanche is less common than collapse and water inrush (Wang et al. 2019: 773) and occurs when construction, project operation, or other disturbance triggers movement of deep snow on steep slopes.

Because of geologic conditions in the study area, all of these geologic hazards present potential risks to construction of the proposed rail line tunnels. The tunnels would be constructed in a seismically active area (Utah Geological Survey 2020a), so faults would potentially be present in the tunnel area, increasing likelihood of collapse. While depth to groundwater at tunnel entrances has been measured at 100 feet below ground surface or more (UDWRi 2020), it is possible that higher groundwater could be encountered and water inrush could occur. The tunnel in the southwestern portion of the Action Alternatives would be constructed in the Green River Formation (Bryant 2010; Sprinkel 2007; Weiss et al. 1990), which is known to be unstable and prone to mass movement, increasing risk of both collapse and portal landslide. The area is known to have both gas and oil reserves (Utah Division of Oil, Gas, and Mining 2017, 2020), meaning that inflammable gases may be present.

OEA is recommending mitigation requiring the Coalition design and construct tunnels in accordance with applicable U.S. Occupational Safety and Health Administration guidelines for underground construction (OSHA 2003). These guidelines includes measures for controlling geologic hazards associated with underground constructing (tunneling) and include required safety measures, such as ensuring adequate ventilation, air monitoring, and emergency procedures (GEO-MM-6). Further, OEA is recommending mitigation requiring the Coalition conduct geotechnical studies prior to beginning construction and take actions to identify and address such geologic hazards before starting tunnel construction (GEO-MM-2). If the Coalition were to implement these mitigation measures, OEA concludes that the risks associated with collapse, water inrush, portal landslide, and gas explosion during tunnel construction would be minimized.

Wells, Crude Oil, and Natural Gas Pipelines—Potential Spills and Accidental Releases

Three UIC water injection wells occur in the study area for the Wells Draw Alternative (Table 3.5-6) and various active, plugged, and other wells are located in the study area for all three Action Alternatives (Table 3.5-4). If soil disturbance activities occur where these wells are located and if they intersect the area of excavation, there is potential for an accidental release of oil or gas to the environment. Thus, OEA anticipates that oil and gas-producing wells and shut-in wells would need to be plugged and abandoned as part of construction of the proposed rail line. Proper abandonment or plugging of these wells would minimize the potential for construction to affect or be affected by the existence of oil, gas, or water wells in the study area. Therefore, OEA is recommending mitigation requiring the Coalition to abide by the requirements of the Utah Department of Natural Resources, Division of Oil, Gas and Mining Permitting for the proper abandonment or plugging of wells under Utah Administrative Code Rule R649-3-24 (ENGY-MM-2).

As discussed in Subsection 3.5.2.4, *Hazardous Waste*, two pipelines are located in the study area, one natural gas pipeline and one crude oil pipeline. If soil disturbance activities occur near these pipelines, there is potential for an accidental release of natural gas or crude oil. Because construction would not require any pipelines to be temporarily or permanently relocated, modified, removed, or abandoned in place, the potential for crude oil or natural gas release is low. The Coalition has committed to securing agreements with utilities to establish responsibility for protecting or relocating existing utilities, if affected by construction (VM-47). Additionally, OEA is recommending mitigation requiring the Coalition design crossings of pipeline rights-of-way in accordance with applicable Utah Division of Public Utilities regulatory standards (ENGY-MM-3).

Operations

Unstable Geologic Units

As discussed previously, the proposed rail line would be located on geologic units known to be unstable and susceptible to mass movement, including landslides. Cut and fill for tunnels, bridges, embankments, culverts, retaining walls, and grade separations could exacerbate the risk of mass movement. Other factors that can exacerbate instability during rail operations include changes in drainage patterns, increased erosion, heavy precipitation, freezing and thawing cycles, and seismic ground shaking. The Coalition has submitted voluntary mitigation stating that the Coalition would comply with FRA regulations, which address track safety requirements and engineering standards during rail construction and operations (VM-1). If this mitigation is implemented, OEA does not anticipate that rail operations, including maintenance, would affect slope stability and result in landslide, rock fall, or debris flow that would affect the environment or the rail line.

Erosion

Operation and maintenance activities could result in erosion. Based on soil ratings, all of the Action Alternatives would have similar susceptibility to wind erosion and water erosion during rail operations. Erosion effects during operation of the proposed rail line would result from changed drainage patterns and from maintenance activities that may disturb vegetation and soils. Substantial erosion could undermine foundations including bridge foundations, the railbed, and other support for rail facilities. With the implementation of the Coalition’s voluntary mitigation measures and OEA’s additional recommended mitigation measures (VM-19, VM-20, VM-21, VM-26, WAT-MM-6) these impacts would be insignificant.

Corrosion

Corrosivity to concrete and steel are important considerations because many rail line components are made of these materials. Corrosion could cause damage to the rail line that could result in derailments and other accidents that could affect the environment and cause injury to people.

Based on soil ratings, all of the Action Alternatives would have similar susceptibility to corrosivity to concrete and steel. A small portion of the study area includes soils with high corrosivity to concrete or steel. In these soils, support structures including foundations for rail and vehicle bridges and culverts that are either buried or extend underground would be vulnerable to corrosion. OEA is recommending mitigation measures that would require the Coalition to conduct geotechnical investigations to identify areas where corrosive soils are present. If corrosive soils are identified, the Coalition would be required to implement site-specific measures to address the issue. These measures could include replacing corrosive soils with non-corrosive engineered soils (GEO-MM-3). These mitigation measures would prevent excessive corrosion that could significantly affect the environment or create a hazard to the proposed rail line.

Surface Fault Rupture, Seismic Ground Shaking, and Seismically Induced Liquefaction

Two of the Action Alternatives, the Indian Canyon Alternative and the Whitmore Park Alternative, would cross the Duchesne-Pleasant Valley fault system, and the Wells Draw Alternative would lie within 0.4 mile of that fault system. Although this fault system is not well understood, it could have been active in the late Quaternary, possibly even in the Holocene; therefore, there is a risk that seismic movement along this fault could result in surface fault rupture. Ground rupture could distort, break, or otherwise damage the alignment, resulting in derailments, and could also damage any structural foundations present in the fault zone. In addition, there is a risk of strong seismic ground shaking that could affect the project footprint. Ground shaking could cause landslide, which could damage or dislocate rail line features and could potentially result in derailments. Because all of the Action Alternatives are a similar distance from faults with potential for large earthquakes, all of the Action Alternatives would have similar susceptibility to surface fault rupture and seismic ground shaking. The Coalition's voluntary mitigation measures state that the Coalition would construct and operate the rail line in accordance with applicable FRA safety regulations, which would minimize risks associated with ground shaking and surface fault rupture (VM-1). In addition, OEA is recommending mitigation requiring the Coalition conduct geophysical investigations to assess the likely seismic hazards associated with the Duchesne-Pleasant Valley fault prior to construction (GEO-MM-8).

Some of the active fault zones near the Action Alternatives have a history of ground-rupturing seismic events and strong ground shaking. These events have caused numerous rock falls. The risk exists of similar rock falls in the future, particularly in the unstable Green River Formation, including along Indian Canyon. OEA is recommending mitigation requiring the Coalition conduct geotechnical investigations to identify soils and bedrock in cut areas with potential for mass movement or slumping (GEO-MM-2). These mitigation measures would minimize the risk from rock falls caused by seismic events to damage the rail line.

Because all of the Action Alternatives are a similar distance from faults with potential for a large earthquake and traverse unconsolidated Quaternary deposits in the northeast portion of the proposed rail line, all of the Action Alternatives would also have similar susceptibility to seismically induced liquefaction. The depth to groundwater in the study area is variable, lying close to ground surface where water discharges into streams and much deeper in higher terrain. Liquefaction may occur in areas with saturated sandy to somewhat gravelly soils to a depth of 30 to 50 feet in case of seismic ground shaking, depending on type of sediments that occur and strength of ground shaking. Liquefaction can result in both settlement and differential settlement, changing the alignment of the track, which could, if not repaired promptly, result in a derailment. OEA is recommending mitigation to require the Coalition to conduct geotechnical studies to identify areas at risk of liquefaction and to implement site-specific measures in areas where liquefaction risk is identified. These measures could include replacing soils subject to liquefaction with engineered soils that are not prone to liquefaction (GEO-MM-5).

3.5.3.2 Impact Comparison between Action Alternatives

This subsection describes the potential impacts related to geology, soils, seismic hazards, and hazardous waste sites that would be different between the three Action Alternatives.

Unstable Geologic Units

The rail line footprint of the Wells Draw Alternative would include the largest area (approximately 30,000 acres) located on the unstable Green River Formation and existing mapped landslide areas, followed by the Indian Canyon Alternative (just over 21,000 acres) and Whitmore Park Alternative (just less than 21,000 acres). Therefore, the Wells Draw Alternative would have a greater risk of mass movement than the Indian Canyon Alternative or the Whitmore Park Alternative. Table 3.5-10 shows the risk of mass movement by Action Alternative. In addition, the Wells Draw Alternative would have the greatest area (approximately 1,000 acres) located on steep slopes (30 percent slope and greater) on unstable geologic units, followed by the Indian Canyon Alternative (approximately 150 acres) and the Whitmore Park Alternative (approximately 115 acres).

Table 3.5-10. Risk of Mass Movement on Green River Formation and Mapped Landslide Area by Action Alternative

Risk	Indian Canyon Alternative	Wells Draw Alternative	Whitmore Park Alternative
Area of unstable geologic units[a] in the rail line footprint[b] (acres)	394	1,740	287
Area of unstable geologic units in the temporary footprint[c] (acres)	1,089	5,178	991
Area of unstable geologic units[a] in the study area	21,304	29,889	20,914
Distance of the proposed rail line that would cross unstable geologic units (miles)	21	54	18
Number of sensitive project features[d] within unstable geologic units	84	262	85

Notes:

[a] Unstable geologic units include the Green River formation and other mapped units of high landslide risk.

[b] The rail line footprint is the area that would be permanently disturbed by the proposed rail line.

[c] The temporary footprint is the area that could be temporarily disturbed by construction activities.

[d] Sensitive project features include bridges, tunnels, and culverts. These features may be especially sensitive to geologic hazards and their construction could exacerbate the risk of mass movement in unstable geologic units.

Soil Disturbance

Each of the Action Alternatives would permanently affect soils in the rail line footprint, which would vary based on the dimensions of the area of disturbance. Table shows the dimensions of each Action Alternative by maximum and minimum width of disturbance and length. The width varies considerably from a minimum of 100 feet to a much wider area where cut and fill or other facilities would be required.

Table 3.5-11. Dimensions of Each Action Alternative (Rail Line Footprint)

Length of Disturbance	Indian Canyon Alternative	Wells Draw Alternative	Whitmore Park Alternative
Minimum Width (feet)	100	100	100
Maximum Width (feet)	1,027	3,254	1,043
Length (miles)	81	103	88

As shown in Figure 3.5-3, the study area contains areas where soils have been mapped (NRCS 2018) and other areas where no soil data exist. It is not known what soils exist in the unmapped areas; it is possible that soils are thin or nonexistent where bedrock outcrops. Table shows the area of mapped and unmapped soils that would be permanently disturbed within the rail line footprint for each Action Alternative. The Wells Draw Alternative would result in the greatest area of soil disturbance among the Action Alternatives, followed by the Whitmore Park Alternative and Indian Canyon Alternative.

Table 3.5-12. Soil Disturbance by Action Alternative (Rail Line Footprint)

	Indian Canyon Alternative		Wells Draw Alternative		Whitmore Park Alternative	
Disturbed Area	Acreage	Percent of Area	Acreage	Percent of Area	Acreage	Percent of Area
Mapped	816	61%	1,611	63%	885	62%
Unmapped	524	39%	949	37%	546	38%
Total disturbance	1,340	100%	2,560	100%	1,431	100%

Hazardous Waste Sites

As stated previously, OEA identified 11 hazardous waste sites in the project footprint, none of which would be likely to affect or be affected by the proposed rail line. OEA identified one off-site location in the study area that does have a history of releasing hazardous waste. That site is the Chevron Pipeline Myton Facility, which is located approximately 1,421 feet to the north-northeast of the Indian Canyon Alternative and the Whitmore Park Alternative. A release of approximately 2,000 gallons of heavy crude oil occurred north of this location in June 2012. It was contained at the time to minimize impacts on the surrounding environment. Because this site is located outside of the project footprint for the Indian Canyon Alternative and the Whitmore Park Alternative, construction of either of those alternatives would not disturb soil that could have been contaminated during the June 2012 release. Therefore, the Chevron Pipeline Myton Facility hazardous waste site would not affect and would not be affected by construction and operation of the proposed rail line.

Hazards Associated with Tunnel Construction

The Action Alternatives differ regarding the number and length of proposed tunnels. The Indian Canyon Alternative would have 3 tunnels totaling 4.3 miles, the Wells Draw Alternative would have 13 tunnels totaling 5.6 miles, and the Whitmore Park Alternative would have 5 tunnels totaling 5.7 miles. Because each tunnel is susceptible to geologic hazards, including collapse, water inrush, portal landslide, gas explosion, and avalanche, the Action Alternatives with the largest number and most tunnel mileage—the Wells Draw Alternative and the Whitmore Park Alternative—would incur the greatest risk from geohazards associated with tunnel construction. The Action Alternative with the least number and length of tunnels—the Indian Canyon Alternative—would incur the least risk. Implementation of OEA's recommended mitigation measures (GEO-MM-2, GEO-MM-5, GEO-MM-6) to address such geologic hazards before starting tunnel construction would minimize the risks from geohazards for all Action Alternatives.

3.5.3.3 No-Action Alternative

Under the No-Action Alternative, the Coalition would not construct and operate the proposed rail line, and there would be no impacts related to geology, soils, seismic hazards, and hazardous waste sites.

3.5.4 Mitigation and Unavoidable Environmental Effects

In general, impacts related to erosion, collapse, corrosion, and seismic hazards would be similar across the three Action Alternatives. The Coalition has proposed voluntary mitigation measures and OEA is recommending additional mitigation measures to avoid or mitigate impacts from construction and operations related to geology, soils, seismic hazards, and hazardous waste sites (Chapter 4, *Mitigation*). If the Coalition were to implement these mitigation measures, these impacts would not be significant. Across the three Action Alternatives, the Wells Draw Alternative would have a slightly higher potential for impacts related to mass movement, including landslides, because it would cross a larger area of unstable geologic units than the Indian Canyon Alternative or the Whitmore Park Alternative. The Wells Draw Alternative would also have a slightly higher potential for impacts related to hazardous waste sites because its study area includes more crude oil wells than the study areas for the Indian Canyon Alternative or the Whitmore Park Alternative. OEA concludes that the potential for impacts related to hazardous waste sites would be insignificant if OEA's recommended mitigation measures were implemented.