3.10. SOILS

3.10.1. Analysis Methods

3.10.1.1. Analysis Area

Soil investigations for the analysis area were conducted by WESTECH Environmental Services, Inc. (WESTECH), which are included as Appendix E (WESTECH 2017) of the MOP Application (Tintina 2017). The soil analysis area included the MOP Application Boundary (i.e., Project area), encompassing approximately 1,888 acres, and the surrounding area for a total of 3,368 acres. This area includes, but is not limited to, all land to be disturbed by mining including the reclamation material stockpile areas, access roads, portal pad, cement tailings area, subsoil stockpile, spillway, and ponds.

3.10.1.2. Information Sources

WESTECH conducted the soil investigations for the analysis area in July and October of 2015 to identify and describe soil profiles, sample representative soil horizons, and determine suitability for reclamation. WESTECH based their study on the soil survey procedures developed by the Natural Resource Conservation Service (NRCS) as part of the Soil Survey Manual (USDA 1993). The baseline soils survey contains descriptions of field, laboratory, and interpretation methods (WESTECH 2017). Meagher County soils have been mapped and data are available online as part of the U.S. Department of Agriculture's Web Soil Survey.

3.10.1.3. Methods of Analysis

The baseline soil survey included 30 soil survey sites that were selected after traversing the landscape and observing variable soil conditions in the field. Of these 30 sites, samples were collected from major soil horizons at 25 locations. Each soil survey site was manually excavated with a shovel or hand auger to either a depth of 40 inches, auger refusal, or upon hitting bedrock. For each sample location, the following characteristics were recorded in the field: drainage class, slope range, parent material, vegetation and land use, topography and position, aspect, surface runoff, erosion, permeability, horizon types, depths and thickness, color and texture, coarse fragment content, carbonates, clay films, effervescence, roots, and structure.

Laboratory analyses were performed on selected physical and chemical characteristics of the soils. Particle size analysis, percent rock fragments, organic matter percent, salinity/conductivity, and chemical properties including soil pH, arsenic, cadmium, copper, lead, and zinc were determined as part of the study. Baseline soils survey interpretations were used to access the likely impacts of each alternative. Laboratory analyses were completed in August and November of 2015.

Initial map unit boundaries were drawn based on field results and then refined based on literature review and laboratory analysis results.

3.10.2. Affected Environment

3.10.2.1. Soil Types

Based on the results of the baseline soil survey, 18 NRCS-established soil series were identified as components of identified soil map units in the analysis area (see **Figure 3.10-1**). The following sections summarize relevant physical and chemical properties of each series. **Table 3.10-1** provides a breakdown of map units by acres present within the analysis area.

Table 3.10-1
Summary of Soil Map Units in the Analysis Area

Map Unit Name	Acres in the Analysis Area	Percent of the Analysis Area
Adel loams	26.9	<1
Caseypeak, skeletal loams	222.4	7
Caseypeak, skeletal loams steep	79.3	2
Cheadle, channery loams	798.5	24
Clunton, clay loams	26.5	<1
Duckcreek, clay loams	138.0	4
Farlin, clay loams	46.5	1
Houlihan, sandy loams	50.2	2
Kimpton, skeletal loams	345.8	10
Kimpton, skeletal loams steep	127.7	4
Libeg, clay loams	197.8	6
Medicinelodge frequently flooded	256.4	8
Medicinelodge occasionally flooded	71.7	2
Poin, skeletal sandy loams	188.3	6
Raynesford, silty clay loams	67.5	2
Redchief, silty loams	86.5	3
Redfish, occasionally flooded	31.5	<1
Sebud, gravelly loams	35.7	1
Wineglass, channery clay loams	166.4	5
Woodhall, skeletal loams	328.1	10
Woodhurst, skeletal loams	27.9	<1
Disturbed Land	36.9	1
Rock Outcrop	11.3	<1
Total	3,367.8	100[a]

Source: WESTECH 2017
Notes:
[a] Percent totals are greater or less than 100 percent due to rounding.

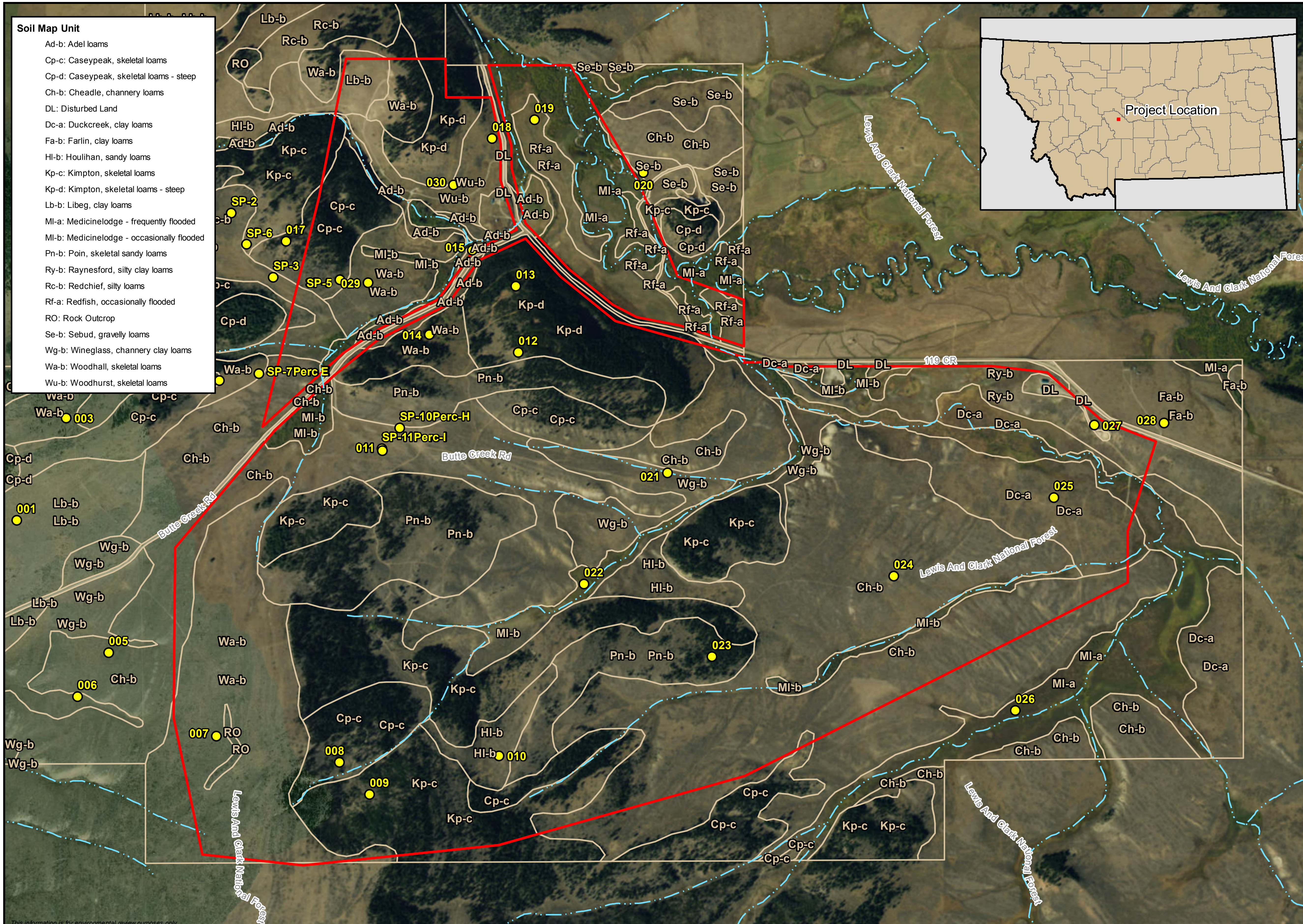

Figure 3.10-1
Black Butte
Copper Project
Baseline Soil Survey Map
Meagher County, Montana

Soil Sample Point
Project Area
Soil Boundary
Stream

N W E S

0 1,000 2,000
Feet

1:15,000

FILE: M:\Clients\M-O\MTDEQ\BlackBute_Copper_ArcGIS\2017\12\Soils_MTDEQ_Black_Butte_Soils.mxd | REVISED: 02/01/2019 | SCALE: 1:15,000 when printed at 11x17 DRAWN BY: JPB

Ad-b: Adel loam (5 to 15 percent slopes)

Soils within the Adel series consist of very deep and well-drained soils that typically form in alluvium, colluvium, or slide deposits. Permeability is moderate, and soils are found on a variety of landforms including alluvial fans, mountain slopes, hills, stream terraces, and drainage ways. High volumes of coarse fragments were found in the Adel loam sample survey Site BB15 with 50 percent coarse fragments identified at a depth of 15 to 32 inches and 60 percent at a depth of 32 to 40 inches. The Adel series has a wind erodibility group (WEG) rating of 5 and a soil erodibility factor rating of 0.2 to 0.3, both exhibiting low to moderate susceptibility to erosion. Chemical property test results indicated levels exceeding the Montana DEQ threshold levels for arsenic, lead, zinc, and cadmium (WESTECH 2017; NRCS 2017; Hydrometrics, Inc. 2013). Adel loams represent less than 1 percent of the soils proposed to be disturbed as part of the Project.

Cp-c: Caseypeak, skeletal loams (15 to 40 percent slopes) and Cp-d: Caseypeak, skeletal loams steep (40 to 70 percent slopes)

Soils within the Caseypeak series consist of shallow and well-drained soils that typically form in residuum derived from coarse-grained, igneous rocks such as granite. Permeability is moderately rapid and soils are found on mountains and hills. High volumes of coarse fragments were found in the Caseypeak sample survey Sites BB02 and BB17. Site BB02 showed 75 percent coarse fragments at a depth of 0 to 3 inches. Site BB17 showed 50 percent coarse fragments identified at a depth of 0 to 4 inches and 75 percent coarse fragments at a depth of 4 to 12 inches. Shallow bedrock was also identified at sample Sites BB02, BB08, and BB17 at depths of 20, 3, and 12 inches, respectively. Soil series Cp-d was identified as having a slope limit that could inhibit soil salvage. The Caseypeak series has a WEG rating of 5 and a soil erodibility factor rating of 0.2 to 0.3, both exhibiting low to moderate susceptibility to erosion. Chemical property test results indicated levels exceeding the DEQ threshold levels for arsenic, lead, and zinc (WESTECH 2017; NRCS 2017; Hydrometrics, Inc. 2013). Caseypeak, skeletal loams represent 8 percent of the soils proposed to be disturbed as part of the Project.

Ch-b: Cheadle, channery loams (5 to 15 percent slopes)

Soils within the Cheadle series consist of shallow and well-drained soils that typically form in colluvium and residuum derived primarily from hard sandstone. Permeability is moderate and soils are found on plains, hills, mountains, ridges, and escarpments. High volumes of coarse fragments were found in the Cheadle sample survey Sites BB05, BB11, and BB24. Site BB05 showed 50 percent coarse fragments identified at a depth of 4 to 9 inches and 80 percent coarse fragments at a depth of 9 inches and deeper. Site BB11 showed 50 percent coarse fragments at a depth of 19 to 30 inches, while Site BB24 exhibited 90 percent coarse fragments at a depth of 6 to 10 inches. Shallow bedrock was also identified at sample Sites BB05, BB11, and BB24 at depths of 9, 30, and 10 inches, respectively. The Cheadle series has a WEG rating of 6 and a soil erodibility factor rating of 0.3 to 0.4, both exhibiting low to moderate susceptibility to erosion. Chemical property test results indicated levels exceeding the DEQ threshold level for lead

(WESTECH 2017; NRCS 2017; Hydrometrics, Inc. 2013). Cheadle, channery loams represent 27 percent of the soils proposed to be disturbed as part of the Project.

Cl-a: Clunton, clay loams frequently flooded (0 to 5 percent slopes)

Soils within the Clunton series consist of very deep and very poorly drained soils that typically form in alluvium. Permeability is moderate and soils are found on floodplains, floodplain steps, and drainage ways. Depth to groundwater for the Clunton series is ten inches, which may restrict soil salvage operations. The Clunton series has a WEG rating of 5 and a soil erodibility factor rating of 0.2 to 0.4, both exhibiting low to moderate susceptibility to erosion. Chemical property test results indicated levels exceeding the DEQ threshold level for lead (WESTECH 2017; NRCS 2017; Hydrometrics, Inc. 2013).

Dc-a: Duckcreek, clay loams (0 to 5 percent slopes)

Soils within the Duckcreek series consist of moderately deep and well-drained soils that typically form in interbedded sandstone and shale residuum as well as clayey sedimentary beds. Permeability is slow and soils are found on hills, mountains, and escarpments. Soil texture at Site BB25 exceeded clay content levels identified by DEQ for reclamation potential. The Duckcreek series has a WEG rating of 6 and a soil erodibility factor rating of 0.2 to 0.3, both exhibiting low to moderate susceptibility to erosion. Chemical property test results indicated levels exceeding the DEQ threshold level for lead (WESTECH 2017; NRCS 2017; Hydrometrics, Inc. 2013). Duckcreek, clay loams represent 1 percent of the soils proposed to be disturbed as part of the Project.

Fa-a: Farlin, clay loams (0 to 5 percent slopes)

Soils within the Farlin series consist of very deep and well-drained soils that typically form in alluvium, colluvium, and limestone slide deposits. Permeability is moderate and soils are found on hills, mountain slopes, ridges, landslides, fan remnants, and escarpments. The Farlin series has a WEG rating of 6 and a soil erodibility factor rating of 0.2 to 0.3, both exhibiting low to moderate susceptibility to erosion (WESTECH 2017 and NRCS 2017).

Hl-b: Houlihan, sandy loams (5 to 15 percent slopes)

Soils within the Houlihan series consist of very deep and well-drained soils that typically form in alluvium and colluvium. Permeability is moderate and soils are found on hills, mountain slopes, swales, and fan remnants. High volumes of coarse fragments were found in the Houlihan sample survey Site BB11, showing 50 percent coarse fragments at a depth of 19 to 30 inches. The Houlihan series has a WEG rating of 6 and a soil erodibility factor rating of 0.2 to 0.4, both exhibiting low to moderate susceptibility to erosion (WESTECH 2017 and NRCS 2017). Houlihan, sandy loams represent 1 percent of the soils proposed to be disturbed as part of the Project.

Kp-c: Kimpton, skeletal loams (15 to 40 percent slopes) and Kp-d: Kimpton, skeletal loams steep (40 to 70 percent slopes)

Soils within the Kimpton series consist of moderately deep and well-drained soils that typically form in colluvium and slope alluvium. Permeability is moderate and soils are found on bedrock-floored plains, mountain slopes, hills, and ridges. Soil texture at Site BB12 exceeded clay content levels identified by DEQ for reclamation potential. High volumes of coarse fragments were found in the Kimpton sample survey Sites BB09, BB12, and BB13. Site BB09 showed 60 percent coarse fragments identified at a depth of 12 to 30 inches. Site BB12 showed 60 percent coarse fragments at a depth of 36 to 42 inches and deeper. Site BB13 exhibited 55 percent coarse fragments at a depth of 5 to 14 inches and 70 percent coarse fragments at a depth of 14 to 24 inches and deeper. Shallow bedrock was also identified at sample Sites BB09 and BB12 at depths of 30 and 24 inches, respectively. Soil series Kp-d was identified as having a slope limit that could inhibit soil salvage. The Kimpton series has a WEG rating of 6 and a soil erodibility factor rating of 0.3 to 0.4, both exhibiting low to moderate susceptibility to erosion. The pH value identified at Site BB09 fell within the acidic range, which could impede revegetation. Chemical property test results indicated levels exceeding the DEQ threshold levels for arsenic, lead, zinc, and cadmium (WESTECH 2017; NRCS 2017; Hydrometrics, Inc. 2013). Kimpton, skeletal loams represent 26 percent of the soils proposed to be disturbed as part of the Project.

Lb-b: Libeg, clay loams (5 to 15 percent slopes)

Soils within the Libeg series consist of very deep and well-drained soils that typically form in alluvium, colluvium, outwash, till, or slide deposits. Permeability is moderate and soils are found on a variety of landforms including alpine moraines, mountain slopes, avalanche chutes, stream terraces, and hills. The Libeg series has a WEG rating of 7 and a soil erodibility factor rating of 0.2 to 0.4, both exhibiting low to moderate susceptibility to erosion. The pH value identified at Site BB01 fell within the acidic range, which could impede revegetation. Chemical property test results indicated levels exceeding the DEQ threshold levels for arsenic, lead, zinc, and cadmium (WESTECH 2017; NRCS 2017; Hydrometrics, Inc. 2013).

Ml-a: Medicinelodge frequently flooded (0 to 5 percent slopes) and Mb-b: Medicinelodge occasionally flooded (5 to 15 percent)

Soils within the Medicinelodge series consist of very deep and poorly drained soils that typically form in clayey alluvium. Permeability is slow and soils are found on stream terraces, drainage ways, floodplain steps, depressions, and landslides. High volumes of coarse fragments were found in the Medicinelodge sample survey Site BB26 with 50 percent coarse fragments identified at a depth of 24 to 36 inches and 60 percent at a depth of 36 to 42 inches. Depth to groundwater for the Medicinelodge series is 24 to 36 inches, which may restrict soil salvage operations. The Medicinelodge series has a WEG rating of 7 and a soil erodibility factor rating of 0.2 to 0.3, both exhibiting low to moderate susceptibility to erosion. The pH value identified at Site BB022 fell within the acidic range, which could impede revegetation (WESTECH 2017 and

NRCS 2017). Medicinelodge soils represent less than 1 percent of the soils proposed to disturbed as part of the Project.

Pn-b: Poin, skeletal sandy loams (5 to 10 percent)

Soils within the Poin series consist of shallow and well-drained soils that typically form in colluvium and residuum derived from various rocks including granite, sandstone, and quartzite. Permeability is moderately rapid and soils are found on bedrock-floored plains, mountains, ridges, and hills. High volumes of coarse fragments were found in the Poin sample survey Site BB23 with 50 percent coarse fragments identified at a depth of 4 to 9 inches and 55 percent at a depth of 9 to 12 inches. Shallow bedrock was also identified at sample Site BB23 at a depth of 16 inches. The Poin series has a WEG rating of 6 and a soil erodibility factor rating of 0.3 to 0.4, both exhibiting low to moderate susceptibility to erosion. The pH value identified at Site BB23 fell within the acidic range, which could impede revegetation (WESTECH 2017 and NRCS 2017). Poin, skeletal sandy loams represent about 25 percent of the soils proposed to be disturbed as part of the Project.

Ry-b: Raynesford, silty clay loams (5 to 15 percent)

Soils within the Raynesford series consist of very deep and well-drained soils that typically form in alluvium and slope alluvium, or colluvium derived from limestone and shale. Permeability is moderate and soils are found on a variety of landforms including swales, stream terraces, mountain slopes, and alluvial fans. Soil texture at Site BB27 exceeded clay content levels identified by DEQ for reclamation potential. The Raynesford series has a WEG rating of 6 and a soil erodibility factor rating of 0.3 to 0.4, both exhibiting low to moderate susceptibility to erosion (WESTECH 2017 and NRCS 2017).

Rc-b: Redchief, silty loams (5 to 15 percent)

Soils within the Redchief series consist of very deep and well-drained soils that typically form in slope alluvium, colluvium, till, or glaciofluvial deposits. Permeability is slow and soils are found on a variety of landforms including alluvial fans, stream terraces, hills, and mountain slopes. High volumes of coarse fragments were found in the Redchief sample survey Site BB16 with 60 percent coarse fragments identified at a depth of 22 to 30 inches. Shallow bedrock was also identified at sample Site BB16 at a depth of 30 inches. The Redchief series has a WEG rating of 7 and a soil erodibility factor rating of 0.2 to 0.3, both exhibiting low to moderate susceptibility to erosion. The pH value identified at Site BB16 fell within the acidic range, which could impede revegetation (WESTECH 2017 and NRCS 2017).

Rf-a: Redfish occasionally flooded (0 to 5 percent slopes)

Soils within the Redfish series consist of very deep and poorly to very poorly drained soils which typically form in alluvium. Soils are found on floodplains, fan remnants, and valley floors. High volumes of coarse fragments were found in the Redfish sample survey Site BB19 with 70 percent coarse fragments identified at a depth of 17 to 28 inches and deeper. Depth to groundwater for the Redfish series is 20 inches, which may restrict soil salvage operations. The

Redfish series has a WEG rating of 7 and a soil erodibility factor rating of 0.2, both exhibiting low to moderate susceptibility to erosion (WESTECH 2017 and NRCS 2017). Redfish occasionally flooded soils represent 1 percent of the soils proposed to be disturbed as part of the Project.

Sb-b: Sebud, gravelly loams (5 to 15 percent slopes)

Soils within the Sebud series consist of very deep and well-drained soils that typically form in till, outwash, alluvium, slope alluvium, and colluvium. Permeability is moderate and soils are found on till plains, alluvial fans, moraines, alluvial fans, hills, and mountains. High volumes of coarse fragments were found in the Sebud sample survey Site BB20 with 60 percent coarse fragments identified at a depth of 32 to 48 inches and 85 percent coarse fragments identified at a depth of 48 inches and deeper. The Sebud series has a WEG rating of 6 and a soil erodibility factor rating of 0.2 to 0.3, both exhibiting low to moderate susceptibility to erosion (WESTECH 2017 and NRCS 2017).

Wg-b: Wineglass, channery clay loams (5 to 15 percent slopes)

Soils within the Wineglass series consist of very deep and well-drained soils that typically form in colluvium, alluvium, and residuum derived from various rock types. Permeability is moderately slow and soils are found on mountain side slopes. High volumes of coarse fragments were found in the Wineglass sample survey Site BB06 with 65 percent coarse fragments identified at a depth of 34 to 50 inches. The Wineglass series has a WEG rating of 6 and a soil erodibility factor rating of 0.3 to 0.4, both exhibiting low to moderate susceptibility to erosion. Chemical property test results indicated levels exceeding the DEQ threshold level for lead, zinc, and cadmium (WESTECH 2017; NRCS 2017; Hydrometrics, Inc. 2013). Wineglass, channery clay loams represent about 4 percent of soils proposed to be disturbed as part of the Project.

Wa-b: Woodhall, skeletal loams (5 to 15 percent slopes)

Soils within the Woodhall series consist of moderately deep and well-drained soils that typically form in non-calcareous gravelly colluvium or slope alluvium derived from either igneous or sedimentary rock. Permeability is moderate and soils are found on a variety of landforms including structural benches, ridges, upland hills, and U-shaped valleys. High volumes of coarse fragments were found in the Woodhall sample survey Sites BB03, BB07, and BB14. Site BB03 showed 60 percent coarse fragments identified at a depth of 13 to 22 inches and 70 percent coarse fragments at a depth of 22 to 36 inches. Site BB07 showed 50 percent coarse fragments at a depth of 9 to 14 inches, while Site BB14 exhibited 75 percent coarse fragments at a depth of 11 to 24 inches. Shallow bedrock was also identified at sample Site BB07 at a depth of 14 inches. The Woodhall series has a WEG rating of 6 and a soil erodibility factor rating of 0.2 to 0.4, both exhibiting low to moderate susceptibility to erosion. The pH value identified at Site BB16 fell within the acidic range, which could impede revegetation. Chemical property test results indicated levels exceeding the DEQ threshold level for lead, zinc, and cadmium (WESTECH 2017; NRCS 2017; Hydrometrics, Inc. 2013). Woodhall skeletal loams represent about 5 percent of the soils proposed to be disturbed as part of the Project.

Wu-b: Woodhurst, skeletal loams (5 to 15 percent slopes)

Soils within the Woodhurst series consist of moderately deep and well-drained soils that typically form in colluvium over residuum derived from igneous rocks (nonacid). Permeability is moderate and soils are found on hills and mountains. High volumes of coarse fragments were found in the Woodhurst sample survey Site BB18 with 70 percent coarse fragments identified at a depth of 24 to 35 inches and 75 percent coarse fragments identified at a depth of 35 to 45 inches. The Woodhurst series has a WEG rating of 5 and a soil erodibility factor rating of 0.2 to 0.4, both exhibiting low to moderate susceptibility to erosion. Chemical property test results indicated levels exceeding the DEQ threshold level for arsenic, copper, lead, zinc, and cadmium (Hydrometrics, Inc. 2013). The Woodhurst series was the only sample to also exceed the U.S. Environmental Protection Agency regional screening level threshold for lead (WESTECH 2017 and NRCS 2017). Woodhurst, skeletal loams represent less than 1 percent of the soils proposed to be disturbed as part of the Project.

3.10.3. Environmental Consequences

This section addresses soil impacts resulting from the Proposed Action and other alternatives identified as described in Chapter 2, Description of Alternatives. Soil impacts resulting from the Project, typical of any operations where soil is removed, stored, and replaced, would include:

- Loss of soil and soil profile development;
- Soil erosion from disturbed areas and loss of suitable salvage materials through handling and erosion;
- Reduction of favorable physical soil properties;
- Reduction in biological activity; and
- Changes in soil nutrient levels.

These impacts, in combination with the proposed reclamation plan, aid in determining the success of restoring land to existing land use and vegetation types after mine operations have ceased. Where reclamation success is limited, secondary impacts on soils including soil erosion and sedimentation into waterbodies, reduced soil productivity, and seasonal increases in air pollution due to wind erosion may occur.

3.10.3.1. No Action Alternative

Under the No Action Alternative, the Project would not be developed and impacts on soil resources would be limited compared with other alternatives. Erosion and sedimentation would occur at current rates along the existing roads. Natural erosional processes due to rainfall and wind would continue to occur throughout the analysis area. Loss of soil development characteristics would be minimized and limited to new disturbances planned in the Project area in the future.

3.10.3.2. Proposed Action

Soil Loss

The majority of the soils proposed for disturbance and salvage under the Proposed Action are skeletal loams and channery loams with a high percentage of rock fragments. Many of the soils identified in the analysis area and discussed in Section 3.10.2.1, Soil Types, are not proposed for disturbance or reclamation. While not identified in **Table 3.10-2,** these "undisturbed" soils could be disturbed as part of 10 percent construction buffer, which includes a 25-foot perimeter around all Project facilities and was added to the total soil volume calculations.

Under the Proposed Action, a total of 283.7 acres of soils would be disturbed as part of the Project in areas of stockpiled and non-stockpiled soils (as depicted in **Table 3.10-2**). Soils would be stripped from the majority of these areas. Total soil volumes of about 563,692 cubic yards would be salvaged and stockpiled long-term for reclamation activities associated with mine closure, and approximately 304,773 cubic yards of soils would be temporarily stored and replaced on site for reclamation of construction activities, including grading, slope stabilization, drainage control, topsoil and subsoil placement, and seeding. An additional approximately 29.6 acres of disturbance would occur in areas where no soil salvage would occur.

Table 3.10-2
Acres of Disturbance and Estimated Salvage Volumes for Soil Series Associated with the Project

Map Unit Name	Soils to be Stockpiled		Soils to be Stored and Replaced on Site (No Stockpiling)	
	Total Acres of Disturbance	Total Soil Volume (Topsoil and Subsoil) (yd^3)	Total Acres of Disturbance	Total Soil Volume (Topsoil and Subsoil) (yd^3)
Adel loams	0.0	0.0	0.1	542.0
Caseypeak, skeletal loams	15.1	27,285.0	4.7	8,493.0
Caseypeak, skeletal loams steep	0.0	0.0	0.0	0.0
Cheadle, channery loams	41.9	75,711.0	28.6	51,678.0
Clunton, clay loams	0.0	0.0	0.0	0.0
Duckcreek, clay loams	0.0	0.0	2.9	15,720.0
Farlin, clay loams	0.0	0.0	0.0	0.0
Houlihan, sandy loams	0.0	0.0	2.9	15,720.0
Kimpton, skeletal loams	52.5	284,592.0	9.3	50,413.0
Kimpton, skeletal loams steep	0.0	0.0	0.4	0.0
Libeg, clay loams	0.0	0.0	0.0	0.0
Medicinelodge frequently flooded	0.0	0.0	1.2	6,505.0
Medicinelodge occasionally flooded	0.0	0.0	0.7	3,795.0
Poin, skeletal sandy loams	36.6	66,134.0	25.6	46,258.0
Raynesford, silty clay loams	0.0	0.0	0.0	0.0

Map Unit Name	Soils to be Stockpiled		Soils to be Stored and Replaced on Site (No Stockpiling)	
	Total Acres of Disturbance	Total Soil Volume (Topsoil and Subsoil) (yd^3)	Total Acres of Disturbance	Total Soil Volume (Topsoil and Subsoil) (yd^3)
Redchief, silty loams	0.0	0.0	2.0	10,842.0
Redfish, occasionally flooded	0.0	0.0	1.8	9,757.0
Sebud, gravelly loams	0.0	0.0	0.0	0.0
Wineglass, channery clay loams	7.5	40,656.0	5.7	30,899.0
Woodhall, skeletal loams	5.0	18,069.0	6.7	24,213.0
Woodhurst, skeletal loams	0.0	0.0	0.6	2,168.0
Disturbed land	1.8	0.0	0.5	0.0
10% construction buffer	--	51,245.0	--	27,770.0
Total	**160.4**	**563,692.0**	**93.7**	**304,773.0**

Source: Tintina 2017
yd^3 = cubic yards

The potential for soil loss would occur during Project construction and operations phases. Vegetation removal during clearing and grading exposes soil and makes it more susceptible to erosive forces. Loss of soil would also occur from the removal and storage of soils during mine construction and operations, and during reclamation where redistributed soils would once again be subject to erosive forces.

All stockpiled soil would be susceptible to erosion. Topsoil and subsoil would be stored in two separate stockpiles and would be constructed with horizontal to vertical ratios of 2.5H:1V side slopes and 3H:1V for access ramps. Stockpiles would be in place for the life of the mine until reclamation occurs. The Proponent has proposed implementation of interim seeding to minimize water and wind erosion until the soil is needed during reclamation. Broadcast seeding would occur during the first seeding season following stockpiling. If needed, the stockpile surface would be scarified to provide a better seeding surface.

Erosion would occur during reclamation activities when salvaged soil is redistributed on recontoured surfaces. Salvaged soils would be redistributed evenly over disturbed areas with an average depth of approximately 14.6 inches of topsoil and 12.4 inches of subsoil. Areas reclaimed without storage (direct-hauled soil), would have less potential for erosion than areas reclaimed with stored stockpiled soil. Vegetation would establish more rapidly on direct-hauled soil as the soil would still be biologically active and would retain a higher level of favorable physical and chemical soil characteristics. Areas where soil would be immediately replaced include pipeline trenches, roadside disturbances, diversion ditch perimeters, and buried power lines.

Soil losses would be long-term and have a high likelihood to occur within all disturbed Project areas given that erosion rates would remain elevated after reclamation until vegetated ground cover reaches predisturbance levels. After vegetation is well established, soil losses would be similar to preconstruction rates. The Proponent would implement sediment control BMPs and install berms around topsoil and subsoil stockpiles to minimize impacts on soil loss during construction, operations, and closure phases of the Project. These BMPs would include:

- Vegetation management and revegetation;
- Mulching;
- Rolled erosion control products;
- Slope roughening;
- Recontouring;
- Use of silt fences, temporary sediment traps, and sediment basins;
- Use of filter bags and flocculants; and
- Use of collection ditches, diversion ditches, culverts, and water bars.

Additionally, soil erosion and construction monitoring would occur during active construction and maintenance monitoring during mine closure. Monitoring would occur at all Project ground disturbances to identify where slumps, rills, gullies, and sheet wash may occur. All identified erosion control issues would be immediately corrected. Monitoring and the implementation of BMPs would minimize soil losses; however, soil loss would still occur under the Proposed Action.

Although implementation of BMPs and monitoring would reduce the overall impact of soil loss, residual impacts remain likely and long-term.

Physical, Biological, and Chemical Characteristics

The Proposed Action would alter the physical, biological, and chemical characteristics of soil. Soil structure and nutrient levels would be altered by handling, salvage, and storage activities. Potential impacts to chemical properties include changes in heavy metal concentrations and pH.

Changes in soil structure, compaction (destruction of pore space continuity and soil structure), and loss of organic matter due to mixing and storage would occur. In areas where the soil profile would be altered, it would take years for soil productivity to return to predisturbance conditions after reclamation. The establishment of vegetation, root systems, and physical processes (e.g., freezing and thawing, wetting and drying) would restart the soil building processes and help rebuild the natural soil profile.

Soil compaction modifies the structure and reduces the porosity and moisture-holding capacity of soils. Construction equipment traveling over wet soils could disrupt the soil structure, reduce pore space, increase runoff potential, or cause rutting. The degree of compaction depends on moisture content and soil texture. Fine-textured soils with poor internal drainage that are moist or saturated during construction are most susceptible to compaction and rutting. Soils with a high potential for compaction and structural damage in the Project area are typically very poorly drained soils with an organic soil component. Coarse-textured and well-drained soils are typically not considered compaction-prone. To minimize these impacts and reduce compaction, where practicable, the Proponent would time salvage activities to avoid periods of wet or saturated soil. Prior to soil redistribution, compacted areas would be ripped to relieve compaction and eliminate the potential for slippage along soil layer contacts, and promote root growth. Following reclamation, compaction in re-spread soils would be similar to pre-mine conditions. Soil compaction would be short-term and have a high likelihood to occur.

Biological impacts would occur in salvaged soils. The majority of disturbed soils would not be reclaimed until the end of mine operations and would be stockpiled for 19 years or longer. Storing topsoil and subsoil for prolonged periods of time reduces the number of vital soil microorganisms (i.e., fungi, bacteria, and algae) that are key to soil nutrient cycling. Additional components typically found in native soils that are lost during soil storage include native plant seeds and stems, which are both capable of producing new plants (Birnbaum et al. 2017). While the surface layer of each stockpile would be revegetated, this would only replenish organisms to the first 6 or 8 inches of the stockpile, leaving the majority of the soil with reduced biological activity.

Mycorrhizae are important soil structures that develop when certain plant roots and fungi form a symbiotic relationship and serve as an extension of a plant's root system. These structures are primarily present in forested areas or where lower woody species are present. Many species rely on mycorrhizae for their survival, especially in soils lacking needed nutrients. These systems are eliminated in soils stored for extended periods of time (Malloch et al. 1980). As discussed in Section 3.13.2.1, Vegetation and Plant Communities, the majority of the analysis area consists of upland grassland and shrubland habitat; however some forested land is present. Biological impacts would be long-term and have a high likelihood to occur. The Proponent would minimize these impacts by removing vegetation during initial Project construction with small shrubs and herbaceous vegetation being salvaged with topsoil. Non-commercial trees, slash, tall shrubs, and small stumps would be chipped and salvaged with topsoil. Over time after reclamation, mycorrhizae would spread from adjacent undisturbed land, thereby increasing species diversity.

Aluminum, iron, and manganese are common metals released by the weathering of soil parent materials, even in non-mineralized areas. They can become concentrated in a particular soil horizon by various soil-formation processes. While these metals are usually not available to plants with soils of neutral pH values, if soil surveys indicate soil pH is around 5.0, additional soil metal testing may be required to identify possible naturally occurring concentrations of these and other metals.

Soil samples tested had pH values from 5.0 to 8.0, with values between 5.7 and 7.5 being the most common. Only six sample locations had pH values lower than 5.5 with none being lower than 5.0. Samples with low pH were all observed within the rooting zone of existing native vegetation. Given the minimal presence of low pH soils, no impacts on vegetation growth are expected from salvaged soil due to the prevalence of soil materials with neutral pH values. No changes to soil pH values are expected from Project construction or operations.

Soil samples in the analysis area were tested for a number of heavy metals that often are associated with mineralized zones and could hinder plant growth. These included lead, zinc, copper, arsenic, and cadmium. As discussed in Section 3.10.2.1, Soil Types, multiple soils in the analysis area exhibited levels that exceed DEQ baseline background values for these inorganic elements (Hydrometrics, Inc. 2013). Given that these exceedances were found in vegetated native soils, they are not anticipated to reduce soil suitability for reclamation. Exceptions to this include the high levels of inorganic elements found in the deep horizons of the Woodhurst soils, which were taken into consideration in the development of proposed soil salvage depths.

Impacts to biological and chemical compositions of the soil would have a high likelihood and moderate severity; therefore, impacts would be moderate in all disturbed areas.

Reclamation Impacts

DEQ's guidelines for soil salvage consider soils on slopes greater than 50 percent to be unsalvageable due to equipment limitations and safety requirements. In addition to the slope criteria, soil depth, percent rock fragments, pH, and soils texture are also used to determine if the soil can be used in reclamation. While DEQ's guidelines advise soil salvage suitability, individual site conditions may necessitate the salvage of less suitable soils to achieve reclamation goals. The soils in the analysis area are generally suitable for salvage and reclamation. Salvageable soils, including surface soil and subsoil layers, occur in depths ranging from 12 to 36 inches. Organic matter levels in surface soils were on average high, and pH values ranged from 5.0 to 8.0, but were typically between 5.5 and 7.0.

Topsoil and subsoil would be salvaged and stockpiled for the majority of facility construction areas including the CTF, mill pad, portal pad, copper-enriched stockpile pad, temporary WRS pad, CWP, PWP, and NCWR embankment footprint. Soils would be salvaged, but not stored in the main stockpiles for facilities such as new roads, diversion ditches, infiltration galleries, vent raises, and buried pipelines. When possible, soil removed from a specific construction area would be hauled directly to, and used to reclaim, another previously disturbed area, thereby eliminating the need for prolonged storage. Additionally, soils removed during road and diversion ditch construction would be concurrently used to revegetated adjacent cut and fill slopes.

The volume of soil suitable for salvage and reclamation would be limited by slope, shallow depth to bedrock, coarse fragment quantity, and exposed bedrock. The principal limitation of soil suitability for reclamation identified during the baseline soil survey was rock fragment content. Thirteen of the 18 soil series had 50 percent or greater rock fragments identified in at least one survey location. High levels of rock fragment content ranged from 50 to 90 percent. The Proponent's proposed salvage recommendations are presented in **Table 3.10-3;** however, a soils scientist would be present on site during initial soil salvage activities to establish salvage guidelines for specific soil types and landscape features. If there is a shortage of cover soils, soils containing more than 50 percent coarse rock fragments would be screened and salvaged for use during reclamation to avoid the need for offsite topsoil. The remaining coarse material would be used as fill during mine closure.

Table 3.10-3
Salvage Recommendations for Soil Series Associated with Project Disturbance

Soil Series	Soil Limitations	Recommendations
Adel (Ad-b)	Coarse fragment content of 50% and arsenic and cadmium levels exceeding DEQ levels	1st lift salvage depth of 12 inches and a 2nd lift depth of 24 inches to a total of 36 inches
Caseypeak (Cp-c and Cd-d)	Poor salvage potential due to very high coarse fragment content, shallow bedrock, steep slopes, and exceeding DEQ levels for lead and zinc	Single lift depth of 12 inches for Cp-c and no salvage for Cp-d
Cheadle (Ch-b)	Coarse fragment content of 50% and arsenic and cadmium levels exceeding DEQ levels	Single lift depth of 12 inches
Duckcreek (Dc-a)	Exceeding DEQ levels for lead	1st lift salvage depth of 12 inches and a 2nd lift depth of 24 inches to a total of 36 inches
Houlihan (Hl-b)	None	1st lift salvage depth of 12 inches and a 2nd lift depth of 24 inches to a total of 36 inches
Kimpton (Kp-s and Kp-d)	High coarse fragment content, pH levels below 5.5, occurring on slopes steeper than 50%, and exceeding DEQ levels for arsenic, cadmium, lead, and zinc	1st lift salvage depth of 12 inches and a 2nd lift depth of 24 inches to a total of 36 inches for Kp-c. No salvage recommended for Kp-d.
Medicinelodge (Ml-a and Ml-b)	Associated with wetlands and shallow groundwater and high coarse fragment content	1st lift salvage depth of 12 inches and a 2nd lift depth of 24 inches to a total of 36 inches
Poin (Pn-b)	High coarse fragment content, pH levels below 5.5, and shallow depth to bedrock	Single lift depth of 12 inches
Redfish (Rf-a)	High coarse fragment content and shallow depth to groundwater	1st lift salvage depth of 12 inches and a 2nd lift depth of 24 inches to a total of 36 inches
Wineglass (Wg-b)	High coarse fragment content and exceeding DEQ levels for lead and zinc	1st lift salvage depth of 12 inches and a 2nd lift depth of 24 inches to a total of 36 inches
Woodhall (Wa-b)	High coarse fragment content, pH levels below 5.5, and exceeding DEQ levels for cadmium, arsenic, lead, and zinc	1st lift salvage depth of 12 inches and a 2nd lift depth of 12 inches to a total of 24 inches
Woodhurst (Wu-b)	High coarse fragment content and exceeding DEQ levels of arsenic, cadmium, copper, lead, and zinc	1st lift salvage depth of 12 inches and a 2nd lift depth of 12 inches to a total of 24 inches

Source: WESTECH 2017

The recognition of inherent soil properties and design of salvage programs to retain these favorable properties can increase reclamation success. The potential for reclamation success of disturbed lands is improved when soil is salvaged and later replaced in two or more lifts to provide an adequate growth medium for plants. As shown in **Table 3.10-3**, the majority of soils associated with the Proposed Action would be salvaged using a two-lift method. This method would limit impacts from mixing soil horizons; however, time would be needed to re-establish a new soil profile. Over time, natural processes would rebuild a new soil profile that may be similar or different from preexisting conditions. The loss of soil development and the time required to rebuild a new soil profile would be unavoidable long-term Project impacts.

Reclamation success may be enhanced by the use of soil amendments. Use of mulches and/or tackifiers could reduce the amount of soil loss until seedlings can establish. The Proponent has proposed the use of mulch (e.g., straw, wood fiber, wood chips) for erosion control and protection of seed beds during revegetation. Wood-based organic amendments could be added to the soil to reduce compaction, crusting, and bulk density; increase soil fertility and organic matter content; and potentially improve establishment of mycorrhizae communities and increase the growth of woody plant species. The Proponent would mow or chip small shrubs, herbaceous vegetation, noncommercial trees, slash, tall shrubs, and small stumps. This woody debris would then be salvaged with topsoil.

The primary factors that would determine the success of revegetation include scheduling of final revegetation, plant species selection, planting plans, establishment success, and growth rates to achieve cover and density objectives. Revegetation success would be monitored each year during the growing season until all reclaimed areas have achieved a vegetative cover of at least 70 percent of the comparable vegetative cover on a nearby undisturbed site. Revegetation is discussed in more detail in Section 3.13, Vegetation.

If there is a temporary period of inactivity at the mine, where the continuation of mining is still under consideration, temporary closure of the site (to last no longer than 1 year) would occur. Temporary short-term closure of the mine would include stabilization and revegetation of existing disturbances. The Proponent would implement final reclamation activities within 1 year of deciding to permanently discontinue mining in the Project area. Before initiating final closure procedures, the Proponent would meet with DEQ to review their final long-term closure plan and revise as needed. The Proponent would comply with all applicable requirements outlined in § 82-4-366, MCA, for permanent reclamation.

Over time, natural processes would rebuild a new soil profile that may be similar or different from preexisting conditions. The loss of soil development and the time required to rebuild a new soil profile would be unavoidable long-term Project impacts. Overall, the impacts on soils from the reclamation process are expected to be major.

Smith River Assessment

The Project would not have any direct impacts on soil resources in the Smith River area. Potential secondary impacts include increased or decreased erosion rates due to changes in water quantity. As discussed in Section 3.5.3.1, Surface Water Quantity, based on the Proposed Action description, impacts on surface water quantity in Sheep Creek are expected to be minor; therefore, potential impacts on water quantity in the Smith River would be insignificant. Any secondary impacts associated with soil resources along the Smith River would also be insignificant.

3.10.3.3. Agency Modified Alternative

The potential impacts of the AMA on soils would be the same as described for the Proposed Action. The disturbance footprint would also be the same for the AMA; therefore, the same amount and types of soils would be impacted by the alternative. Additionally, the AMA does not propose any changes to soil reclamation. Any potential secondary impacts would be similar to those described for the Proposed Action Alternative as surface water impacts would be similar to those for the Proposed Action Alternative.

Smith River Assessment

The potential impacts of the AMA on soils would be the same as described for the Proposed Action. The disturbance footprint would also be the same for the AMA; therefore, no direct impacts on soil resources in the Smith River area would occur.