3.1 GEOLOGY, SOILS, BIOLOGICAL SOIL CRUSTS, AND EROSION

This section presents information about the existing environment and potential environmental effects from the Project, and proposes mitigation for Project effects to geology, soils, and biological soil crusts in the Project Area. Potential effects from the Project include erosion and seismic hazards. The Proposed Action (including the two options of the Proposed Action), the alternatives, and the No Action Alternative were evaluated as part of this analysis.

3.1.1 Methodology

The evaluation was conducted using digital data sources and previously conducted studies. Sources reviewed included the Oregon Department of Geology and Mineral Industries (ODOGMI) digital geological maps and seismicity maps and U.S. Geological Survey (USGS) fault zone maps. A geological report (Smith 2008) and geotechnical report (Shannon and Wilson 2009) completed for the Echanis Wind Energy Project (Echanis Project) were also reviewed.

Soil characteristics discussed herein were obtained from the Harney County Soil Survey digital soils maps (NRCS 1997). Locations of biological soil crust monitoring stations were supplied by the BLM.

The analysis incorporated comments from the public scoping process that was conducted from July to September 2009 and the DEIS comment period from July through September 2010. In general, comments related to this resource area from local organizations and private citizens were limited to the following key issues:

- Effects to fragile soils and geological features;
- Increased erosion; and
- Presence of and effects to biotic soil crusts.

The Proposed Action, Alternative Actions, and procedures that were evaluated were based upon information provided in the Plan of Development for the transmission lines (Columbia Energy Partners [CEP] 2009) and the Application for Conditional Use Permit for the wind farm (CEP 2007), along with supplemental information provided through personal communications (Kane 2009).

3.1.2 Affected Environment

This section presents a summary of the geology and soils for the entire Project Area. The affected environments for each of the Project Alternatives are presented together because of their proximity and shared characteristics.

3.1.2.1 Geology

The Project would be located primarily in the northernmost edge of the Basin and Range Province, which extends from southern Oregon to northern Mexico. This region was shaped 20 million years ago by the east-west extension of the continental crust and upper mantle (USGS 2004). The resultant faulting created a series of alternating linear mountain ranges and down-dropped valleys trending north-south, also known as horst and graben topography. These mountains or horst tend to be steep and are subject to erosion, which fills the low valleys or graben with thick deposits of rock debris. This extension is still occurring at a rate of 1 centimeter per year; faults in the region are active and mountains continue to uplift as sediment fills the valleys (USGS 2004).

Basalt flows also play a large role in the current geological conditions in eastern Oregon. The Columbia River Basalt Group (CRBG) inundated an extensive area of the Columbia River Basin with multiple flows

from 17 to 6 million years ago (Ma). The Steens Basalt flowed onto the surface relatively rapidly from 16.6 to 15.3 Ma as part of the CRBG (Hooper et al. 2002). Later lava flows (younger than 15.3 Ma) were smaller in volume and erupted from fissures associated with Basin and Range extension, such as the Devine Canyon tuff (ca. 9.7 Ma) and the Drinkwater basalt (ca. 6.9 Ma) (Camp et al. 2003).

The proposed site for the Project would be located on Steens Mountain, which is an uplifted fault block between the Alvord Basin and the Catlow Basin. The Echanis Project Area is mapped as Steens Basalt of the Columbia River Basalt Terrane, with a small portion mapped on Devine Canyon Welded Ashflow Tuffs of the Harney Basin Volcanic Field Terrane. The proposed transmission line route alternatives and access roads would be in an area primarily composed of basalt flows and other volcanics, along with more recent surficial sediments. The Project would cross a number of geological units, as described in Table 3.1-1 and presented in Figure 3.1-1.

Table 3.1-1 Geological Units Crossed by Proposed Project and Alternatives

Map Unit Symbol	Geological Formation	Terrane	Age (Ma) and Period
Qal	Alluvium	Quaternary Surficial Deposits	12,000 years - 1.8 Ma
Qal/Qs	Alluvium and Holocene sedimentary deposits, undifferentiated	Quaternary Surficial Deposits	12,000 years - 1.8 Ma
Qaf	Alluvial fan deposits	Quaternary Surficial Deposits	Present – 1.8 Ma
Qb1	Basalt/ Diamond Craters Volcanics	Quaternary Volcanics	Present – 1.8 Ma
QTls	Landslide debris	Quaternary Surficial Deposits	Present – 1.8 Ma
Qmv	Mafic vent complexes	Neogene Volcanic Rocks	Present – 1.8 Ma
Qtb	Diamond Craters Volcanics	Quaternary Volcanics	1.8 - 5.2 Ma
Tmtr	Rattlesnake Ashflow Tuff	Harney Basin Volcanic Field	4 - 10 Ma
Tts Tmst2 Tmst3	Tuffaceous sedimentary rocks	Neogene Sedimentary Rocks	4 - 10 Ma
Tmtd Td Tdv Tst2	Devine Canyon Welded Ashflow Tuff	Harney Basin Volcanic Field	4 - 10 Ma

Steens Mountain is cut by northwest trending extensional faults and northeast trending range front faults on both flanks. The mountain is very steep on the eastern flank, which is up-faulted, and has a relatively gentle slope on the west side, which is down-faulted (Shannon and Wilson 2009). A number of northwest trending faults cut through the rest of the Project Area, particularly in the southern half. Weldon et al. (2002) mapped several faults in the Project Area that have been active during the Quaternary period (1.6 Ma).

As summarized in *Geologic Report in the Echanis Wind Project* by Smith (2008), three minor faults were inferred in the Echanis Project Area using remote sensing and topographic maps. No field investigations were conducted as part of that investigation to confirm the locations or quantify the movement rates of these faults. In addition, no geological study was conducted for the transmission line route alternatives. Nonetheless, the fault map of the area shows approximately seven faults crossing the Alternative B – West Route and approximately nine faults crossing the Alternative C – North Route (Figure 3.1-2).

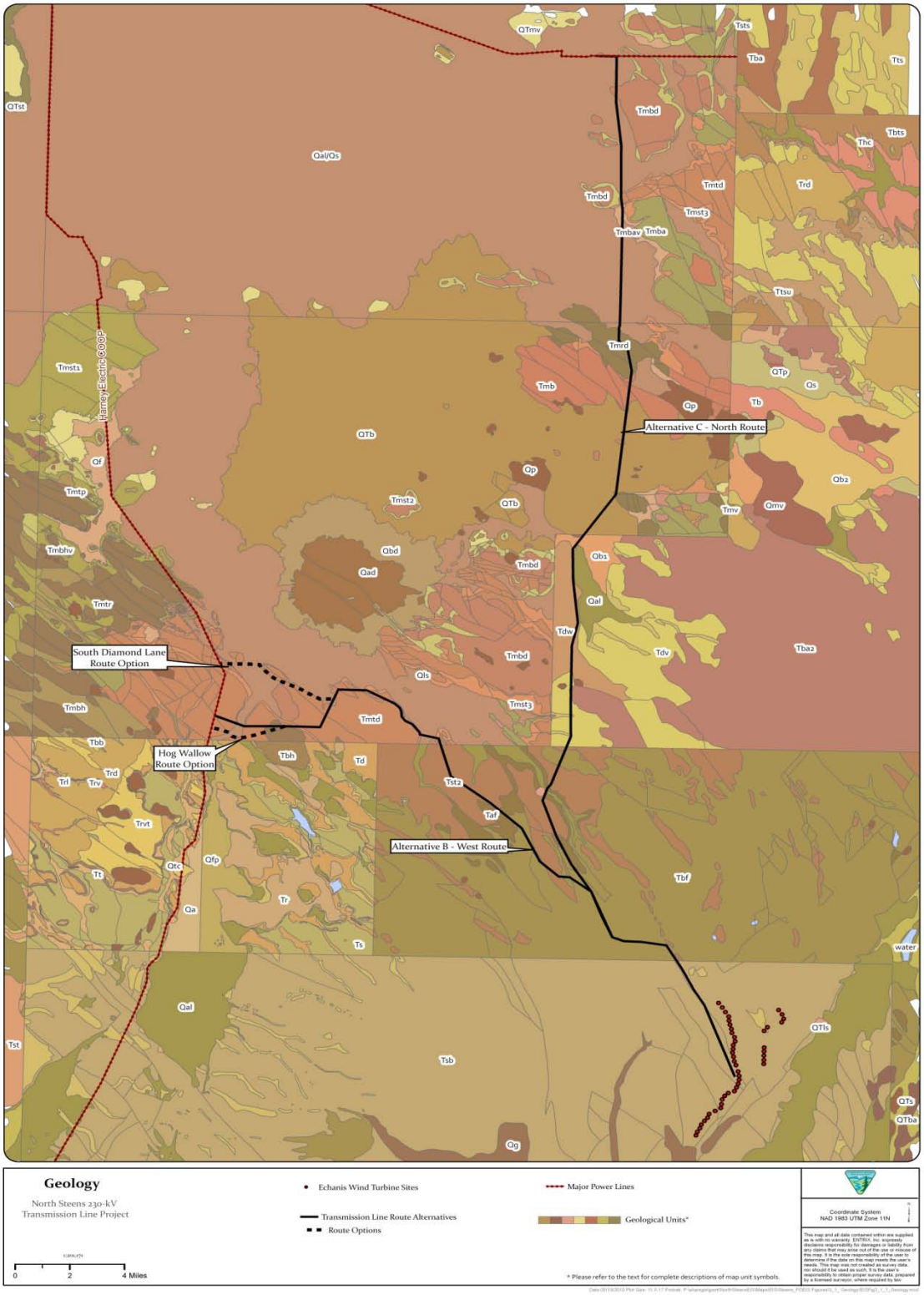

Figure 3.1-1 Geological Units.

This region is prone to earthquakes as movement on faults releases energy. The amount of energy released is measured on the Richter scale as the magnitude of the largest seismic vibration or wave. Earthquakes of magnitude 2 or less are usually not felt, while earthquakes of magnitude 3 and 4 can be felt, but generally do not cause damage. Magnitude 5 or 6 earthquakes may cause damage and earthquakes of magnitude 7 and greater would likely cause major damage.

Based upon earthquake data from 1841 to 2002 as compiled by the ODOGAMI (Niewendorp and Neuhaus 2003), major historical earthquakes occurred in south-central Oregon around Klamath Falls, Klamath County in 1993 (magnitude 5.9 to 6.0) and near Adel, Lake County in 1968 (magnitude 5.1). They were likely caused by movement along extensional faults. Four earthquakes of magnitude 4.0 to 4.9 and four earthquakes of magnitude 3.0 to 3.9 have also been recorded in Harney County during this time period.

Although unlikely, landslides on unstable slopes could be triggered by precipitation, snowmelt, earthquakes, or anthropogenic changes to slopes and subsurface water saturation. While slope stability was not mentioned as a concern in the geologic or geotechnical reports reviewed, historical Quaternary landslide deposits are shown on the geologic map within and near the Project Area.

3.1.2.2 Soils

The Alternative B – West Route would be located completely within the Donner und Blitzen watershed and the Alternate C – North Route would be located in the Donner und Blitzen, Harney-Malheur Lakes and Upper Malheur watersheds. The Echanis wind turbines would be located on the ridge between the Donner und Blitzen and Alvord Lake watersheds.

The soil types generally present in the Project Area are cobbly loams, clay stony loams, silty clay loams, and rock outcrops. Hackwood soils of the Baconcamp-Rock outcrop-Hackwood complex with 30 to 80 percent slopes have a very high rating for erosion potential by water. This unit accounts for 5.7 percent of the ROW for Alternative B – West Route and 3.6 percent of the ROW for Alternative C – North Route.

Of the soils that would be crossed by Alternative B, 69 percent have moderate erosion potential by water and 26 percent have low erosion potential. Wind erosion is moderate in 1.2 percent of the soil units; the rest are rated as low. Of the soils crossed by Alternative C, 33 percent have moderate erosion potential by water and 64 percent have low erosion potential. Wind erosion is moderate in 1.3 percent of the soil units; the rest are rated as low. The soil units mapped within the ROW for the access roads have a moderate potential in 62.6 percent of the units for water erosion and 0.1 percent for wind erosion. All other soil units within the access road ROWs have low potential for erosion. The soil units mapped within a 150-foot ROW are presented in Tables 3.1-2 and 3.1-3 and Figure 3.1-3.

Resource concerns related to soils in these subbasins include wind erosion in sandy soils where forage cover is lacking; and rill and sheet erosion (NRCS 2005; 2006a; 2006b). Soil erosion potential by water and wind are presented in Figure 3.1-4 and 3.1-5, respectively.

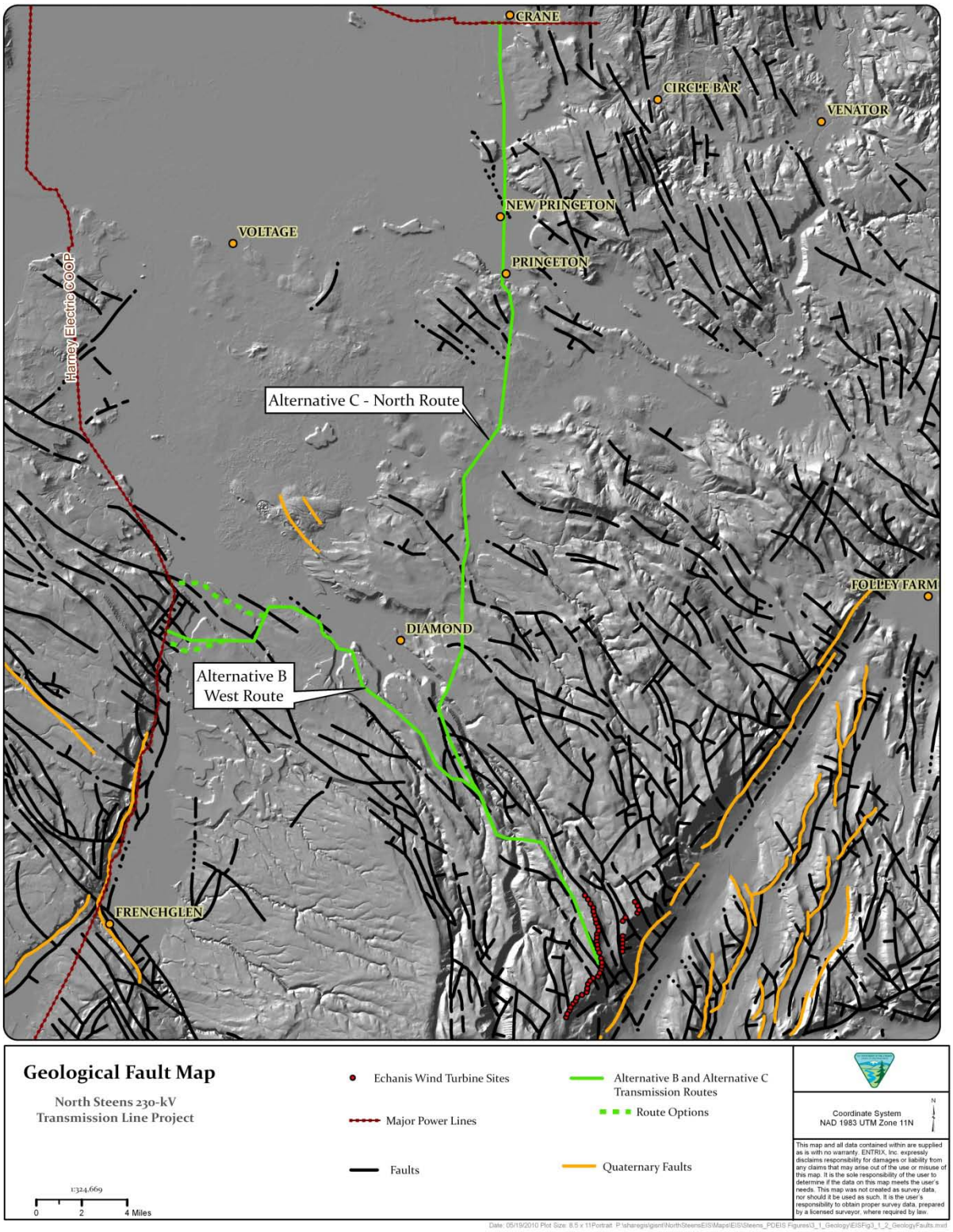

Figure 3.1-2 Geological Fault Map.

Table 3.1-2 Soil Units Crossed by Alternative B – West Route (150-foot ROW)

Map Unit Code	Map Unit Name and Slope	Water Erosion Potential	Wind Erosion Potential	Description	Area (Acres)
1	Actem cobbly loam - 2 to 20 percent slopes	Moderate	Low	Neutral clay and clay loam. The depth to a restrictive feature is 20 to 30 inches to bedrock (lithic); 12 to 20 inches to duripan. It is well drained.	71.6
28	Baconcamp-Clamp complex - 5 to 20 percent slopes	Low; Moderate	Low	Baconcamp soils make up 45 percent: neutral very stony clay loam, neutral gravelly loam, neutral very gravelly loam. The depth to a restrictive feature is 20 to 40 inches to bedrock (lithic). It is well drained. Clamp soils make up 40 percent: neutral very stony clay loam, neutral very cobbly clay loam. The depth to a restrictive feature is 4 to 14 inches to bedrock (lithic). It is well drained.	81.7
33	Baconcamp-Rock outcrop-Hackwood complex - 30 to 80 percent slopes	Moderate; Very High	Low	Baconcamp soils make up 40 percent: neutral very stony loam, neutral gravelly loam, neutral very gravelly loam. The depth to a restrictive feature is 20 to 40 inches to bedrock (lithic). It is well drained. Outcrop of unweathered bedrock makes up 30 percent of the map unit. Hackwood soils make up 15 percent: neutral gravelly loam, neutral loam. The depth to a restrictive feature is greater than 60 inches. It is well drained.	29.7
64	Carvix silt loam - 0 to 5 percent slopes	Low	Low	Neutral silt loam, moderately alkaline silt loam, moderately alkaline loam. The depth to a restrictive feature is greater than 60 inches. It is well drained.	2.5
97	Erakatak extremely stony silty clay loam - 50 to 80 percent north slopes	Moderate	Low	Neutral extremely stony silty clay loam, neutral very cobbly clay loam, neutral very cobbly clay. The depth to a restrictive feature is 20 to 40 inches to bedrock (lithic). It is well drained.	11.2
102	Felcher extremely stony clay loam - 20 to 40 percent slopes	Low	Low	Neutral extremely stony clay loam, neutral very gravelly clay loam. The depth to a restrictive feature is 20 to 40 inches to bedrock (lithic). It is well drained.	2.3
120	Fury-Degarmo complex - 0 to 2 percent slopes	Low	Low	Fury soils make up 55 percent: moderately alkaline silt loam, slightly alkaline silty clay loam; slightly alkaline silt loam. This component is on lake plains. The depth to a restrictive feature is greater than 60 inches. It is poorly drained. Degarmo soils make up 30 percent: moderately alkaline silt loam, slightly alkaline silty clay loam, slightly alkaline clay, slightly alkaline clay loam, slightly alkaline sandy clay loam, slightly alkaline very gravelly sandy loam. This component is on lake plains. The depth to a restrictive feature is greater than 60 inches. It is somewhat poorly drained.	6.6
125	Fury-Widowspring complex - 0 to 2 percent slopes	Low	Low	Fury soils make up 45 percent: moderately alkaline silt loam, slightly alkaline silty clay loam, slightly alkaline silt loam. This component is on lake plains. The depth to a restrictive feature is greater than 60 inches. It is poorly drained. Widowspring soils make up 40 percent: neutral silt loam. This component is on lake plains. The depth to a restrictive feature is greater than 60 inches. It is moderately well drained.	11.9
144	Housefield mucky silt loam - 0 to 1 percent slopes	Low	Low	Housefield soils make up 85 percent: neutral mucky silt loam, neutral mucky silty clay loam, neutral silty clay. This component is on lake plains. The depth to a restrictive feature is greater than 60 inches. It is very poorly drained.	3.2
191	McBain-Ausmus complex - 0 to 2 percent slopes	Low	Low; Moderate	Mcbain soils make up 45 percent: strongly alkaline silt loam, strongly alkaline loam, strongly alkaline clay loam, moderately alkaline very fine sandy loam, moderately alkaline clay loam, moderately alkaline loam. This component is on lake terraces. The depth to a restrictive feature is greater than 60 inches. It is moderately well drained. Ausmus soils make up 40 percent: very strongly alkaline silty clay loam, very strongly alkaline silt loam, very strongly alkaline loam. This component is on lake plains. The depth to a restrictive feature is greater than 60 inches. It is moderately well drained.	1.8
217	Ninemile gravelly loam – hummocky - 0 to 8 percent slopes	Moderate	Low	Neutral gravelly loam, neutral gravelly clay. The depth to a restrictive feature is 10 to 20 inches to bedrock (lithic). It is well drained.	29.9
256	Pernty-Rock outcrop complex - 30 to 70 percent south slopes	Moderate	Low	Pernty soils make up 60 percent neutral gravelly silt loam, neutral cobbly loam, neutral very cobbly loam. The depth to a restrictive feature is 14 to 20 inches to bedrock (lithic). It is well drained. Rock Outcrop makes up 25 percent of the map unit.	54.2

Table 3.1-2 Soil Units Crossed by Alternative B – West Route (150-foot ROW)

Map Unit Code	Map Unit Name and Slope	Water Erosion Potential	Wind Erosion Potential	Description	Area (Acres)
272	Raz-Brace complex - 2 to 20 percent slopes	Low; Moderate	Low	Raz soils make up 50 percent: slightly alkaline very cobbly loam, moderately alkaline gravelly clay loam, moderately alkaline clay loam. The depth to a restrictive feature is 20 to 40 inches to bedrock (lithic); 10 to 18 inches to duripan. It is well drained. Brace soils make up 35 percent: neutral stony loam, slightly alkaline clay loam, moderately alkaline loam of the map unit. The depth to a restrictive feature is 22 to 40 inches to bedrock (lithic); 20 to 37 inches to duripan. It is well drained.	92.6
278	Reluctan very stony silt loam - 2 to 20 percent slopes	Low	Low	Neutral very stony silt loam, neutral sandy loam, moderately alkaline sandy clay loam, moderately alkaline sandy clay loam. The depth to a restrictive feature is 20 to 40 inches to bedrock (lithic). It is well drained.	48.0
288	Robson-Fourwheel complex - 3 to 30 percent slopes	Low	Low	Robson soils make up 45 percent: neutral very cobbly clay loam, neutral very gravelly clay. The depth to a restrictive feature is 12 to 20 inches to bedrock (lithic). It is well drained. Fourwheel soils make up 40 percent: neutral clay loam, neutral clay. The depth to a restrictive feature is 20 to 40 inches to bedrock (lithic). It is well drained.	51.4
304	Skidoosprings sandy loam - 0 to 3 percent slopes	Low	Moderate	Very strongly alkaline sandy loam, The depth to a restrictive feature is 40 to 50 inches to duripan. It is moderately well drained	4.4
362	Westbutte-Lambring-Rock outcrop complex - 35 to 65 percent north slopes	Moderate	Low	Westbutte soils make up 40 percent: neutral extremely stony loam, neutral very cobbly loam. The depth to a restrictive feature is 20 to 40 inches to bedrock (lithic). It is well drained. Lambring soils make up 25 percent: neutral very cobbly loam, neutral gravelly loam, neutral very cobbly loam. The depth to a restrictive feature is greater than 60 inches. It is well drained. Rock Outcrop makes up 20 percent of the map unit.	19.9
370	Widowspring silt loam - 0 to 2 percent slopes	Low	Low	Widowspring soils make up 85 percent: neutral silt loam, neutral loam. This component is on lake plains. The depth to a restrictive feature is greater than 60 inches. It is moderately well drained.	2.5
Hog Wallow Route Option Soils					
144	Housefield mucky silt loam - 0 to 1 percent slopes	Low	Low	(see soil description above)	0.6
191	McBain-Ausmus complex - 0 to 2 percent slopes	Low	Low; Moderate	(see soil description above)	1.1
272	Raz-Brace complex - 2 to 20 percent slopes	Low; Moderate	Low	(see soil description above)	4.1
278	Reluctan very stony silt loam - 2 to 20 percent slopes	Low	Low	(see soil description above)	37.9
308	Skunkfarm-McBain-Doubleo complex - 0 to 2 percent slopes	Low	Low	Skunkfarm soils make up 35 percent: slightly alkaline silt loam, moderately alkaline clay loam, moderately alkaline loam, moderately alkaline fine sandy loam. This component is on lake plains. The depth to a restrictive feature is greater than 60 inches. It is somewhat poorly drained. Mcbain soils make up 30 percent: strongly alkaline silt loam, strongly alkaline loam, strongly alkaline clay loam, moderately alkaline very fine sandy loam, moderately alkaline clay loam, moderately alkaline loam. This component is on lake terraces. The depth to a restrictive feature is greater than 60 inches. It is moderately well drained. Doubleo soils make up 20 percent: moderately alkaline loam, moderately alkaline silty clay, moderately alkaline clay, moderately alkaline clay loam, moderately alkaline fine sandy loam. This component is on lake plains. The depth to a restrictive feature is greater than 60 inches. It is poorly drained.	2.8
362	Westbutte-Lambring-Rock outcrop complex - 35 to 65 percent north slopes	Moderate	Low	(see soil description above)	5.6

Table 3.1-2 Soil Units Crossed by Alternative B – West Route (150-foot ROW)

Map Unit Code	Map Unit Name and Slope	Water Erosion Potential	Wind Erosion Potential	Description	Area (Acres)
South Diamond Lane Route Option Soils					
121	Fury-Housefield complex - 0 to 1 percent slopes	Low	Low	Fury soils make up 50 percent: moderately alkaline silt loam, slightly alkaline silty clay loam, slightly alkaline silt loam. This component is on lake plains. The depth to a restrictive feature is greater than 60 inches. It is poorly drained. Housefield soils make up 35 percent: neutral mucky silt loam, neutral mucky silty clay loam, neutral silty clay. This component is on lake plains. The depth to a restrictive feature is greater than 60 inches. It is very poorly drained.	2.8
176	Lolak-Ausmus complex - 0 to 1 percent slopes	Low	Moderate	Lolak soils make up 50 percent: moderately alkaline very fine sandy loam, very strongly alkaline clay loam, very strongly alkaline clay, strongly alkaline silty clay loam, strongly alkaline loam. This component is on lake plains. The depth to a restrictive feature is greater than 60 inches. It is poorly drained. Ausmus soils make up 35 percent: very strongly alkaline silty clay loam, very strongly alkaline silt loam, very strongly alkaline loam. This component is on lake plains. The depth to a restrictive feature is greater than 60 inches. It is moderately well drained, strongly alkaline fine sandy loam.	1.5
272	Raz-Brace complex - 2 to 20 percent slopes	Low; Moderate	Low	(see soil description above)	28.9
299	Seharney cobbly silt loam - 3 to 12 percent slopes	Low	Low	Neutral cobbly silt loam, neutral silt loam, neutral cobbly silt loam, slightly alkaline very cobbly silt loam. The depth to a restrictive feature is 20 to 30 inches to bedrock (lithic); 10 to 20 inches to duripan. It is well drained.	2.2
304	Skidoosprings sandy loam - 0 to 3 percent slopes	Low	Moderate	(see soil description above)	9.4
307	Skunkfarm-Doubleo complex - 0 to 1 percent slopes	Low	Low	Skunkfarm soils make up 45 percent: slightly alkaline silt loam, moderately alkaline clay loam, moderately alkaline loam, moderately alkaline fine sandy loam. This component is on lake plains. The depth to a restrictive feature is greater than 60 inches. It is somewhat poorly drained. Doubleo soils make up 40 percent: moderately alkaline loam, moderately alkaline silty clay, moderately alkaline clay, moderately alkaline clay loam, moderately alkaline fine sandy loam, moderately alkaline loam. This component is on lake plains. The depth to a restrictive feature is greater than 60 inches. It is poorly drained	16.0
308	Skunkfarm-McBain-Doubleo complex - 0 to 2 percent slopes	Low	Low	Skunkfarm soils make up 35 percent: slightly alkaline silt loam, moderately alkaline clay loam, moderately alkaline loam, moderately alkaline fine sandy loam. This component is on lake plains. The depth to a restrictive feature is greater than 60 inches. It is somewhat poorly drained. Mcbain soils make up 30 percent: strongly alkaline silt loam, strongly alkaline loam, strongly alkaline clay loam, moderately alkaline very fine sandy loam, moderately alkaline clay loam, moderately alkaline loam. This component is on lake terraces. The depth to a restrictive feature is greater than 60 inches. It is moderately well drained. Doubleo soils make up 20 percent: moderately alkaline loam, moderately alkaline silty clay, moderately alkaline clay, moderately alkaline clay loam, moderately alkaline fine sandy loam. This component is on lake plains. The depth to a restrictive feature is greater than 60 inches. It is poorly drained.	1.8
340	Vining loam - 2 to 20 percent slopes	Moderate	Low	Neutral loam, neutral sandy loam. The depth to a restrictive feature is 20 to 40 inches to bedrock (lithic). It is well drained.	19.0
362	Westbutte-Lambring-Rock outcrop complex - 35 to 65 percent north slopes	Moderate	Low	(see soil description above)	2.3

Table 3.1-3 Soil Units Crossed by Alternative C – North Route (150-foot ROW)

Map Unit Code	Map Unit Name and Slope	Water Erosion Potential	Wind Erosion Potential	Description	Area (Acres)
6	Alyan gravelly sandy loam - 3 to 15 percent slopes	Low	Moderate	Neutral gravelly sandy loam, neutral loam, neutral cobbly clay loam, neutral cobbly clay. The depth to a restrictive feature is 20 to 40 inches to bedrock (lithic). It is well drained.	16.7
28	Baconcamp-Clamp complex - 5 to 20 percent slopes	Low; Moderate	Low	Baconcamp soils make up 45 percent: neutral very stony clay loam, neutral gravelly loam, neutral very gravelly loam. The depth to a restrictive feature is 20 to 40 inches to bedrock (lithic). It is well drained. Clamp soils make up 40 percent: neutral very stony clay loam, neutral very cobbly clay loam. The depth to a restrictive feature is 4 to 14 inches to bedrock (lithic). It is well drained.	81.7
33	Baconcamp-Rock outcrop-Hackwood complex - 30 to 80 percent slopes	Moderate; Very High	Low	Baconcamp soils make up 40 percent: neutral very stony loam, neutral gravelly loam, neutral very gravelly loam. The depth to a restrictive feature is 20 to 40 inches to bedrock (lithic). It is well drained. Outcrop of unweathered bedrock makes up 30 percent of the map unit. Hackwood soils make up 15 percent: neutral gravelly loam, neutral loam. The depth to a restrictive feature is greater than 60 inches. It is well drained.	29.7
47	Brace-Vergas complex - 2 to 20 percent slopes	Low	Moderate	Brace soils make up 45 percent: neutral cobbly fine sandy loam, slightly alkaline clay loam, moderately alkaline loam. The depth to a restrictive feature is 22 to 40 inches to bedrock (lithic); 20 to 37 inches to duripan. It is well drained. Vergas soils make up 40 percent: neutral fine sandy loam, neutral gravelly sandy clay loam, moderately alkaline gravelly loamy sand, moderately alkaline extremely gravelly coarse sand. The depth to a restrictive feature is greater than 60 inches. It is well drained.	43.7
57	Carryback very gravelly loam- low elevation - 3 to 20 percent slopes	Low	Low	Slightly alkaline very gravelly loam, slightly alkaline clay. The depth to a restrictive feature is 20 to 40 inches to bedrock (lithic). It is well drained.	114.7
60	Carryback complex- low elevation - 20 to 40 percent slopes	Low	Low	Slightly alkaline very gravelly loam, slightly alkaline clay. The depth to a restrictive feature is 20 to 40 inches to bedrock (lithic). It is well drained.	16.3
64	Carvix silt loam - 0 to 5 percent slopes	Low	Low	Neutral silt loam, moderately alkaline silt loam, moderately alkaline loam. The depth to a restrictive feature is greater than 60 inches. It is well drained.	22.3
91	Edemaps loam - 5 to 20 percent slopes	Moderate	Low	Neutral loam, neutral clay moderately alkaline very cobbly clay loam. The depth to a restrictive feature is 24 to 40 inches to bedrock (lithic); 20 to 35 inches to duripan. It is well drained.	8.7
103	Felcher-Rock outcrop complex - 40 to 70 percent south slopes	Low	Low	Felcher soils make up 65 percent: neutral very stony clay loam, neutral very gravelly clay loam. The depth to a restrictive feature is 20 to 40 inches to bedrock (lithic). It is well drained. Rock Outcrop makes up 20 percent of the map unit.	1.2
105	Felcher-Rock outcrop-Westbutte complex - 20 to 40 percent slopes	Low	Low	Felcher soils make up 35 percent: neutral extremely stony sandy clay loam, neutral, very cobbly clay loam. The depth to a restrictive feature is 20 to 40 inches to bedrock (lithic). It is well drained. Rock Outcrop makes up 30 percent of the map unit. Brezniak soils make up 25 percent: neutral cobbly loam, neutral clay. The depth to a restrictive feature is 7 to 12 inches to bedrock (lithic). It is well drained.	2.0
113					
116	Fourwheel extremely cobbly loam - 20 to 40 percent north slopes	Low	Low	Neutral extremely cobbly loam, neutral clay. The depth to a restrictive feature is 20 to 40 inches to bedrock (lithic). It is well drained.	30.1

Table 3.1-3 Soil Units Crossed by Alternative C – North Route (150-foot ROW)

Map Unit Code	Map Unit Name and Slope	Water Erosion Potential	Wind Erosion Potential	Description	Area (Acres)
120	Fury-Degarmo complex - 0 to 2 percent slopes	Low	Low	Fury soils make up 55 percent: moderately alkaline silt loam, slightly alkaline silty clay loam; slightly alkaline silt loam. This component is on lake plains. The depth to a restrictive feature is greater than 60 inches. It is poorly drained. Degarmo soils make up 30 percent: moderately alkaline silt loam, slightly alkaline silty clay loam, slightly alkaline clay, slightly alkaline clay loam, slightly alkaline sandy clay loam, slightly alkaline very gravelly sandy loam. This component is on lake plains. The depth to a restrictive feature is greater than 60 inches. It is somewhat poorly drained.	1.6
125	Fury-Widowspring complex - 0 to 2 percent slopes	Low	Low	Fury soils make up 45 percent: moderately alkaline silt loam, slightly alkaline silty clay loam, slightly alkaline silt loam. This component is on lake plains. The depth to a restrictive feature is greater than 60 inches. It is poorly drained. Widowspring soils make up 40 percent: neutral silt loam. This component is on lake plains. The depth to a restrictive feature is greater than 60 inches. It is moderately well drained.	12.9
132	Gradon gravelly fine sandy loam - 0 to 8 percent slopes	Low	Moderate	Neutral gravelly fine sandy loam, neutral loam, slightly alkaline clay loam, moderately alkaline sandy loam. The depth to a restrictive feature is 20 to 40 inches to duripan. It is well drained.	4.1
151	Kegler fine sandy loam - 2 to 5 percent slopes	Low	Low	Neutral fine sandy loam, moderately alkaline sandy clay loam, moderately alkaline silt loam. The depth to a restrictive feature is 25 to 40 inches to duripan. It is well drained.	30.7
168	Lawen fine sandy loam - 2 to 5 percent slopes	Low	Low	Slightly alkaline fine sandy loam, moderately alkaline loam, moderately alkaline fine sandy loam. This component is on lake terraces. The depth to a restrictive feature is greater than 60 inches. It is well drained.	76.4
217					
219	Ninemile very stony clay loam - 0 to 20 percent slopes	Low	Low	Neutral very stony clay loam, neutral gravelly clay. The depth to a restrictive feature is 10 to 20 inches to bedrock (lithic). It is well drained.	32.2
222	Ninemile-Edemaps complex - 2 to 10 percent slopes	Moderate; Low	Low	Ninemile soils make up 50 percent: neutral gravelly loam, neutral gravelly clay. The depth to a restrictive feature is 10 to 20 inches to bedrock (lithic). It is well drained. Edemaps soils make up 35 percent: neutral cobbly clay loam, neutral clay, moderately alkaline very cobbly clay loam. The depth to a restrictive feature is 24 to 40 inches to bedrock (lithic); 20 to 35 inches to duripan. It is well drained.	44.9
256	Pernty-Rock outcrop complex - 30 to 70 percent south slopes	Moderate	Low	Pernty soils make up 60 percent neutral gravelly silt loam, neutral cobbly loam, neutral, very cobbly loam. The depth to a restrictive feature is 14 to 20 inches to bedrock (lithic). It is well drained. Rock Outcrop makes up 25 percent of the map unit: unweathered bedrock.	88.4
268	Poujade very fine sandy loam - 0 to 2 percent slopes	Low	Low	Neutral very fine sandy loam, moderately alkaline loam, very strongly alkaline silty clay loam, very strongly alkaline loam, very strongly alkaline stratified very fine sandy loam to silty clay loam. This component is on lake terraces. The depth to a restrictive feature is greater than 60 inches. It is moderately well drained.	17.6
269	Poujade very fine sandy loam - 2 to 5 percent slopes	Low	Moderate	Neutral very fine sandy loam, moderately alkaline loam, very strongly alkaline silty clay loam, very strongly alkaline loam, very strongly alkaline stratified very fine sandy loam to silty clay loam. This component is on lake terraces. The depth to a restrictive feature is greater than 60 inches. It is moderately well drained.	38.5
270	Poujade-Ausmus complex - 0 to 2 percent slopes	Low	Moderate	Poujade soils make up 50 percent: neutral very fine sandy loam, moderately alkaline loam, very strongly alkaline silty clay loam, very strongly alkaline loam, very strongly alkaline stratified very fine sandy loam to silty clay loam. This component is on lake terraces. The depth to a restrictive feature is greater than 60 inches. It is moderately well drained. Ausmus soils make up 35 percent: strongly alkaline fine sandy loam, very strongly alkaline silty clay loam, very strongly alkaline silt loam, very strongly alkaline loam. This component is on lake plains. The depth to a restrictive feature is greater than 60 inches. It is moderately well drained.	3.8

Table 3.1-3 Soil Units Crossed by Alternative C – North Route (150-foot ROW)

Map Unit Code	Map Unit Name and Slope	Water Erosion Potential	Wind Erosion Potential	Description	Area (Acres)
272	Raz-Brace complex - 2 to 20 percent slopes	Low; Moderate	Low	Raz soils make up 50 percent: slightly alkaline very cobbly loam, moderately alkaline gravelly clay loam, moderately alkaline clay loam. The depth to a restrictive feature is 20 to 40 inches to bedrock (lithic); 10 to 18 inches to duripan. It is well drained. Brace soils make up 35 percent: neutral stony loam, slightly alkaline clay loam, moderately alkaline loam of the map unit. The depth to a restrictive feature is 22 to 40 inches to bedrock (lithic); 20 to 37 inches to duripan. It is well drained.	15.0
288	Robson-Fourwheel complex - 3 to 30 percent slopes	Low	Low	Robson soils make up 45 percent: neutral very cobbly clay loam, neutral very gravelly clay. The depth to a restrictive feature is 12 to 20 inches to bedrock (lithic). It is well drained. Fourwheel soils make up 40 percent: neutral clay loam, neutral clay. The depth to a restrictive feature is 20 to 40 inches to bedrock (lithic). It is well drained.	8.3
290	Roca very cobbly clay loam - 15 to 40 percent south slopes	Low	Low	Neutral very cobbly clay loam, moderately alkaline very gravelly clay loam, moderately alkaline very cobbly clay loam. The depth to a restrictive feature is 20 to 40 inches to bedrock (lithic). It is well drained.	3.8
316	Swaler-Swalesilver association - 0 to 2 percent slopes	Low	Low	Swaler soils make up 70 percent: neutral silt loam, slightly alkaline silty clay, slightly alkaline silty clay loam. This component is on closed depressions. The depth to a restrictive feature is greater than 60 inches. It is moderately well drained. Swalesilver soils make up 20 percent: neutral silt loam, moderately alkaline clay, moderately alkaline stratified silt loam to clay loam. This component is on closed depressions. The depth to a restrictive feature is greater than 60 inches. It is somewhat poorly drained.	9.2
362	Westbutte-Lambring-Rock outcrop complex - 35 to 65 percent north slopes	Moderate	Low	Westbutte soils make up 40 percent: neutral extremely stony loam, neutral very cobbly loam. The depth to a restrictive feature is 20 to 40 inches to bedrock (lithic). It is well drained. Lambring soils make up 25 percent: neutral very cobbly loam, neutral gravelly loam, neutral very cobbly loam. The depth to a restrictive feature is greater than 60 inches. It is well drained. Rock Outcrop makes up 20 percent of the map unit.	5.1
371	Windybutte silt loam - 2 to 5 percent slopes	Low	Low	Neutral silt loam, moderately alkaline silty clay loam, strongly alkaline loam. The depth to a restrictive feature is greater than 60 inches. It is well drained.	33.5

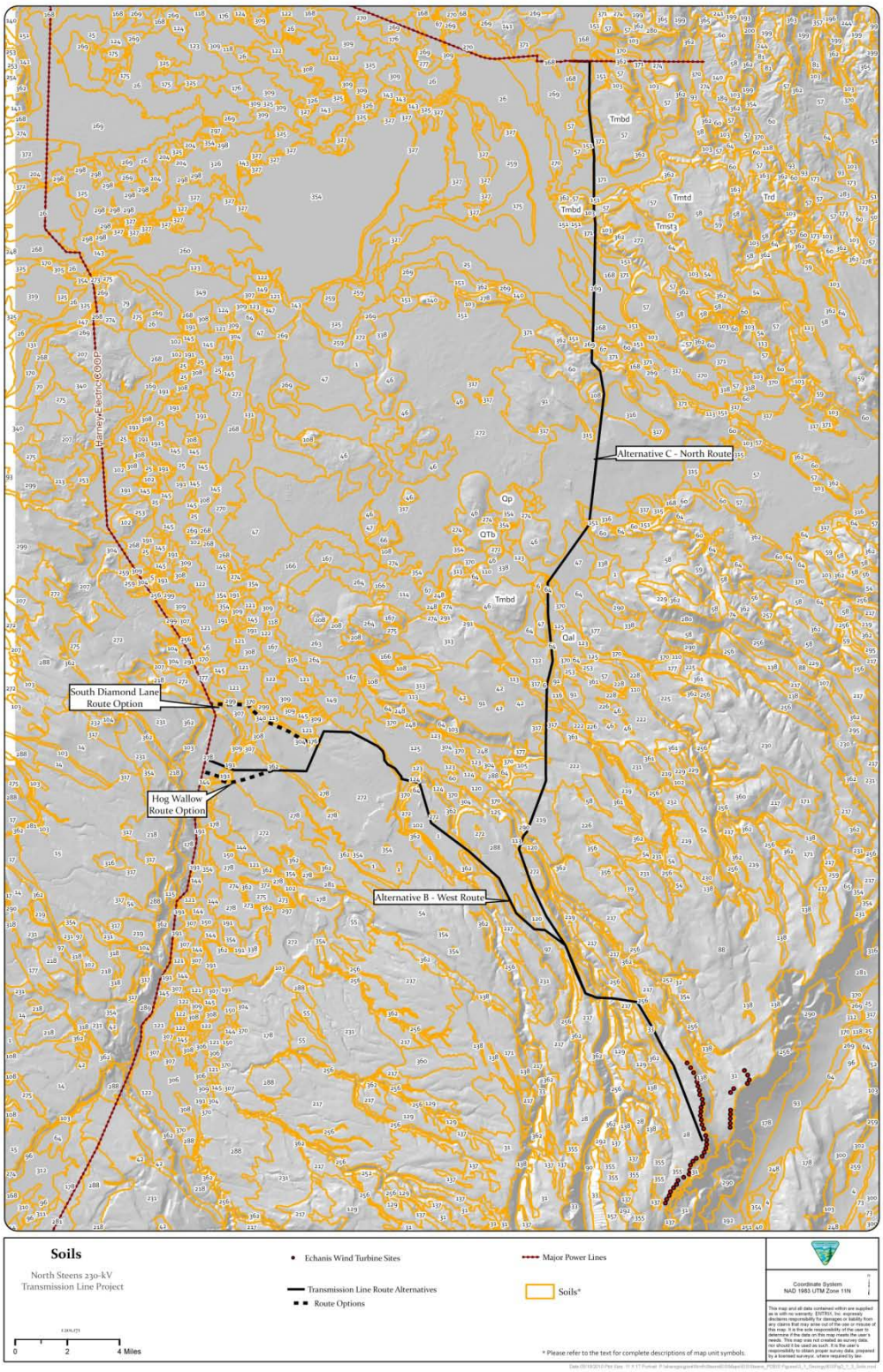

Figure 3.1-3 Soils Map.

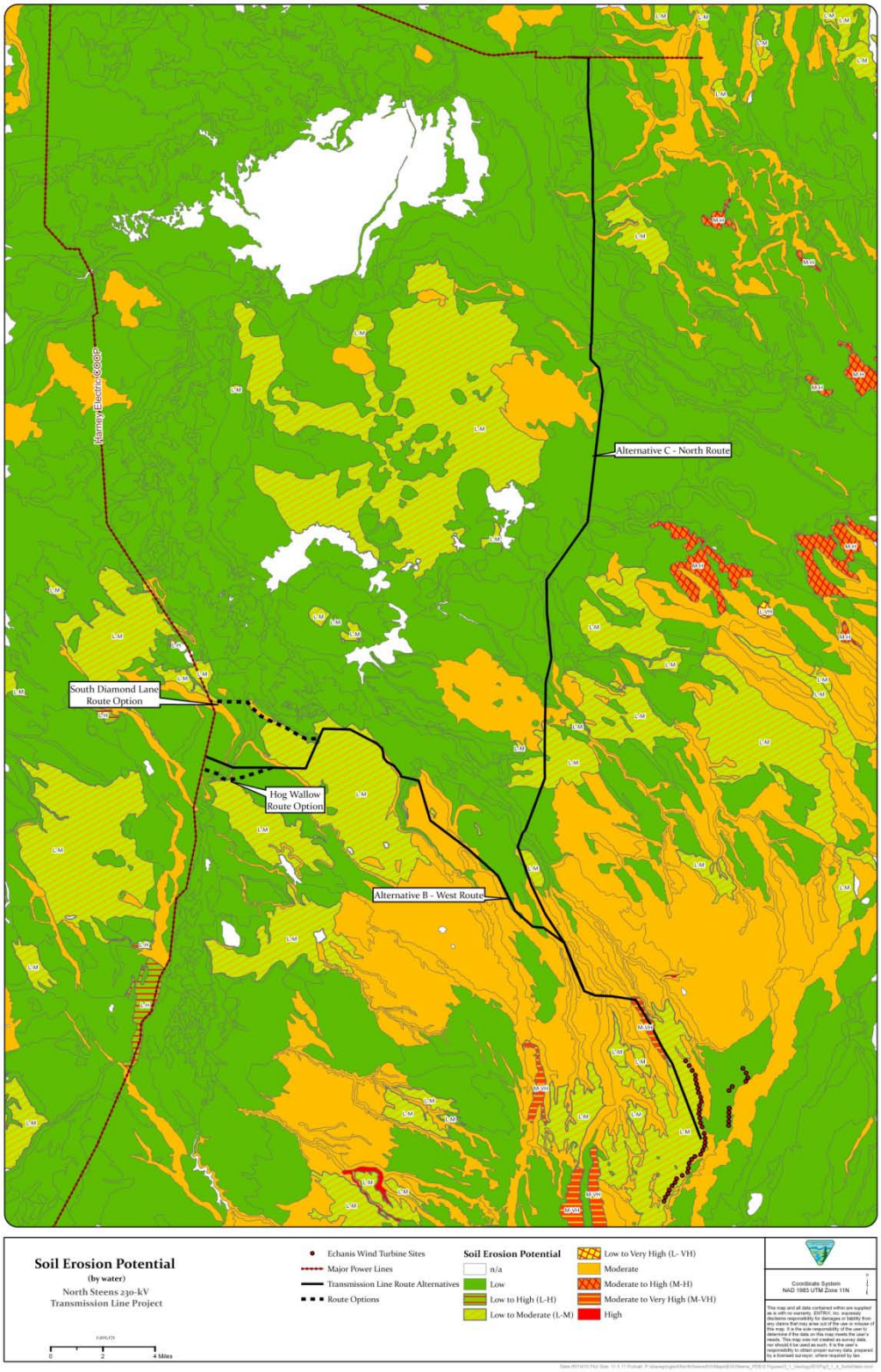

Figure 3.1-4 Soil Erosion Potential by Water.

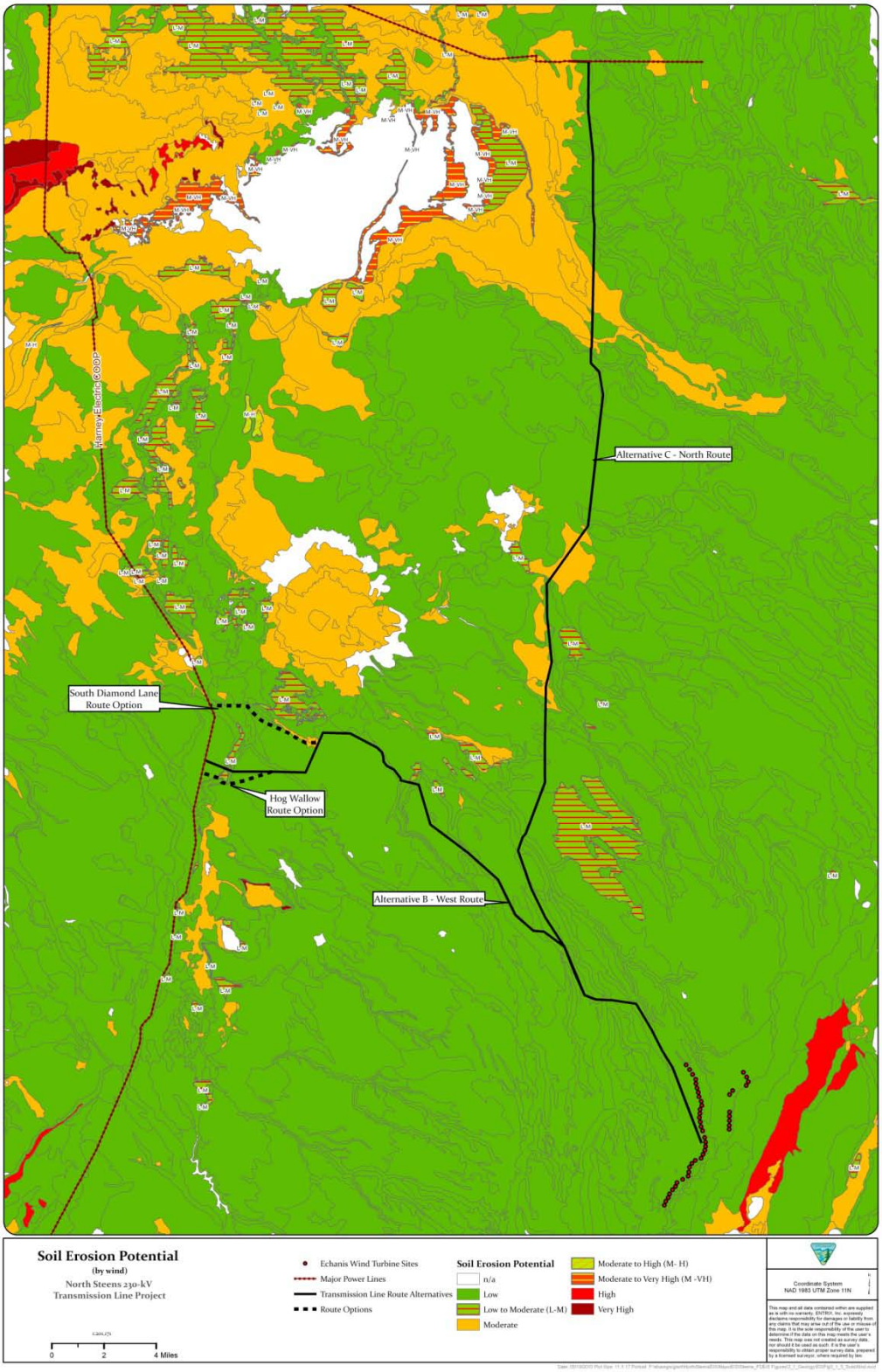

Figure 3.1-5 Soil Erosion Potential by Wind.

3.1.2.3 Biological Soil Crusts

Biological Soil Crusts (BSCs) are a community of lichens, mosses, algae, fungi, and cyanobacteria that grow in the spaces between vascular vegetation in arid lands. BSCs provide numerous ecological benefits by retaining moisture, suppressing weeds, fixing atmospheric nitrogen, and increasing organic material. They also bind soil particles together and significantly reduce erosion by water and wind (Evans and Johansen 1999). In the Great Basin, the dominant components of BSCs are moss and lichen (Belnap et al. 2001). In this cold desert region, BSCs are especially instrumental in increasing infiltration of precipitation by increasing roughness and reducing overland flow (Belnap et al. 2001).

A number of habitat types in the area support BSCs. For example, the Project Area consists primarily of grassland with juniper, sagebrush steppe, shrub-steppe, and riparian habitats (Tagliabue 2008). This type of community has been shown to support well-developed BSC in the northern Great Basin (Belnap et al. 2001; Darrach and Luginbuhl 2007).

3.1.3 Environmental Effects and Mitigation

This section analyzes the potential effects resulting from implementation of the Proposed Action, Alternative Actions, and the No Action Alternative. Geology and soil resources could be affected by construction and operation of the access roads, transmission lines, wind turbines, and associated structures. For all alternatives, the permanent ROW width would be 150 feet. ~~In certain areas, an additional 10 feet of temporary construction easement would be required on each side of the ROW to allow for equipment operation during installation of poles, conductors and any required guy wires. The areas required for temporary construction easements have not yet been determined and are not included in the required permanent ROW totals described below. A 40-foot wide ROW would be required on public lands to accommodate new and improved access roads.~~

The potential effects on geology, soils, and biological soil crusts during the short-term construction phase and the long-term operational phase of the Project are described below. It should be noted that a variety of project design features and best management practices to reduce the effects on geology, soils, and biological soil crusts, from both the Echanis Project and the transmission line alternatives, would be implemented as part of the Proposed Action. These measures are not repeated in the mitigation sections below, but are summarized in Appendix A.

3.1.3.1 Alternative A – No Action

Under the No Action Alternative, existing conditions would remain and no additional environmental effects to soils, BSCs, or geology would be created. Currently, land is used for agriculture and grazing. These activities increase erosion through soil disturbance and changes to vegetation community structure.

3.1.3.2 Echanis Project Effects Common to All Action Alternatives

The permanent and temporary effects on geology and soils from construction and operation of the Echanis Wind Energy Project would be the same for all Action Alternatives (i.e., Alternative B, the Alternative B route options, and Alternative C). Because the Echanis Project would be a common element to all transmission line alternatives (i.e., a connected non-federal action), the effects from the Echanis Project are described separately from the effects of the transmission line alternatives. The effects associated with each transmission line alternative are described separately below. The combined effects of the Echanis Project and each transmission line alternative on geology and soils are summarized in Section 3.1.3.10.

Seismically, the Project Area is not anticipated to be hazardous for general construction (Smith 2008). Nonetheless, earthquakes have occurred and faults have been mapped in the region. As summarized in *Geologic Report in the Echanis Wind Project* by Smith (2008), three minor faults were inferred in the Echanis Project Area using remote sensing and topographic maps. Damage from frequent small earthquakes may be

equivalent to damage from a large, rare event. The level of risk to any structure depends upon the importance of the structure, how hazardous the facility is, and the likelihood of earthquakes. Since movement along faults can trigger mass movement, landslides could be a concern. As stated above, historical landslide deposits are shown on the geologic map within and near the Project Area.

Soil erosion could increase due to the construction of impervious surfaces. The Substation site consists of approximately 1.84 acres that would be cleared and covered with gravel and concrete foundations for electrical equipment. The adjacent maintenance building would add another 1,152 square feet of impervious surfaces. The Echanis Project would also include an 18.95-mile main access road. Construction and operation of the main access road could cause an increase in soil erosion due to vegetation clearance. Additionally, approximately 12.81 miles of new access road construction (30-ft width), 17.11 miles of string road construction (16-ft width), and approximately 6.14 miles of existing road improvements (an additional 10-ft width) are planned for the Echanis Project.

An onsite concrete batch plant and aggregate storage area would be used to make the concrete for the foundations for the towers. The aggregate quarry site, and associated aggregate crushing and storage areas, have not yet been selected. However, they will be located on the Mann Lake Ranch property and not on lands encumbered with Federal mineral rights. Currently, the quarry would occupy an estimated 0.92 acre, the crushing equipment would occupy 0.23 acre, and an aggregate storage area would occupy 0.69 acre.

The disturbance caused by excavation and compaction during Project construction could directly affect BSCs, if they are present in the Project Area. Clearing of the Substation site and adjacent maintenance building could affect any BSCs in the immediate vicinity.

PERMANENT EFFECTS

In summary, the permanent effects could include:

- Seismic hazard risk to structures, including landslides triggered by potential seismic events.
- Increased soil erosion caused by larger amounts of runoff due to construction of other impervious surfaces.
- Potential destruction of BSCs, where present in the Project Area.

Best Management Practices (BMPs) that address geology and soils concerns are described in the Application for Conditional Use Permit for the Echanis Wind Farm (CEP 2007), in accordance with the ODEQ Erosion and Sediment Control Manual (GeoSyntec Consultants 2005). Additional Project Design Features (PDFs) and BMPs that would be implemented as part of the Project are listed in Appendix A.

TEMPORARY EFFECTS

Project construction activities could increase erosion above the natural levels by increasing soil compaction. Indirect effects could include erosion from the clearing and trampling of vegetation or the disturbance of the BSCs that bind soils. Impervious surfaces reduce precipitation infiltration, and increase the rate and amount of soil erosion. Additionally, pollutants could be introduced from equipment use or fueling.

The Echanis Wind Energy Project would involve deployment and operation of 40 to 69 wind turbines on a 10,500-acre site. A temporary effect on soil erosion would occur in areas where vegetation was cleared, or where overland travel or trampling effectively eliminated vegetation. The areas proposed for the wind turbines and structures would be cleared of vegetation. Trampled vegetation and surface disturbance would be restored when construction was complete. The greatest effects to soils would be during excavation and installation.

As described above, the potential temporary effects during construction could include:

- Increased soil erosion due to construction activities, including the destruction of BSCs and/or clearing of vegetation.
- Potential for spills of hazardous materials during construction.

BMPs would be used to minimize the effects to soils. BMPs are described in the Plan of Development for the transmission lines (CEP 2009) and the Application for Conditional Use Permit for the wind farm (CEP 2007), in accordance with the ODEQ Erosion and Sediment Control Manual (GeoSyntec Consultants 2005). The BMPs are described in Appendix A.

MITIGATION

No additional mitigation measures would be required because Project design features (PDFs) and best management practices (BMPs) taken into account in the effects analysis of the action alternatives and would be implemented to reduce the geology and soils effects (see Section 2 and Appendix A.3.1).

3.1.3.3 Alternative B – West Route (Proposed Action)

PERMANENT EFFECTS

Seismically, the Project Area is not anticipated to be hazardous for general construction (Smith 2008). Nonetheless, earthquakes have occurred and faults have been mapped in the region. The Alternative B – West Route would cross seven mapped faults. In general, earthquakes could threaten structural integrity of facilities. Damage from frequent small earthquakes could be equivalent to damage from a large, rare event. The level of risk to any structure would depend upon the importance of the structure, how hazardous the facility was, and the likelihood of earthquakes. Because movement along faults could trigger mass movement, landslides could be a concern. As stated above, historical landslide deposits are shown on the geologic map within and near the Project Area. Overall, 28.87 miles of transmission line of Alternative B – West Route would require a total of 525.31 acres of ROW.

Soil erosion could increase due to the construction of impervious surfaces. During construction of the Interconnection Station (ICS), vegetation would be cleared and replaced with a gravel surface and impervious concrete pads for equipment. The total area for the ICS would be 0.69 acre. Approximately 0.2 mile of new access road construction and approximately 2.0 miles of existing road improvements are planned. Road maintenance would include vegetation clearing; however, grasses and small vegetation would be left on the road bed if it did not obstruct access. These actions would reduce infiltration and increase runoff locally. Additionally, the Alternative B – West Route would likely require approximately 26.07 miles of overland vehicle access. Overland vehicle access would likely consist of an 8-ft width of surface disturbance (25.28 acres).

The disturbance caused by excavation and compaction during Project construction could directly affect BSCs, if they were present in the Project Area. Clearing of the Interconnection Station and gravel access roads could adversely affect any BSCs in the immediate vicinity. The ROW, tensioning sites, and laydown sites would not be cleared, but effects could occur to any present BSCs from compaction and damage to trampled vegetation. Assuming that poles would be placed at 600-ft intervals, Alternative B would contain approximately 260 poles. Assuming a surface disturbance of a 10-ft radius around each pole, Alternative B would impact 1.87 acres. <u>In addition, overland vehicle access could affect up to 25.28 acres of BSC, assuming that BSC were present in all areas potentially disturbed by overland access roads.</u>

In summary, the permanent effects for Alternative B could include:

- Seismic hazard risk to structures, including landslides triggered by potential seismic events.

- Increased soil erosion caused by larger amounts of runoff due to access road construction and construction of other impervious surfaces.
- Potential destruction of BSCs, where present in the Project Area.

PDFs and BMPs would be used to minimize the effects on soils and geology during Project operation. BMPs are described in the Plan of Development for the transmission line (CEP 2009) and in accordance with the ODEQ Erosion and Sediment Control Manual (GeoSyntec Consultants 2005). The PDFs and BMPs are listed in Appendix A.

TEMPORARY EFFECTS

Project construction activities could increase erosion above the natural levels by increasing soil compaction. Indirect effects could include erosion from the clearing and trampling of vegetation or the disturbance of the BSCs that bind soils. Impervious surfaces reduce precipitation infiltration, and increase the rate and amount of soil erosion. Additionally, pollutants could be introduced from equipment use or fueling.

The 28.87 miles of transmission line of Alternative B – West Route would require a total of 525.31 acres of ROW. A temporary effect on soil erosion would occur in areas where vegetation was cleared or where overland travel or trampling effectively eliminates vegetation. The areas proposed for the ROW and structures would be cleared of vegetation, however tensioning sites, laydown sites, and downguys would not be cleared of vegetation. Trampled vegetation and surface disturbance would be restored when construction was completed. The transmission line poles would be located approximately 600 feet apart, requiring approximately 260 poles for Alternative B and would impact approximately 1.87 acres. The greatest effects to soils and BSC would be during excavation and installation.

As described above, the potential temporary effects during construction could include:

- Increased soil erosion due to construction activities, including the destruction of BSCs and/or clearing of vegetation.
- Potential for spills of hazardous materials during construction.

PDFs and BMPs would be used to minimize the effects to soils. BMPs are described in the Plan of Development for the transmission lines (CEP 2009) and the Application for Conditional Use Permit for the wind farm (CEP 2007), in accordance with the ODEQ Erosion and Sediment Control Manual (GeoSyntec Consultants 2005). The PDFs and BMPs are listed in Appendix A.

FUTURE CONSTRUCTION PHASE – UPGRADE TO 230-KV

The upgrade of the initial single-circuit transmission line to a full double-circuit 230-kV transmission line would require a second construction phase at a future date, when additional capacity was required on the transmission line. The second construction phase would not require any additional ROW, access roads, or new permanent features outside of areas previously affected by installation of the initial line. Most effects from installation of the second circuit would be temporary and similar to those described above. Temporary effects would be associated primarily with increased soil erosion as a result of construction activities, including the destruction of BSCs and/or clearing of vegetation. In addition, the potential for spills of hazardous materials during construction could also be a possibility.

MITIGATION

No additional mitigation measures would be required because Project Design Features (PDFs) and best management practices (BMPs) were taken into account in the effects analysis for the action alternatives and would be implemented to reduce the geology and soils effects (see Section 2 and Appendix A.3.1).

South Diamond Lane Route Option

The South Diamond Lane Route Option of Alternative B would incorporate the same construction procedures for transmission line and access road construction as described for Alternative B. The mitigation and BMPs utilized would be the same for both routes. Because the route options would differ only in the approximately 5 miles before the tie-in, the effects to geology would be similar to those discussed for Alternative B. Although the South Diamond Lane Route Option would follow low flat marshland compared to the other alignment options that are located over rock buttes, erosion potential for each of these options are low to moderate. The effects on soils and BSCs would differ in that the South Diamond Lane Option would require a total of 514.18 acres of ROW, from the Echanis Substation to the tie-in with the HEC 115-kV line. In addition, approximately 254 towers would be needed for this option (Kane 2009). The total effects from the ROW and ICS would cover 515.44 acres. The effects and mitigation for the distribution line would be similar to those described for the Echanis Project Effects Common to all Action Alternatives.

PERMANENT EFFECTS

Seismically, the Project Area would not likely to be hazardous for general construction (Smith 2008). Nonetheless, earthquakes have occurred and faults have been mapped in the region. The Alternative B – South Diamond Lane Option would cross six mapped faults. In general, earthquakes could threaten structural integrity of facilities. Damage from frequent small earthquakes could be equivalent to damage from a large, rare event. The level of risk to any structure would depend upon the importance of the structure, how hazardous the facility was, and the likelihood of earthquakes. Because movement along faults could trigger mass movement, landslides could be a concern. As stated above, historical landslide deposits are shown on the geologic map within and near the Project Area. Overall, 28.26 miles of transmission line for the Alternative B – South Diamond Lane Option would require a total of 514.18 acres of affected area.

Soil erosion could increase from the construction of impervious surfaces. During construction of the ICS, vegetation would be cleared and replaced with a gravel surface and impervious concrete pads for equipment. The total area for the ICS would be 0.69 acre.

Approximately 0.2 mile of new access road construction and approximately 2.0 miles of existing road improvements are planned. Road maintenance would include vegetation clearing; however, grasses and small vegetation would be left on the road bed if it did not obstruct access. These actions would reduce infiltration and increase runoff locally.

Additionally, the Alternative B – South Diamond Lane Option would require approximately 21.68 miles of overland vehicle access. Overland vehicle access would likely consist of an 8-ft width of surface disturbance (21.02 acres).

The disturbance caused by excavation and compaction during Project construction could directly affect BSCs, if they were present in the Project Area. Clearing of the Substation site, adjacent maintenance building, Interconnection Station, and gravel access roads could adversely affect any BSCs in the immediate vicinity. The ROW, tensioning sites, and laydown sites would not be cleared, but effects to any present BSCs could occur from compaction and damage to trampled vegetation. Assuming that poles would be placed at 600-ft intervals, the South Diamond Lane Route Option would contain approximately 254 poles. Assuming a surface disturbance of a 10-ft radius around each pole, the South Diamond Lane Route Option would impact 1.83 acres. <u>In addition, overland vehicle access could affect up to 21.68 acres of BSC, assuming that BSC were present in all areas potentially disturbed by overland access roads.</u>

In summary, the permanent effects for the South Diamond Lane Route Option of Alternative B could include:

- Seismic hazard risk to structures, including landslides triggered by potential seismic events.

- Increased soil erosion caused by larger amounts of runoff due to access road construction and construction of other impervious surfaces.
- Potential destruction of BSCs, where present in the Project Area.

PDFs and BMPs would be used to minimize the effects to soils and geology during Project operation. BMPs are described in the Plan of Development for the transmission line (CEP 2009), in accordance with the ODEQ Erosion and Sediment Control Manual (GeoSyntec Consultants 2005). The PDFs and BMPs are listed in Appendix A.

TEMPORARY EFFECTS

Project construction activities could increase erosion above the natural levels by increasing soil compaction. Indirect effects could include erosion from the clearing and trampling of vegetation, or the disturbance of the BSCs that bind soils. Impervious surfaces reduce precipitation infiltration, and increase the rate and amount of soil erosion. Additionally, pollutants could be introduced from equipment use or fueling.

The 28.26 miles of transmission line of the Alternative B – South Diamond Lane Option would require a total of 514.18 acres of ROW. A temporary effect on soil erosion would occur in areas where vegetation was cleared, or where overland travel or trampling effectively eliminated vegetation. The areas proposed for the ROW and structures would be cleared of vegetation, however tensioning sites, laydown sites, and downguys would not be cleared of vegetation. Trampled vegetation and surface disturbance would be restored when construction was completed. The transmission line poles would be located approximately 600 feet apart, requiring approximately 254 poles for the Alternative B – South Diamond Lane Option, and would impact approximately 1.83 acres. The greatest effects to soils would be during excavation and installation.

As described above, the potential temporary effects during construction could include:

- Increased soil erosion due to construction activities, including the destruction of BSCs and/or clearing of vegetation.
- Potential for spills of hazardous materials during construction.

PDFs and BMPs would be used to minimize the effects to soils. BMPs are described in the Plan of Development for the transmission lines (CEP 2009) and the Application for Conditional Use Permit for the wind farm (CEP 2007), in accordance with the ODEQ Erosion and Sediment Control Manual (GeoSyntec Consultants 2005). The PDFs and BMPs are listed in Appendix A.

FUTURE CONSTRUCTION PHASE – UPGRADE TO 230-KV

As with Alternative B, the second construction phase would not require any additional ROW, access roads, or new permanent features outside of areas already affected by installation of the initial line. The effects from installation of the second circuit would be temporary, as described above.

MITIGATION

No additional mitigation measures would be required because Project design features (PDFs) and best management practices (BMPs) were taken into account in the effects analysis for the action alternatives and would be implemented to reduce the geology and soils effects (see Section 2 and Appendix A.3.1).

Hog Wallow Route Option

The Hog Wallow Route Option of Alternative B would incorporate the same procedures for transmission line and access road construction as described for Alternative B and the South Diamond Lane Route Option. The mitigation and BMPs used would be the same for both route options. Because the route options would differ only in the approximately 5 miles before the tie-in, the effects to geology would be similar to those discussed

for Alternative B. Although the Hog Wallow Route Option and the proposed alternative would be located over rock buttes, compared to the South Diamond Lane Route Options that would follow low flat marshland, erosion potential for each of these options would be low to moderate. The effects to soils and BSCs would differ in that the Hog Wallow Option would require a total of 528.78 acres of ROW, from the Echanis Substation to the tie-in with the HEC 115-kV line. In addition, approximately 262 towers would be needed for this option. The total effects from the ROW, Substation, maintenance building, and ICS would cover 530.04 acres. The effects and mitigation for the distribution line would be similar to those described for the Alternative B Proposed Action and South Diamond Lane Route Option.

PERMANENT EFFECTS

Seismically, the Project Area would not likely be hazardous for general construction (Smith 2008). Nonetheless, earthquakes have occurred and faults have been mapped in the region. The Alternative B – Hog Wallow Route would cross seven mapped faults. In general, earthquakes could threaten structural integrity of facilities. Damage from frequent small earthquakes could be equivalent to damage from a large, rare event. The level of risk to any structure would depend upon the importance of the structure, how hazardous the facility was, and the likelihood of earthquakes. Because movement along faults could trigger mass movement, landslides could be a concern. As stated above, historical landslide deposits are shown on the geologic map within and near the Project Area. Overall, 29.06 miles of transmission line of Alternative B – Hog Wallow Route would require a total of 528.78 acres of ROW.

Soil erosion could increase from the construction of impervious surfaces. During construction of the ICS, vegetation would be cleared and replaced with a gravel surface and impervious concrete pads for equipment. The total area for the ICS would be 0.69 acre.

Approximately 0.2 mile of new access road construction and approximately 2.0 miles of existing road improvements are planned. Road maintenance would include vegetation clearing; however, grasses and small vegetation would be left on the road bed if it did not obstruct access. These actions would reduce infiltration and increase runoff locally.

Additionally, the Alternative B – Hog Wallow Route Option would likely require approximately 26.38 miles of overland vehicle access. Overland vehicle access would likely consist of an 8-ft width of surface disturbance (25.58 acres).

The disturbance caused by excavation and compaction during Project construction could directly affect BSCs, if they were present in the Project Area. Clearing of the Substation site, adjacent maintenance building, Interconnection Station, and gravel access roads could adversely affect any BSCs in the immediate vicinity. The ROW, tensioning sites, and laydown sites would not be cleared, but the effects to any present BSCs could occur from compaction and damage to trampled vegetation. Assuming that poles would be placed at 600-ft intervals, Alternative B – Hog Wallow Route Option would contain approximately 262 poles. Assuming a surface disturbance of a 10-ft radius around each pole, the Alternative B – Hog Wallow Route Option would impact 1.89 acres. <u>In addition, the overland vehicle access could affect up to 25.58 acres of BSC, assuming BSC are present in all areas potentially disturbed by overland access roads.</u>

In summary, the permanent effects for Alternative B – Hog Wallow Route Option could include:

- Seismic hazard risk to structures, including landslides triggered by potential seismic events.
- Increased soil erosion caused by larger amounts of runoff due to access road construction and construction of other impervious surfaces.
- Potential destruction of BSCs, where present in the Project Area.

PDFs and BMPs would be used to minimize the effects to soils and geology during Project operation. BMPs are described in the Plan of Development for the transmission line (CEP 2009), in accordance with the ODEQ Erosion and Sediment Control Manual (GeoSyntec Consultants 2005). The PDFs and BMPs are discussed in Appendix A.

TEMPORARY EFFECTS

Project construction activities could increase erosion above the natural levels by increasing soil compaction. Indirect effects could include erosion from the clearing and trampling of vegetation or the disturbance of the BSCs that bind soils. Impervious surfaces reduce precipitation infiltration, and increase the rate and amount of soil erosion. Additionally, pollutants could be introduced from equipment use or fueling.

The 29.06 miles of transmission line of Alternative B – Hog Wallow Route Option would require a total of 528.78 acres of ROW. A temporary effect on soil erosion would occur in areas where vegetation was cleared, or where overland travel or trampling effectively eliminated vegetation. The areas proposed for the ROW and structures would be cleared of vegetation, however tensioning sites, laydown sites, and downguys would not be cleared of vegetation. Trampled vegetation and surface disturbance would be restored when construction was completed. The transmission line poles would be located approximately 600 feet apart, requiring approximately 262 poles for the Alternative B – Hog Wallow Route Option, and would impact approximately 1.89 acres. The greatest effects to soils would be during excavation and installation.

As described above, the potential temporary effects during construction of the Alternative B – Hog Wallow Route Option could include:

- Increased soil erosion due to construction activities, including the destruction of BSCs and/or clearing of vegetation.
- Potential for spills of hazardous materials during construction.
- Potential for destruction of nearby rock shelters or other cultural resources from blasting, where identified.

PDFs and BMPs would be used to minimize the effects to soils. BMPs are described in the Plan of Development for the transmission lines (CEP 2009) and the Application for Conditional Use Permit for the wind farm (CEP 2007), in accordance with the ODEQ Erosion and Sediment Control Manual (GeoSyntec Consultants 2005). The PDFs and BMPs are discussed in Appendix A.

FUTURE CONSTRUCTION PHASE – UPGRADE TO 230-KV

As with Alternative B, the second construction phase would not require any additional ROW, access roads, or new permanent features outside of areas already affected by installation of the initial line. Most effects from installation of the second circuit would be temporary and similar to those described above.

MITIGATION

No additional mitigation measures would be required because Project design features (PDFs) and best management practices (BMPs) were taken into account in the effects analysis for the action alternatives and would be implemented to reduce the geology and soils effects (see Section 2 and Appendix A.3.1).

115-kV Transmission Line Option

PERMANENT AND TEMPORARY EFFECTS

The 115-kV Transmission Line Option would require the same pole heights, pole spacing, ROW widths, construction methods, interconnection points, and access requirements as the 230-kV routes. However, construction of the transmission line using the 115-kV Transmission Line Option would not allow the line to

be expanded to a 230-kV line in the future. The effects and mitigation for the distribution line are similar to those described for the Alternative B – Proposed Action.

MITIGATION

No additional mitigation measures would be required because Project design features (PDFs) and best management practices (BMPs) were taken into account in the effects analysis for the action alternatives and would be implemented to reduce the geology and soils effects (see Section 2 and Appendix A.3.1).

3.1.3.4 Alternative C – North Route (Preferred Alternative)

PERMANENT EFFECTS

Seismically, the Project Area would not likely be hazardous for general construction (Smith 2008). Nonetheless, earthquakes have occurred and faults have been mapped in the region. The Alternative C – North Route would cross nine mapped faults. In general, earthquakes could threaten the structural integrity of the facilities. Damage from frequent small earthquakes could be equivalent to damage from a large, rare event. The level of risk to any structure would depend upon the importance of the structure, how hazardous the facility was, and the likelihood of earthquakes. Because movement along faults could trigger mass movement, landslides could be a concern. As stated above, historical landslide deposits are shown on the geologic map within and near the Project Area. Overall, 45.95 miles of transmission line of Alternative C – North Route would require a total of 835.85 acres of ROW.

Soil erosion could increase from the construction of impervious surfaces. During construction of the ICS at the tie-in to the HEC 115-kV line, vegetation would be cleared and replaced with a gravel surface and impervious concrete pads for equipment. The total area for the ICS would be 0.69 acre.

Approximately 5.03 miles of new access road construction are planned. Road maintenance would include vegetation clearing; however, grasses and small vegetation would be left on the road bed if it did not obstruct access. These actions would reduce infiltration and increase runoff locally. Additionally, Alternative C – North Route would likely require approximately 25.05 miles of overland vehicle access. Overland vehicle access would likely consist of an 8-ft width of surface disturbance (24.29 acres).

The disturbance caused by excavation and compaction during Project construction could directly affect BSCs, if they were present in the Project Area. Clearing of the Substation site, adjacent maintenance building, Interconnection Station, and gravel access roads could adversely affect any BSCs in the immediate vicinity. The ROW, tensioning sites, and laydown sites would not be cleared, but the effects to any present BSCs could occur from compaction and damage to trampled vegetation. Assuming that poles would be placed at 600-ft intervals, Alternative C – North Route would contain approximately 414 poles. Assuming a surface disturbance of a 10-ft radius around each pole, the Alternative C – North Route would impact 2.98 acres. In addition, overland vehicle access could affect up to 24.29 acres of BSC, assuming BSC were present in all areas potentially disturbed by overland access roads.

In summary, the permanent effects for Alternative C – North Route could include:

- Seismic hazard risk to structures, including landslides triggered by potential seismic events.
- Increased soil erosion caused by larger amounts of runoff due to access road construction and construction of other impervious surfaces.
- Potential destruction of BSCs, where present in the Project Area.

PDFs and BMPs would be used to minimize the effects to soils and geology during Project operation. BMPs are described in the Plan of Development for the transmission lines (CEP 2009), in accordance with the

ODEQ Erosion and Sediment Control Manual (GeoSyntec Consultants 2005). The PDFs and BMPs are discussed in Appendix A.

TEMPORARY EFFECTS

Project construction activities could increase erosion above the natural levels by increasing soil compaction. Indirect effects could include erosion from the clearing and trampling of vegetation, or the disturbance of the BSCs that bind soils. Impervious surfaces reduce precipitation infiltration, and increase the rate and amount of soil erosion. Additionally, pollutants could be introduced from equipment use or fueling.

The 45.95 miles of transmission line of Alternative C – North Route would require a total of 835.85 acres of ROW. A temporary effect on soil erosion would occur in areas where vegetation was cleared, or where overland travel or trampling effectively eliminated vegetation. The areas proposed for structures would be cleared of vegetation; tensioning sites, laydown sites, and downguys, however would not be cleared of vegetation. Trampled vegetation and surface disturbance would be restored when construction was completed. The transmission line poles would be located approximately 600 feet apart, requiring approximately 414 poles for Alternative C – North Route, and would impact approximately 2.98 acres. The greatest effects to soils would be during excavation and installation.

As described above, the potential temporary effects of Alternative C – North Route during construction could include:

- Increased soil erosion due to construction activities, including the destruction of BSCs and/or clearing of vegetation.
- Potential for spills of hazardous materials during construction.

PDFs and BMPs would be used to minimize the effects to soils during construction. BMPs are described in the Plan of Development for the transmission lines (CEP 2009), in accordance with the ODEQ Erosion and Sediment Control Manual (GeoSyntec Consultants 2005). The PDFs and BMPs are discussed in Appendix A.

FUTURE CONSTRUCTION PHASE – UPGRADE TO 230-KV

As with Alternative B, the second construction phase would not require any additional ROW, access roads, or new permanent features outside of areas already affected by installation of the initial line. Most effects from installation of the second circuit would be temporary and similar to those described above.

MITIGATION

No additional mitigation measures would be required because Project design features (PDFs) and best management practices (BMPs) were taken into account in the effects analysis for the action alternatives and would be implemented to reduce the geology and soils effects (see Section 2 and Appendix A.3.1).

115-kV Transmission Line Option

PERMANENT AND TEMPORARY EFFECTS

The 115-kV Transmission Line Option would require the same pole heights, pole spacing, ROW widths, construction methods, interconnection points, and access requirements as the 230-kV routes. However, construction of the transmission line using the 115-kV Transmission Line Option would not allow the line to be expanded to a 230-kV line in the future. The effects and mitigation for the distribution line are the same as those described for the Alternative B – Proposed Action.

3.1.3.5 Residual Effects after Mitigation

Residual effects related to the Proposed Action ~~would last only as long as the construction period, and~~ would include soil compaction and erosion.

3.1.3.6 Summary Comparison of Alternatives

The effect to geology and soils from development of the Echanis wind development, primary access road, and each alternative is summarized in Table 3.1-4. The table includes the effect to geology and soils along the primary access road to Echanis in addition to geological and soil effects from each alternative.

Table 3.1-4 Summary of Effects to Geology and Soils

			Alternative B			
Component	Alternative A - No Action	Echanis Wind Energy Project	West Route (Proposed Action)	S. Diamond Lane Route Option	Hog Wallow Route Option	Alternative C - North Route (Preferred Alternative)
Geology	Under No Action, existing conditions would remain and no additional environmental effects to geology would be created.	Seismically, the Project Area is not anticipated to be hazardous for general construction (Smith 2008). Earthquakes have occurred and faults have been mapped in the region. Because movement along faults could trigger mass movement, landslides might be a concern.	Seismically, the Project Area is not anticipated to be hazardous for general construction (Smith 2008). Alternative B would cross seven mapped faults. Earthquakes could threaten the structural integrity of facilities. Because movement along faults could trigger mass movement, landslides might be a concern.	Seismically, the Project Area is not anticipated to be hazardous for general construction (Smith 2008). Alternative B would cross six mapped faults. Earthquakes could threaten the structural integrity of the facilities. Because movement along faults could trigger mass movement, landslides might be a concern.	Seismically, the Project Area is not anticipated to be hazardous for general construction (Smith 2008). Alternative B would cross seven mapped faults. Earthquakes could threaten the structural integrity of facilities. Because movement along faults could trigger mass movement, landslides might be a concern.	Seismically, the Project Area is not anticipated to be hazardous for general construction (Smith 2008). Alternative B would cross nine mapped faults. Earthquakes could threaten the structural integrity of facilities. Because movement along faults could trigger mass movement, landslides might be a concern.
Soils	Currently, land in project area is used for agriculture and grazing. These activities increase erosion through soil disturbance and changes to vegetation community structure.	Soil erosion could increase from the construction of impervious surfaces. Substation site would consist of approximately 1.84 acres which would be cleared and covered with gravel and concrete foundations. O&M building would add 1,152 square feet of impervious surfaces. Construction and operation of the 18.95 mile main access road could cause an increase in soil erosion due to vegetation clearance. Construction	Increased erosion and sedimentation from clearing approx 1.87 acres for the transmission line poles and 0.69 acre for ICS facility. Increased runoff from roads and impervious surfaces resulting in more erosion. Approx 0.2 mile of new roads and 2.0 miles of road improvements are planned. Potential spills of harmful materials during construction.	Increased erosion and sedimentation from clearing approx 1.83 acres for the transmission line poles and 0.69 acre for ICS facility. Increased runoff from roads and impervious surfaces resulting in more erosion. Approx 0.2 mile of new roads and 2.0 miles of road improvements are planned. Potential spills of harmful materials during construction.	Increased erosion and sedimentation from clearing of approx 1.89 acres for the transmission line poles and ICS facility. Increased runoff from roads and impervious surfaces resulting in more erosion. Approx 0.2 mile of new roads and 2.0 miles of road improvements are planned. Potential spills of harmful materials during construction.	Increased erosion and sedimentation from clearing approx 2.98 acres for transmission line poles and ICS facility. Increased runoff from roads and impervious surfaces resulting in more erosion. Approx 5.03 miles of new roads are planned. Potential spills of harmful materials during construction.

Table 3.1-4 Summary of Effects to Geology and Soils

Component	Alternative A - No Action	Echanis Wind Energy Project	Alternative B: West Route (Proposed Action)	Alternative B: S. Diamond Lane Route Option	Alternative B: Hog Wallow Route Option	Alternative C - North Route (Preferred Alternative)
		includes 12.81 miles of new access road (30 ft width), 17.11 miles of string roads (16 ft width) and 6.14 miles of existing road improvements (additional 10 ft width).				
Biological Soil Crusts (BSCs)	Ongoing grazing agriculture could diminish Biological Soils Crusts through soil compaction, direct disturbance, and changes to the vegetation community structure.	Increased soil erosion from construction activities including the destruction of BSCs and/or clearing of vegetation. Introduction of exotic vegetation that would not support BSC recovery. Potential spills of harmful materials during construction.	Potential destruction to BSCs present in approx 1.87 acres for the transmission line poles and 0.69 acre for the ICS facility. In addition, overland vehicle access could affect up to 25.28 acres of BSC, assuming that BSC were present in all areas potentially disturbed by overland access roads. Introduction of exotic vegetation that would not support BSC recovery. Potential spills of harmful materials during construction.	Potential destruction to BSCs present in approx 1.83 acres for the transmission line poles and 0.69 acre for the ICS facility. In addition, overland vehicle access could affect up to 21.68 acres of BSC, assuming that BSC were present in all areas potentially disturbed by overland access roads. Introduction of exotic vegetation that would not support BSC recovery. Potential spills of harmful materials during construction.	Potential destruction to BSCs present in approx 1.89 acres for the transmission line poles and ICS facility. In addition, the overland vehicle access could affect up to 25.58 acres of BSC, assuming BSC are present in all areas potentially disturbed by overland access roads. Introduction of exotic vegetation that would not support BSC recovery. Potential spills of harmful materials during construction.	Potential destruction to BSCs present in approx 2.98 acres for the transmission line poles and ICS facility. In addition, overland vehicle access could affect up to 24.29 acres of BSC, assuming BSC were present in all areas potentially disturbed by overland access roads. Introduction of exotic vegetation that would not support BSC recovery. Potential spills of harmful materials during construction.