# Chokecherry and Sierra Madre Wind Energy Project
# Site-Specific Reclamation Plan

Phase I

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# 1.0 INTRODUCTION

Power Company of Wyoming LLC (PCW) proposes to construct, operate, maintain, and decommission the Chokecherry and Sierra Madre Wind Energy Project (CCSM Project), located in Carbon County, Wyoming. The CCSM Project consists of up to 1,000 wind turbines capable of generating approximately 2,000 to 3,000 megawatts (MW) of clean, renewable wind energy. The primary components of the CCSM Project include the wind turbine generators, an internal road network, a rail facility, a quarry, an internal electrical collection and transmission system, substations, and operations and maintenance buildings.

The CCSM Project is located south of the city of Rawlins, primarily within the bounds of the Overland Trail Ranch (Ranch). The Ranch is owned and operated by PCW affiliate, The Overland Trail Cattle Company LLC (TOTCO). The Ranch is situated within an area of alternating sections of private and federal lands commonly referred to as the "checkerboard." The vast majority of the private lands are owned by TOTCO and the federal lands are administered by the Bureau of Land Management (BLM) Rawlins Field Office (RFO). A small percentage of the land within the Ranch is owned by the State of Wyoming and is administered by the State Board of Land Commissioners. Finally, Anadarko Land Corporation owns some sections located on the periphery of the northwest boundary of the Ranch.

In 2008, PCW applied to BLM for right-of-way grants to construct, operate, maintain, and decommission the CCSM Project on federal land within the CCSM Project Area. On June 29, 2012, the Notice of Availability for the Final Environmental Impact Statement (FEIS) concerning the CCSM Project was published in the Federal Register (77 FR 63328). On October 9, 2012 the Secretary of the Interior signed the Record of Decision (ROD). In the ROD, BLM determined that over 200,000 acres within the CCSM Project Area are suitable for wind energy development subject to the requirements described under the Selected Alternative in the ROD. The area that was determined to be suitable for wind energy development consists of two wind development areas (WDAs) in which turbines would be located. The northern WDA is known as Chokecherry and the southern WDA is known as Sierra Madre. The WDAs are located approximately 9 miles apart.

Prior to issuing right-of-way grants for the CCSM Project, BLM will conduct subsequent environmental analysis of site-specific plans of development submitted by PCW. The site-specific plans of development will be screened against the analysis conducted in the FEIS and the requirements described under the Selected Alternative in the ROD. Included in the ROD is the Master Reclamation Plan for the CCSM Project (BLM 2012a: Appendix B). The Master Reclamation Plan for the CCSM Project provides an overview of the reclamation goals, standards, and procedures that will be used to ensure successful reclamation of disturbed areas.

This Site-specific Reclamation Plan is for Phase I of the CCSM Project. Phase I of the CCSM Project (CCSM Phase I) represents the infrastructure components and the first half of the CCSM Project's electrical generation. PCW has developed four Site-Specific Plans of Development for CCSM Phase I, as follows:

1. Phase I Haul Road and Facilities
2. West Sinclair Rail Facility
3. Road Rock Quarry
4. Phase I Wind Turbine Development

Collectively, the project elements described in the four Site-Specific Plans of Development make up CCSM Phase I.

This Site-specific Reclamation Plan describes the methods for reclaiming disturbance associated with CCSM Phase I and the processes for monitoring and reporting on reclamation success. These procedures were developed in accordance with BLM Wyoming Reclamation Policy (2012b), Rawlins Field Office (RFO) Resource Management Plan (RMP) (BLM 2008), RFO Reclamation Guidance (BLM 2011), Wyoming Department of Environmental Quality (WDEQ) Land Quality Division reclamation guidelines (WDEQ 2007), and State of Wyoming's reclamation guidance for wind development, in coordination with BLM staff.

The reclamation procedures and success standards set out in the CCSM Project Master Reclamation Plan and this Site-specific Reclamation Plan apply to federal lands within the CCSM Phase I Site. While the preference is to use these procedures and standards on private lands and state lands, specific reclamation procedures and standards on private lands and state lands may vary and will be developed in coordination with private landowners, the Wyoming Industrial Siting Council, the State Land Board and the Wyoming Game and Fish Commission (WGFC), as appropriate. This Site-Specific Reclamation Plan is intended to be adaptive to take into account changing conditions and technologies. PCW, in coordination with the BLM Authorized Officer (AO), may update, modify, or change the procedures contained in this Reclamation Plan if warranted due to site conditions or other factors.

## 1.1 DEFINITIONS, OBJECTIVES, AND SUCCESS STANDARDS

The Master Reclamation Plan for the CCSM Project defines reclamation goals, objectives, and success standards for the CCSM Project; including initial stabilization, interim reclamation, and final reclamation (BLM 2012a). This section reiterates those objectives and success standards.

Reclamation is defined in the CCSM Project Master Reclamation Plan as the rehabilitation of a disturbed area to make it acceptable for designated use. Reclamation measures are intended to ensure that biophysical conditions are maintained in the short term to achieve long-term goals of revegetation and ecosystem reconstruction (BLM 2012b).

In accordance with the CCSM Project Master Reclamation Plan, PCW will stabilize soils and control erosion for all disturbed areas immediately after surface disturbance occurs. Following initial stabilization, PCW will initiate interim reclamation for those areas that are not required for routine operations and maintenance, but which may be re-disturbed during non-routine activities or decommissioning. The objective of interim reclamation is to maintain healthy, biologically active topsoil; control erosion; minimize visual impacts; and, reduce habitat and forage loss until final reclamation is initiated.

For areas that will not be re-disturbed during operations and maintenance, and for all other areas following decommissioning, PCW will proceed with final reclamation as soon as practicable. The objective of final reclamation is to return the land to a condition approximating that which existed prior to disturbance with allowances for an improved and/or stable ecological condition where possible. This includes reconstruction of the landform to approximate its original state along with re-establishment of a stable vegetative community, hydrologic systems, visual resources, agricultural values, and wildlife habitats.

The success of reclamation on federal lands will be measured against the standards set out in the BLM RFO RMP (BLM 2008) and the CCSM Project Master Reclamation Plan, as further clarified in the Site-specific Monitoring and Reporting Plan (Attachment A). These success standards address soil handling, drainage and erosion control, revegetation, invasive plants and noxious weeds, and landscape reconstruction (see *Section 7.0 – Reclamation Monitoring*). PCW will reclaim wetlands per the requirements of the Clean Water Action section 404 permit from the U.S. Army Corps of Engineers.

# 2.0 PRE-DISTURBANCE SITE CHARACTERIZATION

As discussed in the CCSM Project Master Reclamation Plan, pre-disturbance site characterization is critical for reclamation monitoring purposes to describe the surrounding landscape, determine ecological community types, and assess biophysical parameters.
To complete pre-disturbance site characterization for CCSM Phase I, PCW used soil surveys, vegetation data, aerial imagery, climate information, and other natural features to delineate the ecological sites that occur within CCSM Phase I Site. Vegetation and soil surveys were conducted in 2009 and 2013 - 2014 for CCSM Phase I to ensure that each identified ecological site is appropriately classified.

The baseline information collected includes topographic, hydrologic, vegetation, and soil parameters. Methods for the pre-disturbance characterization and reclamation success monitoring are consistent with the methods used by NRCS to develop ecological sites (Caudle et al. 2013; Herrick et al. 2009; Schoeneberger et al. 2012) and are provided in the Reclamation Monitoring and Reporting Plan (Attachment A). The vegetation and soils data collected as part of the pre-disturbance site characterization were used to develop ecological site reclamation implementation plans (Attachments B-F). These plans contain the detailed site-specific information necessary to conduct reclamation.

## 2.1 ECOLOGICAL SITE DELINEATION

An ecological site is a specific type of land defined by its physical characteristics that differs from other communities within a landscape in its ability to produce and support a distinctive type and amount of vegetation, and in its ability to respond similarly to management actions and natural disturbances (Natural Resources Conservation Service [NRCS] 2011). NRCS-approved ecological site descriptions have not been published for areas within the CCSM Project Site. The NRCS also has not published soil data or approved ecological sites spatial data for the CCSM Project Site; as a result, ecological sites were delineated from the best available biophysical parameters for the reclamation area and further supported and refined through ground surveys (Attachments B-F). PCW described ecological sites for the CCSM Project area using a spatially implicit modeling approach that incorporated spatially available vegetation, soil, and digital elevation model (DEM) data. The model was further ground-truthed and supplemental data were gathered at 126 sampling locations spatially distributed throughout the CCSM Project Site in 2013. An additional 82 locations were sampled in 2014 for purposes of refining ecological site characterization as well as to establish reference sites for monitoring purposes.

Biophysical and climatic parameters have been characterized in the disturbance area to delineate ecological sites, assess pre-disturbance conditions, and determine ecological site-specific seed mixtures for revegetation (Attachments B-F). Twenty-five ecological sites occur within CCSM Phase I within three precipitation zones: 7-9 inch precipitation zone, 10-14 inch precipitation zone, and 15-19 inch precipitation zone (Table 1) (NRCS 2012). Descriptions for each ecological site are included in the Ecological Site Reclamation Implementation Plans (Attachments B-F). The CCSM Phase I Map Book (Attachment G) illustrates the distribution of each ecological site within the limits of disturbance.

Ecological site-specific reclamation procedures and Best Management Practices (BMPs) have been developed for each ecological site and are presented in Attachments B-F. Additionally, because many BMPs will be implemented across ecological sites with similar soil, vegetation, precipitation, and reclamation characteristics, individual ecological sites have been grouped into similar ecological site classes (loamy, sandy, clayey, saline, and shallow). Grouping similar ecological sites into a common ecological site class will increase efficiency and effectiveness of reclamation efforts as many of these common sites have identical or very similar measures for soil handling, site preparation, and revegetation.

**Table 1. Ecological sites and ecological site classes for CCSM Phase I**

| Clay ecological site class | Loam ecological site class | Shallow ecological site class | Saline ecological site class | Sand ecological site class |
|---|---|---|---|---|
| Clayey 7-9 Inch | Loamy 7-9 Inch | Very Shallow 7-9 Inch | Deep Shale 7-9 Inch | Sandy 7-9 Inch |
| Clayey 10-14 Inch | Loamy 10-14 Inch | Shallow Loamy 7-9 Inch | Deep Shale 10-14 Inch | Sandy 10-14 Inch |
| Clayey Overflow 7-9 Inch | Loamy 15-19 Inch | Shallow Loamy 10-14 Inch | Saline Lowland 7-9 Inch | |
| | Loamy Overflow 10-14 Inch | Shallow Loamy 15-19 Inch | Saline Upland 7-9 Inch | |
| | Wetland and Riparian 10-14 Inch | Shallow Sandy 10-14 Inch | Saline Upland 10-14 Inch | |
| | Aspen 15-19 Inch | Mountain Windswept Ridge 15-19 Inch | Shale 7-9 Inch[1] | |
| | Wet Fresh Meadow 15-19 Inch | | Shale 10-14 Inch | |

1 Not impacted by CCSM Phase I activities and not included in Clay Ecological Site Class Reclamation Implementation Plan

## 2.2 REFERENCE SITES

As discussed in the CCSM Project Master Reclamation Plan, reference sites document the site characteristics necessary to evaluate reclamation success standards and serve as a reference to the surrounding landscape and ecological community types within the disturbance area. A minimum of three reference sites for each ecological site occurring in CCSM Phase I will be used for reclamation monitoring purposes. Multiple reference sites for each ecological site account for local variability in vegetation, soil, and climatic conditions and provide a range of vegetation and soil baseline standards to assess reclamation success. In addition to reference sites, characterizations have been completed within the disturbance area to further verify that the disturbance area is similar in character to the selected reference site(s).

## 2.3 SOIL CONDITIONS

Soil depths, composition, textures, colors, and other physical and chemical properties, have been evaluated during soil surveys for CCSM Phase I and during geotechnical testing. Attachments B-F describes the soil conditions for each ecological site per the requirements of the BLM Wyoming Reclamation Policy (BLM 2012b) and the RFO Reclamation Plan

template (BLM 2011). Soils within the CCSM Phase I Site are described in the Site-specific Plans of Development, Fugro 2013 and BLM 2012a. The Ecological Site Reclamation Implementation Plans (Attachments B-F) contain physical, chemical, and biological soil attributes for each ecological site that occurs within the CCSM Phase I Site.

## 2.4 PRE-DISTURBANCE VEGETATION COMPOSITION

The CCSM Phase I Site includes several vegetation types characterized by areas of rolling sagebrush steppe, salt desert shrub basins, and foothills shrubland. Aspen-mixed conifer woodland, upland grasslands, and sparsely vegetated communities are also present. Vegetation communities were confirmed from 2012 through 2014 across the CCSM Phase I Site. Wetland delineation data were collected in 2012, 2013 and 2014 to characterize the wetland plant communities within the CCSM Phase I Site, the results of which are included in Appendix K of the Site-Specific Plans of Development and are not further summarized here. Table 2 includes a summary of the primary vegetation communities within the CCSM Phase I Site. Vegetation communities within CCSM Phase I are also described in the site-specific Ecological Site Descriptions in Attachments B-F.

## Table 2. Vegetation communities within the CCSM Phase I Site

| Vegetation Community | Infrastructure Components[1] | | Phase I Wind Turbine Development | | | CCSM Phase I Total | |
|---|---|---|---|---|---|---|---|
| | *Initial (acres)* | *Long-term[2] (acres)* | *Initial (acres)* | *Long-term[2] (acres)* | *Activity Area[3] (acres)* | *Initial (acres)* | *Long-term (acres)* |
| Wyoming Big Sagebrush Communities | 337 | 66 | 716 | 130 | 84 | 1,137 | 197 |
| Mountain Big Sagebrush Communities | 141 | 30 | 669 | 99 | 110 | 920 | 130 |
| Black Sagebrush Communities | 6 | <1 | 467 | 76 | 42 | 515 | 76 |
| Shadscale Saltbush Communities | 326 | 75 | 419 | 66 | 77 | 822 | 141 |
| Upland Grass Communities | 69 | 12 | 328 | 50 | 43 | 441 | 62 |
| Gardner's Saltbush Communities | 269 | 103 | 196 | 19 | 28 | 493 | 123 |
| Disturbed and Developed Areas[4] | 155 | 47 | 110 | 26 | 19 | 283 | 73 |
| Greasewood Communities | 83 | 23 | 61 | 10 | 22 | 166 | 33 |
| Riparian/Mesic Lowland Communities | 15 | 3 | 36 | 4 | 7 | 58 | 7 |
| Aspen Woodland Communities | 5 | 1 | 16 | 2 | 2 | 23 | 3 |
| Basin Big Sagebrush Communities | 11 | 1 | 8 | 1 | 4 | 23 | 2 |
| Barren Slopes | 3 | <1 | 4 | 1 | 0 | 7 | 2 |
| Mixed Mountain Shrub Communities | 1 | <1 | 4 | <1 | 2 | 7 | <1 |
| Bird's Foot Sagebrush Communities | 7 | 2 | 1 | 0 | 0 | 8 | 2 |
| Lowland Grass Communities | <1 | <1 | 0 | 0 | 0 | <1 | <1 |
| Riparian Woodland Communities | <1 | 0 | 0 | 0 | 0 | <1 | 0 |
| **Total[5]** | **1,428** | **364** | **3,035** | **485** | **440** | **4,904** | **850** |

1 Infrastructure Components include Phase I Haul Road and Facilities, West Sinclair Rail Facility, and Road Rock Quarry
2 Long-term disturbance includes surface disturbances remaining after interim reclamation.
3 Activity areas are work areas in which surface disturbing activities will not occur. Some vegetation removal may occur in activity areas.
4 Includes areas with existing surface disturbance as well as hay meadows, pastures, and other agricultural lands and facilities.
5 Values may not always sum to total due to rounding

## 2.5 LIMITED RECLAMATION POTENTIAL AREAS AND SENSITIVE SOILS

The BLM defines Limited Reclamation Potential (LRP) areas and sensitive soils as sites that are particularly difficult to restore due to highly sensitive physical, biological, and/or chemical characteristics (BLM 2012b). The BLM uses the following criteria, relevant to the CCSM Phase I Site, to identify potential LRP areas:

- Slopes greater than 25% on south or southwest facing aspects;
- Rock outcrops;
- Marine shale and seleniferous geological substrates;
- Vegetation communities dominated by salt-loving (halophytic) plant species or other sensitive plant communities;
- Noxious and invasive weed species; or
- Annual precipitation less than nine inches.

Sensitive soil conditions can be identified from the site-specific soils and vegetation data incorporated into the ecological site mapping. The BLM defines sensitive soils as containing one or more the following characteristics (BLM 2012b):

- Topsoil depth: no topsoil available or very shallow – less than 3 inches.
- pH: greater than 8.4.
- Electrical conductivity: greater than 8 deciSiemens per meter (dS/m), indicating strongly saline soils.
- Sodium absorption ratio (SAR): greater than 13 (laboratory test), indicating sodic soils.
- Texture: sand, sandy clay, silty clay, clay, or silt.
- Parent materials: marine shale, clay/siltstone, seleniferous geological substrates.
- Halophytes: e.g., Gardner's saltbush.
- Alkali halophytes: e.g., black greasewood.
- Selenium accumulator plants: e.g., two-grooved milkvetch, prince's plume, and wood aster.
- Very shallow, saline, lowland, sands, clayey, or badland ecological sites.

PCW has identified and avoided LRP areas in the vicinity of the CCSM Phase I Site to the extent practicable, in accordance with the requirements of the ROD (BLM 2012a). Where avoidance is not practicable, best management practices (BMPs) and other strategies designed to address site-specific conditions will be implemented to increase reclamation success (Attachments B-F). PCW has addressed the potential LRP areas within the CCSM Phase I Site as follows:

- PCW used LiDAR topography data to determine slopes within the CCSM Project Site. PCW has avoided disturbance on terrain with slopes greater than 25% in the CCSM Phase I Site to the extent practicable.

- PCW used geologic analysis, aerial photography, and ground observations to identify rock outcroppings in the CCSM Phase I Site. To the extent practicable, PCW has avoided rock outcroppings, and in the event that rock outcroppings are disturbed, BMPs and other strategies will be implemented to address site-specific conditions and increase reclamation success (Attachments B-F).
- The underlying geologic substrate within the CCSM Phase I Site potentially supports the occurrence of marine shales (Fugro 2013). PCW has designed CCSM Phase I to avoid mapped shale ecological sites where possible and impacts have been minimized (Attachments B and G). Where marine shale substrates are disturbed, BMPs and other strategies will be implemented to address site-specific conditions and increase reclamation success (Attachment B).
- Seleniferous soils and sensitive plant communities have been identified and avoided to the extent practicable. To the extent these conditions could not be avoided or if they are further identified during construction or reclamation activities, appropriate BMPs and strategies will be determined in coordination with the BLM AO to increase reclamation success (Attachments B-F).
- Noxious and invasive weeds have been identified in the CCSM Phase I Site (Site-specific Plans of Development – Appendix J). Noxious and invasive weeds will be controlled in accordance with the CCSM Project Weed Management Plan.
- Portions of the CCSM Phase I Site have annual precipitation less than nine inches per year; therefore these areas could not feasibly be avoided. Soil handling techniques, site preparation techniques, and seeding techniques will be implemented to account for arid conditions (Attachments B-F).

LRP areas and sensitive soils occur in portions of the CCSM Phase I Site. These include areas of slopes greater than 25% and southerly aspects, shallow soils, sandy and clayey soils, and areas with saline conditions. Areas of slopes greater than 25% and southerly aspects will be avoided to the extent possible. Shallow ecological sites generally have limited reclamation potential due to poor topsoil quality, increased rock fragment content, and shallow depth to bedrock or a restrictive layer. Saline ecological sites contain soil conditions that are difficult to reclaim due to low strength and high erosive potential and seed sources for suitable plant species in these saline environments are often limited. These soils are generally more difficult to reclaim due to poor topsoil suitability and seed source for suitable plant species are limited. BMPs and other strategies will be implemented to increase reclamation success, including providing proper soil handling techniques and seed mixes to promote the re-establishment of sensitive plant communities (Attachments B-F).

Additional LRP areas and sensitive soils may be identified during construction activities (BLM 2012b). These sites will be identified by the Environmental Inspector(s) and reported to the compliance manager and BLM AO prior to additional surface-disturbing activities. LRP areas and sensitive soils may include: rock outcroppings and limiting geological substrate (e.g., marine shale, clay/siltstone, seleniferous parent material); shallow topsoil depths (less than 3 inches); potential sodic soils and heightened sodium absorption ratios (SARs); extremely coarse (i.e., sand dunes) or fine textures (i.e., massive clay features); and, limiting plant communities (e.g., halophytic plants, selenium accumulators, noxious and undesirable

plant species, and unique plant communities). In the event site-specific LRP areas or sensitive soils are identified, additional LRP/sensitive soil BMPs and protective measures will be implemented in coordination with the BLM AO. Following the implementation of reclamation and monitoring, if reclamation standards are not being met in LRP areas and/or sensitive soils, PCW will implement additional site-specific BMPs and protective measures (e.g., topsoil amendments, soil remediation, weed control, etc.) as needed and in coordination with the BLM AO.

# 3.0 SURFACE-DISTURBING ACTIVITIES

The Site-specific Plans of Development for CCSM Phase I includes details of the project design and the location of all surface-disturbing activities. Reclamation will begin immediately following construction with initial stabilization followed by interim and final reclamation, as appropriate. The Site-specific Plans of Development provides additional information on the CCSM Phase I components that are discussed below.

## 3.1 PHASE I HAUL ROAD AND FACILITIES

The Site-specific Plan of Development for the Phase I Haul Road and Facilities includes details of the Phase I Haul Road and Facilities design and the location of all surface-disturbing activities. Reclamation will begin immediately following construction with initial stabilization followed by interim and final reclamation, as appropriate. The Site-specific Plan of Development provides additional information on the Phase I Haul Road and Facilities components that are discussed below.

The Phase I Haul Road and Facilities will disturb approximately 875.1 acres initially and 225.4 acres long-term (Table 3). The Phase I Haul Road and Facilities include the haul road, water extraction roads, operations and maintenance areas, and work areas.

**Table 3. Initial and long-term disturbance for the Phase I Haul Road and Facilities.**

| Ecological Site | Initial Disturbance[1] (Acres) | Long-Term Disturbance[2] (Acres) |
|---|---|---|
| **Clay Ecological Site Class (Attachment B)** | | |
| Clayey 7-9 Inch | 57.6 | 15.6 |
| Clayey 10-14 Inch | 78.1 | 19.9 |
| Clayey Overflow 7-9 Inch | - | - |
| **Loam Ecological Site Class (Attachment C)** | | |
| Loamy 7-9 Inch | 23.5 | 5.7 |
| Loamy 10-14 Inch | 194.0 | 53.4 |
| Loamy 15-19 Inch | 34.4 | 5.4 |
| Loamy Overflow 10-14 Inch | 17.2 | 4.5 |
| Wetland and Riparian 10-14 Inch | 4.7 | 0.9 |
| Aspen 15-19 Inch | 9.0 | 0.9 |
| Wet Fresh Meadow 15-19 Inch | | |
| **Shallow Ecological Site Class (Attachment D)** | | |
| Very Shallow 7-9 Inch | 9.1 | 2.1 |
| Shallow Loamy 7-9 Inch | 19.4 | 5.6 |
| Shallow Loamy 10-14 Inch | 16.0 | 2.8 |
| Shallow Loamy 15-19 Inch | 1.3 | 0.1 |
| Shallow Sandy 10-14 Inch | 9.2 | 2.5 |
| Mountain Windswept Ridge 15-19 Inch | 13.6 | 1.5 |
| **Saline Ecological Site Class (Attachment E)** | | |
| Deep Shale 7-9 Inch | 132.9 | 40.0 |
| Deep Shale 10-14 Inch | 17.1 | 6.3 |
| Saline Lowland 7-9 Inch | 39.2 | 9.9 |
| Saline Upland 7-9 Inch | 88.9 | 21.8 |
| Saline Upland 10-14 Inch | 6.2 | 1.3 |
| Shale 10-14 Inch | - | - |
| **Sand Ecological Site Class (Attachment F)** | | |
| Sandy 7-9 Inch | 66.6 | 16.6 |
| Sandy 10-14 Inch | 12.4 | 3.6 |
| **Other** | | |
| Agriculture/Pasture | 0.3 | 0 |
| Disturbed/Developed | 24.3 | 5.3 |
| **Total[3]** | **875.1** | **225.4** |

1 Initial disturbance includes all surface disturbing activities plus activity areas in which surface disturbance will not occur
2 Long-term disturbance includes surface disturbances remaining after interim reclamation.
3 Values may not always sum to total due to rounding

The design documentation for the Phase I Haul Road and Facilities includes infrastructure locations, initial and long-term disturbance areas, and information on soil management and drainage crossings (Phase I Haul Road and Facilities Site-specific Plan of Development - Appendix B). Overall, the Phase I Haul Road and Facilities has a net total balance of cut and fill (Table 4). Topsoil from the cut will be salvaged and used in the immediate area for reclamation purposes. Excess subsoil not used as fill will be hauled and stockpiled at the Road Rock Quarry for use as reclamation fill (Section 4.1.3).

**Table 4. Cut and fill earthwork summary for the Phase I Haul Road and Facilities.**

| Phase I Haul Road and Facilities Component | Total Cut | Total Adjusted Fill | Net [Long / (Short)] |
|---|---|---|---|
| | C.Y. | C.Y. | C.Y. |
| North Road | 225,000 | 225,000 | 0 |
| Smith Draw Road | 119,000 | 119,000 | 0 |
| Chokecherry Road – North of Little Sage Creek | 776,000 | 776,000 | 0 |
| Chokecherry Road – Little Sage Creek to Basin Laydown | 233,000 | 233,000 | 0 |
| Chokecherry Road – West of Basin Laydown | 234,000 | 234,000 | 0 |
| Lower Miller Hill Road | 544,000 | 544,000 | 0 |
| Miller Hill Road Upgrade | 87,000 | 87,000 | 0 |
| Facilities | 82,000 | 82,000 | 0 |
| **Total** | **2,300,000** | **2,300,000** | **0** |

*C.Y. = cubic yard

## 3.2 WEST SINCLAIR RAIL FACILITY

The Site-specific Plan of Development for the West Sinclair Rail Facility (Rail Facility) includes details of the Rail Facility design and the location of all surface-disturbing activities. Reclamation will begin immediately following construction with initial stabilization followed by interim and final reclamation, as appropriate. The Site-specific Plan of Development provides additional information on the Rail Facility components that are discussed below.

The Rail Facility will disturb approximately 377.0 acres initially and 121.2 acres long-term (Table 5). The Rail Facility components include the Wye Track, Running Track, Lead Track, Loop Track, other unloading tracks, laydown areas, and access roads.

**Table 5. Initial and Long-term Disturbance for the Rail Facility.**

| Ecological Site | Initial Disturbance[1] (Acres) | Long-Term Disturbance[2] (Acres) |
|---|---|---|
| **Clay Ecological Site Class (Attachment B)** | | |
| Clayey 7-9 Inch | - | - |
| Clayey 10-14 Inch | - | - |
| Clayey Overflow 7-9 Inch | - | - |
| **Loam Ecological Site Class (Attachment C)** | | |
| Loamy 7-9 Inch | - | - |
| Loamy 10-14 Inch | - | - |
| Loamy 15-19 Inch | - | - |
| Loamy Overflow 10-14 Inch | - | - |
| Wetland and Riparian 10-14 Inch | - | - |
| Aspen 15-19 Inch | - | - |
| Wet Fresh Meadow 15-19 Inch | - | - |
| **Shallow Ecological Site Class (Attachment D)** | | |
| Very Shallow 7-9 Inch | - | - |
| Shallow Loamy 7-9 Inch | - | - |
| Shallow Loamy 10-14 Inch | - | - |
| Shallow Loamy 15-19 Inch | - | - |
| Shallow Sandy 10-14 Inch | - | - |
| Mountain Windswept Ridge 15-19 Inch | - | - |
| **Saline Ecological Site Class (Attachment E)** | | |
| Deep Shale 7-9 Inch | 8.8 | 3.6 |
| Deep Shale 10-14 Inch | - | - |
| Saline Lowland 7-9 Inch | 119.3 | 62.8 |
| Saline Upland 7-9 Inch | 138.6 | 23.8 |
| Saline Upland 10-14 Inch | - | - |
| Shale 10-14 Inch | - | - |
| **Sand Ecological Site Class (Attachment F)** | | |
| Sandy 7-9 Inch | 72.9 | 18.5 |
| Sandy 10-14 Inch | - | - |
| **Other** | | |
| Agriculture/Pasture | - | - |
| Disturbed/Developed | 30.4 | 12.6 |
| **Total[3]** | **370.0** | **121.2** |

1 Initial disturbance includes all surface disturbing activities plus activity areas in which surface disturbance will not occur
2 Long-term disturbance includes surface disturbances remaining after interim reclamation.
3 Values may not always sum to total due to rounding

The design documentation for the Rail Facility includes infrastructure locations, initial and long-term disturbance areas, and information on soil management and drainage crossings (Rail Facility Site-specific Plan of Development - Appendix B). Overall, the Rail Facility has a net total balance of cut and fill (Table 6). Topsoil from the cut will be salvaged and used in the immediate area for reclamation purposes. Excess subsoil not used as fill will be hauled and stockpiled at the Road Rock Quarry for use as reclamation fill (Section 4.1.3).

**Table 6. Cut and Fill Earthwork Summary for the Rail Facility**

| Rail Facility Component | Total Cut | Total Adjusted Fill | Net [Long / (Short)] |
|---|---|---|---|
| | C.Y. | C.Y. | C.Y. |
| Union Pacific Running Track | 75,000 | 277,000 | (202,000) |
| Union Pacific Wye Track | 7,000 | 82,000 | (75,000) |
| Lead Line (23+48 to 99+00) | 69,000 | 142,000 | (73,000) |
| Loop Area (from 99+00) | 590,000 | 496,000 | 94,000 |
| Rail Access Road | 20,000 | 16,000 | 4,000 |
| Laydown Areas | 849,000 | 597,000 | 252,000 |
| **Total** | **1,610,000** | **1,610,000** | **0** |

*C.Y. = cubic yard

## 3.3 ROAD ROCK QUARRY

The Site-specific Plan of Development for the Road Rock Quarry (Quarry) includes details of the Quarry design and the location of all surface-disturbing activities. Federal lands within the Quarry Site are limited to portions of the Quarry Road. For those portions of Quarry Road on federal lands, reclamation will be in accordance with this site-specific reclamation plan and reclamation will begin immediately following construction with initial stabilization followed by interim and final reclamation, as appropriate. The Site-specific Plan of Development provides additional information on the Quarry components that are discussed below.

The Quarry components include the quarry site, infrastructure, access road, overburden storage areas, and soil stockpiles. The Quarry will disturb approximately 183.6 acres initially and 17.7 acres long-term (Table 7). Only 24.7 acres of initial disturbance (13.5%) and 6.0 acres of long-term disturbance (33.9%) are located on federal lands. All disturbance on federal lands is associated with Quarry Road.

**Table 7. Initial and long-term disturbance for the Quarry.**

| Ecological Site | Initial Disturbance[1] (Acres) | Long-Term Disturbance[2] (Acres) |
|---|---|---|
| **Clay Ecological Site Class (Attachment B)** | | |
| Clayey 7-9 Inch | - | - |
| Clayey 10-14 Inch | - | - |
| Clayey Overflow 7-9 Inch | - | - |
| **Loam Ecological Site Class (Attachment C)** | | |
| Loamy 7-9 Inch | 77.6 | 11.1 |
| Loamy 10-14 Inch | - | - |
| Loamy 15-19 Inch | - | - |
| Loamy Overflow 10-14 Inch | - | - |
| Wetland and Riparian 10-14 Inch | - | - |
| Aspen 15-19 Inch | - | - |
| Wet Fresh Meadow 15-19 Inch | - | - |
| **Shallow Ecological Site Class (Attachment D)** | | |
| Very Shallow 7-9 Inch | - | - |
| Shallow Loamy 7-9 Inch | 62.4 | 0.6 |
| Shallow Loamy 10-14 Inch | - | - |
| Shallow Loamy 15-19 Inch | - | - |
| Shallow Sandy 10-14 Inch | - | - |
| Mountain Windswept Ridge 15-19 Inch | - | - |
| **Saline Ecological Site Class (Attachment E)** | | |
| Deep Shale 7-9 Inch | - | - |
| Deep Shale 10-14 Inch | - | - |
| Saline Lowland 7-9 Inch | 1 | 0.3 |
| Saline Upland 7-9 Inch | - | - |
| Saline Upland 10-14 Inch | - | - |
| Shale 10-14 Inch | - | - |
| **Sand Ecological Site Class (Attachment F)** | | |
| Sandy 7-9 Inch | 42.5 | 5.5 |
| Sandy 10-14 Inch | - | - |
| **Other** | | |
| Agriculture/Pasture | - | - |
| Disturbed/Developed | - | - |
| **Totals[3]** | **183.6** | **17.7** |

1 Initial disturbance includes all surface disturbing activities plus activity areas in which surface disturbance will not occur
2 Long-term disturbance includes surface disturbances remaining after interim reclamation.
3 Values may not always sum to total due to rounding

The design documentation for the Quarry site includes infrastructure locations, initial and long-term disturbance areas, and information on soil management and drainage crossings (Road Rock Quarry Site-specific Plan of Development - Appendix B). While the Quarry itself cannot feasibly have a balance of cut and fill since the intent of the Quarry is to provide material for construction, the Quarry Road has a net total balance of cut and fill (Table 8).

**Table 8. Cut and fill earthwork summary for the Quarry**

| Quarry Site Component | Total Cut | Total Adjusted Fill | Net [Long / (Short)] |
|---|---|---|---|
| | C.Y. | C.Y. | C.Y. |
| Quarry Access Road | 179,000 | 179,000 | 0 |
| Quarry Loop Road | 9,000 | 9,000 | 0 |
| **Total** | **186,000** | **186,000** | **0** |

*C.Y. = cubic yard

## 3.4 PHASE I WIND TURBINE DEVELOPMENT

The Site-specific Plan of Development for the Phase I Wind Turbine Development includes details of the Phase I Wind Turbine Development design and the location of all surface-disturbing activities. Reclamation will begin immediately following construction with initial stabilization followed by interim and final reclamation, as appropriate. The Site-specific Plan of Development provides additional information on the Phase I Wind Turbine Development components that are discussed below.

The Phase I Wind Turbine Development will disturb approximately 3,035 acres initially and 485 acres long-term (Table 9). An additional 440 acres of activity area would also be used for Phase I Wind Turbine Development construction and operations activities. The Phase I Wind Turbine Development includes 500 wind turbines and associated elements for the CCSM Project such as roads, electrical lines, substations, operation and maintenance buildings, meteorological towers, utilities, and temporary construction features.

**Table 9. Initial and long-term disturbance for the Phase I Wind Turbine Development**

| Ecological Site | Initial Disturbance[1] (Acres) | Long-Term Disturbance[2] (Acres) | Activity Areas[3] (Acres) |
|---|---|---|---|
| **Clay Ecological Site Class (Attachment B)** | | | |
| Clayey 7-9 Inch | 42.4 | 8.2 | 9.9 |
| Clayey 10-14 Inch | 245.4 | 34.0 | 36.3 |
| Clayey Overflow 7-9 Inch | 3.1 | 0.5 | 5.0 |
| **Loam Ecological Site Class (Attachment C)** | | | |
| Loamy 7-9 Inch | 185.7 | 26.5 | 13.6 |
| Loamy 10-14 Inch | 666.0 | 110.0 | 119.8 |
| Loamy 15-19 Inch | 482.2 | 71.1 | 56.2 |
| Loamy Overflow 10-14 Inch | 14.7 | 2.4 | 4.3 |
| Wetland and Riparian 10-14 Inch | 1.8 | 0.1 | 1.3 |
| Aspen 15-19 Inch | 26.3 | 3.5 | 4.8 |
| Wet Fresh Meadow 15-19 Inch | 10.5 | 1.4 | 0.9 |
| **Shallow Ecological Site Class (Attachment D)** | | | |
| Very Shallow 7-9 Inch | 15.5 | 6.2 | 12.9 |
| Shallow Loamy 7-9 Inch | 214.0 | 33.8 | 47.2 |
| Shallow Loamy 10-14 Inch | 258.9 | 39.0 | 23.4 |
| Shallow Loamy 15-19 Inch | 29.0 | 4.1 | 1.8 |
| Shallow Sandy 10-14 Inch | 9.1 | 2.6 | 5.2 |
| Mountain Windswept Ridge 15-19 Inch | 317.2 | 53.4 | 24.8 |
| **Saline Ecological Site Class (Attachment E)** | | | |
| Deep Shale 7-9 Inch | 119.6 | 10.0 | 25.2 |
| Deep Shale 10-14 Inch | 104.3 | 14.8 | 13.4 |
| Saline Lowland 7-9 Inch | 10.2 | 0.6 | 2.8 |
| Saline Upland 7-9 Inch | 12.4 | 5.7 | 1.9 |
| Saline Upland 10-14 Inch | 12.5 | 1.3 | 1.4 |
| Shale 10-14 Inch | 29.7 | 3.9 | 2.2 |
| **Sand Ecological Site Class (Attachment F)** | | | |
| Sandy 7-9 Inch | 146.2 | 33.4 | 2.0 |
| Sandy 10-14 Inch | 4.3 | 2.4 | 5.7 |
| **Other** | | | |
| Agriculture/Pasture | 55.9 | 10.2 | 16.9 |
| Disturbed/Developed | 18.5 | 6.3 | 0.7 |
| **Totals[4]** | **3,035** | **485** | **440** |

1 Initial disturbance includes all surface disturbing activities plus activity areas in which surface disturbance will not occur
2 Long-term disturbance includes surface disturbances remaining after interim reclamation.
3 Activity areas are work areas in which surface disturbing activities will not occur. Some vegetation removal may occur in activity areas.
4 Values may not always sum to total due to rounding

The design documentation for the Phase I Wind Turbine Development includes infrastructure locations, initial and long-term disturbance areas, and information on soil management and drainage crossings (Phase I Wind Turbine Development Site-specific Plan of Development - Appendix B). Overall, the Phase I Wind Turbine Development has a net total balance of cut and fill (Table 10). Topsoil from the cut will be salvaged and used in the immediate area for reclamation purposes. Excess subsoil not used as fill will be hauled and stockpiled at the Road Rock Quarry for use as reclamation fill (Section 4.1.3).

**Table 10. Cut and fill earthwork summary for the Phase I Wind Turbine Development**

| **Chokecherry and Sierra Madre Wind Energy Project<br>Phase I Wind Turbine Development<br>Earthwork Summary** | | | | |
|---|---|---|---|---|
| **Region** | **Sub-Region** | **Total Cut** | **Total Adjusted Fill** | **Net Long / (Short)** |
| | | **C.Y.** | **C.Y.** | **C.Y.** |
| NVR | Nevins Valley | 1,859,000 | 1,859,000 | 0 |
| NVR | Smith Draw | 1,480,000 | 1,480,000 | 0 |
| LMH | McCarthy | 755,000 | 755,000 | 0 |
| LMH | Pine Grove | 880,000 | 880,000 | 0 |
| UMH | Upper Miller Hill | 1,437,000 | 1,437,000 | 0 |
| | Interconnect * | 844,000 | 844,000 | 0 |
| | **TOTAL** | **7,255,000** | **7,255,000** | **0** |

* A portion of the work at the interconnect will be performed by the transmission provider.

# 4.0 SOIL MANAGEMENT

The overall goal of soil management is to maintain physical, chemical, and biological properties of soils while achieving a site balance of the soil resource. Salvaged soil will be removed as cut, used as fill, or stockpiled for future reclamation (interim and final reclamation). Components of soil management include soil handling, landscape reconstruction, and erosion control. Soil will be managed in accordance with the CCSM Project Master Reclamation Plan (BLM 2012a) and BLM Wyoming Reclamation Policy (BLM 2012b), as further detailed below.

## 4.1 SOIL HANDLING

Surface disturbing activities include clearing existing vegetation, stripping topsoil, extracting subsoil, and backfilling and grading. Soil for CCSM Phase I will be managed in accordance with the CCSM Project Master Reclamation Plan (BLM 2012a) and BLM Wyoming Reclamation Policy (BLM 2012b) including provisions for segregating and marking stockpiles, and protecting stockpiled material from erosion, contamination and degradation. Each type of surface disturbing activity is described below. PCW will apply BMPs, as described in Section 4.4 during surface disturbing activities.

### 4.1.1 Vegetation Clearing

PCW will perform vegetation clearing in areas of ground disturbance as appropriate based upon the vegetation characteristics and design requirements. Where possible, vegetation clearing will be performed a few days prior to topsoil stripping. PCW anticipates vegetation clearing as follows:

- In areas with no significant amount of woody shrubs (less than 5 percent), PCW will strip topsoil in areas that contain relatively low and sparse native grasses without performing vegetation clearing so that the native vegetation is mixed directly into the stripped topsoil, increasing organic matter and maintaining the native soil biota and seedbank.
- In areas where the amount of native grasses would hinder topsoil stripping, the height of the vegetation will be first be reduced by mowing the area, typically with a tractor pulled brush hog (Figure 1 [left]), allowing the clippings to remain with the topsoil during the stripping process.
- Areas with higher concentrations of woody brush will be cleared first by cutting and mulching the vegetation prior to stripping the topsoil. Cutting and mulching is commonly done with a skid steer equipped with a clearing and mulching attachment (Figure 1 [right]). The mulch will remain with the topsoil during the stripping process.
- For areas with very dense vegetation including wooded areas, PCW may push vegetation to the limits of disturbance using bulldozers or similar equipment prior to stripping topsoil. Once the topsoil storage piles are established, PCW would chip and mulch the vegetation and place it on top of the topsoil storage piles for purposes of stabilization.

**Figure 1. Typical Vegetation Clearing Equipment**

### 4.1.2 Topsoil Stripping and Stockpiling

As discussed in Section 2.1, PCW has determined that twenty-five ecological sites exist within the CCSM Phase I Site (Table 1). Topsoil boundaries and depth have been delineated during the ecological site mapping process and will be used to inform topsoil stripping and stockpiling, as shown in Table 11, below. To minimize soil horizon mixing and loss of topsoil integrity, for those ecological sites listed in Table 11 with an average topsoil depth greater than 6 inches, PCW will salvage the top 6 inches of topsoil (within the tolerance of the stripping equipment, discussed below) . For those ecological sites listed in Table 11 with an average depth less than 6 inches, PCW will salvage the top 3 inches of topsoil or will salvage to a restrictive layer within the top 6 inches. When the topsoil depth is greater than 6 inches, PCW will generally not salvage to the soil horizon depth to minimize mixing topsoil with subsoils, and to reduce overall stockpile footprints. However, topsoil suitability may extend below the top soil horizon and be suitable for reclamation and plant growth. Soil horizons below the top horizon may be biologically active in the upper portion of the soil profile and maintain suitable rooting material for plants and may be considered as suitable topsoil, unless a restrictive layer is present. PCW may elect to remove some additional topsoil for use in interim and final reclamation, with approval from the BLM AO. Topsoil will not be salvaged saline ecological sites, and instead soil from all depths will be handled as subsoil to minimize movement and mixing of strongly saline soils.

When performing topsoil stripping, PCW will set the stripping equipment (typically motor grader or similar) to strip topsoil to the depth discussed above. Typical industry experience is that such equipment has a tolerance of plus or minus 2 to 3 inches due to terrain effects.

## Table 11. Ecological Sites by Topsoil Depth

| Ecological Site | Topsoil Texture | Topsoil Depth (in)[1, 2] | Anticipated Topsoil Salvage Depth (in) |
|---|---|---|---|
| **Clay Ecological Site Class (Attachment B)** | | | |
| Clayey 7-9 Inch | Clay loam | 4.7 ± 0.28 | 3 |
| Clayey 10-14 Inch | Fine sandy loam to clay loam | 6.8 ± 1.26 | 6 |
| Clayey Overflow 7-9 Inch | Sandy clay loam to clay loam | 4.7 ± 0.84 | 3 |
| **Loam Ecological Site Class (Attachment C)** | | | |
| Loamy 7-9 Inch | Sandy loam to fine sandy loam | 5.9 ± 0.96 | 6 |
| Loamy 10-14 Inch | Fine sandy loam to sandy clay loam | 5.4 ± 1.06 | 6 |
| Loamy 15-19 Inch | Very fine sandy loam to loam | 6.8 ± 0.21 | 6 |
| Loamy Overflow 10-14 Inch | Fine sandy loam to clay loam | 6.4 ± 1.05 | 6 |
| Wetland and Riparian 10-14 Inch | Loam to silty clay loam | 7.7 ± 0.39 | 6 |
| Aspen 15-19 Inch | Fine sandy loam to loam | 7.6 ± 0.70 | 6 |
| Wet Fresh Meadow 15-19 Inch | Loam | 7.7 ± 0.39 | 6 |
| **Shallow Ecological Site Class (Attachment D)** | | | |
| Very Shallow 7-9 Inch | Fine sand to fine sandy loam | 5.8 ± 0.47 | * |
| Shallow Loamy 7-9 Inch | Loamy fine sand to loam | 6.0 ± 0.77 | * |
| Shallow Loamy 10-14 Inch | Sandy loam to sandy clay loam | 4.1 ± 0.60 | * |
| Shallow Loamy 15-19 Inch | Loamy very fine sand to very fine sandy loam | 6.3 ± 0.67 | * |
| Shallow Sandy 10-14 Inch | Fine sand to fine sandy loam | 9.4 ± 0.19 | * |
| Mountain Windswept Ridge 15-19 Inch | Very fine sandy loam | 4.6 ± 0.21 | 3 |
| **Saline Ecological Site Class (Attachment E)** | | | |
| Deep Shale 7-9 Inch | Fine sandy loam to clay loam | 5.8 ± 0.62 | 3 |
| Deep Shale 10-14 Inch | Loam to clay loam | 8.0 ± 1.03 | 6 |
| Saline Lowland 7-9 Inch | Silty clay loam to clay loam | 3.7 ± 0.65 | 0 |
| Saline Upland 7-9 Inch | Silty clay loam to silty clay | 4.9 ± 0.66 | 0 |
| Saline Upland 10-14 Inch | Silty clay loam to silty clay | 6.0 ± 0.65 | 0 |
| Shale 10-14 Inch | Clay loam | 6.7 ± 1.61 | 6 |
| **Sand Ecological Site Class (Attachment F)** | | | |
| Sandy 7-9 Inch | Loamy sand to sandy loam | 4.6 ± 0.70 | 3 |
| Sandy 10-14 Inch | Fine sand to loamy fine sand | 5.2 ± 0.28 | 3 |

1Topsoil depth = inches ± 1 standard error
2Topsoil includes the upper part of the soil profile and may extend beyond the A horizon. However, for planning purposes, topsoil depth is defined by the A horizon.
*Strip to restrictive layer, assumed to be total topsoil depth for planning purposes

Stripped topsoil will be stored in stockpiles segregated by the ecological sites from which it was removed. PCW will establish signage identifying the ecological site membership of each stockpile, and maintain records of the dates of stockpiling, approximate stockpile depth, and applied erosion control measures. Topsoil stockpile locations have been identified in Appendix B of the Site-specific Plans of Development. Topsoil along linear elements of CCSM Phase I such as roads, buried cables, and water pipelines, will be stripped and windrowed at the edge of the temporary disturbance area. Topsoil within discrete elements such as wind turbine sites, buildings, and laydown areas, will be stripped and stockpiled at the edge of the temporary disturbance area. Topsoil stockpiles have been designed to minimize the surface area and to maintain geomorphic stability. Soil stabilization will be implemented as soon as practicable on topsoil stockpiles. All topsoil stockpiles are located so as not to affect existing drainages.

The stockpiled topsoil will be re-spread on disturbance areas that do not have aggregate or rock following final grading. Stockpiled topsoil from specific ecological sites will be used within the same ecological site. If topsoil is needed for additional reclamation activities and requires movement across ecological site boundaries, ecological site will be noted and ecological site compatibility will be determined prior to redistribution of topsoil, in coordination with the BLM AO. Compatible ecological sites may include sites that share the similar predominant soil texture but are located in different precipitation zones (e.g., Sandy 7-9 Inch ecological sites and Sandy 10-14 Inch ecological sites) Topsoil that is not used to reclaim temporary disturbance will remain stockpiled for reclamation following decommissioning.

### 4.1.3 Subsoil Excavation and Stockpiling

All soils below the stripped topsoil will be handled as subsoil. PCW has designed the CCSM Project to have a local cut/fill balance wherever possible. Priority is given to having subsoil pushed or transported very short distances to achieve the required site grading. This soil handling practice commonly has the effect of keeping subsoil within the same ecological site. However, since the vegetative viability of most ecological sites is not significantly impacted by the subsoil composition, the movement of subsoil between ecological sites will occur with the exception of the Saline ecological site class. Cut is expected in saline ecological sites, however, PCW will not use cut from saline ecological sites as fill in any other ecological site without coordination with the BLM AO. Conversely, subsoil from other ecological sites may be cut and used as fill within a saline ecological site.

PCW is anticipating a net balance from CCSM Phase I; however, subsoil storage may be necessary. Short-term subsoil storage (less than 24 months) will occur within the CCSM Phase I disturbance areas (Attachment G). Longer-term subsoil storage (longer than 24 months) may occur at the Road Rock Quarry's overburden soil storage area, described in the Road Rock Quarry Site-Specific Plan of Development.

### 4.1.4 Backfill and Grading

Once topsoil and subsoil have been removed and any necessary components have been installed, the construction area will be brought to final elevation by backfilling (if necessary) and grading. Backfilling will primarily involve moving soil locally with bulldozers over short distances. If sufficient subsoil is not available locally to meet the design requirements, PCW will obtain it from nearby subsoil storage piles within the disturbance areas associated with CCSM Phase I, or the overburden soil storage area at the Road Rock Quarry and transport it to the area using dump trucks. Following backfilling, construction areas will be graded to their final elevation and slope. Grading involves placing subsoil using excavators, scrapers, and bulldozers, typically in "lifts" between 6 and 12 inches deep. Each lift will be wet by water truck if required, and compacted using vibratory rollers. Lifts will be applied until the final design grades are achieved. For roads and laydown yards, aggregate will then be applied to surfaces.

### 4.1.5 Unsuitable Soil

Subsurface soil from beneath controlled fill or within common excavation or subgrade excavation areas may be unsuitable for placement as structural fill. This soil will be removed as part of subgrade correction and will be placed in fill areas. If excess soil remains after filling in the uncontrolled fill areas, the additional soil will be hauled to the Road Rock Quarry. There will be a designated area within the Road Rock Quarry to store soil unsuitable for uses other than reclamation fill, as mentioned above. While the soil is unsuitable for structural fill, this soil is suitable for use in recontouring the Road Rock Quarry during reclamation. If construction sequencing allows, trucks delivering aggregate to the CCSM Phase I Site will be loaded with unsuitable fill material for their return trip to the Road Rock Quarry.

### 4.1.6 Contaminated Soil

Contaminated soil includes soil that is subject to a foreign substance during construction or operation that modifies the chemical properties of the soils to the extent that vegetation re-establishment is not achievable within a reasonable amount of time. Contaminated soils will be handled, transported, and disposed of according to the procedures outlined in the Waste Management Plan (Site-specific Plans of Development – Appendix P) and Spill Prevention Control and Countermeasures Plan (Site-specific Plans of Development – Appendix Q). In compliance with BLM Wyoming Reclamation Policy (2012), all hazardous, non-hazardous, special, and general wastes will be segregated and will be disposed of off-site at authorized disposal facilities. No waste will be buried on-site. Hazardous material will be managed and disposed of in accordance with the Waste Management Plan (Site-specific Plans of Development – Appendix P) and the Health and Safety Plan (Site-specific Plans of Development – Appendix R).

## 4.2 LANDSCAPE RECONSTRUCTION AND EROSION CONTROL

Surface runoff and erosion in areas exposed to surface-disturbing activities will be controlled by reconstructing the landscape to maintain soil stability. The landscape will be reconstructed to achieve a desired topography, slope stability, and surface stability in accordance with the BLM Wyoming Reclamation Policy (2012b) and as detailed in the CCSM Project Master

Reclamation Plan (BLM 2012a). In the event that the original topography and landscape cannot be reconstructed, PCW will propose alternative landscape designs in coordination with the BLM AO prior to reconstruction activities.

Water courses and drainage features will be reconstructed, where feasible, to approximate the natural features and hydrologic characteristics of pre-disturbance conditions by maintaining the drainage pattern, profile, and dimension. Slope stability will be controlled by implementing erosion control measures and BMPs to minimize sheet and rill erosion (Site-specific Plans of Development – Appendix H). Surface stability will be accomplished by maintaining soil physical properties and treating compacted surfaces using BMPs. It is anticipated that silt fencing, riprap, mulch cover, and erosion control blankets will be used as detailed in the Erosion Control Plan and Storm Water Pollution Prevention Plan (Site-specific Plans of Development - Appendices H and I). PCW will apply BMPs, as described in Section 4.4 during landscape reconstruction.

## 4.3 SUBSURFACE INTEGRITY

Surface disturbances for subsurface infrastructure will be trenched and backfilled with excavated material or appropriately engineered backfill in a reverse method from which they were excavated in order to maintain soil horizon integrity. Trench breakers made from sand bags or prefabricated concrete bags will be used where necessary to minimize the potential for any ‘French drain’ effect or inadvertent subsurface drainage of water bodies, as well as to prevent ‘piping’ or lateral subsurface water movement. Water quality will be maintained during surface-disturbing activities, as detailed in the Erosion Control Plan and Storm Water Pollution Prevention Plan (Site-specific Plans of Development - Appendices H and I). The CCSM Project design maintains subsurface integrity and prevents surface and ground water contamination as required by the BLM Wyoming Reclamation Policy (2012b).

## 4.4 SOIL HANDLING BEST MANAGEMENT PRACTICES

PCW will apply soil handling BMPs to the surface disturbing activities associated with CCSM Phase I, as indicated in Table 6. Soil handling BMPs are designed and implemented to improve the likelihood of reclamation success. If necessary, the BLM will provide input on remedial actions to further facilitate reclamation success. Administrative BMPs may include soil stabilization measures, contamination remediation, and soil amendments, and will be determined in coordination with the BLM AO.

**Table 12. Soil Handling Best Management Practices.**

| Best Management Practice | Activity | | | | |
|---|---|---|---|---|---|
| | Topsoil Stripping | Subsoil Excavation | Stockpiling | Backfill and Grading | Landscape Reconstruction |
| LRP areas and sensitive soils (section 2.5) on federal lands will be avoided to the extent practicable. Where they cannot be avoided, reclamation practices will follow the measures identified for each ecological site (Attachments B-F). | ● | ● | ● | ● | |
| Topsoil from excavations and construction activities will be salvaged and reapplied during reclamation. | ● | | | ● | ● |
| Surface disturbing activities on federal lands will be avoided in unstable areas (e.g., slopes greater than 25%, slumps, landslides, and areas exhibiting soil creep) to the extent practicable. | ● | ● | ● | ● | ● |
| Topsoil from each ecological site will be segregated and stockpiled individually. | ● | | ● | | |
| Topsoil from the same ecological site, but different surface disturbance areas, will be stockpiled together, when practicable, to reduce stockpile locations and minimize additional surface disturbance. | ● | | ● | | |
| Stockpiled topsoil will be used within the same ecological site or another suitable ecological site, in coordination with the BLM AO. | | | | ● | ● |
| Stockpiles will generally be located within laydown areas or adjacent to linear features (e.g. roads and transmission rights-of-way) in the form of windrows. | ● | ● | ● | | |
| Subsoil will not be used as topsoil or spread on top of topsoil without laboratory testing of the subsoil physical and chemical characteristics to determine compatibility between subsoil and topsoil and in coordination with the BLM AO. | | ● | ● | ● | |
| If reclamation success standards are not met, additional BMPs such as soil stabilization measures, contamination remediation, and topsoil amendments will be implemented, in coordination with the BLM AO. | | | ● | ● | ● |

| Best Management Practice | Activity | | | | |
|---|---|---|---|---|---|
| | **Topsoil Stripping** | **Subsoil Excavation** | **Stockpiling** | **Backfill and Grading** | **Landscape Reconstruction** |
| Stockpiles will be handled according to the measures identified for each ecological site (Attachments B-F) | ● | ● | ● | | |
| Topsoil stored longer than 2 years will be piled no more than 2 feet high exclusive of native topsoil depth. In locations where limiting the pile to 2 feet would significantly increase the disturbance area, PCW will propose an alternative stockpile design in coordination with the BLM AO. | | | ● | | |
| If topsoil will be stockpiled for longer than a month, stockpiles will be ridged (roughened) to maximize surface area. | | | ● | | |
| If topsoil is stockpiled on ground in a different ecological site than where the soil was taken (with approval of the BLM AO), the existing native vegetation will be left intact, to minimize migration of the stockpiled soil into a different soil type. | | | ● | | |
| Temporary stockpiles stored longer than one growing season (NRCS 1995) will be covered with mulch and/or soil tackifiers to assist in mitigating stockpile wind erosion and contribute organic materials. | | | ● | | |
| Stockpiles stored longer than 2 years will be seeded with a seed mix approved by the BLM AO. Seeding schedule and timing for long-term stockpiles will be determined on a site-specific basis and in coordination with the BLM AO and the WYDEQ permit requirements (WYDEQ 2007). | | | ● | | |
| Topsoil and subsoil (including any spoil/unconsolidated parent material) will be stored in separate piles and clearly labeled. | ● | ● | ● | | |
| Permanent and temporary erosion control devices will be installed during construction in accordance with the Erosion Control Plan and Stormwater Pollution Prevention Plan. | ● | ● | ● | ● | ● |
| During reclamation, disturbed areas will be recontoured to blend with adjacent topography and will simulate the original topography to the extent practicable. | | | | ● | ● |
| Recontoured surfaces will be stabilized and will have adequate surface roughness to reduce surface run-off. | | | | ● | ● |

| Best Management Practice | Activity | | | | |
|---|---|---|---|---|---|
| | **Topsoil Stripping** | **Subsoil Excavation** | **Stockpiling** | **Backfill and Grading** | **Landscape Reconstruction** |
| Pre-disturbance surface drainage patterns will be re-established to minimize erosion and restore the original hydrologic functions to the extent practicable. | | | | • | • |
| Compacted subsoils will be disked or harrowed prior to reclamation to reduce soil compaction. | | | | • | |
| Highwalls, cut slopes, and or topographic depressions will be eliminated, unless approved by BLM AO. | | | | • | • |
| Sheet and rill erosion will be avoided or minimized on or adjacent to the reclaimed area by implementing erosion control measures detailed in Appendix H of the Site-Specific Plan of Development. | | | | • | • |
| Physical characteristics that approximate the visual quality of adjacent areas with regard to location, scale, contour, color, and orientation of major landscape features will be recreated to the extent practicable. | | | | | • |
| Turnouts, ditches, and water bars, will be constructed, as appropriate, across side slopes at periodic intervals according to slope gradient along recontoured and disturbed slopes. | | | | • | • |
| Ripped and aerated surfaces will be mulched with mulch/soil tackifiers (e.g., weed-free native grass, hay, small grain straw, wood straw, and/or live mulch), in coordination with the BLM AO. | | | | • | • |
| Snow fences will be used, as needed, in moisture-limited ecological sites, to trap additional moisture. | | | | | • |

• - indicates that BMPs will be implemented during reclamation activities

# 5.0 SITE PREPARATION AND REVEGETATION

Disturbed areas on federal lands in the CCSM Phase I Site will be prepared and revegetated using BLM-approved measures and seed mixtures, as described below.

## 5.1 SITE PREPARATION

Soil conditioning, decompaction, and topsoil protection measures will be implemented to reestablish topsoil properties and to protect the seeding surface, as described in the CCSM Project Master Reclamation Plan (BLM 2012a) and in compliance with BLM Wyoming Reclamation Policy (BLM 2012b). Seedbed preparation maximizes seeding efficiency and improves reclamation success and includes topsoil replacement, discing, and surface roughening techniques. Preparation techniques will be closely monitored and evaluated based on revegetation success. Soil conditioning and amendments may be necessary to ameliorate poor topsoil and subsoil quality.

PCW will implement the following BMPs to redistribute topsoil and protect the seeding surface, as appropriate and necessary:

- Suspend construction activities when soils are too wet to support construction equipment without significant rutting. In general, activities that cause in excess of four inches of rutting will be halted, unless such rutting occurs in subsoils that will be cut or filled beyond the extent of the rutting (Site-specific Plans of Development – Appendix A).
- To the extent practicable, do not mix topsoil and subsoil during site preparation.
- Perform primary tillage of the subsoil prior to the replacement of topsoil to improve drainage.
- Perform secondary tillage of topsoil to break up clods; secondary tillage will be no deeper than the depth of the replaced topsoil.
- Till across slope or perpendicular to the prevailing wind to reduce erosion.
- Prior to seeding, perform a final tillage to break up any remaining clods and produce a firm seed bed.
- Inspect the soil surface for ponding or gullying.
- After seeding, create furrows or pits to roughen the soil surface, increase moisture infiltration, capture blowing snow, and slow the surface velocity of wind and water to reduce erosion and sedimentation.
- If, during operation, it is determined that snow accumulation causes significant accelerated erosion, implement appropriate mitigation measures (e.g., snow fence construction) in accordance with the Winter Access Plan (Site-specific Plans of Development – Appendix E).

## 5.2 REVEGETATION

The primary objective of revegetation is to establish the species composition, diversity, structure, and total ground cover appropriate for the desired plant community (BLM 2012b). In accordance with BLM Wyoming Reclamation Policy (2012b), proper seed mixtures will be used to reclaim disturbed areas on federal lands with native vegetation, as detailed in the

CCSM Project Master Reclamation Plan (2012a), and further refined for each ecological site in Attachments B-F.

Initial seeding will be used to achieve temporary vegetation coverage or stabilization of soil stockpiles or until interim or final reclamation measures can be implemented. Longer term reclamation measures include seeding following the redistribution of soils to the original vertical profiles, compaction evaluations, mulching and amendment additions, and soil roughening.

### 5.2.1 Seed Mixture Design

Seed mixtures will be tailored to establish species diversity, composition, and ground cover that reflects the baseline conditions in each ecological site in CCSM Phase I. The seed mixture selection process will consider commercial availability and cost, growth form, seasonal variety, and prevailing dominant and locally adapted species. Only approved, certified weed-free seeds will be used. PCW, in coordination with the BLM AO, will develop a specific seed mixture for each reclamation prescription on federal lands. To increase the likelihood of successful reclamation, locally adapted native plant materials based on the site characteristics and ecological setting (i.e., the pre-disturbance site characterization) will be selected when possible. Seed mixtures for private and state lands will be developed in coordination with private landowners and state agencies, as appropriate.

The seed mixture for each ecological site will contain the following elements:

- Species composition and diversity for the desired plant community, ecological setting, and current soil properties based on pre-disturbance vegetation characteristics.
- Native dominant herbaceous species that support or augment the post-disturbance land uses, including species-specific wildlife habitat, rangelands, and other uses.
- Full shrub and/or sub-shrub species when these species will help achieve reclamation objectives while supporting post-disturbance land uses and/or wildlife habitat needs.
- Native forb species or other plant species approved by the BLM, private landowner, or state agency, as appropriate.
- Seed banking and onsite seed collection will only be considered if native and locally adapted seed sources are not available.

### 5.2.2 Seeding Schedule

Seeding will be implemented during all phases of development depending on initial or long-term reclamation objectives. When possible, seeding will occur prior to anticipated precipitation events to increase the likelihood of germination and vegetation establishment. Seeding will be preferable prior to snowfall so that seeds are not blown away or eaten by birds. Seeding schedule and timing will be determined on a site-specific basis and in coordination with the BLM AO, private landowners and in accordance with the WYDEQ permit requirements (WYDEQ 2007).

PCW will implement the following BMPs and protective measures related to seeding schedules, as necessary and appropriate (BLM 2008; WRRC 2010):

- Follow proper timing for the specific seed mix. Dormant seeding after October 15 before the ground freezes or before April 15 is anticipated to be most effective.
- Seed when soil temperatures are around 40 °F

### 5.2.3 Seeding Rates and Methods

Seeding rates will vary by application method, reclamation objective, desired plant community, and wildlife considerations. Typically, broadcast seeding may require significantly more seed than drill seeding to achieve similar results. Reclamation areas around specific wildlife habitats or environmentally sensitive areas may require higher seeding rates to establish vegetation more quickly for erosion control and reestablishment of forage base. Seeding rates and methods will be determined on a site-specific basis and in coordination with the BLM AO.

PCW will implement the following BMPs and protective measures, as necessary and appropriate, to reestablish vegetation (BLM 2008; WRRC 2010):

- Calculate seeding rates using Natural Resources Conservation Service (NRCS) worksheets.
- Alter seeding rates as needed based on site slope, stability and soil quality (e.g., increasing the rate for critical areas where germination is inhibited by low soil quality).
- Base seeding rates on application method (e.g., increased rate for broadcast seeding).
- In coordination with the BLM AO, reduce seeding rates in areas where a viable seed bank remains in the topsoil.
- Calibrate seed drills or broadcast seeders regularly.
- Select appropriate equipment for the terrain, e.g. drill seeding is currently preferred on flat ground but broadcast seeding will be suitable for steeper slopes.
- Harrow or rake broadcast seed to increase germination.
- Where feasible, hydromulch on steep slopes after seeding.
- Establish proper seeding depths, e.g. 0.25 to 0.5 inch for many grasses and large seeded forbs and less than 0.125 inch for small seeded shrubs and forbs.
- Purchase certified seeds or seeds from a reputable seller.
- Follow proper seed handling guidelines, including storage temperature and humidity.
- Post signs or establish physical barriers where needed to limit public use of the reclaimed surfaces while the vegetation reestablishes.
- Use snow fences, as needed in moisture-limited ecological sites, to trap additional moisture.
- Exclude livestock from reclaimed areas, as practicable, until appropriate levels of site stabilization and revegetation are achieved.

# 6.0 WEED MANAGEMENT

PCW will control noxious, non-native, and invasive weeds in the CCSM Phase I Site in accordance with the Weed Management Plan (Site-specific Plans of Development – Appendix H). Weed management will be a cooperative effort between the surface landowner, BLM, and PCW.

BLM has recorded occurrences of several noxious and invasive weed species occurring in the CCSM Phase I Site (BLM 2012). Areas most susceptible to noxious and invasive weed infestations or occurrences include recently disturbed soils, roadsides, pipeline rights-of-way, drainages, and agricultural improvements. Noxious and invasive weed species surveys were conducted within the CCSM Phase I Site between 2012 and 2014 (Site-specific Plans of Development – Appendix J).

The treatment and control of known occurrences will follow the Weed Management Plan (Site-Specific Plans of Development – Appendix H) for all weed occurrences influenced by the development of CCSM Phase I

As appropriate, PCW will implement the following BMPs and protective measures for the control of noxious and invasive plant species CCSM Phase I Site (BLM 2008; WRRC 2010):

- Only approved, certified weed-free seeds will be used.
- PCW will monitor the CCSM Phase I Site for noxious and invasive weed species regularly in accordance with the CCSM Project Weed Management Plan (BLM 2012a).
- PCW will control weeds in accordance with the CCSM Project Weed Management Plan (BLM 2012a).
- PCW will wash construction equipment in accordance with the CCSM Project Weed Management Plan (BLM 2012a).
- PCW will mark weed occurrences during construction in accordance with the CCSM Project Weed Management Plan (BLM 2012a).
- PCW will train employees on noxious and invasive plant species awareness and measures to prevent the spread of weeds in accordance with the Environmental and Construction Compliance Monitoring Plan (Site-specific Plans of Development – Appendix F).

# 7.0 RECLAMATION MONITORING

The BLM Wyoming Reclamation Policy (2012b) requires that a reclamation monitoring and reporting plan be developed and implemented to conduct compliance and effectiveness monitoring. Reclamation monitoring is required to evaluate reclamation progress to determine reclamation success and if additional measures are required. Reclamation success will be evaluated based on the objectives specified in the CCSM Project Master Reclamation Plan.

Reclamation monitoring for the CCSM Project has four primary objectives: 1) to document the condition of reclaimed areas relative to the adjacent undisturbed reference sites; 2) to

provide an expeditious means for monitoring all reclamation sites to document reclamation progress; 3) to standardize monitoring protocols across the CCSM Project and incorporate digital data-tracking and database development; and 4) to establish a monitoring plan for managing bond release.

Reclamation monitoring will occur annually in accordance with BLM requirements, as outlined in the Reclamation Monitoring and Reporting Plan (Attachment A). Vegetation will be evaluated against the reclamation success standards contained in the CCSM Project Master Reclamation Plan and the reference sites established during pre-disturbance characterization. The current condition class of the majority of plant communities in each ecological site occurring in the CCSM Project Site is not representative of the Historic Climax Plant Community (HCPC) and occurs in an alternative state condition class. Reclamation success will be evaluated on the current plant community condition class as established by the appropriate reference site conditions and in coordination with the BLM AO. In addition, erosional assessments and photopoints will be completed to support reclamation monitoring efforts.

A data dictionary has been developed by the BLM RFO to track monitoring parameters (Attachment A). The application of GPS, GIS, and digital data-tracking during reclamation and monitoring activities allows for in-depth knowledge of disturbance site conditions and will facilitate more informed and targeted remediation actions. By incorporating standardized monitoring protocols and a universal data dictionary, as further described in the Reclamation Monitoring and Reporting Plan (Attachment A), the information can be used to establish a field-wide, geo-referenced database with immediate access to disturbance acres, reclamation status, and monitoring history. In addition, this information provides the BLM with a reclamation history to evaluate reclamation success and expedite future reclamation activities.

The monitoring approach is designed to provide a standardized tool for evaluating reclamation status throughout the CCSM Project that can be used to make informed decisions on what actions are needed to obtain field-wide reclamation success. These decisions may range from a high-level action such as revising this Reclamation Plan to a site-specific action such as installing a silt fence. The record will be used to track reclamation progress and initiate appropriate remedial actions.

PCW and BLM will evaluate whether reclamation is progressing towards success. If necessary, PCW will propose additional measures to facilitate reclamation success. In coordination with the BLM AO, PCW will implement these measures. Additional measures may include reseeding, soil stabilization and amendments, weed control, mulching, fertilizing, fencing, and irrigation. The reporting procedures for areas requiring additional reclamation management are provided in the Reclamation Monitoring and Reporting Plan (Attachment A).

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# ATTACHMENT A

## Reclamation Monitoring and Reporting Plan

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# 1.0 INTRODUCTION

Power Company of Wyoming LLC (PCW) has prepared this Reclamation Monitoring and Reporting Plan (Plan) for Phase I of the Chokecherry and Sierra Madre Wind Energy Project (CCSM Project). This Plan is based on four primary objectives: 1) to document the condition of reclaimed areas relative to reference sites; 2) to provide an expeditious means for monitoring reclamation sites and documenting reclamation progress; 3) to standardize monitoring protocols across the CCSM Project incorporating digital data-tracking and database development; and 4) to establish a program for managing bond release.

Monitoring for Phase I of the CCSM Project will consist of ecological site delineation, pre-disturbance site characterization, and reclamation success monitoring. The monitoring procedures outlined in this Plan were developed in cooperation with BLM and adhere to the Wyoming Reclamation Policy (BLM 2012a), management directives presented in the Rawlins Field Office (RFO) Resource Management Plan (RMP) (BLM 2008), BLM RFO Reclamation Guidance (BLM 2011), and the CCSM Project Master Reclamation Plan (BLM 2012b), and further incorporate methodologies described in the *Interagency Ecological Site Handbook for Rangelands* (Caudle et al. 2013). The CCSM Project is a large development that will take place over a short time period. The methods and procedures described in this Plan are commensurate with the complexity of the CCSM Project.

This Plan is intended to be adaptive to take into account changing conditions and techniques. PCW, with concurrence from the BLM Authorized Officer (AO), may update, modify, or change the procedures contained in this Plan when warranted.

# 2.0 ECOLOGICAL SITE APPROACH

Reclamation planning for the CCSM Project is based upon ecological sites. An ecological site is a division of the landscape into distinctive kinds of land based on recurring soil, landform, geological, and climate characteristics that differ in their ability to produce distinctive types and amounts of vegetation and in their ability to respond similarly to management actions and natural disturbances (Caudle et al. 2013). Each ecological site is identified, differentiated, and described based on the relationship between abiotic and biotic environmental factors and how they influence plant community composition.

Ecological site descriptions (ESDs) provide a consistent framework for stratifying and describing rangelands and their soil, vegetation, and abiotic features, while providing delineated units that share similar potential to respond to management activities or disturbance processes (Caudle et al. 2013). Assessing ecological site characteristics and developing ecological site-specific reclamation techniques will increase the likelihood that revegetation is successful and that reclamation success standards are met.

To facilitate the development of ecological site descriptions and site-specific reclamation plans and procedures, PCW identified ecological sites across the precipitation zones (7-9 inch precipitation zone, 10-14 inch precipitation zone, and 15-19 inch precipitation zone)

associated with the development of Phase I of the CCSM Project. Ecological sites within these zones were identified as having unique physiographic and biophysical characteristics including elevation, moisture regime, soil conditions, and vegetation characteristics that are important considerations in the development of site-specific reclamation procedures, best management practices, and monitoring approaches. PCW used soil surveys along with vegetation data, aerial imagery, climate information, and other natural features to delineate each ecological site.

The development of reclamation plans and reclamation procedures based on ecological sites will provide a consistent and science-based approach to reclamation and facilitate the development of protocols necessary to meet the requirements of Wyoming BLM Reclamation Policy (BLM 2011; 2012a). Ecological sites have been identified for Phase I of the CCSM Project and Attachment B contains the site-specific data, descriptions, and best management practices for the ecological sites associated with each site-specific reclamation plan.

# 3.0 MONITORING

Reclamation monitoring for the CCSM Project consists of ecological site delineation, pre-disturbance site characterization, and reclamation success monitoring. The monitoring procedures outlined in this Plan adhere to the Wyoming Reclamation Policy (BLM 2012a), the CCSM Master Reclamation Plan (BLM 2012b), and incorporate methodologies described in the *Interagency Ecological Site Handbook for Rangelands* (Caudle et al. 2013).

## 3.1 ECOLOGICAL SITE DELINEATION

The objective of ecological site delineation is to confirm the attributes that differentiate, classify, and characterize the ecological sites for the CCSM Project and to provide a systematic framework to detect patterns of similar vegetation composition and relationships between vegetation, soil properties, and other environmental factors. During monitoring for ecological site delineation, potential reference sites were also identified for use during reclamation success monitoring (Section 3.3 – Reclamation Success Monitoring).

Monitoring to determine ecological site delineation was completed in 2013 and was used to refine the ecological sites modeled for Phase I of the CCSM Project Site. The baseline information collected includes topographic, hydrologic, vegetation, and soil parameters. Monitoring was conducted as described in Section 4.0– Monitoring Protocols. Monitoring locations for ecological site delineation monitoring are shown in Attachment B. The vegetation and soils data collected as part of the ecological site delineation and pre-disturbance site characterization were used to develop ecological site-specific reclamation implementation plans (Attachment B); these plans contain the site-specific detailed information necessary to conduct successful reclamation. Through the data collection process, PCW also identified ecological sites and other areas that may have limited reclamation potential (LRP).

## 3.2 PRE-DISTURBANCE SITE CHARACTERIZATION

Pre-disturbance site characterization is a critical component for reclamation monitoring to describe the surrounding landscape, determine ecological site types, and assess biophysical parameters during planning. The use of ecological sites allows for proper planning and timely implementation of activities, as well as baseline landscape, soil, and vegetation characteristics to be recreated with reclamation practices.

When practicable, vegetation and soil data collected for the sites during the ecological site delineation monitoring will be used for pre-disturbance site characterization; however, additional pre-disturbance site characterization may be necessary and any additional monitoring that is necessary will be conducted during the growing season prior to surface disturbing activities. Additional pre-disturbance site characterization locations will be determined in coordination with the BLM. The sampling methods described in Section 4.0 – Monitoring Protocols will be used for pre-disturbance site characterization.

## 3.3 RECLAMATION SUCCESS MONITORING

In accordance with the BLM Wyoming Reclamation Policy (BLM 2012a), reference sites will be identified and used for annual reclamation success monitoring. A minimum of three reference sites will be established for each ecological site to capture the expected variability within each site, inform annual monitoring, and define reclamation standards. Each site will be identified in coordination with BLM. Sites identified during ecological site delineation may be suitable for use as reference sites and will be used to the maximum extent possible. Reference sites will be characterized using the monitoring protocols described in Section 4.0 – Monitoring Protocols (Caudle et al. 2013). Each reference site will be protected from any future development or other anthropogenic disturbance to provide for long-term comparison of natural plant communities in the CCSM Project Site to reclaimed areas and to identify natural trends as they occur.

### 3.3.1 Reclamation Success Standards

Reclamation success standards will be used to assess whether reclamation requirements are being met. These success standards are outlined in the CCSM Project Master Reclamation Plan (BLM 2012b), and reiterated here, with additional clarification to facilitate monitoring and reporting. Success standards are organized by three major groups: Surface and Soils Stabilization, Landscape Reconstruction, and Revegetation:

A. Surface and Soils Stabilization Standards

    1. Undesirable materials (e.g., contaminated soils, potentially hazardous materials) will be isolated and/or removed to protect the reclaimed landscape from contamination.
    2. The land surface will be recontoured and other soil conservation, surface manipulation, and water management techniques will be implemented to establish stable slopes, watercourses, and drainage features to minimize

erosion and sedimentation (also protecting surface water and groundwater resources).

3. The soil surface must be stable and have adequate surface roughness to reduce run-off and capture rainfall and snow melt.
4. Short-term measures, such as the application of mulch or mechanical surface roughening may be used to limit surface soil movement.

B. Landscape Reconstruction Standards

1. The original landform will be restored or approximated for disturbed areas that are not required for regular operations and maintenance activities.
2. The reclaimed landscape will have characteristics that approximate the visual quality of adjacent areas with regard to location, scale, contour, color, and orientation of major landscape features and will support existing and future land uses.
3. Erosional features will be less than or equal to the surrounding area.

C. Revegetation Standards

1. Qualitative Standards
   i. A self-sustaining and locally native plant community will be established on the site.
   ii. Vegetation will have a density sufficient to control erosion and non-native plant invasion and re-establish wildlife habitat and forage production.
   iii. Resilient vegetation will be established on the site. Plants must be resilient as evidenced by well-developed root systems and successful reproduction.
   iv. Shrub communities will be established on sites on federal lands (only in communities where shrubs were present prior to construction). Shrubs must be well established, at least in a “young” age class (not comprised mainly of seedlings that may not survive until the following year) showing evidence of reproduction.

2. Quantitative Standards

   i. Sufficient species diversity will be established. No single species will account for more than 30 percent of total vegetative composition on federal lands unless it is evident at higher levels in adjacent undisturbed reference sites.
   ii. Reclamation of permanent vegetative cover will be determined successful when the basal cover of desirable perennial species is at 80 percent of the reference sites for that ESD (Attachment B).
   iii. Invasive plants and state-listed noxious weed species are a minor component of the plant community on the site. Invasive plant species should account for less than 5 percent total plant cover and reclamation species should be outcompeting weed species within two years of reclamation initiation. BLM has zero tolerance for state-listed noxious

weed species and weed control may be necessary even after reclamation standards have been met.

### 3.3.2 Monitoring Data Collection Overview

Data compiled to support the annual reclamation monitoring report includes:

A. Spatial data (Exhibit III):
   1. Surface Disturbance;
   2. Ecological Site; and
   3. Weed Infestation
B. Field-based monitoring of percent cover using methods described in Section 4.1.1 – Vegetation Sampling Protocols.
C. Photopoints of reclamation areas as described in Section 4.1.1 – Vegetation Sampling Protocols.
D. Seeding contractor reports for all seeding activities.
E. Weed contractor reports for all weed control activities.

### 3.3.3 Field-Based Monitoring of Reclamation

Vegetation data will be collected as described in Section 4.1.1 – Vegetation Sampling Protocols. Data will be compared to success standards (Section 3.3.1 – Reclamation Success Standards) as defined by the selected reference sites for each ecological site and summarized in the annual reclamation monitoring report (Section 5.0 – Reporting). Basal cover (line-point intercept) will be used to evaluate vegetation standards and reclamation success. Shrub intercept and SamplePoint protocols will not be used to evaluate reclamation success, per BLM reclamation requirements (BLM 2012). Photopoints will be taken from permanently established locations for the start of each monitoring location as described in Section 4.1.1 – Vegetation Sampling Protocols.

## 4.0 MONITORING PROTOCOLS

Attribute data have been collected to characterize and delineate ecological sites (Attachment B) across the CCSM Project Site (Caudle et al. 2013). The following sampling protocols and methodologies were selected and modified as needed to identify, evaluate, and document landscape, vegetation, and soil characteristics within each ecological site. Data forms have been developed for tablet technology to support more efficient and standardized field data collection.

Ecological site monitoring is intended to be rapid and focused on sampling the environmental range associated with initial ecological site concepts (Caudle et al. 2013). Vegetation and soil measurement methods will include line-intercept for canopy cover; canopy gap intercept; line-point intercept for basal and foliar cover; species composition; and, an evaluation of soil chemical and physical properties. The following data are required to inform the ecological site concept and confirm the ecological site model (Caudle et al. 2013):

- Representative species list

- Canopy or foliar cover, by species, growth form, and vertical strata
- Vegetation vertical and horizontal structure
- Inherent and dynamic soil properties
    - Physical Properties
        - Soil profile horizons and topsoil depth
        - Color
        - Structure and consistence
        - Texture
        - Texture modifiers
    - Chemical Properties
        - Electrical conductivity
        - Carbonate Equivalent (percent)
        - Soil reaction (pH)
- Topography (i.e., landform, slope, aspect, elevation, slope shape)
- Ground cover (unprotected soil, basal vegetation cover, litter, gravel, rock, biological soil crust – includes mosses, lichens and cyanobacteria)
- Photographs that capture landscape setting as well as dominant vegetation components

Sampling methods have been developed in coordination with the BLM. The protocols sufficiently characterize soil diagnostic horizons and their properties (e.g., soil texture, soil texture modifiers, soil depth to a restrictive horizon), landform, topographic features (slope and aspect), complete species lists, variations in plant species cover and structure, and soil surface properties.

Monitoring and reference sites will be selected prior to surface disturbing activities. Reference locations will be selected from the pre-site characterization survey locations that were sampled during ESD-characterization efforts and described above. It is anticipated that a minimum of one and not more than three reference sites will be established per ecological site.

Reclamation evaluation areas (REAs) will be used to evaluate reclamation success for linear features, areas of contiguous disturbance, and groups of turbines. One reclamation monitoring location will be established within each REA to measure reclamation success for a disturbed feature(s). All monitoring locations will be evaluated in the field prior to data collection and will be micro-sited to serve as representative monitoring locations with consistent environmental settings (i.e., elevation, slope, aspect, landform, etc.). REAs for each project disturbance type are described below:

- Linear Features - Linear features will be split into segments of 1 mile in length. If the entire 1 mile length of a segment falls within a single ecological site, that segment will become the REA in which reclamation success will be measured. If the segment crosses multiple ecological sites, the segment will be subdivided into smaller REAs for each ecological site.

- Contiguous disturbances - Blocks of contiguous disturbance (operations centers, laydown yards, etc.) will be split into 10-acre plots of a contiguous ESD representing the REA. If a 10-acre plot cannot be formed within an ESD, a smaller REA will be established.
- Turbines - Turbines in each turbine string will be characterized according to the ecological site in which they are located. Turbines falling within the same ecological site will be subdivided into groups of ten or fewer turbines which will represent the REA that will be used to measure reclamation success.

For all REAs, monitoring locations are subject to change based on abiotic and biotic conditions (i.e., fire, drought, etc.) that might change after reclamation monitoring begins.

### 4.1.1 Vegetation Sampling Protocols

Vegetation data will include a qualitative and quantitative inventory of plant species, canopy and basal vegetation cover estimates, ground cover estimates, dominant plant species, and canopy and basal gap intercepts. Opportunistic observations of rare plant species and noxious and invasive weed species will also be documented and recorded.

A vegetation sampling transect (100 meter) will be established in each REA and for each reference site to quantitatively assess vegetation composition and structure (Exhibit I). Location and direction of each transect will be randomly assigned to effectively assess vegetation characteristics within each ecological site. Percent cover along each sampling transect will be evaluated using line-point intercept (LPI) methods (Herrick et al. 2009). Top canopy, sub-canopy, basal layers, and ground cover will be recorded at 1-meter intervals (Herrick et al. 2009). LPI is the preferred method for percent cover because it is more repeatable and more efficient than quadrat (e.g., Daubenmire and grid-point) techniques (Marlow and Clary 1996; Wirth and Pyke 2007; Gordínez-Alvarez et al. 2009). Continuous line intercept (shrub intercept) will be used to estimate shrub canopy cover within the site (Herrick et al. 2009).

A qualitative assessment will be conducted to capture all species, when practicable, that are present within the vicinity of the transect. This will be accomplished by walking the transect and recording occurrences of each species observed within 2.5 meters of the transect line. A species list will be tabulated for each monitoring location.

Photopoints will be taken from the permanently established locations for the start of each transect. The location will be marked with a permanent stake and UTM coordinates of the location will be recorded. Six photographs will be taken from each location following modified procedures described by Herrick et al. (2009). A representative transect photo will be captured at the beginning (0 meter) of each vegetation transect. Additional landscape photos will be established for each of the four cardinal directions (North – $0^o$; East – $90^o$; South – $180^o$; and, West – $270^o$). A nadir photograph will be taken of the ground cover from a height of approximately 1.5 m at 10 meters along the vegetation transect. Along with photopoints documenting the surrounding conditions of the ecological site, 20 nadir

photographs will be taken at 5 m intervals along the 100-meter transect of representative reference sites.

Photopoints will also be established at each turbine location (photos taken in each of the cardinal directions and nadir) to allow for an ocular comparison of reclamation success versus that measured at the monitoring location for the REA.

### 4.1.2 Soil Sampling Protocols

Erosion potential will be qualitatively assessed for each REA by evaluating soil erosion standards described in Pellant et al. 2005. A site evaluation for each erosional feature (pedestals, flow patterns, rills, and gullies) will be conducted to estimate overall risk of erosion for each monitoring location and for the ecological site overall. Where erosion potential is identified as being severe or critical, measures to decrease erosion potential will be identified in coordination with BLM through the adaptive management process. .

Soil testing has been completed as part of pre-site characterization efforts including sampling at potential reference sites. Soil physical and chemical characteristics have been characterized for each ecological site using testing kits developed by the Wyoming Reclamation & Restoration Center [WRRC] with adapted protocols from the *Field Book for Describing and Sampling Soils* (Schoeneberger et al. 2012).

It is anticipated that the pre-site characterization efforts and soil handling methods identified for each ecological site will limit the need for post-construction soil sampling unless reclamation efforts are not successful. If reclamation success is limited by post-construction soil conditions, appropriate testing methods and locations will be determined in coordination with BLM through the adaptive management process.

# 5.0 REPORTING

Reclamation monitoring and reporting will occur annually in accordance with BLM requirements. Vegetation will be evaluated against the reclamation success standards described in Section 3.3.1 – Reclamation Success Standards and the reference sites established during pre-disturbance planning. In addition, erosional assessments and photopoints will be completed to support reclamation monitoring efforts.

PCW will submit annual reclamation monitoring reports and digital and geo-referenced reclamation data to BLM by February 1 of each year and BLM will complete an evaluation of annual monitoring reports and provide recommendations by March 31 of each year. This will enable PCW to adaptively manage reclamation, if necessary, prior to the next field and reclamation season.

## 5.1 REPORT REQUIREMENTS

PCW will be responsible for the following:

A. Monitoring of reference sites and reclamation areas;

B. Determining if reclamation success standards are being met;

C. Developing and implementing remedial actions if success standards are not being met;

D. Reporting monitoring results to BLM annually (February 1);

E. Providing digital copies of monitoring data:

   1. Required spatial data in digital format, including tabular data as described in Exhibit III.

   2. Vegetation monitoring data (line-point intercept) in digital format

F. Requesting concurrence from BLM that success standards have been met and monitoring is no longer required; and

G. Monitoring for noxious weeds

H. Spatial data for all reclaimed and disturbed areas.

The BLM will be responsible for the following:

A. Evaluating annual monitoring reports;

B. Providing a determination as to whether or not reclamation assessments are accurate and success standards are being met, including the rationale for the determination; and

C. Providing input on remedial actions to facilitate reclamation success (which may include requiring certain actions such as soil testing, soil amendments, irrigation, etc. that are not required by this plan).

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# Exhibit I

## Vegetation Sampling Protocols
## (Herrick et al. 2009)

## Line-point Intercept Method (Herrick et al. 2009)

Line-point intercept (LPI) is a rapid, accurate method for quantifying soil cover, including vegetation, litter, rocks and biotic crusts. These measurements are related to wind and water erosion, water infiltration and the ability of the site to resist and recover from disturbance. For a detailed discussion of this and other methods for measuring plant cover and/or composition, see Elzinga et al. 2002.

### Materials

- Measuring tape (length of transect)—100 meters
- Two steel pins for anchoring tape
- One pointer—a straight piece of wire or rod, such as a long pin flag, at least 75 cm (2.5 ft) long and less than 3 mm (0.12 in) in diameter
- Panasonic Toughpad with LPI Digital Data Form

### Standard methods (rule set)

1. Pull out the tape and anchor each end with a steel pin.

   ***Rules***

   1.1 Line should be taut along surface layer.

   1.2 Line should be as close to the ground as possible.

2. Begin at the "0" end of the line.
3. Working from left to right, move to the first point on the line (1-meter increments). Always stand on the same side of the line.
4. Drop a pin flag to the ground from a standard height (__ cm) next to the tape.

   ***Rules***

   4.1 The pin should be vertical.

   4.2 The pin should be dropped from the same height each time. A low drop height minimizes "bounces" off of vegetation but increases the possibility for bias.

   4.3 Do not guide the pin all the way to the ground. It is more important for the pin to fall freely to the ground than to fall precisely on the mark.

5. Once the pin flag is flush with the ground, record every plant species it intercepts.

   ***Rules***

   5.1 Record the species of the first stem, leaf or plant base intercepted in the "top canopy" column using the PLANTS database species code (http://plants.usda.gov/), a four-letter code based on the first two letters of the genus and species, or the common name.

   5.2 If no leaf, stem or plant base is intercepted, record "NONE" in the "Top canopy" column.

5.3 Record all additional species intercepted by the pin.

5.4 Record herbaceous litter as "L," if present. Litter is defined as detached dead stems and leaves that are part of a layer that comes in contact with the ground. Record "W" for detached woody litter that is greater than 5 mm (or ~1/4 in) in diameter and in direct contact with soil.

5.5 Record each canopy species only once, even if it is intercepted several times.

5.6 If you can identify the genus, but not the species either use the PLANTS database genus code (http://plants.usda.gov) or record a number for each new species of that genus. ALWAYS define the genus portion of the code and the functional group at the bottom of the data form (*Artemisia* species = AR01).

5.7 If you *cannot* identify the genus, use the following codes:

**AF#** = Annual forb (also includes biennials)

**PF#** = Perennial forb

**AG#** = Annual graminoid

**PG#** = Perennial graminoid

**SH#** = Shrub

**TR#** = Tree

If necessary, collect a sample of the unknown off the transect for later identification.

5.8 Canopy can be live or dead, but only record each species once. Be sure to record all species intercepted.

6. Record whether the pin flag intercepts a plant base or one of the following in the "Soil surface" column.

**R** = Rock (> 5 mm or ~1/4 inch in diameter)

**BR** = Bedrock

**L** = Herbaceous litter

**W** = Wood

**BSC** = Biological soil crust (includes cyanobacteria, lichens, and moss)

**S** = Unprotected soil

***Rules***

6.1 For unidentified plant bases, use the codes listed under 5.7.

## Continuous Line Intercept (Shrub Intercept) Method (Herrick et al. 2009)

Continuous line intercept measurements provide information about the proportion of the line covered by vegetation and large gaps between plants. Large gaps between plant canopies are important indicators of potential wind and water erosion and weed invasion. Continuous line intercept (shrub intercept) will be used to estimate shrub canopy cover along the transect. This protocol qualifies the shrub diversity and quantifies the amount of live and dead shrub canopy (parsed by species) that intersects the transect. For a detailed discussion of this and other methods for measuring plant cover and/or composition, see Elzinga et al. 2002.

**Standard methods (rule set)**

1. Pull out the tape and anchor each end with a steel pin.

   ***Rules***

   1.1 Line should be taut along surface layer.

   1.2 Line should be as close to the ground as possible.

2. Begin at the "0" end of the line.

3. Working from left to right, move to the first point on the line (1-meter increments). Always stand on the same side of the line.

   ***Rules***

   3.1 Look straight down on the tape. Use a meter stick or other stiff stick to project a line vertically to the ground.

   3.2 Assume that there is a wall at each end of the tape. Do not consider gaps or vegetation that occur off the end of the tape.

4. Canopy intercept. Record the beginning and end of each shrub canopy by species or sub-species.

   ***Rules***

   4.1 Identify shrub species to species or subspecies.

   4.2 Canopy occurs any time the tape edge intercepts live or dead shrub foliar or branch cover based on a vertical projection from canopy to round.

   4.3 A plant canopy can be live or dead.

   4.4 Record the start and end of a gap to the nearest centimeter (0.1 ft)

   4.5 Exclude gaps in the shrub canopy greater than 10 cm (2 inches)

## Surface Cover Documentation

Nadir photographs will be taken at 5-meter intervals along the 100 meter transect of vegetation sampling sites to estimate soil surface cover and vegetative cover and evaluate reclamation success.

**Standard methods (rule set)**

1. Pull out the tape and anchor each end with a steel pin.

   ***Rules***

   1.1 Line should be taut along surface layer.

   1.2 Line should be as close to the ground as possible

2. Begin at the "0" end of the line.

3. Working from left to right, move to the first point on the line (5-meter intervals).

   ***Rules***

   3.1 Always work on the same side of the line.

4. Establish 0.8 m scale/grid for nadir photograph by placing one pin flag perpendicular to the tape at the meter point and another pin flag perpendicular to the tape at 0.8 m from the meter point.

5. Capture nadir photograph to include tape measure and the two scalar pin flags (to ensure correct resolution and scale).

   ***Rules***

   5.1 Use a digital camera set at minimum of 8 megapixel resolution.

   5.2 Avoid observer shadow and minimize poor light conditions by shooting toward sun.

# Exhibit II

## Soil Sampling Protocols
## (Wyoming Reclamation & Restoration Center)
## (Schoeneberger et al. 2012)

**Soil Sampling Protocol**

A modified pedon description data sheet will be used to collect site descriptions, soil physical properties, and soil chemical properties needed to assess ecological site characteristics (Schoeneberger et al. 2012). Site descriptions will provide the physiographic setting of the monitoring location, including climate features, geomorphic descriptions, and surface morphometry. Soil physical properties will provide horizon characteristics for each soil pit, including depth, boundary descriptions, matrix color, texture, and structure and consistence. Soil chemical properties will evaluate chemical characteristics that influence aboveground vegetative composition and erosion potential, and include saline class (electrical conductivity), effervescence (carbonate equivalency), and soil reaction (pH).

**Materials**

- Bi-metal dial thermometer
- Black permanent marker
- Conductivity calibration solution
- Distilled water
- Electrical conductivity meter
- *Field Book for Describing and Sampling Soils* (Schoeneberger et al. 2012)
- Garden trowel
- Hydrochloric acid (0.10 N)
- Level
- Magnetic nails
- Magnifying glass
- Measuring/mixing cup
- Measuring tape
- Measuring tube
- Munsell soil color charts
- pH 4.0 buffer solution
- pH 10.0 buffer solution
- pH meter
- Plastic cups
- Plastic bags (quart)
- Plastic spoon
- Red eye markers
- Safety goggles
- Soil sieve

**Pit Construction**

A wall/floor, small pit (SP) will be excavated to examine soil horizons, roots, geological substrata, etc. Soil pits will be constructed to a depth of approximately 50 cm (20 inches) or to the first layer of consolidated bedrock. Each pit will be oriented such that the largest pit face is facing the sun and well lighted. Topsoil and subsoil will be removed sequentially and separated so that it can be returned in opposite order to maintain the physical, chemical, and biological integrity of the soil and to approximate the visual state equivalent to its original undisturbed state, when practicable. A photograph will be taken of the soil pit and pedon, including scale and horizon indicators.

**Site Description**

**Recording Date**

Record the observation date (MM/DD/YYYY).

**Location**

Record precisely the point or site location coordinates (latitude, longitude) and geodetic datum.

**Observer**

Record the observer(s) making the description.

**Site ID**

Assign a site identification number as determined by ecological site and soil pit number.

**Photopoint**

Photograph the soil pit and pedon, including scale and horizon indicators, of the largest pit face that is facing the sun and well lighted.

## Weather and Temperature

### Weather

Document the prevailing weather conditions at time of observation (a site condition that affects some field methods). Weather conditions should be recorded as the following classes:

| Class | Description |
|---|---|
| 0 | Clear or few clouds |
| 1 | Partly cloudy (scattered) or variable sky |
| 2 | Cloudy (broken) or overcast |
| 3 | Fog or smoke |
| 4 | Drizzle |
| 5 | Showers |
| 6 | Flurries |
| 7 | Snow showers |

### Air Temperature

Record the ambient air temperature at chest height (Celsius or Fahrenheit).

### Soil Temperature

Record the ambient soil temperature and depth at which the soil temperature was determined. Soil temperature should only be determined from a freshly excavated surface that reflects the ambient soil conditions. When soil pit is first opened, soil temperature should be determined immediately. Temperature measurements will be taken at the bottom of the pit at 50 cm. In shallow pits, this may be modified, but temperatures should always be taken at least at the maximum depth of any given pit. In a newly opened pit, temperatures will be taken by inserting the temperature probe into the wall of the pit a minimum of 5 cm. The temperature is recorded when stabilized (about three minutes).

## Geomorphic Description

### Landscape

A landscape feature is a broad assemblage or unique group of natural, spatially associated features. Record the representative landscape feature associated with the described soil as defined in Schoeneberger et al. 2012.

### Landform

A landform is a discrete, natural, individual earth-surface feature that is mappable at common survey scales. Record the representative landform feature associated with the described soil as defined in Schoeneberger et al. 2012.

**Microfeatures**

A microfeature is a discrete, natural earth-surface feature too small to delineate at common survey scales. Record the representative microfeature associated with the described soil as defined in Schoeneberger et al. 2012.

**Geomorphic Component**

Geomorphic components are three-dimensional descriptors of parts of landforms or microfeatures that are best applied to areas. Unique descriptors are available for *Hills*, *Terraces and Stepped Landforms*, *Mountains*, and *Flat Plains* (Schoeneberger et al. 2012). Record the representative geomorphic component associated with the described soil as defined in Schoeneberger et al. 2012.

**Drainage Pattern**

Drainage patterns describe the arrangement of drainage features and channels on the land surface. Record the representative drainage network associated with the described soil as defined in Schoeneberger et al. 2012.

**Anthropogenic Features**

An anthropogenic feature is a discrete, artificial (human-made) earth surface feature. Record any anthropogenic feature associated with the described soil as defined in Schoeneberger et al. 2012.

**Surface Morphometry**

**Slope Aspect**

Record the compass bearing (in degrees, corrected for declination) that a slope faces, viewed downslope.

**Slope Gradient**

Record the angle of the ground surface (in percent) through the ecological site and in the direction that overland water would flow (commonly referred to as slope).

**Slope Complexity**

Describe the relative uniformity or irregularity of the ground surface leading downslope through the point of interest. Smooth, linear or curvilinear slopes are simple (*S*) and irregular slopes with multiple changes in angle are complex (*C*).

**Slope Shape**

Slope shape is described in two directions: 1) vertical – up and down slopes, perpendicular or normal to the contour; and 2) horizontal – across slope, along the horizontal contour. These two descriptors are commonly reported as a pair. The first term refers to vertical slope and the second term refers to across slope. Record the vertical and horizontal slope shape for the described soil as defined in Schoeneberger et al. 2012.

| Vertical Slope (Down) | Horizontal Slope (Across) | Code |
|---|---|---|
| Concave | Concave | CC |
| Concave | Convex | CV |
| Concave | Linear | CL |
| Convex | Concave | VC |
| Convex | Convex | VV |
| Convex | Linear | VL |
| Linear | Concave | LC |
| Linear | Convex | LV |
| Linear | Linear | LL |

**Hillslope Profile Position**

Describe the two-dimensional hillslope position along the soil pit.

| Position | Code |
|---|---|
| Summit | SU |
| Shoulder | SH |
| Backslope | BS |
| Footslope | FS |
| Toeslope | TS |

**Microrelief**

Microrelief is a small, relative difference in elevation between adjacent areas on earth's surface. Record any microrelief associated with the soil surface as defined in Schoeneberger et al. 2012.

**Profile Description**

**Horizon**

Horizons are considered to be layers of pedogenically derived or modified material. Layers are deemed to be zones of nonpedogenically derived/modified material (e.g., geologic strata). These strata are differentiated by the weathering on geologic strata in developing soil horizons and are influenced by climate, relief, biological activity, parent material, and time. The physical and chemical properties (see below) will be described for each pedogenically distinguishable soil horizon to 50 cm depth or to the first restrictive geologic layer (Schoeneberger et al. 2012).

**Depth**

Soil depth will be sub-divided into horizons. Often the upper most horizon is made up of un-decomposed organic matter. Record the depths of both the upper and lower boundary for each horizon (in cm). Begin at the ground surface, which is not necessarily the mineral surface.

**Boundary**

Record the **Distinctness** and **Topography** of horizon boundaries. Distinctness is the vertical distance through which the bottom of one horizon grades (transitions) into another. Topography is the lateral undulation and continuity of the boundary between horizons.

**Matrix Color**

Record the soil matrix color according to Munsell notation (Hue, Value, Chroma) (Munsell Color 2010). Soil organic matter can be estimated using Munsell Color charts. Soil color will be recorded for dry and moist soil conditions.

**Texture and Structure**

**Texture**

Soil texture is the numerical proportion (weight percentage) of the sand, silt, and clay separates in the fine-earth fraction of the soil (less than 2mm). Coarse fragments can be very important to physical, chemical and biological soil properties, but generally the fine fraction of the soil has the most impact on soil properties. Soil texture will be field determined by hand texturing. Record the texture class and subclass as defined in Schoeneberger et al. 2012 and the Soil Texture Triangle. If necessary, use a Texture Class Modifier (see below)

| Texture Class or Subclass | Code |
|---|---|
| Coarse Sand | COS |
| Sand | S |
| Fine Sand | FS |
| Very Fine Sand | VFS |
| Loamy Coarse Sand | LCOS |
| Loamy Sand | LS |
| Loamy Fine Sand | LFS |
| Loamy Very Fine Sand | LVFS |
| Coarse Sandy Loam | COSL |
| Sandy Loam | SL |
| Fine Sandy Loam | FSL |
| Very Fine Sandy Loam | VFSL |

| Texture Class or Subclass | Code |
|---|---|
| Loam | L |
| Silt Loam | SIL |
| Silt | SIL |
| Sandy Clay Loam | SCL |
| Clay Loam | CL |
| Silty Clay Loam | SICL |
| Sandy Clay | SCL |
| Silty Clay | SIC |
| Clay | C |

**Rock Fragments**

Record any rock fragment texture modifiers that describe the percent volume range for rock fragments and relative size of modifiers. The "Quantity" modifier is the volume percent whole soil of the total rock fragment content. The "Size" modifier is independently based on the largest, dominant fragment size. For a size mixture, a smaller size class is named if its quantity (%) sufficiently exceeds that of a larger size class. For field texture determination, a small rock fragment size class must exceed either 1.5 or 2 times the quantity (volume 5) of a larger size class before it is named.

| Rock Fragments Quantity and Size | Code | Criteria |
|---|---|---|
| ***Rock Fragments (> 2mm; ≥ Strongly Cemented)*** | | |
| Gravelly | GR | ≥ 15% but < 35% gravel |
| Fine Gravelly | GRF | ≥ 15% but < 35% fine gravel |
| Medium Gravelly | GRM | ≥ 15% but < 35% med. gravel |
| Coarse Gravelly | GRC | ≥ 15% but < 35% coarse gravel |
| Very Gravelly | GRV | ≥ 35% but < 60% gravel |
| Extremely Gravelly | GRX | ≥ 60% but < 90% gravel |
| Cobbly | CB | ≥ 15% but < 35% cobbles |
| Very Cobbly | CBV | ≥ 35% but < 60% cobbles |
| Extremely Cobbly | CBX | ≥ 60% but < 90% cobbles |

| Rock Fragments Quantity and Size | Code | Criteria |
|---|---|---|
| ***Rock Fragments (> 2mm; ≥ Strongly Cemented)*** | | |
| Stony | ST | ≥ 15% but < 35% stones |
| Very Stony | STV | ≥ 35% but < 60% stones |
| Extremely Stony | STX | ≥ 60% but < 90% stones |
| Bouldery | BY | ≥ 15% but < 35% boulders |
| Extremely Bouldery | BYX | ≥ 35% but < 60% boulders |
| Channery | CN | ≥ 15% but < 35% channers |
| Very Channery | CNV | ≥ 35% but < 60% channers |
| Extremely Channery | CNX | ≥ 60% but < 90% channers |
| Flaggy | FL | ≥ 15% but < 35% flagstones |
| Very Flaggy | FLV | ≥ 35% but < 60% flagstones |
| Extremely Flaggy | FLX | ≥ 60% but < 90% flagstones |

**Structure**

Soil structure is the naturally occurring arrangement of soil particles into aggregates that results from pedogenic processes. Peds are aggregates of soil particles that are usually easily distinguished from other such aggregates. Often in soils, boundaries sometimes appearing as cracks separate one ped from another. Where boundaries are indistinct visually, surface of separation may be more obvious as soil is chipped away mechanically or broken physically. Peds may be very small to massive. Peds may be blocky, prismatic, columnar, platy, or crumb-like, and may have angular and sub-angular point on the peds. Record the Grade, Size, and Type as defined by Schoeneberger et al. 2012. Record the dominant type of ped, by layer. If a prevailing large shape readily breaks into smaller units, record as "(larger type) parting to (smaller type)".

**Consistence**

Consistence is the degree and kind of cohesion and adhesion that soil exhibits and or the resistance of soil to deformation or rupture under an applied stress. Soil-water state strongly influences consistence. Stickiness of the soil, when wet will be noted as well as rupture resistance. Record soil consistence when defining soil texture as defined in Schoeneberger et al. 2012.

**Chemical Properties**

Chemical response is the reaction of a soil sample to an applied chemical solution or a measured chemical value. Responses are used to identify the presence or absence of certain materials, to obtain a rough assessment of the amount present, to measure the intensity of a chemical parameter (e.g., pH), or to identify the presence of chemical species in the soil.

**Saline Class (Electrical Conductivity)**

Soil salinity class can be based on electrical conductivity (EC) measurements from a saturated paste extract. Gypsum ($CaSO_4 \cdot 2H_2O$) and salts more soluble than gypsum (e.g., Na, Mg, and Ca chlorides and sulfates) are the sole or major contributors to the saturated paste extract EC. Electrical conductivity may be measured at various soil solution extract ratios. The resultant EC values are not directly comparable because of the dilution effect. The salinity standard is the saturated paste extract.

Measurement of EC is done by taking a weight of soil and adding twice as much deionized water (1:2 – soil to water = $EC_{1:2}$), mixing and then waiting five minutes before taking an EC measurement (using a handheld portable EC meter and probe).

| **Salinity Class** | **Code** | **Saturated Paste $EC_{1:2}$ (dS/m)** |
|---|---|---|
| Non-saline | 0 | < 0.4 |
| Very Slightly Saline | 1 | 0.4 to < 0.8 |
| Slightly Saline | 2 | 0.8 to < 1.6 |
| Moderately Saline | 3 | 1.6 to < 2.4 |
| Strongly Saline | 4 | 2.4 to < 3.2 |
| Very Strongly Saline | 5 | ≥ 3.2 |

**Effervescence (Carbonate Equivalency)**

Carbonates are present sometimes in soils of neutral to high pH. Their presence is often related to the parent material of the soil. Limestone and many types of sandstone contain carbonates and on weathering impart these to the resulting soil. Lime content of soil can be generally determined by adding a few drops of dilute hydrochloric acid (0.10 N HCl) to a few grams of soil. Bubbles emanating from the soils (effervescence) indicate the presence of carbonates. The amount of effervescence is directly related to the amount of carbonate present. The rate of effervescence is related to the kind of carbonate present. Sodium carbonates ($Na_2CO_3$, $NaHCO_3$) effervesce rapidly whereas carbonates associated with divalent metals (e.g., $CaCO_3$, $MgCO_3$) effervesce more slowly. Record effervescence of soils as defined in Schoeneberger et al. 2012.

**Soil Reaction (pH)**

Soil reaction (pH) is the measure of the hydrogen ion ($H^+$) activity of the soil. Hydrogen ion activity can be viewed as approximately equal to the hydrogen ion concentration, and when hydrogen ions are dilute, concentration and activity are for all practical purposes, equal. Measurement of pH is done by taking a weight of soil and adding twice as much deionized water (1:2 – soil to water = $pH_{1:2}$), mixing and then waiting five minutes before taking a pH measurement (using a handheld portable pH meter and probe). In cases where there is some suspicion that there is considerable sodium in the soil, the ratio of soil to water should be raised to 1:5. The pH meter should be standardized daily.

| Descriptive Term | Code | Criteria: pH range |
|---|---|---|
| Ultra Acid | 0 | < 3.5 |
| Extremely Acid | 1 | 3.5 to 4.4 |
| Very Strongly Acid | 2 | 4.4 to 5.0 |
| Strongly Acid | 3 | 5.1 to 5.5 |
| Moderately Acid | 4 | 5.6 to 6.0 |
| Slightly Acid | 5 | 6.1 to 6.5 |
| Neutral | 6 | 6.6 to 7.3 |
| Slightly Alkaline | 7 | 7.4 to 7.8 |
| Moderately Alkaline | 8 | 7.9 to 8.4 |
| Strongly Alkaline | 9 | 8.5 to 9.0 |
| Very Strongly Alkaline | 10 | > 9.0 |

# Exhibit III

## BLM Rawlins Field Office
## Geospatial Guidance
## (BLM 2011)

**Method for collecting data for baseline data of disturbance**

- GPS units will be used to collect data along the perimeter of each disturbance.
- GPS data will be collected as individual polygons using GPS units along the edge of each disturbance based on attributes discussed below.
- GPS units must have a rated accuracy of 4 meters or better (95% confidence interval).
- GPS data will be converted into the format of a shapefile and data will be referenced to NAD 1983 (CORS 96), UTM Zone 13N, meters.
- Attributes may be collected during field collection using a data dictionary on the GPS units or incorporated into the shape file during post processing.
- Rawlins Field Office (RFO) will provide any standardized data dictionaries that are requested.

**GIS Shapefile Requirements**

- Shapefiles will include all surface-disturbance.
- Shapefiles will be submitted at a minimum with the annual reclamation monitoring report on February 1 of each year for the previous year's work.
- Data will be submitted as polygons, not as point or line files.
- A minimum of three shapefiles will be submitted with annual reports:
    - Type 1 "Surface Disturbance" that includes all "as-built disturbance", interim/final reclamation, and long term disturbance data (annual submittals are dependent upon surface disturbance and reclamation occurring during each monitoring year).
    - Type 2 "Ecological Sites" that include polygons for ecological site information mapped to the as-built (this only needs to be submitted during the first annual report).
    - Type 3 "Weed Infestations" that include polygons for weed infestation associated with disturbance
- Polygons are required to have attributes (see details below)
- Submit your shapefiles to the BLM RFO, Attention: Reclamation Specialist
- Include a metadata file

**Polygon Boundaries**

- Shapefile Type 1 "Surface Disturbance" polygons will be defined by the following:
    1. As-built construction
    2. Un-reclaimed (interim and long term) disturbance
    3. Reclamation (interim and long term)

- Shapefile Type 2 "Ecological Site" (intended for reclamation and seed mix selection) will be defined by the following:
    1. Delineation of Ecological Sites
    2. Ready for Assessment by the BLM for rollover
- Shapefile Type 3 "Weed Infestation" polygons will be defined by the following:
    1. Weed Infestation patch (plants within 120 feet of each other)
    2. Distinct polygon for each weed species

## Attribute Requirements

**Shapefile 1 "Surface Disturbance"** will contain the following attributes and be formatted as shown in the table:

| **True Name** | **Site Number** | **ROW Number** | **API Number** | **Project Name** | **Project Number** | **Project Feature** | **Date of Disturbance** | **Disturbance** | **Acres** |
|---|---|---|---|---|---|---|---|---|---|
| **Shapefile Alias** | Site_Num | WYW_Num | API_Num | Projec_Nam | Proj_Num | Proj_Feat | Date | Dist_Type | Acres |
| **Format** | Text | Text | Text | Text | Text | Text | 99/99/9999 | Text | Integer |
| **Width** | 20 | 20 | 20 | 50 | 20 | 50 | 99/99/9999 | 20 | 20 |

**Shapefile 2 "Ecological Site"** will contain the following attributes and be formatted as shown in the table:

| **True Name** | **Site Number** | **ROW Number** | **API Number** | **Project Name** | **Project Number** | **Project Feature** | **Ecological Site** | **Date of Disturbance** | **Disturbance** | **Acres** | **Ready for Assessment** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Shapefile Alias** | Site_Num | WYW_Num | API_Num | Projec_Nam | Proj_Num | Proj_Feat | ESD | Date | Dist_Type | Acres | Rollover |
| **Format** | Text | Text | Text | Text | Text | Text | Text | 99/99/9999 | Text | Integer | Text |
| **Width** | 20 | 20 | 20 | 50 | 20 | 50 | 50 | 99/99/9999 | 20 | 20 | 10 |

**Shapefile 3 "Weed Infestations"** will contain the following attributes and be formatted as shown in the table:

| **True Name** | **Site Number** | **ROW Number** | **API Number** | **Project Feature** | **Weed Species** | **Patch Density** | **Treated** | **Treatment Type** | **Treatment Date** | **Acres** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Shapefile Alias** | Site_Num | WYW_Num | API_Num | Proj_Feat | Weed_Spec | Patch_Den | Treated | Treat_Type | Treat_Date | Acres |
| **Format** | Text | Text | Text | Text | Text | Text | Text | Text | 99/99/9999 | Integer |
| **Width** | 20 | 20 | 20 | 50 | 50 | 20 | 10 | 50 | 99/99/9999 | 20 |

# ATTACHMENT B

## Clay Ecological Site Class Reclamation Implementation Plan
## and
## Clayey Ecological Site Descriptions
## for
## Phase I of the Chokecherry and Sierra Madre Wind Energy Project

## Introduction

This Clay Ecological Site Class Reclamation Implementation Plan describes the common and ecological site-specific characteristics, reclamation practices, and BMPs that will be applied within the CCSM Project Site. Ecological sites in the CCSM Project Site were established cooperatively with the BLM and are a result of robust soil and vegetation sampling, landform analysis, and precipitation zone evaluation. The ecological sites are consistent with the Cool Central Desertic Basins and Plateaus (Major Land Resource Area [MLRA] – 34A) and Southern Rocky Mountain Foothills (MLRA – 49) MLRAs (Natural Resources Conservation Service [NRCS] 2006) and are primarily located in the Wyoming Basin Province of the Rocky Mountain System (NRCS 2011).

Based on common reclamation characteristics, individual ecological sites were grouped into similar ecological site classes (clay, loam, shallow, saline, and sand). Grouping similar ecological sites into a common ecological site class will increase efficiency and effectiveness of reclamation efforts as many of these common sites will have identical or very similar measures for soil handling, site preparation, and revegetation.

The following reclamation implementation plan describes the reclamation procedures and BMPs that will be applied to the ecological sites within the Clay ecological site class. The Clay ecological site class includes the following ecological sites:

- Clayey 7-9 Inch (see Exhibit I)
- Clayey 10-14 Inch (see Exhibit II)
- Clayey Overflow 7-9 Inch (see Exhibit III)

## Reclamation Procedures and Best Management Practices

Site-specific reclamation procedures and BMPs have been developed for this Clay Ecological Site Class Reclamation Implementation Plan. Many of the reclamation procedures and BMPs will be implemented across all clayey ecological sites in the CCSM Project while other measures will be specific to an individual ecological site or smaller group of ecological sites within the Clay ecological site class.

Reclamation procedures and BMPs account for abiotic landscape features, soil characteristics, and vegetation characteristics and were designed to mitigate impacts to the abiotic and biotic factors characteristic of each ecological site and increase reclamation success. These procedures were developed in accordance with the CCSM Project Master Reclamation Plan (BLM 2012a), BLM Wyoming Reclamation Policy (2012b), management directives presented in the Rawlins Field Office (RFO) Resource Management Plan (RMP) (BLM 2008), RFO Reclamation Guidance (BLM 2011), Wyoming Department of Environmental Quality (WDEQ) Land Quality Division reclamation guidelines (WDEQ 2007), Wyoming Reclamation and Restoration Center (WRRC) Handbook of Western Reclamation Techniques (WRRC 2006), State of Wyoming's reclamation guidance for wind development, and in coordination with BLM staff. This Clay Ecological Site Class Reclamation Implementation Plan is intended to be adaptive and to take into account changing conditions and technologies. PCW, with concurrence from the BLM AO, may update, modify, or change the procedures contained in this plan if warranted due to site conditions or other factors.

In accordance with the guidance described above, reclamation practices and BMPS have been developed to address abiotic landscape features, soil handling, site preparation, and vegetation handling and revegetation. The following sections describe the practices specific to clayey ecological sites in Phase I of the CCSM Project.

**Soil Handling and Site Preparation**

Soil associated with each ecological site will be managed in accordance with the BLM Wyoming Reclamation Policy (2012b) and as detailed in the CCSM Project Master Reclamation Plan (2012a) and the site-specific reclamation plan for Phase I of the CCSM Project. Provisions are included below for segregating and marking stockpiles, as well as requirements to protect stockpiled material from erosion, contamination and degradation. Site-specific soil handling and site preparation measures for clayey ecological sites are listed below:

*Soil handling practices and BMPs for* ***all clayey ecological sites***[1]*. These measures would be applied to all clayey ecological sites.*

- Apply mulch and/or soil tackifiers to assist in mitigating stockpile wind erosion and contribute organic materials.
- As necessary, rip and aerate prior to mulching.
- As necessary, apply wood straw to improve soil aggregation, increase porosity and permeability, and improve aeration and drainage, for stockpiles stored for more than two years.
- When applicable, use growth and till cycles of long-term stockpiles to maintain biological activity, reduce compaction, and incorporate native organic matter and seed sources, when practicable.
- Seed long-term stockpiles with appropriate vegetation to maintain biological activity and prevent wind erosion.
- Trap moisture during winter months through the use of snow fences, if appropriate.
- Include native vegetation into salvaged topsoil to include organic matter and maintain native seedbank.
- When applicable, locate stockpiles within disturbed areas to reduce additional surface disturbance to native topsoil.

[1] Clayey Ecological Sites include Clayey 7-9 Inch, Clayey 10-14 Inch, Clayey Overflow 7-9 Inch, Deep Shale 7-9 Inch, Deep Shale 10-14 Inch, and Shale 10-14 Inch

*Site preparation practices and BMPs for **all clayey ecological sites**. These measures would be applied to all clayey ecological sites.*

- Deep rip subsoils prior to application of topsoil to improve drainage.
- Perform secondary tillage of topsoil to break up clods; secondary tillage will be no deeper than the depth of the replaced topsoil.
- Till across slope or perpendicular to the prevailing wind to reduce erosion.
- Create good surface and internal drainage through the use of directional flow and open ditches to increase drainage, as appropriate.
- If necessary, add soil amendments to ameliorate physical, biological, and chemical attributes that may limit reclamation potential, to meet fair to good topsoil suitability criteria (BLM 2011), as approved by the BLM AO.
- If necessary, add soil amendments to reduce salt and/or sodium content.
- Inspect the soil surface for ponding or gullying.
- Suspend construction activities when soils are wet and rutting exceeds 4 inches, as appropriate.

*Additional soil handling and site preparation practices and BMPs for the **Clayey 7-9 inch** ecological site. These measures would be applied in addition to those described above for all clayey ecological sites.*

- Apply suitable subsoil as topsoil following testing of physical and chemical characteristics to determine compatibility between subsoil and topsoil, if necessary, with approval from the BLM AO.
- To achieve soil balance across the CCSM Project Site, if physical and chemical characteristics are compatible and will not limit reclamation success, use suitable subsoil from other ecological sites as subsoil or construction fill in clayey ecological sites.

*Additional soil handling and site preparation practices and BMPs for the **Clayey 10-14 inch** ecological site. These measures would be applied in addition to those described above for all clayey ecological sites.*

- Apply suitable subsoil as topsoil following testing of physical and chemical characteristics to determine compatibility between subsoil and topsoil, if necessary, with approval from the BLM AO.
- To achieve soil balance across the CCSM Project Site, if physical and chemical characteristics are compatible and will not limit reclamation success, use suitable subsoil from other ecological sites as subsoil or construction fill in clayey ecological sites.

*Additional soil handling and site preparation practices and BMPs for the **Clayey Overflow 7-9 inch** ecological site. These measures would be applied in addition to those described above for all clayey ecological sites.*

- No site-specific BMPs for soil handling have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

**Vegetation Handling**

The primary objective of revegetation is to establish the species composition, diversity, structure, and total ground cover appropriate for the desired plant community (BLM 2012b). In accordance with BLM Wyoming Reclamation Policy (2012b), proper seeding mixtures will be used to reclaim disturbed areas on federal lands with native vegetation, as detailed in the CCSM Project Master Reclamation Plan (2012a) and the site-specific reclamation plan for Phase I of the CCSM Project. Soil conditioning, de-compaction, and topsoil protection measures will be implemented to reestablish topsoil properties and to protect the seeding surface, as presented in Table 2 and described in the CCSM Project Master Reclamation Plan (BLM 2012a), the site-specific reclamation plan for Phase I of the CCSM Project, and in compliance with BLM Wyoming Reclamation Policy (2012b).

Seed mixtures will be tailored to establish species diversity, composition, and ground cover appropriate for the desired plant community that has been documented for each ecological site in the CCSM Project Site. Seed mixtures may be refined based on soil management, wildlife, or rangeland needs. Seed mixtures will be designed for each ecological site based on the RFO ecological site specific pick lists combined with site-specific vegetation characteristics (BLM 2008, 2011). The use of non-native species on federal lands will only be considered as the result of the documented failure to revegetate any area with native species and will be implemented in coordination with the BLM AO. BMPs and reclamation measures will be refined for site-specific characteristics and implemented as necessary in coordination with the BLM AO.

Recommended BMPs and protective measures for successfully reestablishing site vegetation are listed below:

*Revegetation practices and BMPs for **all clayey ecological sites***

- For each ecological site, using BLM pick lists (BLM 2011) contained in Exhibits I-VI, design ecological site-specific seed mixes for reclamation to achieve species composition and diversity for the desired plant community, ecological setting, and current soil properties based on pre-disturbance vegetation characteristics. Final selection of seed mixes will be dependent on seed availability and will be coordinated with the BLM AO.
- Increase seeding rate for critical areas where germination is inhibited by low soil quality, as necessary.
- Broadcast seed after disking.
- Use snow fences to trap additional soil moisture, if necessary.
- Exclude livestock from reclaimed areas, as practicable, until appropriate levels of site stabilization and revegetation are achieved.

*Additional revegetation practices and BMPs for the **Clayey 7-9 inch** ecological site. These measures would be applied in addition to those described above for all clayey ecological sites.*

- No site-specific BMPs for revegetation have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

*Additional revegetation practices and BMPs for the **Clayey 10-14 inch** ecological site. These measures would be applied in addition to those described above for all clayey ecological sites.*

- No site-specific BMPs for revegetation have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

*Additional revegetation practices and BMPs for the **Clayey Overflow 7-9 inch** ecological site. These measures would be applied in addition to those described above for all clayey ecological sites.*

- Harrow or rake broadcast seed to increase germination, if necessary.
- Hydromulch on steep slopes after seeding, if necessary.

**Exhibit I**

**Clayey 7-9 inch Ecological Site Description**

**Adapted from NRCS (2011)**

Site-specific conditions for clayey 7-9 inch ecological sites in the CCSM Phase I Site were characterized using data collected at two monitoring locations (Table 1, Figure 1). Long-term monitoring reference sites for clayey 7-9 inch ecological sites have been established in coordination with the BLM Authorized Officer (AO). Any additional monitoring site that is used for ecological site characterization that is located 100 meters outside of the CCSM Phase I limits of disturbance (LODs) may be suitable as a long-term monitoring reference site for clayey 7-9 inch ecological sites and may be used for future reclamation success monitoring purposes.

**Table 1. Representative transects for clayey 7-9 inch ecological sites in the CCSM Phase I Site.**

| Transect Number | Record Date | Latitude | Longitude | Altitude | Transect Bearing |
|---|---|---|---|---|---|
| CL_79_01 | 6/11/2014 | 41.72630 | -107.17921 | 6,831 | 240 |
| CL_79_02 | 6/12/2014 | 41.70369 | -107.10479 | 6,939 | 60 |
| CL_79_03 | TBD | - | - | - | - |

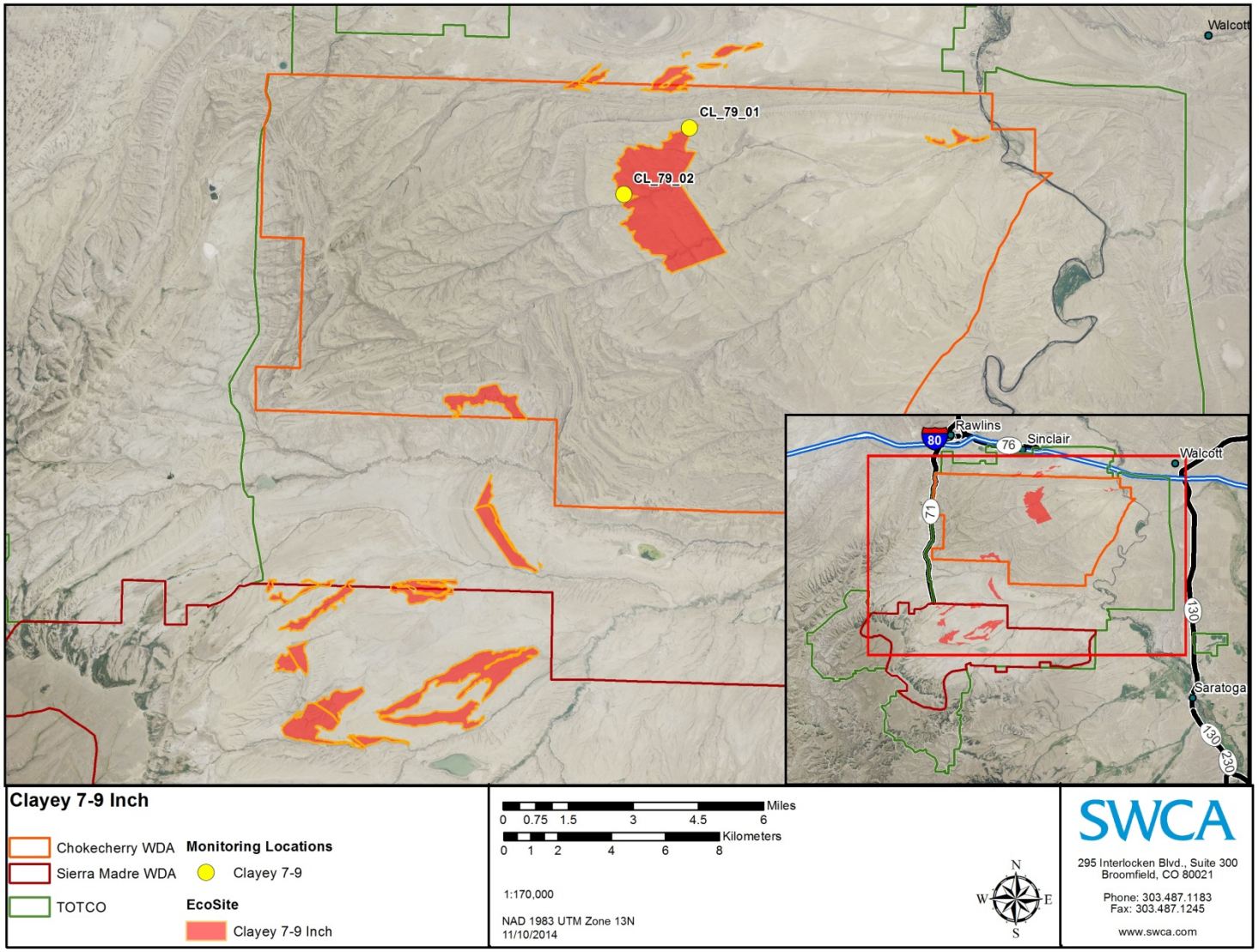


**Figure 1. Location of vegetation transects and soil samples used to characterize clayey 7-9 inch ecological sites in the CCSM Phase I Site.**

**Site Characteristics**

## Climate

Mean annual precipitation is 8.0 inches (ranges from 7-9 inches per year), with peaks observed in May and the lowest totals recorded in the winter months. Average snow fall often exceeds 20 inches annually. Wide fluctuations do occur and result in more dry years than normal years (NRCS 2011). Due to the high elevations and dry air, temperatures at clayey 7-9 inch ecological sites range significantly between summer and winter and daily maximum and minimums. The average annual air temperature is 41.9 °F (25.7 °F Avg. Min. to 58.1 °F Avg. Max.). Extreme minimum temperatures can occur during the winter months when cold air outbreaks and winter storms move rapidly from northwest to southeast.

## Abiotic Landscape Features

Clayey 7-9 inch ecological sites in the CCSM Phase I Site occur on all exposures along nearly level toeslopes and bottomlands. Slopes vary, but are typically between 0% and 5% (NRCS 2011). Examples of landforms found in this ecological site include basin floors, terrace breaks, and alluvial fans. Elevation is variable and ranges between 6,500 feet and 7,300 feet in the CCSM Phase I Site.

## Soil Characteristics

Clayey 7-9 inch ecological sites within the CCSM Phase I Site are characterized by moderately deep to very deep fine textured soils that are well drained with moderately slow to slow permeability (NRCS 2011). Soil cracking (not severe) occurs during the dry summer months, especially where the plant cover has been reduced. Root penetration is somewhat restricted due to the fine textures, clay structures in the subsurface layers and reduced depth of moisture penetration (NRCS 2011).

Topsoil depth averages 4.7 ± 0.28 inches. Lower soil horizons generally exceed 15.0 inches. Topsoil soil textures are generally clay loams. Subsoil textures are characterized by silty clays to clays.

Clayey 7-9 inch ecological sites in the CCSM Phase I Site are characterized by soils with very slow to moderately slow infiltration and moderate to high runoff potential (NRCS 2011). Infiltration rates are highest, and runoff rates lowest where ground cover exceeds 75%. Rills and gullies are typically not present and surface water flow patterns are often indistinguishable (NRCS 2011). Chemical and physical crusts are rare to non-existent at these sites (NRCS 2011).

Soils are moderately to strongly alkaline with pH values between 8.36 and 8.93 and non-saline to very slightly saline with electrical conductivities ranging between 0.08 and 0.61 dS/m (Table 2). Where soil pH ranges exceed 8.4 soils may have limited reclamation potential may need to be evaluated for potential soil treatment. Soils are strongly to violently effervescent indicating very strongly covalent carbonates.

Figures 2 and 3 illustrate the soil surface and soil profile characteristics of a typical clayey 7-9 inch site in the CCSM Phase I Site.

**Table 2. Soil characteristics typical of clayey 7-9 inch ecological sites.**

| Soil Characteristics | Description |
|---|---|
| **Parent Material (Kind)** | Alluvium, residuum |
| **Parent Material (Origin)** | Sedimentary |
| **Topsoil Depth[1]** | 4.7 ± 0.28 inches |
| **Topsoil Texture** | Clay loam |
| **Subsoil Depth[2]** | 15.0 ± 0.28 inches |
| **Subsoil Texture** | Silty clay to clay |
| **Topsoil Fragments** | 5%–20% volume, sedimentary, fine to medium gravel, subangular |
| **Subsoil Fragments** | 0%–35% volume, sedimentary, medium gravel, subangular |
| **Electrical Conductivity (Topsoil)** | 0.08-0.12 dS/m |
| **Salinity Class (Topsoil)** | Non-saline |
| **Electrical Conductivity (Subsoil)** | 0.20-0.61 dS/m |
| **Salinity Class (Subsoil)** | Non-saline to very slightly saline |
| **Soil Reaction (Topsoil)** | 8.74-8.82 |
| **pH Class (Topsoil)** | Strongly alkaline |
| **Soil Reaction (Subsoil)** | 8.36-8.93 |
| **pH Class (Subsoil)** | Moderately to strongly alkaline |
| **Carbonate Equivalent (Topsoil)** | Strongly to violently effervescent |
| **Carbonate Equivalent (Subsoil)** | Strongly to violently effervescent |

[1]Topsoil depth determined by depth of A Horizon.
[2]Subsoil depth determined by B and C horizons to a maximum of 20 inches depth including topsoil.

**Figure 2. Representative soil surface and ground cover for clayey 7-9 inch ecological sites in the CCSM Phase I Site (CL_79_01).**

**Figure 3. Representative soil profile for clayey 7-9 inch sites in the CCSM Phase I Site (CL_79_01).**

## Vegetation Characteristics

Plant communities associated with clayey 7-9 inch ecological sites in the CCSM Phase I Site are characterized by sparsely vegetated surfaces with 25%–28% basal cover (Tables 3 and 4). The remaining soil surface is characterized primarily by unprotected soils (30–35%), rock fragments (22–28%), and litter (13–15%). Figure 4 illustrates representative vegetation communities associated with clayey 7-9 inch ecological sites in the CCSM Phase I Site.

Where clayey 7-9 inch ecological sites are subjected to frequent and severe grazing, the woody species component including species such as big sagebrush (*Artemisia tridentata*) and low rabbitbrush (*Chrysothamnus viscidiflorus*) will increase. Indian ricegrass (*Achnatherum hymenoides*) will decrease in frequency and production, in turn increasing unprotected soil exposure. In the absence of grazing and fire, clayey 7-9 inch ecological sites will convert to the heavy big sagebrush/Indian ricegrass state; conversely, under heavy continuous season-long grazing they will convert to the big sagebrush/bare ground state wheatgrass state (NRCS 2011).

The BLM pick list in Table 5 (BLM 2011) and the species composition and cover (Tables 3 and 4) observed for clayey 7-9 inch ecological sites will be used to guide the selection of appropriate seed mixes and application rates for revegetation. Final seed mixes will be determined based on seed availability at the time of revegetation efforts and in coordination with the BLM AO.

**Table 3. Vegetation characteristics typical of clayey 7-9 inch ecological sites.**

| | | |
|---|---|---|
| Basal Vegetative Cover (LPI*) | 25% – 28% | |
| Biological Soil Crust and Lichen (LPI*) | 0% – 2% | |
| Litter Cover (LPI*) | 13%–15% | |
| Surface Fragment/Rock Cover (LPI*) | 22% – 28% | |
| Unprotected Soil(LPI*) | 30% – 35% | |
| Representative Species and Top-Canopy Cover* | *Poa secunda* | 15.0% average |
| | *Artemisia pedatifida* | 8.0% average |
| | *Elymus trachycaulus* | 6.0% average |
| | *Achnatherum hymenoides* | 4.0% average |
| | *Atriplex gardneri* | 4.0% average |
| | *Artemisia tridentata* ssp. *wyomingensis* | 3.0% average |

* Line point intercept

**Table 4. Species commonly associated with clayey 7-9 inch ecological sites.**

| | |
|---|---|
| *Achnatherum hymenoides* | *Erigeron engelmannii* |
| *Allium textile* | *Eriogonum ovalifolium* |
| *Alyssum desertorum* | *Koeleria macrantha* |
| *Arenaria hookeri* | *Opuntia polyacantha* |
| *Artemisia pedatifida* | *Pascopyrum smithii* |
| *Artemisia tridentata ssp. wyomingensis* | *Phlox hoodii* |
| *Astragalus sp.* | *Pleuraphis jamesii* |
| *Atriplex confertifolia* | *Poa secunda* |
| *Atriplex gardneri* | *Pseudoroegneria spicata* |
| *Bromus tectorum* | *Sphaeralcea coccinea* |
| *Cryptantha sp.* | *Stenotus acaulis* |
| *Delphinium geyeri* | *Tetradymia nuttallii* |
| *Descurainia pinnata* | *Trifolium gymnocarpon* |
| *Elymus elymoides* | *Xylorhiza glabriuscula* |
| *Elymus trachycaulus* | |

**Figure 4. Characteristic vegetation communities associated with clayey 7-9 inch ecological sites in the CCSM Phase I Site (CL_79_01).**

**Table 5. Recommended seed pick list for dry clayey ecological sites (BLM 2011).**

| **Name** | ***Scientific*** | **Variety** | **SYMBOL** |
|---|---|---|---|
| ***Grasses*** | | | |
| Thickspike wheatgrass | *Elymus lanceolatus* | Sodar, Critana | ELLA3 |
| Western wheatgrass | *Pascopyrum smithii* | Rosana | PASM |
| Indian ricegrass | *Achnatherum hymenoides* | Rimrock (Nez Par) | ACHY |
| Bottlebrush squirreltail | *Elymus elymoides* | Sand hollow | ELEL |
| Slender wheatgrass | *Elymus trachycaulus* | Pryor (San Luis) | ELTR |
| Little bluegrass "Sandberg" | *Poa secunda* | High Plains | POSE |
| Bluebunch wheatgrass | *Pseudoroegneria spicata* | Secor | PSSP6 |
| Galleta grass | *Pleuraphis jamesii* | Viva | PLJA |
| ***Shrubs*** | | | |
| Wyoming big sagebrush | *Artemisia tridentata* ssp. *wyomingensis* | | ARTRW8 |
| Gardner's saltbush | *Atriplex gardneri* | | ATGA |
| Fourwing saltbush | *Atriplex canaescens* | Wytana | ATCA2 |
| Shadscale saltbush | *Atriplex confertifolia* | | ATCO |
| Green rabbitbrush | *Ericameria nauseosa* | | ERNA10 |
| Yellow rabbitbrush | *Chrysothamnus viscidiflorus* | | CHVI8 |
| Winterfat | *Krascheninnikovia lanata* | Open Range | KRLA |
| ***Forbs*** | | | |
| Rocky Mountain beeplant | *Cleome serrulata* | Appar | CLSE |
| Textile onion | *Allium textile* | | ALTE |
| Scarlet globemallow | *Sphaeralcea coccinea* | | SPCO |
| Western wallflower | *Erysium capitatum* | | ERCA14 |
| Scarlet gilia | *Ipomopsis aggregata* | | IPAGA3 |
| Spiny phlox | *Phlox hoodii* | | PHHO |
| Desert biscuitroot | *Lomatium foeniculaceum* | | LOFO |

**Exhibit II**

**Clayey 10-14 inch Ecological Site Description**

**Adapted from NRCS (2011)**

Site-specific conditions for clayey 10-14 inch ecological sites were characterized using data collected at three monitoring locations (Table 1, Figure 1). Long-term monitoring reference sites for clayey 10-14 inch ecological sites have been established in coordination with the BLM Authorized Officer (AO). Any additional monitoring site that is used for ecological site characterization that is located 100 meters outside of the CCSM Phase I limits of disturbance (LODs) may be suitable as a long-term monitoring reference site for clayey 10-14 inch ecological sites and may be used for future reclamation success monitoring purposes.

**Table 1. Representative transects for clayey 10-14 inch ecological sites in the CCSM Phase I Site.**

| Transect Number | Record Date | Latitude | Longitude | Altitude | Transect Bearing |
|---|---|---|---|---|---|
| CL_1014_01 | 6/27/2014 | 41.63536 | -107.14240 | 7,352 | 110 |
| CL_1014_02 | 7/22/2014 | 41.52679 | -107.28658 | 7,346 | 170 |
| CL_1014_03 | 7/23/2014 | 41.50647 | -107.28898 | 7,274 | 110 |

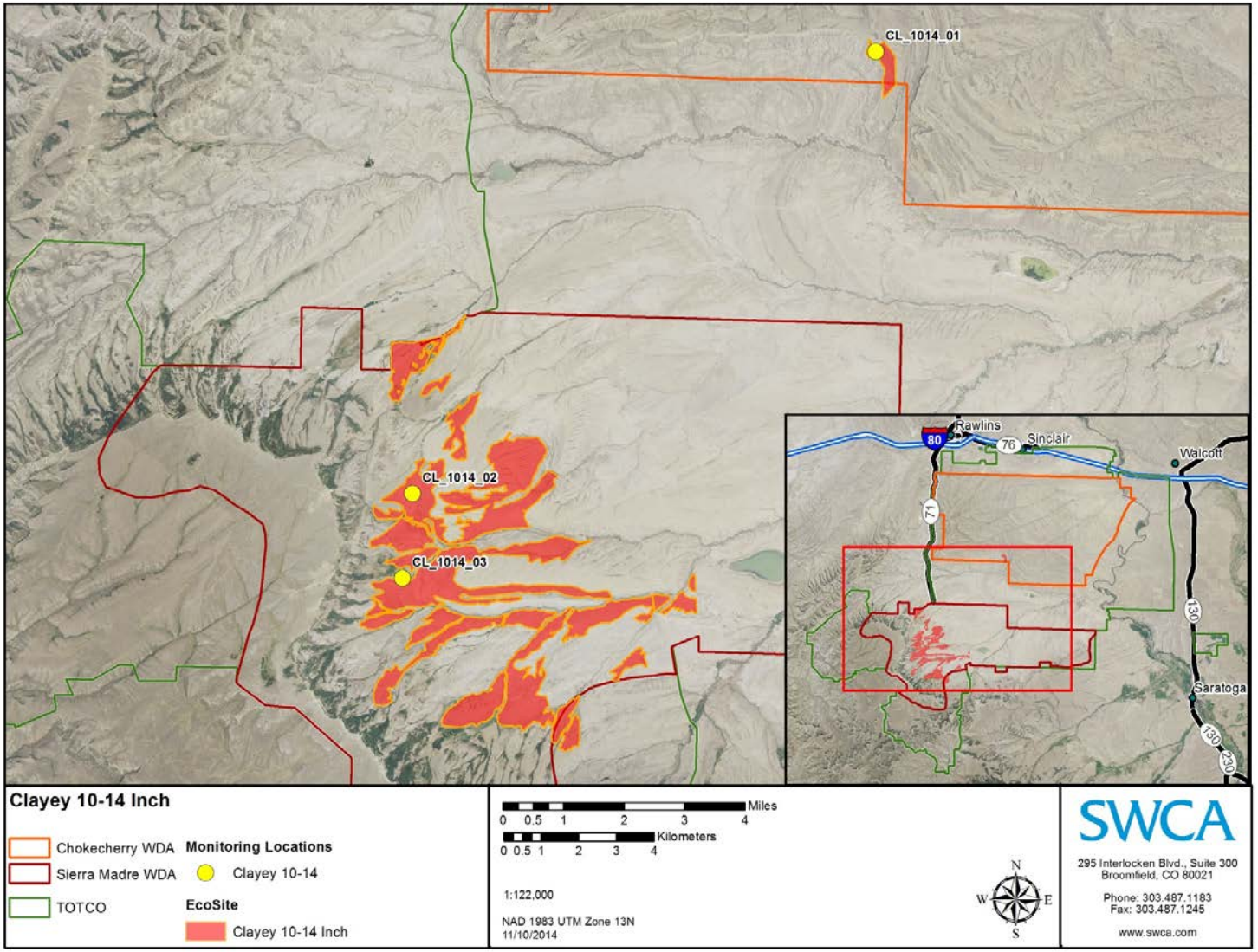


**Figure 1. Location of reference sites used to characterize clayey 10-14 inch ecological sites in the CCSM Phase I Site.**

**Site Characteristics**

## Climate

The mean annual precipitation at these sites is 12.4 inches, with peaks observed in May and the lowest totals recorded in the winter months. Average snow fall often exceeds 20 inches annually. Wide fluctuations do occur and result in more dry years than normal years (NRCS 2011). Due to the high elevations and dry air, temperatures at clayey (10-14 inch) ecological sites range significantly between summer and winter and daily maximum and minimums. The average annual air temperature is 46.2° F (30.1°F Avg. Min. to 62.3°F Avg. Max.). Extreme minimum temperatures can occur during the winter months when cold air outbreaks and winter storms move rapidly from northwest to southeast.

## Abiotic Landscape Features

Clayey 10-14 inch ecological sites in the CCSM Phase I Site typically occur on hill, alluvial fans, or stream terraces with slopes nearly level to 15%. Examples of landforms found in this ecological site include basin floors, hillslopes, and alluvial fans. Elevation is variable and ranges between 7,000 feet and 7,700 feet in the CCSM Phase I Site.

## Soil Characteristics

Clayey 10-14 inch ecological sites within the CCSM Phase I Site are moderately deep to very deep, moderately well to well drained soils with slow to moderate permeability. Topsoil textures range from fine sandy loams to clay loams and subsoil textures are generally sandy clay loams to silty clay loams.

Topsoil averages 6.8 ± 1.26 inches in depth. Lower soil horizon depths generally exceed 12.9 inches. Soil cracking occurs during the dry summer months, especially where the plant cover has been reduced. Root penetration is somewhat restricted due to the fine textures and reduced depth of moisture penetration.

Clayey 10-14 inch ecological sites in the CCSM Phase I Site are characterized by soils with slow to moderately slow infiltration and moderate to high runoff potential (NRCS 2011). Infiltration rates are highest, and runoff rates lowest where ground cover exceeds 75%. Rills and gullies are typically present and surface water flow patterns are often distinguishable (NRCS 2011). Chemical and physical crusts are rare to non-existent at these sites (NRCS 2011).

Soils are moderately to very strongly alkaline with pH values between 8.26 and 9.20 and non-saline to very slightly saline with electrical conductivities ranging between 0.04 to 0.41 dS/m. Where soil pH ranges exceed 8.4, soils may have limited reclamation potential (LRP) and may need to be evaluated for potential soil treatment. Soils are slightly effervescent to strongly effervescent indicating presence of weak and strongly covalent carbonates.

Figures 2 and 3 illustrate the soil surface and soil profile characteristics of a typical clayey 10-14 inch ecological site in the CCSM Phase I Site.

**Table 2. Soil characteristics typical of clayey 10-14 inch ecological sites.**

| Soil Characteristics | Description |
|---|---|
| **Parent Material (Kind)** | Alluvium, residuum |
| **Parent Material (Origin)** | Sedimentary |
| **Topsoil Depth[1]** | 6.8 ± 1.26 inches |
| **Topsoil Texture** | Fine sandy loam to clay loam |
| **Subsoil Depth[2]** | 12.9 ± 1.26 inches |
| **Subsoil Texture** | Sandy clay loam to silty clay loam |
| **Topsoil Fragments** | None |
| **Subsoil Fragments** | 0%–50% volume, sedimentary to mixed rock, fine to medium gravel and channers, subangular to subrounded |
| **Electrical Conductivity (Topsoil)** | 0.14-0.41 dS/m |
| **Salinity Class (Topsoil)** | Non-saline to very slightly saline |
| **Electrical Conductivity (Subsoil)** | 0.04-0.11 dS/m |
| **Salinity Class (Subsoil)** | Non-saline |
| **Soil Reaction (Topsoil)** | 8.26-8.80 |
| **pH Class (Topsoil)** | Moderately to strongly alkaline |
| **Soil Reaction (Subsoil)** | 8.53-9.20 |
| **pH Class (Subsoil)** | Strongly to very strongly alkaline |
| **Carbonate Equivalent (Topsoil)** | Slightly to strongly effervescent |
| **Carbonate Equivalent (Subsoil)** | Slightly to violently effervescent |

[1]Topsoil depth determined by depth of A Horizon.
[2]Subsoil depth determined by B and C horizons to a maximum of 20 inches depth including topsoil.

**Figure 2. Representative soil surface and ground cover for clayey 10-14 inch ecological sites in the CCSM Phase I Site (CL_1014_02)**

**Figure 3. Representative soil profile for clayey 10-14 inch sites in the CCSM Phase I Site (CL_1014_02).**

## Vegetation Characteristics

Plant communities associated with clayey 10-14 inch ecological sites in the CCSM Phase I Site are characterized by sparsely vegetated surfaces with 9%–20% basal cover (Tables 3 and 4). The remaining soil surface is characterized by unprotected soils (36%–47%), litter (11%–37%) and surface fragments (0%–44%). Figure 4 illustrates representative vegetation communities associated with clayey 10-14 inch ecological sites in the CCSM Phase I Site.

When clayey 10-14 inch ecological sites subjected to severe grazing pressure species such as Gardner's saltbush (*Atriplex gardneri),* big sagebrush (*Artemisia tridentata*) and rabbitbrush (*Chrysothamnus* and *Ericameria* spp.) will increase; Indian ricegrass (*Achnatherum hymenoides*) and threadleaf sedge (*Carex filifolia*) will decrease in frequency and production, in turn increasing surface exposure. Heavy continuous season-long grazing will convert the community to the rhizomatous wheatgrass/big sagebrush state (NRCS 2011).

The BLM pick list in Table 5 (BLM 2011) and the species composition and cover (Tables 3 and 4) observed for clayey 10-14 inch ecological sites will be used to guide the selection of appropriate seed mixes and application rates for revegetation. Final seed mixes will be determined based on seed availability at the time of revegetation efforts and in coordination with the BLM AO.

**Table 3. Vegetation characteristics typical of clayey 10-14 inch ecological sites.**

| | | |
|---|---|---|
| Basal Vegetative Cover (LPI*) | 9% – 20% | |
| Biological Soil Crust and Lichen (LPI*) | 0% | |
| Litter Cover (LPI*) | 11%–37% | |
| Surface Fragment/Rock Cover (LPI*) | 0%–44% | |
| Unprotected Soil(LPI*) | 36% – 47% | |
| Representative Species and Top-Canopy Cover* | *Artemisia tridentata* ssp. *wyomingensis* | 13.5% average |
| | *Pseudoroegneria spicata* | 10.0% average |
| | *Atriplex gardneri* | 9.0% average |
| | *Poa secunda* | 8.7% average |
| | *Stenotus acaulis* | 8.0% average |

* Line point intercept

**Table 4. Species commonly associated with clayey 10-14 inch ecological sites.**

| | |
|---|---|
| *Achnatherum hymenoides* | *Koeleria macrantha* |
| *Allium textile* | *Krascheninnikovia lanata* |
| *Alyssum desertorum* | *Linanthus pungens* |
| *Arenaria hookeri* | *Lomatium grayi* |
| *Artemisia pedatifida* | *Lomatium sp.* |
| *Artemisia tridentata ssp. vaseyana* | *Lygodesmia grandiflora* |
| *Artemisia tridentata ssp. wyomingensis* | *Lygodesmia juncea* |
| *Astragalus bisulcatus* | *Machaeranthera grindelioides* |
| *Astragalus sp.* | *Machaeranthera sp.* |
| *Atriplex confertifolia* | *Oxytropis lagopus* |
| *Atriplex gardneri* | *Oxytropis sp.* |
| *Balsamorhiza sagittata* | *Pascopyrum smithii* |
| *Castilleja linariifolia* | *Penstemon caespitosus* |
| *Chaenactis stevioides* | *Penstemon eriantherus* |
| *Chrysothamnus viscidiflorus* | *Penstemon sp.* |
| *Cirsium sp.* | *Phlox hoodii* |
| *Comandra umbellata* | *Phlox sp.* |
| *Cryptantha cana* | *Physaria sp.* |
| *Cryptantha sp.* | *Poa fendleriana* |
| *Descurainia pinnata* | *Poa secunda* |
| *Elymus elymoides* | *Pseudoroegneria spicata* |
| *Elymus trachycaulus* | *Sarcobatus vermiculatus* |
| *Erigeron caespitosus* | *Sphaeralcea coccinea* |
| *Erigeron engelmannii* | *Stanleya pinnata* |
| *Eriogonum brevicaule* | *Stenotus acaulis* |
| *Eriogonum flavum* | *Symphoricarpos albus* |
| *Eriogonum ovalifolium* | *Tetradymia canescens* |
| *Eriogonum sp.* | *Tetradymia nuttallii* |
| *Halogeton glomeratus* | *Trifolium gymnocarpon* |
| *Hesperostipa comata* | *Xylorhiza glabriuscula* |

**Figure 4. Characteristic vegetation communities associated with clayey 10-14 inch sites in the CCSM Phase I Site (CL_1014_02)**

**Table 5. Recommended seed pick list for clayey ecological sites (BLM 2011).**

| **Name** | ***Scientific*** | **Variety** | **SYMBOL** |
|---|---|---|---|
| ***Grasses*** | | | |
| Thickspike wheatgrass | *Elymus lanceolatus* | Critana | ELLA3 |
| Western wheatgrass | *Pascopyrum smithii* | Rosana | PASM |
| Indian ricegrass | *Achnatherum hymenoides* | Rimrock (Nez Par) | ACHY |
| Bottlebrush squirreltail | *Elymus elymoides* | Sand hollow | ELEL |
| Slender wheatgrass | *Elymus trachycaulus* | Pryor (San Luis) | ELTR |
| Little bluegrass "Sandberg" | *Poa secunda* | High Plains | POSE |
| Bluebunch wheatgrass | *Pseudoroegneria spicata* | Secor | PSSP6 |
| Galleta grass | *Pleuraphis jamesii* | Viva | PLJA |
| ***Shrubs*** | | | |
| Wyoming big sagebrush | *Artemisia tridentata* ssp. *wyomingensis* | | ARTRW8 |
| Gardner's saltbush | *Atriplex gardneri* | | ATGA |
| Fourwing saltbush | *Atriplex canaescens* | Wytana | ATCA2 |
| Shadscale | *Atriplex confertifolia* | | ATCO |
| Green rabbitbrush | *Ericameria nauseosa* | | ERNA10 |
| Yellow rabbitbrush | *Chrysothamnus viscidiflorus* | | CHVI8 |
| Winterfat | *Krascheninnikovia lanata* | Open Range | KRLA |
| ***Forbs*** | | | |
| Rocky Mountain beeplant | *Cleome serrulata* | Appar | CLSE |
| Textile onion | *Allium textile* | | ALTE |
| Scarlet globemallow | *Sphaeralcea coccinea* | | SPCO |
| Western wallflower | *Erysium capitatum* | | ERCA14 |
| Spiny phlox | *Phlox hoodii* | | PHHO |
| Tufted evening primrose | *Oenothera caespitosa* | | OECA |
| Bulbous springparsley | *Cymopterus bulbosus* | | CYBU |
| Desert biscuitroot | *Lomatium foeniculaceum* | | LOFO |

**Exhibit III**

**Clayey Overflow 7-9 inch Ecological Site Description**

**Adapted from NRCS (2011)**

Site-specific conditions for clayey overflow 7-9 inch ecological sites in the CCSM Phase I Site were characterized using data collected at two monitoring locations (Figure 1). Long-term monitoring reference sites for clayey overflow 7-9 inch ecological sites have been established in coordination with the BLM Authorized Officer (AO). Any additional monitoring site that is used for ecological site characterization that is located 100 meters outside of the CCSM Phase I limits of disturbance (LODs) may be suitable as a long-term monitoring reference site for clayey overflow 7-9 inch ecological site and may be used for future reclamation success monitoring purposes.

**Table 1. Representative transects for clayey overflow 7-9 inch ecological sites in the CCSM Phase I Site.**

| Transect Number | Record Date | Latitude | Longitude | Altitude | Transect Bearing |
|---|---|---|---|---|---|
| CO_79_01 | 6/29/2014 | 41.53772 | -107.18938 | 6,949 | 240 |
| CO_79_02 | 7/8/2014 | 41.53299 | -107.24187 | 6,995 | 110 |
| CO_79_03 | - | - | - | - | - |

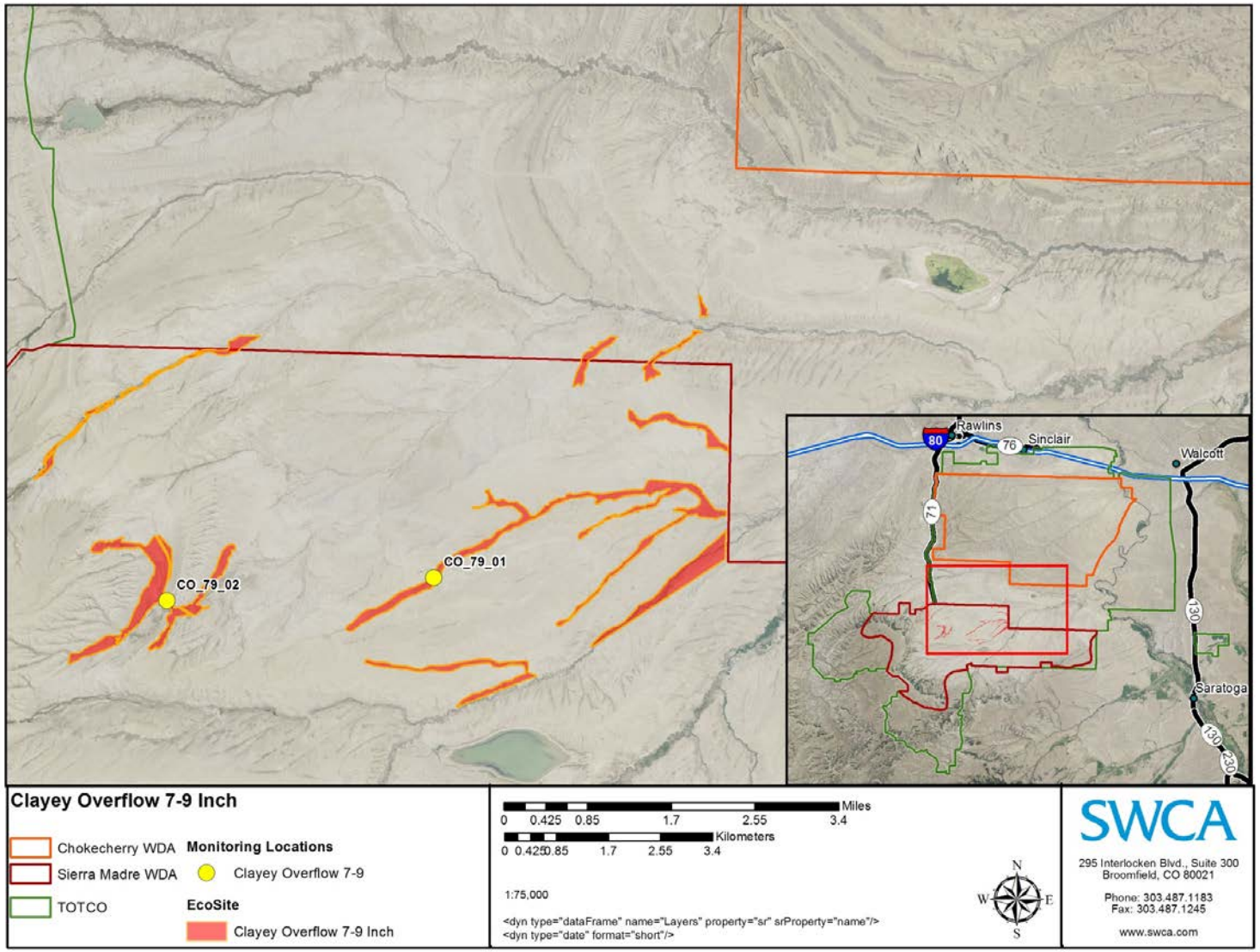


**Figure 1. Locations of reference sites used to characterize clayey overflow 7-9 inch ecological sites in the CCSM Phase I Site.**

**Site Characteristics**

## Climate

The mean annual precipitation is 8.0 inches, with peaks observed in May and the lowest totals recorded in the winter months. Average snow fall often exceeds 20 inches annually. Wide fluctuations do occur and result in more dry years than normal years (NRCS 2011). Due to the high elevations and dry air, temperatures at clayey overflow 7-9 inch ecological sites range significantly between summer and winter and daily maximum and minimums. The average annual air temperature is 42.2 °F (30.4 °F Avg. Min. to 53.9 °F Avg. Max.). Extreme minimum temperatures can occur during the winter months when cold air outbreaks and winter storms move rapidly from northwest to southeast. Chinook winds can occur in winter bringing rapid rises in temperature. Winds speeds are lower than other areas of the state. Daytime winds are stronger than nighttime with some strong gusts associated with the passage of winter storms (NRCS 2011).

## Abiotic Landscape Features

Clayey overflow 7-9 inch ecological sites in the CCSM Phase I Site occur on gently sloping to moderately sloping flood plains, canyons, and small valley bottoms along intermittent streams. The site is found on all exposures. Elevation is variable and ranges between 6,800 feet and 7,300 feet in the CCSM Phase I Site.

## Soil Characteristics

Clayey overflow 7-9 inch ecological sites within the CCSM Phase I Site are moderately deep (greater than 20 inches to bedrock) to very deep, well-drained soils that formed in alluvium or alluvium over residuum (NRCS 2011). Textures range from sandy loam to clay loam (Table 2).

Topsoil depth averages 4.7 ± 0.84 inches. Lower soil horizon depths generally exceed 16.7 inches. Topsoil soil textures range from sandy clay loams to clay loams. These soils may develop severe cracks. These areas receive additional water from overflow of intermittent streams or runoff from adjacent slopes.

Clayey overflow 7-9 inch ecological sites in the CCSM Phase I Site are characterized by soils with moderate to rapid infiltration and moderate to high runoff potential. Infiltration rates are highest, and runoff rates lowest where ground cover exceeds 75%. Rills and gullies are typically present and surface water flow patterns are often distinguishable (NRCS 2011). Chemical and physical crusts are rare to non-existent at these sites (NRCS 2011).

Soils are moderately to strongly alkaline with pH values of ranging from 8.08 to 8.66 and non-saline to slightly saline electrical conductivities of 0.11 to 7.2 dS/m. Where soil pH ranges exceed 8.40 and salinity exceeds 4.0 dS/m, soils may have limited reclamation potential and may need to be evaluated for potential soil treatment. Soils are strongly to violently effervescent indicating presence of very strongly covalent carbonates.

Figures 2 and 3 illustrate the soil surface and soil profile characteristics of a clayey overflow 7-9 inch site in the CCSM Phase I Site.

**Table 2. Soil characteristics typical of clayey overflow 7-9 inch ecological sites[1].**

| Soil Characteristics | Description |
|---|---|
| **Parent Material (Kind)** | Alluvium, residuum |
| **Parent Material (Origin)** | Sedimentary |
| **Topsoil Depth[1]** | 4.7 ± 0.84 inches |
| **Topsoil Texture** | Sandy clay loam to clay loam |
| **Subsoil Depth[2]** | 16.7 ± 2.09 inches |
| **Subsoil Texture** | Sandy clay loam to silty clay loam |
| **Topsoil Fragments** | None |
| **Subsoil Fragments** | None |
| **Electrical Conductivity (Topsoil)** | 0.11-7.2 dS/m |
| **Salinity Class (Topsoil)** | Non-saline to very strongly saline |
| **Electrical Conductivity (Subsoil)** | 0.12-5.8 dS/m |
| **Salinity Class (Subsoil)** | Non-saline to very strongly saline |
| **Soil Reaction (Topsoil)** | 8.57-8.66 |
| **pH Class (Topsoil)** | Strongly alkaline |
| **Soil Reaction (Subsoil)** | 8.08-8.66 |
| **pH Class (Subsoil)** | Moderately to strongly alkaline |
| **Carbonate Equivalent (Topsoil)** | Strongly to violently effervescent |
| **Carbonate Equivalent (Subsoil)** | Violently effervescent |

[1]Topsoil depth determined by depth of A Horizon.
[2]Subsoil depth determined by B and C horizons to a maximum of 20 inches depth including topsoil.

**Figure 2. Representative soil surface and ground cover for clayey overflow 10-14 inch sites in the CCSM Phase I Site (CO_79_02).**

**Figure 3. Representative soil profile for loamy 10-14 inch sites in the CCSM Phase I Site (CO_79_02).**

## Vegetation Characteristics

Plant communities associated with clayey overflow 7-9 inch ecological sites in the CCSM Phase I Site are characterized by vegetated surfaces with 18% basal cover (Tables 3 and 4). The remaining soil surface is characterized primarily by unprotected soils (35% – 51%) and litter (30%–47%). Figure 4 illustrates representative vegetation communities associated with clayey overflow 7-9 inch ecological sites in the CCSM Phase I Site.

When clayey overflow 7-9 inch ecological sites are subjected to severe grazing pressure, woody species such as big sagebrush (*Artemisia tridentata)* and rabbitbrush (*Chrysothamnus* and *Ericameria* spp.) increase, and cool season grasses such as bluebunch wheatgrass (*Pseudoroegneria spicata), slender wheatgrass (Elymus trachycaulus*) and green needlegrass grass (*Nassella viridula*) decrease in productivity, converting the community to a sagebrush/rabbitbrush state.

**Table 3. Vegetation characteristics typical of clayey overflow 7-9 inch ecological sites.**

| | | |
|---|---|---|
| Basal Vegetative Cover (LPI*) | 18% | |
| Biological Soil Crust and Lichen (LPI*) | 0%–1% | |
| Litter Cover (LPI*) | 30%–47% | |
| Surface Fragment/Rock Cover (LPI*) | 0% | |
| Unprotected Soil(LPI*) | 35% – 51% | |
| Representative Species and Top-Canopy Cover* | *Chrysothamnus viscidiflorus* | 21.0% average |
| | *Poa secunda* | 18.0% average |
| | *Artemisia tridentata* ssp. *wyomingensis* | 9.5% average |
| | *Atriplex gardneri* | 5.0% average |
| | *Leymus cinereus* | 4.0% average |
| | *Elymus elymoides* | 4.0% average |

* Line point intercept

**Table 4. Species commonly associated with clayey overflow 7-9 inch ecological sites.**

| | |
|---|---|
| *Achillea millefolium* | *Iva axillaris* |
| *Achnatherum hymenoides* | *Juncus balticus* |
| *Alyssum desertorum* | *Krascheninnikovia lanata* |
| *Artemisia cana* | *Lepidium perfoliatum* |
| *Artemisia pedatifida* | *Leymus cinereus* |
| *Artemisia tridentata ssp. wyomingensis* | *Machaeranthera sp.* |
| *Astragalus bisulcatus* | *Nassella viridula* |
| *Astragalus sp.* | *Pascopyrum smithii* |
| *Atriplex confertifolia* | *Phlox hoodii* |
| *Atriplex gardneri* | *Phlox sp.* |
| *Bassia americana* | *Picrothamnus desertorum* |
| *Ceratocephala testiculata* | *Poa secunda* |
| *Chrysothamnus viscidiflorus* | *Pseudoroegneria spicata* |
| *Cirsium sp.* | *Sarcobatus vermiculatus* |
| *Descurainia pinnata* | *Symphoricarpos sp.* |
| *Elymus elymoides* | *Xylorhiza glabriuscula* |

**Figure 4. Characteristic vegetation communities associated with clayey overflow 7-9 inch sites in the CCSM Phase I Site (CO_79_02).**

**Table 5. Recommended seed pick list for clayey overflow 7-9 inch ecological sites (BLM 2011).**

| **Name** | ***Scientific*** | **Variety** | **SYMBOL** |
|---|---|---|---|
| ***Grasses*** | | | |
| Western wheatgrass | *Pascopyrum smithii* | Rosana | PASM |
| Slender wheatgrass | *Elymus trachycaulus* | Pryor (San Luis) | ELTR |
| Basin wildrye | *Leymus cinereus* | | LECI4 |
| Little bluegrass "Sandberg" | *Poa secunda* | High Plains | POSE |
| ***Shrubs*** | | | |
| Basin big sagebrush | *Artemisia tridentata* ssp. *tridentata* | | ARTRT |
| Silver sagebrush | *Artemisia cana* | | ARCA13 |
| Fourwing saltbush | *Atriplex canaescens* | Wytana | ATCA2 |
| Green rabbitbrush | *Ericameria nauseosa* | | ERNA10 |
| Yellow rabbitbrush | *Chrysothamnus viscidiflorus* | | CHVI8 |
| ***Forbs*** | | | |
| Western yarrow | *Achillea millefolium* var. *occidentalis* | | ACMI2 |
| Hawksbeard | *Crepis acuminata* | | CRAC2 |
| Mountain pea | *Thermopsis rhombifolia* | | THRH |
| Beardtongue | *Penstemon* spp. | | PENST |
| Longleaf phlox | *Phlox longifolia* | | PHLO2 |
| Scarlet globemallow | *Sphaeralcea coccinea* | | SPCO |

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# ATTACHMENT C

## Loam Ecological Site Class Reclamation Implementation Plan

## and

## Loamy Ecological Site Descriptions

## for

## Phase I of the Chokecherry and Sierra Madre Wind Energy Project

## Introduction

This Loam Ecological Site Class Reclamation Implementation Plan describes the common and ecological site-specific characteristics, reclamation practices, and BMPs that will be applied within the CCSM Project Site. Ecological sites in the CCSM Project Site were established cooperatively with the BLM and are a result of robust soil and vegetation sampling, landform analysis, and precipitation zone evaluation. The ecological sites are consistent with the Cool Central Desertic Basins and Plateaus (Major Land Resource Area [MLRA] – 34A) and Southern Rocky Mountain Foothills (MLRA – 49) MLRAs (Natural Resources Conservation Service [NRCS] 2006) and are primarily located in the Wyoming Basin Province of the Rocky Mountain System (NRCS 2011).

Based on common reclamation characteristics, individual ecological sites were grouped into similar ecological site classes (loam, sand, clay, saline, and shallow). Grouping similar ecological sites into a common ecological site class will increase efficiency and effectiveness of reclamation efforts as many of these common sites will have identical or very similar measures for soil handling, site preparation, and revegetation.

The following reclamation implementation plan describes the reclamation procedures and BMPs that will be applied to the ecological sites within the Loam ecological site class. The Loam ecological site class includes the following ecological sites:

- Loamy 7-9 Inch (see Exhibit I)
- Loamy 10-14 Inch (see Exhibit II)
- Loamy 15-19 Inch (see Exhibit III)
- Loamy Overflow 10-14 Inch (see Exhibit IV)
- Aspen 15-19 Inch(see Exhibit V)
- Wet Fresh Meadow 15-19 Inch(see Exhibit VI)
- Wetland/Riparian 10-14 Inch (See Exhibit VII)

## Reclamation Procedures and Best Management Practices

Site-specific reclamation procedures and BMPs have been developed for this Loam Ecological Site Class Reclamation Implementation Plan. Many of the reclamation procedures and BMPs will be implemented across all loamy ecological sites in the CCSM Project while other measures will be specific to an individual ecological site or smaller group of ecological sites within the Loam ecological site class.

Reclamation procedures and BMPs account for abiotic landscape features, soil characteristics, and vegetation characteristics and were designed to mitigate impacts to the abiotic and biotic factors characteristic of each ecological site and increase reclamation success. These procedures were developed in accordance with the CCSM Project Master Reclamation Plan (BLM 2012a), BLM Wyoming Reclamation Policy (2012b), management directives presented in the Rawlins Field Office (RFO) Resource Management Plan (RMP) (BLM 2008), RFO Reclamation Guidance (BLM 2011), Wyoming Department of Environmental Quality (WDEQ) Land Quality Division reclamation guidelines (WDEQ 2007), Wyoming Reclamation and Restoration Center (WRRC) Handbook of Western Reclamation Techniques (WRRC 2006), State of Wyoming's reclamation guidance for wind development, and in coordination with BLM staff. This Loam

Ecological Site Class Reclamation Implementation Plan is intended to be adaptive and to take into account changing conditions and technologies. PCW, with concurrence from the BLM AO, may update, modify, or change the procedures contained in this plan if warranted due to site conditions or other factors.

In accordance with the guidance described above, reclamation practices and BMPS have been developed to address abiotic landscape features, soil handling, site preparation, and vegetation handling and revegetation. The following sections describe the practices specific to loamy ecological sites in Phase I of the CCSM Project.

**Soil Handling and Site Preparation**

Soil associated with each ecological site will be managed in accordance with the BLM Wyoming Reclamation Policy (2012b) and as detailed in the CCSM Project Master Reclamation Plan (2012a) and the site-specific reclamation plan for Phase I of the CCSM Project. Provisions are included below for segregating and marking stockpiles, as well as requirements to protect stockpiled material from erosion, contamination and degradation. Site-specific soil handling and site preparation measures for loamy ecological sites are listed below:

*Soil handling practices and BMPs for* ***all loamy ecological sites***[1]*. These measures would be applied to all loamy ecological sites.*

- Ridge (roughen) topsoil stockpiles to maximize surface area.
- Apply mulch and/or soil tackifiers to assist in mitigating stockpile wind erosion and contribute organic materials.
- When practicable, use growth and till cycles to maintain biological activity, reduce compaction, and incorporate native organic matter and seed sources, in soil stockpiles that are stored for more than two years.
- Seed long-term stockpiles with appropriate vegetation to maintain biological activity and prevent wind erosion.
- Trap moisture during winter months through the use of snow fences, if appropriate.
- Include native vegetation into salvaged topsoil to include organic matter and maintain native seedbanks.
- When applicable, locate stockpiles within disturbed areas to reduce additional surface disturbance to native topsoil.

[1] Loamy Ecological Sites include Loamy 7-9 Inch, Loamy 10-14 Inch, Loamy 15-19 Inch, Aspen 15-19 Inch, Wet Fresh Meadow 15-19 Inch, and Loamy Overflow 10-14 Inch

*Site preparation practices and BMPs for **all loamy ecological sites**. These measures would be applied to all loamy ecological sites.*

- If necessary, add soil amendments to ameliorate physical, biological, and chemical attributes that may limit reclamation potential, to meet fair to good topsoil suitability criteria (BLM 2011), as approved by the BLM AO.
- Inspect the soil surface for ponding or gullying.
- Suspend construction activities when soils are wet and rutting exceeds 4 inches, as appropriate.
- To achieve soil balance across the CCSM Project Site, if physical and chemical characteristics are compatible and will not limit reclamation success, use suitable subsoil from other ecological sites as subsoil or construction fill in loamy ecological sites.
- Till across slope or perpendicular to the prevailing wind to reduce erosion.

*Additional soil handling and site preparation practices and BMPs for the **Loamy 7-9 inch** ecological site. These measures would be applied in addition to those described above for all loamy ecological sites.*

- No site-specific BMPs for soil handling have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

*Additional soil handling and site preparation practices and BMPs for the **Loamy 10-14 inch** ecological site. These measures would be applied in addition to those described above for all loamy ecological sites.*

- No site-specific BMPs for soil handling have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

*Additional soil handling and site preparation practices and BMPs for the **Loamy 15-19 inch** ecological site. These measures would be applied in addition to those described above for all loamy ecological sites.*

- No site-specific BMPs for soil handling have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

*Additional soil handling and site preparation practices and BMPs for the **Loamy Overflow 10-14 inch** ecological site. These measures would be applied in addition to those described above for all loamy ecological sites.*

- No site-specific BMPs for soil handling have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

*Additional soil handling and site preparation practices and BMPs for the **Aspen 15-19 inch** ecological site. These measures would be applied in addition to those described above for all loamy ecological sites.*

- When possible, soil stockpiles stored for more than two years will not be placed in Aspen 15-19 inch ecological site to encourage regrowth in disturbed areas. Stockpiles should be stored on disturbed areas in adjacent ecological sites when possible.
- When possible, surface disturbing activities will be minimized in Aspen 15-19 inch ecological site to avoid disruption of intact root systems
- As appropriate and when safe and feasible for construction and operations activities, aspen will be cut as close to the ground as possible and stumps will be removed to just below the soil surface, leaving the root mass intact to promote regrowth.

*Additional soil handling and site preparation practices and BMPs for the **Wet Fresh Meadow 15-19 inch** ecological site. These measures would be applied in addition to those described above for all loamy ecological sites.*

- No site-specific BMPs for soil handling have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

*Additional soil handling and site preparation practices and BMPs for the **Wetland/Riparian 10-14 inch** ecological site. These measures would be applied in addition to those described above for all loamy ecological sites.*

- Wetland and riparian 10-14 inch ecological sites will be reclaimed and/or mitigated following standards and guidance outlined in the 404 permit process for the CCSM Phase I Site under the federal Clean Water Act (CWA).

**Vegetation Handling**

The primary objective of revegetation is to establish the species composition, diversity, structure, and total ground cover appropriate for the desired plant community (BLM 2012b). In accordance with BLM Wyoming Reclamation Policy (2012b), proper seeding mixtures will be used to reclaim disturbed areas on federal lands with native vegetation, as detailed in the CCSM Project Master Reclamation Plan (2012a) and the site-specific reclamation plan for Phase I of the CCSM Project. Soil conditioning, de-compaction, and topsoil protection measures will be implemented to reestablish topsoil properties and to protect the seeding surface, as presented in Table 2 and described in the CCSM Project Master Reclamation Plan (BLM 2012a), the site-specific reclamation plan for Phase I of the CCSM Project, and in compliance with BLM Wyoming Reclamation Policy (2012b).

Seed mixtures will be tailored to establish species diversity, composition, and ground cover appropriate for the desired plant community that has been documented for each ecological site in the CCSM Project Site. Seed mixtures may be refined based on soil management, wildlife, or rangeland needs. Seed mixtures will be designed for each ecological site based on the RFO ecological site specific pick lists combined with site-specific vegetation characteristics (BLM 2008, 2011). The use of non-native species on federal lands will only be considered as the result of the documented failure to revegetate any area with native species and will be implemented in coordination with the BLM AO. BMPs and reclamation measures will be refined for site-specific characteristics and implemented as necessary in coordination with the BLM AO.

Recommended BMPs and protective measures for successfully reestablishing site vegetation are listed below:

*Revegetation practices and BMPs for* ***all loamy ecological sites***

- Exclude livestock from reclaimed areas, as practicable, until appropriate levels of site stabilization and revegetation are achieved.
- Use snow fences to trap additional soil moisture, if necessary.
- For each ecological site, using BLM pick lists (BLM 2011) contained in Exhibits I-VI, design ecological site-specific seed mixes for reclamation to achieve species composition and diversity for the desired plant community, ecological setting, and current soil properties based on pre-disturbance vegetation characteristics. Final selection of seed mixes will be dependent on seed availability and will be coordinated with the BLM AO.
- Increase seeding rate for critical areas where germination is inhibited by low soil quality, as necessary.
- Reduce seeding rates in areas where a viable seed bank remains in topsoil, as approved by BLM AO.
- Drill seed after tillage.
- Create furrows or pits to roughen the soil surface, increase moisture infiltration, capture blowing snow, and slow the surface velocity of wind and water to reduce erosion and sedimentation, as appropriate.
- Hydromulch on steep slopes after seeding, if necessary.

*Additional revegetation practices and BMPs for the **Loamy 7-9 inch** ecological site. These measures would be applied in addition to those described above for all loamy ecological sites.*

- No site-specific BMPs for revegetation have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

*Additional revegetation practices and BMPs for the **Loamy 10-14 inch** ecological site. These measures would be applied in addition to those described above for all loamy ecological sites.*

- No site-specific BMPs for revegetation have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

*Additional revegetation practices and BMPs for the **Loamy 15-19 inch** ecological site. These measures would be applied in addition to those described above for all loamy ecological sites.*

- No site-specific BMPs for revegetation have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

*Additional revegetation practices and BMPs for the **Loamy Overflow 10-14 inch** ecological site. These measures would be applied in addition to those described above for all loamy ecological sites.*

- No site-specific BMPs for revegetation have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

*Additional revegetation practices and BMPs for the **Aspen 15-19 inch** ecological site. These measures would be applied in addition to those described above for all loamy ecological sites.*

- As appropriate and when safe and feasible for construction and operations activities, aspen will be cut as close to the ground as possible and stumps will be removed to just below the soil surface, leaving the root mass intact to promote regrowth.

*Additional revegetation practices and BMPs for the **Wet Fresh Meadow 15-19 inch** ecological site. These measures would be applied in addition to those described above for all loamy ecological sites.*

- No site-specific BMPs for revegetation have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

*Additional revegetation practices and BMPs for the **Wetland/Riparian 10-14 inch** ecological site. These measures would be applied in addition to those described above for all loamy ecological sites.*

- Wetland and riparian 10-14 inch ecological sites will be reclaimed and/or mitigated following standards and guidance outlined in the 404 permit process for the CCSM Phase I Site under the federal Clean Water Act (CWA).

**Exhibit I**

**Loamy 7-9 inch Ecological Site Descriptions**

**Adapted from NRCS (2011)**

Site-specific conditions for loamy 7-9 inch ecological sites in the CCSM Phase I Site were characterized using data collected at two monitoring locations (Table 1, Figure 1). Long-term monitoring reference sites for loamy 7-9 inch ecological sites have been established in coordination with the BLM Authorized Officer (AO). Any additional monitoring site that is used for ecological site characterization that is located 100 meters outside of the CCSM Phase I limits of disturbance (LODs) may be suitable as a long-term monitoring reference site for loamy 7-9 inch ecological sites and may be used for future reclamation success monitoring purposes.

**Table 1. Representative transects for loamy 7-9 inch ecological sites in the CCSM Phase I Site.**

| Transect Number | Record Date | Latitude | Longitude | Altitude | Transect Bearing |
|---|---|---|---|---|---|
| LY_79_01 | 6/10/2014 | 41.73510 | -107.26043 | 7,077 | 220 |
| LY_79_02 | 6/12/2014 | 41.71030 | -107.14517 | 7,211 | 25 |
| LY_79_03 | 6/13/2014 | 41.71901 | -107.16175 | 7,073 | 42 |

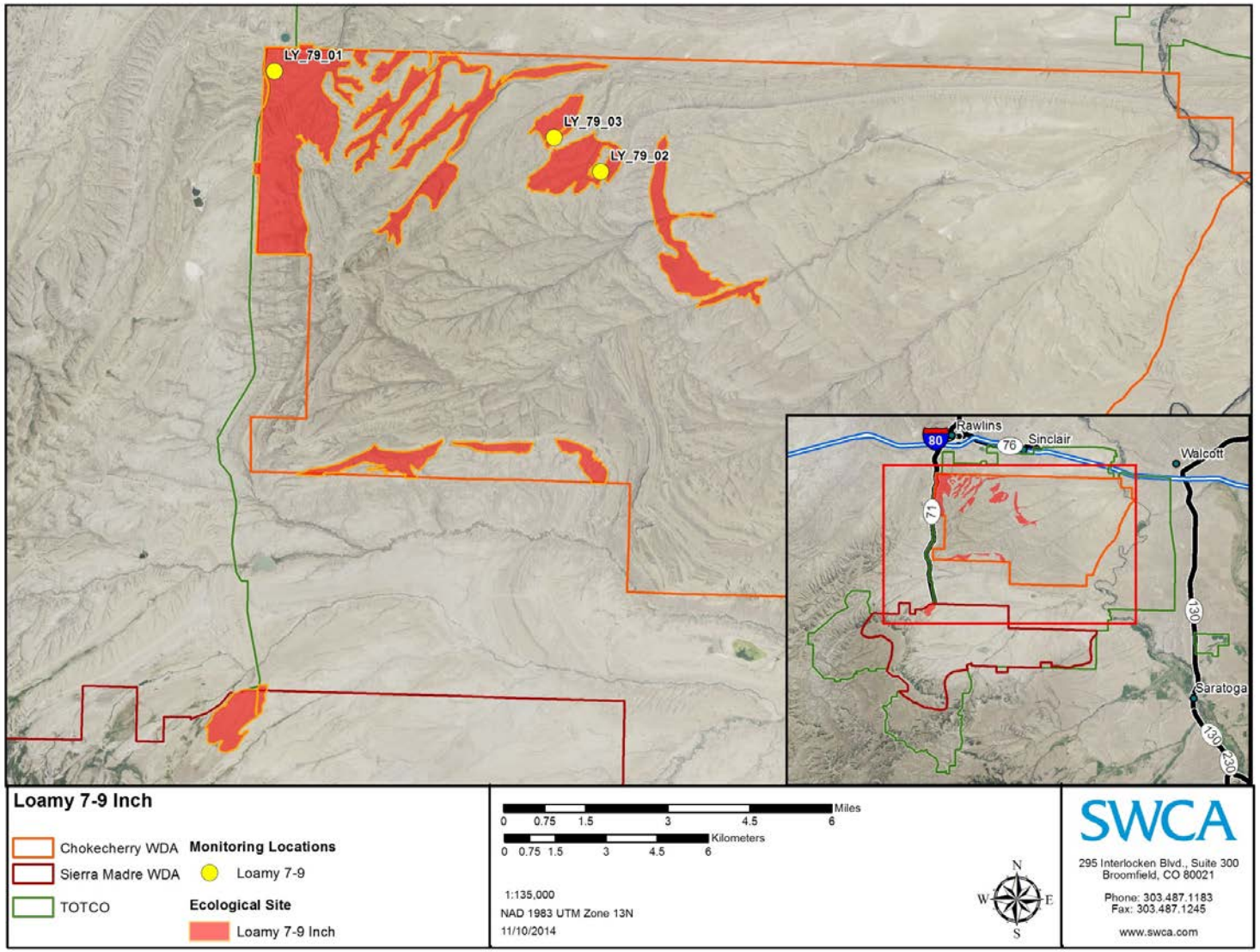


**Figure 1. Locations of reference sites used to characterize loamy 7-9 inch ecological sites in the CCSM Phase I Site.**

**Site Characteristics**

## Climate

Mean annual precipitation is 8.0 inches (ranges from 7-9 inches per year). Due to the high elevations and dry air, temperatures at loamy 7-9 inch sites range significantly between summer and winter and daily maximum and minimums. The average annual air temperature is 41.8° F (25.6°F Avg. Min. to 58.1°F Avg. Max.). Extreme minimum temperatures can occur during the winter months when cold air outbreaks and winter storms move rapidly from northwest to southeast. Daytime winds are stronger than nighttime with some strong gusts associated with the passage of winter storms (NRCS 2011).

## Abiotic Landscape Features

Loamy 7-9 inch ecological sites in the CCSM Phase I Site occur on upland positions on relatively flat to moderately sloping land on all exposures. Slopes vary, but are typically between 0% and 60% on alluvial fans, hill sides, ridges, and stream terraces. Elevation is variable and ranges between 6,900 feet and 7,300 feet in the CCSM Phase I Site.

## Soil Characteristics

Loamy 7-9 inch ecological sites within the CCSM Phase I Site are deep to moderately deep and well-drained. Textures range from sandy loams to clay loams.

Topsoil depths average 5.9 ± 0.96 inches. Lower soil horizon depths generally exceed 13.8 inches. Topsoil textures range from sandy loam to fine sandy loam. Subsoil textures are characterized by sandy loams to clay loams.

Loamy 7-9 inch ecological sites in the CCSM Phase I Site are characterized by soils with moderate to rapid infiltration and low to moderate runoff potential. Infiltration rates are highest, and runoff rates lowest where ground cover exceeds 75%. Rills and gullies are typically not present and surface water flow patterns are often indistinguishable (NRCS 2011). Chemical and physical crusts are rare to non-existent at these sites.

Soils are moderately to very strongly alkaline with pH values between 8.32 and 9.05 and non-saline electrical conductivities ranging between 0.05 and 0.10 dS/m. Where soil pH ranges exceed 8.4, soils may have limited reclamation potential and may need to be evaluated for potential soil treatment. Soils are very slightly to violently effervescent indicating presence of weakly and strongly covalent carbonates.

Figures 2 and 3 illustrate the soil surface and soil profile characteristics of a typical loamy 7-9 inch ecological site in the CCSM Phase I Site.

**Table 2. Soil characteristics typical of loamy 7-9 inch ecological sites.**

| Soil Characteristics | Description |
|---|---|
| **Parent Material (Kind)** | Residuum, colluvium |
| **Parent Material (Origin)** | Sedimentary |
| **Topsoil Depth[1]** | 5.9 ± 0.96 inches |
| **Topsoil Texture** | Sandy loam to fine sandy loam |
| **Subsoil Depth[2]** | 13.8 ± 0.96 inches |
| **Subsoil Texture** | Sandy loam to clay loam |
| **Topsoil Fragments** | 0-10% volume, sedimentary, fine gravel, subrounded |
| **Subsoil Fragments** | 0-50% volume, sedimentary, medium gravel, subrounded |
| **Electrical Conductivity (Topsoil)** | 0.05-0.07 dS/m |
| **Salinity Class (Topsoil)** | Non-saline |
| **Electrical Conductivity (Subsoil)** | 0.09-0.10 dS/m |
| **Salinity Class (Subsoil)** | Non-saline |
| **Soil Reaction (Topsoil)** | 8.48-9.05 |
| **pH Class (Topsoil)** | Moderately to very strongly alkaline |
| **Soil Reaction (Subsoil)** | 8.32-9.00 |
| **pH Class (Subsoil)** | Moderately to very strongly alkaline |
| **Carbonate Equivalent (Topsoil)** | Very slightly to strongly effervescent |
| **Carbonate Equivalent (Subsoil)** | Slightly to violently effervescent |

[1]Topsoil depth determined by depth of A Horizon.
[2]Subsoil depth determined by B and C horizons to a maximum of 20 inches depth including topsoil.

**Figure 2. Representative soil surface and ground cover for loamy 7-9 inch sites in the CCSM Phase I Site (LY_79_02)**

**Figure 3. Representative soil profile for loamy 7-9 inch sites in the CCSM Phase I Site. (LY_79_02)**

## Vegetation Characteristics

Plant communities associated with loamy 7-9 inch ecological sites in the CCSM Phase I Site are characterized by sparsely vegetated surfaces with 35%–50% basal cover (Tables 3 and 4). The remaining soil surface is characterized by unprotected soils (30% – 36%), litter (3%–21%), and rock fragments (5%–20%). Figure 4 illustrates representative vegetation communities associated with loamy 7-9 inch ecological sites in the CCSM Phase I Site.

When loamy 7-9 inch ecological sites are subjected to severe grazing pressure, species such as Wyoming big sagebrush (*Artemisia tridentata* Nutt. ssp. *wyomingensis)*, phlox (*Phlox hoodii)* and yarrow (*Achillea millefolium)* will increase. Cool season grasses such as western wheatgrass *(Pascopyrum smithii)*, bluebunch wheatgrass (*Pseudoroegneria spicata)* and needle and thread grass (*Hesperostipa comata)* will decrease in productivity. In the absence of grazing or fire, this community will convert to the big sagebrush/bunchgrass state. Heavy continuous season long grazing will convert the site to a big sagebrush/rhizomatous wheatgrass state.

The BLM pick list in Table 5 (BLM 2011) and the species composition and cover (Tables 3 and 4) observed for loamy 7-9 inch ecological sites will be used to guide the selection of appropriate seed mixes and application rates for revegetation. Final seed mixes will be determined based on seed availability at the time of revegetation efforts and in coordination with the BLM AO.

**Table 3. Vegetation characteristics typical of loamy 7-9 inch ecological sites.**

| | | |
|---|---|---|
| Basal Vegetative Cover (LPI*) | 35%–50% | |
| Biological Soil Crust and Lichen (LPI*) | 0%–3% | |
| Litter Cover (LPI*) | 3%–21% | |
| Surface Fragment/Rock Cover (LPI*) | 5%–20% | |
| Unprotected Soil(LPI*) | 30% – 36% | |
| Representative Species and Top-Canopy Cover* | *Elymus trachycaulus* | 14.3% average |
| | *Artemisia tridentata* ssp. *wyomingensis* | 14.0% average |
| | *Poa secunda* | 10.7% average |
| | *Alyssum alyssoides* | 5.0% average |
| | *Pseudoroegneria spicata* | 4.0% average |
| | *Pascopyrum smithii* | 3.3% average |

* Line point intercept

**Table 4. Species commonly associated with loamy 7-9 inch ecological sites.**

| | |
|---|---|
| *Achnatherum hymenoides* | *Erigeron engelmannii* |
| *Agoseris glauca* | *Eriogonum ovalifolium* |
| *Agropyron cristatum* | *Grayia spinosa* |
| *Allium textile* | *Hesperostipa comata* |
| *Alyssum alyssoides* | *Krascheninnikovia lanata* |
| *Arenaria hookeri* | *Lygodesmia grandiflora* |
| *Artemisia tridentata ssp. wyomingensis* | *Opuntia polyacantha* |
| *Astragalus purshii* | *Pascopyrum smithii* |
| *Astragalus sp.* | *Penstemon eriantherus* |
| *Atriplex confertifolia* | *Phlox hoodii* |
| *Atriplex gardneri* | *Poa fendleriana* |
| *Castilleja linariifolia* | *Poa secunda* |
| *Chrysothamnus viscidiflorus* | *Pseudoroegneria spicata* |
| *Delphinium nuttallii* | *Sarcobatus vermiculatus* |
| *Descurainia pinnata* | *Sphaeralcea coccinea* |
| *Elymus elymoides* | *Stenotus acaulis* |
| *Elymus trachycaulus* | *Trifolium gymnocarpon* |

**Figure 4. Characteristic vegetation communities associated with loamy 7-9 inch sites in the CCSM Phase I Site (LY_79_02)**

**Table 5. Recommended seed pick list for dry loamy ecological sites (BLM 2011).**

| **Name** | ***Scientific*** | **Variety** | **SYMBOL** |
|---|---|---|---|
| ***Grasses*** | | | |
| Thickspike wheatgrass | *Elymus lanceolatus* | Sodar, Critana | ELLA3 |
| Western wheatgrass | *Pascopyrum smithii* | Rosana | PASM |
| Indian ricegrass | *Achnatherum hymenoides* | Rimrock (Nez Par) | ACHY |
| Bottlebrush squirreltail | *Elymus elymoides* | Sand hollow | ELEL |
| Slender wheatgrass | *Elymus trachycaulus* | Pryor (San Luis) | ELTR |
| Little bluegrass "Sandberg" | *Poa secunda* | High Plains | POSE |
| Bluebunch wheatgrass | *Pseudoroegneria spicata* | Secor | PSSP6 |
| Galleta grass | *Pleuraphis jamesii* | Viva | PLJA |
| ***Shrubs*** | | | |
| Wyoming big sagebrush | *Artemisia tridentata* ssp. *wyomingensis* | | ARTRW8 |
| Green rabbitbrush | *Ericameria nauseosa* | | ERNA10 |
| Yellow rabbitbrush | *Chrysothamnus viscidiflorus* | | CHVI8 |
| Winterfat | *Krascheninnikovia lanata* | Open Range | KRLA |
| ***Forbs*** | | | |
| Rocky Mountain beeplant | *Cleome serrulata* | Appar | CLSE |
| Textile onion | *Allium textile* | | ALTE |
| Scarlet globemallow | *Sphaeralcea coccinea* | | SPCO |
| Western wallflower | *Erysium capitatum* | | ERCA14 |
| Scarlet gilia | *Ipomopsis aggregata* | | IPAGA3 |
| Spiny phlox | *Phlox hoodii* | | PHHO |
| Desert biscuitroot | *Lomatium foeniculaceum* | | LOFO |
| Bluebells | *Mertensia* spp. | | MERTE |
| Penstemon | *Penstemon* spp. | | PENST |
| Sagebrush buttercup | *Ranunculus glaberrimus* | | RAGL |

**Exhibit II**

**Loamy 10-14 inch Ecological Site Description**

**Adapted from NRCS (2011)**

Site-specific conditions for loamy 10-14 inch ecological sites in the CCSM Phase I Site were characterized using data collected at three monitoring locations (Table 1, Figure 1). Long-term monitoring reference sites for loamy 10-14 inch ecological sites have been established in coordination with the BLM Authorized Officer (AO). Any additional monitoring site that is used for ecological site characterization that is located 100 meters outside of the CCSM Phase I limits of disturbance (LODs) may be suitable as a long-term monitoring reference site for loamy 10-14 inch ecological site and may be used for future reclamation success monitoring purposes.

**Table 1. Representative transects for loamy 10-14 inch ecological sites in the CCSM Phase I Site.**

| Transect Number | Record Date | Latitude | Longitude | Altitude | Transect Bearing |
|---|---|---|---|---|---|
| LY_1014_01 | 6/17/2014 | 41.689814 | -107.179208 | 7,402 | 310 |
| LY_1014_02 | 6/27/2014 | 41.662201 | -107.147262 | 7,080 | 280 |
| LY_1014_03 | 6/26/2014 | 41.662251 | -107.235608 | 7,766 | 210 |

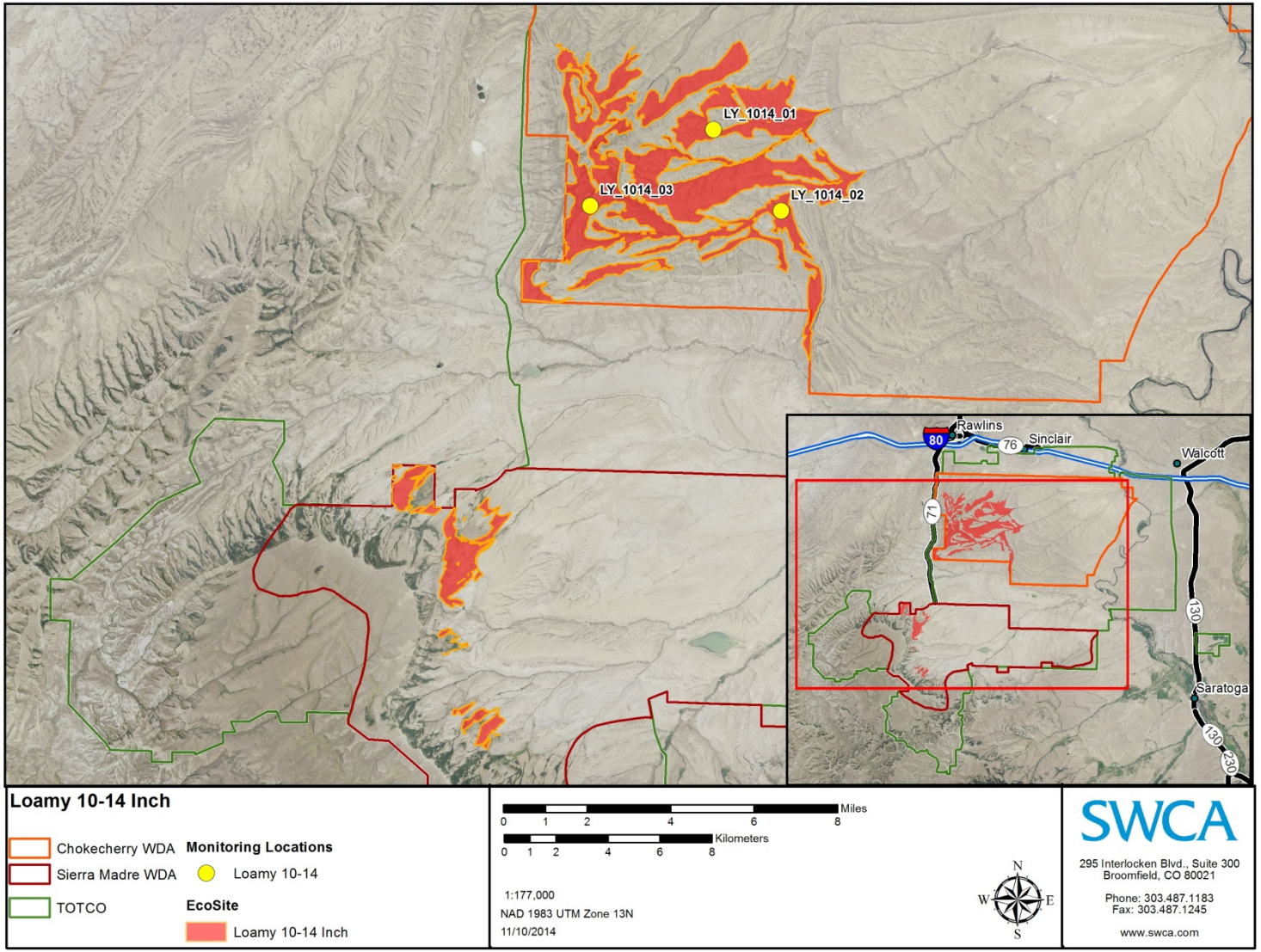


**Figure 1. Locations of reference sites used to characterize loamy 10-14 inch ecological sites in the CCSM Phase I Site.**

**Site Characteristics**

## Climate

Mean annual precipitation is 10.5 inches (ranges from 10-14 inches per year), with peaks observed in May and the lowest totals recorded in the winter months. Average snow fall often exceeds 20 inches annually. Wide fluctuations do occur and result in more dry years than normal years (NRCS 2011). Due to the high elevations and dry air, temperatures at loamy 10-14 inch ecological sites range significantly between summer and winter and daily maximum and minimums. The average annual air temperature is 46.2 °F (30.1 °F Avg. Min. to 62.3 °F Avg. Max.). Extreme minimum temperatures can occur during the winter months when cold air outbreaks and winter storms move rapidly from northwest to southeast.

## Abiotic Landscape Features

Loamy 10-14 inch ecological sites in the CCSM Phase I Site occur in upland positions on near level to gently undulating rolling land. Slopes vary, but are typically less than 10%. Examples of landforms found in this ecological site include alluvial fans, hills, and plateaus. Elevation is variable and ranges between 7,000 feet and 7,800 feet in the CCSM Phase I Site.

## Soil Characteristics

Loamy 10-14 inch ecological sites within the CCSM Phase I Site are very deep to moderately deep and moderately well to well-drained, and moderately slow to moderately permeable. Textures range from sandy loams to clay loams (Table 2).

Topsoil depth averages 5.4 ± 1.06 inches. Lower soil horizon depths generally exceed 14.3 inches. Topsoil soil textures range from fine sandy loams to sandy clay loams. Subsoil textures are characterized by sandy loams to clay loams.

Loamy 10-14 inch ecological sites in the CCSM Phase I Site are characterized by soils with moderate slow to moderate infiltration and low to moderate runoff potential. Infiltration rates are highest, and runoff rates lowest where ground cover exceeds 75%. Rills and gullies are typically not present and surface water flow patterns are often indistinguishable (NRCS 2011). Chemical and physical crusts are rare to non-existent at these sites (NRCS 2011).

Soils are moderately to strongly alkaline with pH values between 8.24 and 8.86 and non-saline electrical conductivities ranging between 0.04 and 0.12 dS/m. Where soil pH ranges exceed 8.40, soils may have limited reclamation potential (LRP) and may need to be evaluated for potential soil treatment. Soils are non-effervescent to strongly effervescent indicating presence of weakly and strongly covalent carbonates.

Figures 2 and 3 illustrate the soil surface and soil profile characteristics of a typical loamy 10-14 inch site in the CCSM Phase I Site.

**Table 2. Soil characteristics typical of loamy 10-14 inch ecological sites.**

| Soil Characteristics | Description |
|---|---|
| **Parent Material (Kind)** | Alluvium, colluvium, residuum |
| **Parent Material (Origin)** | Sedimentary |
| **Topsoil Depth[1]** | 5.4 ± 1.06 inches |
| **Topsoil Texture** | Fine sandy loam to sandy clay loam |
| **Subsoil Depth[2]** | 14.3 ± 1.06 inches |
| **Subsoil Texture** | Sandy loam to clay loam |
| **Topsoil Fragments** | 0%–20% volume, sedimentary, fine gravel, subangular |
| **Subsoil Fragments** | 0%–50% volume, sedimentary, fine to medium gravel, subangular |
| **Electrical Conductivity (Topsoil)** | 0.04-0.05 dS/m |
| **Salinity Class (Topsoil)** | Non-saline |
| **Electrical Conductivity (Subsoil)** | 0.06-0.12 dS/m |
| **Salinity Class (Subsoil)** | Non-saline |
| **Soil Reaction (Topsoil)** | 8.24-8.86 |
| **pH Class (Topsoil)** | Moderately to strongly alkaline |
| **Soil Reaction (Subsoil)** | 8.36-8.63 |
| **pH Class (Subsoil)** | Moderately to strongly alkaline |
| **Carbonate Equivalent (Topsoil)** | Noneffervescent |
| **Carbonate Equivalent (Subsoil)** | Slightly to strongly effervescent |

[1]Topsoil depth determined by depth of A Horizon.
[2]Subsoil depth determined by B and C horizons to a maximum of 20 inches depth including topsoil.

**Figure 2. Representative soil surface and ground cover for loamy 10-14 inch sites in the CCSM Phase I Site (LY_1014_01).**

**Figure 3. Representative soil profile for loamy 10-14 inch sites in the CCSM Phase I Site (LY_1014_01).**

## Vegetation Characteristics

Plant communities associated with loamy 10-14 inch ecological sites in the CCSM Phase I Site are characterized by vegetated surfaces with 23%–28% basal cover (Tables 3 and 4). The remaining soil surface is characterized primarily by litter (19–47%), rock fragments (2–41%), and unprotected soils (16–40%). Figure 4 illustrates representative vegetation communities associated with loamy 10-14 inch ecological sites in the CCSM Phase I Site.

When loamy 10-14 inch ecological sites are subjected to severe grazing pressure, species such as Sandberg bluegrass (*Poa secunda*) and big sagebrush (*Artemisia tridentata*) increase. Weedy annuals will also begin to invade and bluebunch wheatgrass (*Pseudoroegneria spicata*) and Indian ricegrass (*Achnatherum hymenoides*) will begin to decrease. Continuous season-long grazing will cause a transition to a perennial grass/big sagebrush community.

The BLM pick list in Table 5 (BLM 2011) and the species composition and cover (Tables 3 and 4) observed for loamy 10-14 inch ecological sites will be used to guide the selection of appropriate seed mixes and application rates for revegetation. Final seed mixes will be determined based on seed availability at the time of revegetation efforts and in coordination with the BLM AO.

**Table 3. Vegetation characteristics typical of loamy 10-14 inch ecological sites.**

| | | |
|---|---|---|
| Basal Vegetative Cover (LPI*) | 23% – 28% | |
| Biological Soil Crust and Lichen (LPI*) | 0% – 3% | |
| Litter Cover (LPI*) | 19% – 47% | |
| Surface Fragment/Rock Cover (LPI*) | 2% – 41% | |
| Unprotected Soil(LPI*) | 16% – 40% | |
| Representative Species and Top-Canopy Cover* | *Pseudoroegneria spicata* | 14.3% average |
| | *Poa secunda* | 11.7% average |
| | *Artemisia tridentata ssp. wyomingensis* | 10.7% average |
| | *Poa fendleriana* | 8.3% average |
| | *Elymus trachycaulus* | 6.0% average |

* Line point intercept

**Table 4. Species commonly associated with loamy 10-14 inch ecological sites.**

| | |
|---|---|
| *Achnatherum hymenoides* | *Eriogonum sp.* |
| *Agoseris glauca* | *Hesperostipa comata* |
| *Allium textile* | *Koeleria macrantha* |
| *Alyssum desertorum* | *Krascheninnikovia lanata* |
| *Antennaria corymbosa* | *Lappula occidentalis var. cupulata* |
| *Arenaria hookeri* | *Linanthus pungens* |
| *Artemisia pedatifida* | *Machaeranthera grindelioides* |
| *Artemisia tridentata ssp. wyomingensis* | *Nothocalais sp.* |
| *Astragalus purshii* | *Opuntia polyacantha* |
| *Astragalus sp.* | *Oxytropis sp.* |
| *Atriplex confertifolia* | *Pascopyrum smithii* |
| *Balsamorhiza sagittata* | *Penstemon eriantherus* |
| *Bromus tectorum* | *Penstemon sp.* |
| *Calochortus nuttallii* | *Phlox hoodii* |
| *Carex filifolia* | *Phlox sp.* |
| *Castilleja linariifolia* | *Poa fendleriana* |
| *Chrysothamnus viscidiflorus* | *Poa secunda* |
| *Delphinium geyeri* | *Pseudoroegneria spicata* |
| *Descurainia pinnata* | *Senecio sp.* |
| *Elymus elymoides* | *Sphaeralcea coccinea* |
| *Elymus trachycaulus* | *Stenotus acaulis* |
| *Erigeron caespitosus* | *Stenotus armerioides* |
| *Erigeron engelmannii* | *Trifolium gymnocarpon* |
| *Eriogonum ovalifolium* | |

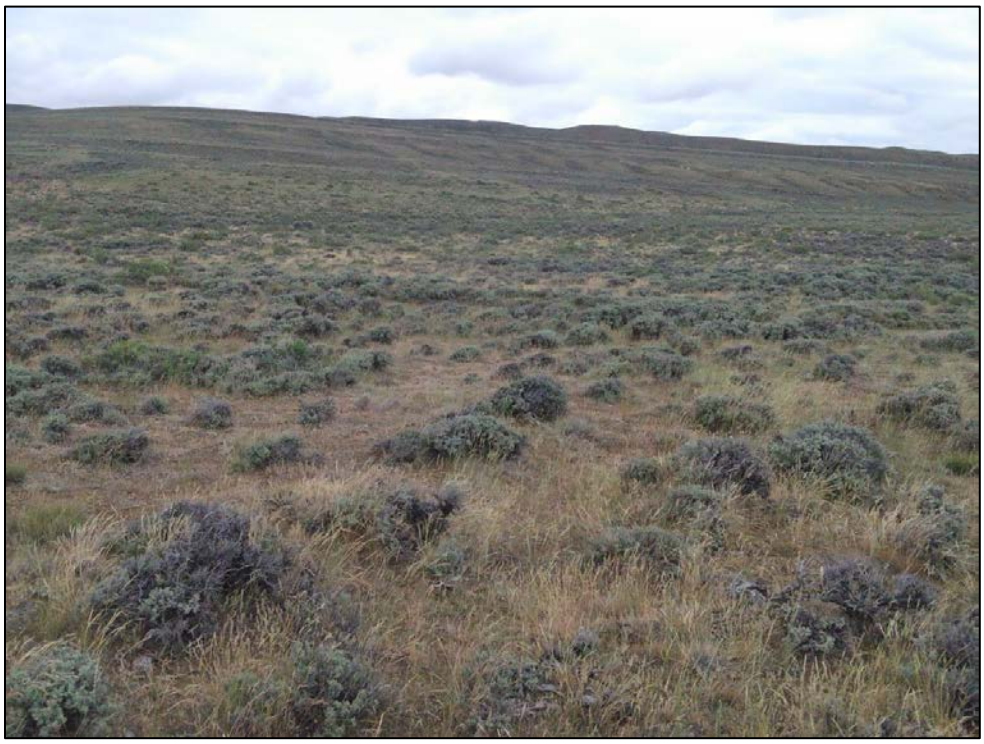

**Figure 4. Characteristic vegetation communities associated with loamy 10-14 inch sites in the CCSM Phase I Site (LY_1014_01).**

**Table 5. Recommended seed pick list for loamy ecological sites (BLM 2011).**

| **Name** | ***Scientific*** | **Variety** | **SYMBOL** |
|---|---|---|---|
| ***Grasses*** | | | |
| Western wheatgrass | *Pascopyrum smithii* | Rosana | PASM |
| Thickspike wheatgrass | *Elymus lanceolatus* | Critana | ELLA3 |
| Indian ricegrass | *Achnatherum hymenoides* | Rimrock (Nez Par) | ACHY |
| Green needlegrass | *Nassella viridula* | Lordon | NAVI4 |
| Prairie junegrass | *Koeleria macrantha* | | KOMA |
| Bottlebrush squirreltail | *Elymus elymoides* | Sand hollow | ELEL |
| Mutton bluegrass | *Poa fendleriana* | | POFE |
| Bluebunch wheatgrass | *Pseudoroegneria spicata* | Secor | PSSP6 |
| Galleta grass | *Pleuraphis jamesii* | Viva | PLJA |
| Oniongrass | *Melica bulbosa* | | MEBU |
| ***Shrubs*** | | | |
| Wyoming big sagebrush | *Artemisia tridentata* ssp. *wyomingensis* | | ARTRW8 |
| Mountain big sagebrush | *Artemisia tridentata* ssp. *vaseyana* | | ARTRV |
| Fourwing saltbush | *Atriplex canaescens* | Wytana | ATCA2 |
| Antelope bitterbrush | *Purshia tridentata* | | PUTR2 |
| Snowberry | *Symphoricarpos* spp. | Maybell | SYOR2 |
| Winterfat | *Krascheninnikovia lanata* | Open Range | KRLA |
| Shadscale saltbush | *Atriplex confertifolia* | | ATCO |
| Mountain mahogany | *Cercocarpus montanus* | Montane | CEMO2 |
| White sagebrush | *Artemisia ludoviciana* | | ARLU |
| ***Forbs*** | | | |
| Scarlet globemallow | *Sphaeralcea coccinea* | | SPCO |
| American vetch | *Vicia americana* | | VIAM |
| Lupine | *Lupinus sericeus* | | LUSE4 |
| Blanketflower | *Gaillardia aristata* | | GAAR |
| Western yarrow | *Achillea millefolium* var. *occidentalis* | | ACMI2 |
| Giant evening primrose | *Oenothera hookeri* | | OEELH |
| Textile onion | *Allium textile* | | ALTE |
| Arrowleaf balsamroot | *Balsamorhiza sagittata* | | BASA3 |
| Balsam groundsel | *Packera paupercula* | | PAPA20 |
| Longleaf phlox | *Phlox longifolia* | | PHLO2 |
| Bluebells | *Mertensia* spp. | | MERTE |

| **Name** | ***Scientific*** | **Variety** | **SYMBOL** |
|---|---|---|---|
| Penstemon | *Penstemon* spp. | | PENST |
| Sagebrush buttercup | *Ranunculus glaberrimus* | | RAGL |
| Prairie goldenbanner | *Thermopsis rhombifolia* | | THRH |
| Nuttall's violet | *Viola nuttallii* | | VINU2 |
| Western stoneseed | *Lithospermum ruderale* | | LIRU4 |

**Exhibit III**

**Loamy 15-19 inch Ecological Site Description**

**Adapted from NRCS (2011)**

Site-specific conditions for loamy 15-19 inch ecological sites in the CCSM Phase I Site were characterized using data collected at three monitoring locations (Table 1, Figure 1). Long-term monitoring reference sites for loamy 15-19 inch ecological sites have been established in coordination with the BLM Authorized Officer (AO). Any additional monitoring site that is used for ecological site characterization that is located 100 meters outside of the CCSM Phase I limits of disturbance (LODs) may be suitable as a long-term monitoring reference site for loamy 15-19 inch ecological site and may be used for future reclamation success monitoring purposes.

**Table 1. Representative transects for loamy 15-19 inch ecological sites in the CCSM Phase I Site.**

| Transect Number | Record Date | Latitude | Longitude | Altitude | Transect Bearing |
|---|---|---|---|---|---|
| LY_1519_01 | 7/25/2014 | 41.52164 | -107.33477 | 8,264 | 230 |
| LY_1519_02 | 8/8/2014 | 41.48956 | -107.32938 | 8,058 | 210 |
| LY_1519_03 | 8/13/2014 | 41.44374 | -107.26480 | 7,841 | 185 |

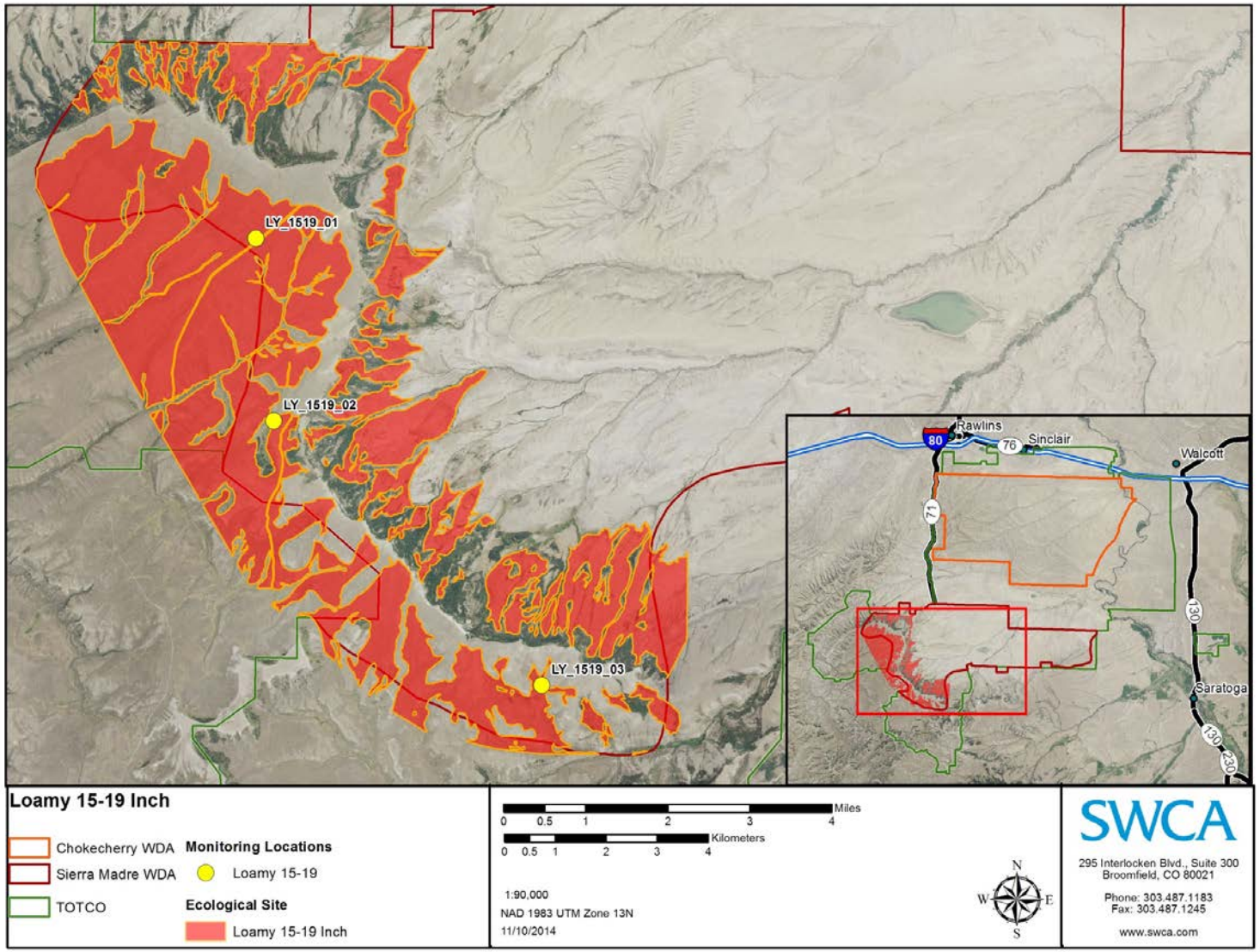


**Figure 1. Locations of reference sites used to characterize loamy 15-19 inch ecological sites in the CCSM Phase I Site.**

**Site Characteristics**

*Climate*

The mean annual precipitation at these sites is 16.04 inches, with peaks observed in August and the lowest totals recorded in the winter months. Wide fluctuations do occur and result in more dry years than normal years (NRCS 2011). Due to the high elevations and dry air, temperatures at loamy 15-19 inch ecological sites range significantly between summer and winter and daily maximum and minimums. The average annual air temperature is 44.7°F (ranging from 32.1°F Avg. Min. to 57.2°F Avg. Max). Extreme minimum temperatures can occur during the winter months when cold air outbreaks and winter storms move rapidly from northwest to southeast.

*Abiotic Landscape Features*

Loamy 15-19 inch ecological sites in the CCSM Phase I Site occur on benches, cuestas, toeslopes, and fans of foothills in landslide areas and in valleys. Slopes range from nearly level to 50%. Elevation is variable and ranges between 7,300 feet and 8,400 feet in the CCSM Phase I Site.

*Soil Characteristics*

Loamy 15-19 inch ecological sites within the CCSM Phase I Site are deep to moderately deep, and well drained and often greater than 20 inches to bedrock. Topsoil textures are characterized by very fine sandy loams to loams. Subsoils are similar in texture and range from sandy loams to clay loams.

Topsoil depth averages 6.8 ± 0.21 inches. Lower soil horizon depths often exceed 12.9 inches. Loamy 15-19 inch ecological sites in the CCSM Phase I Site are characterized by soils with slow to medium runoff potential with moderate erosion hazard.

Soils are moderately alkaline with a pH of 7.91 to 8.49 and non-saline to very slightly saline with electrical conductivities ranging between 0.01 and 0.06 dS/m. Soils are non-effervescent to very slightly effervescent indicating presence of weakly covalent carbonates.

Figures 2 and 3 illustrate the soil surface and soil profile characteristics of a typical loamy 15-19 inch site in the CCSM Phase I Site.

**Table 2. Soil characteristics typical of loamy 15-19 inch ecological sites.**

| Soil Characteristics | Description |
|---|---|
| **Parent Material (Kind)** | Residuum, colluvium |
| **Parent Material (Origin)** | Sedimentary, igneous |
| **Topsoil Depth[1]** | 6.8 ± 0.21 inches |
| **Topsoil Texture** | Very fine sandy loam to loam |
| **Subsoil Depth[2]** | 12.9 ± 0.21 inches |
| **Subsoil Texture** | Sandy loam to clay loam |
| **Topsoil Fragments** | 0-15% volume, mixed rock, fine gravel, subrounded |
| **Subsoil Fragments** | 0-50% volume, mixed rock, fine gravel, subrounded |
| **Electrical Conductivity (Topsoil)** | 0.01-0.04 dS/m |
| **Salinity Class (Topsoil)** | Non-saline |
| **Electrical Conductivity (Subsoil)** | 0.01-0.06 dS/m |
| **Salinity Class (Subsoil)** | Non-saline |
| **Soil Reaction (Topsoil)** | 7.95-8.49 |
| **pH Class (Topsoil)** | Moderately alkaline |
| **Soil Reaction (Subsoil)** | 7.91-8.39 |
| **pH Class (Subsoil)** | Moderately alkaline |
| **Carbonate Equivalent (Topsoil)** | Non-effervescent |
| **Carbonate Equivalent (Subsoil)** | Non-effervescent to very slightly effervescent |

[1]Topsoil depth determined by depth of A Horizon.
[2]Subsoil depth determined by B and C horizons to a maximum of 20 inches depth including topsoil.

**Figure 2. Representative soil surface and ground cover for loamy 15-19 inch sites in the CCSM Phase I Site (LY_1519_03).**

**Figure 3. Representative soil profile for loamy 15-19 inch sites in the CCSM Phase I Site. (LY_1519_01).**

*Vegetation Characteristics*

Plant communities associated with loamy 15-19 inch ecological sites in the CCSM Phase I Site are characterized by highly vegetated surfaces with 15%–35% basal cover (Tables 3 and 4). The remaining soil surface is characterized by litter cover (46%–60%) and unprotected soils (10%–37%). Figure 4 illustrates representative vegetation communities associated with loamy 15-19 inch ecological sites in the CCSM Phase I Site.

Loamy 15-19 inch ecological sites subjected to frequent and severe grazing increases the woody species component such as mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) and rabbitbrush (*Chrysothamnus* and *Ericameria* spp.), and herbaceous species component of Sandberg bluegrass (*Poa secunda*) and Idaho fescue. In the absence of grazing or fire this community would transition to a big sagebrush/low plant density/excess plant litter community. Under moderate continuous season-long grazing the community would transition to a mixed sagebrush/grass plant community.

The BLM pick list in Table 5 (BLM 2011) and the species composition and cover (Tables 3 and 4) observed for loamy 15-19 inch ecological sites will be used to guide the selection of appropriate seed mixes and application rates for revegetation. Final seed mixes will be determined based on seed availability at the time of revegetation efforts and in coordination with the BLM AO.

**Table 3. Vegetation characteristics typical of loamy 15-19 inch ecological sites.**

| | | |
|---|---|---|
| Basal Vegetative Cover (LPI*) | 15%–35% | |
| Biological Soil Crust and Lichen (LPI*) | 0%–1% | |
| Litter Cover (LPI*) | 46%–60% | |
| Surface Fragment/Rock Cover (LPI*) | 0%–1% | |
| Unprotected Soil(LPI*) | 10% – 37% | |
| Representative Species and Top-Canopy Cover* | *Artemisia tridentata* ssp. *vaseyana* | 30.0% average |
| | *Festuca idahoensis* | 20.0% average |
| | *Leucopoa kingii* | 11.0% average |
| | *Arenaria congesta* | 10.0% average |
| | *Nassella viridula* | 7.0% average |

* Line point intercept

**Table 4. Species commonly associated with loamy 15-19 inch ecological sites.**

| | |
|---|---|
| *Achillea millefolium* | *Lithospermum incisum* |
| *Antennaria microphylla* | *Lithospermum sp.* |
| *Antennaria sp.* | *Lupinus argenteus* |
| *Arenaria congesta* | *Nassella viridula* |
| *Artemisia nova* | *Orthocarpus luteus* |
| *Artemisia tridentata ssp. tridentata* | *Oxytropis sericea* |
| *Artemisia tridentata ssp. vaseyana* | *Oxytropis sp.* |
| *Astragalus agrestis* | *Pascopyrum smithii* |
| *Astragalus bisulcatus* | *Penstemon caespitosus* |
| *Astragalus purshii* | *Penstemon sp.* |
| *Astragalus sp.* | *Phleum pratense* |
| *Bromus marginatus* | *Phlox hoodii* |
| *Carex geyeri* | *Phlox multiflora* |
| *Carex rossii* | *Poa ampla* |
| *Castilleja linariifolia* | *Poa fendleriana* |
| *Chrysothamnus viscidiflorus* | *Poa pratensis* |
| *Cirsium scariosum* | *Poa secunda* |
| *Cirsium sp.* | *Potentilla gracilis* |
| *Cordylanthus ramosus* | *Pseudoroegneria spicata* |
| *Elymus glaucus* | *Puccinellia nuttalliana* |
| *Erigeron sp.* | *Purshia tridentata* |
| *Eriogonum flavum* | *Rosa woodsii* |
| *Eriogonum sp.* | *Sedum lanceolatum* |
| *Eriogonum umbellatum* | *Senecio sp.* |
| *Festuca idahoensis* | *Silene parryi* |
| *Geranium richardsonii* | *Sphaeralcea coccinea* |
| *Hesperostipa comata* | *Symphoricarpos albus* |
| *Juniperus communis* | *Symphyotrichum eatonii* |
| *Koeleria macrantha* | *Symphyotrichum lanceolatum* |
| *Leucopoa kingii* | *Taraxacum officinale* |
| *Linanthus pungens* | *Trifolium gymnocarpon* |
| *Lithophragma tenellum* | |

**Figure 4. Characteristic vegetation communities associated with loamy 15-19 inch sites in the CCSM Phase I Site (LY_1519_01)**

**Table 5. Recommended seed pick list for loamy ecological sites (BLM 2011).**

| Name | *Scientific* | Variety | SYMBOL |
|---|---|---|---|
| ***Grasses*** | | | |
| Idaho fescue | *Festuca idahoensis* | | FEID |
| Green needlegrass | *Nassella viridula* | | NAVI4 |
| Mountain brome | *Bromus marginatus* | Garnet | BRMA |
| Oniongrass | *Melica bulbosa* | | MEBU |
| Bluebunch wheatgrass | *Pseudoroegneria spicata* | Secor | PSSP6 |
| Elk sedge | *Carex garberi* | | CAGA3 |
| Columbia needlegrass | *Achnatherum nelsonii* | | ACNE9 |
| Ross' sedge | *Carex rossii* | | CARO5 |
| King spike fescue | *Leucopoa kingii* | | LEKI2 |
| ***Shrubs*** | | | |
| Mountain big sagebrush | *Artemisia tridentata* ssp. *vaseyana* | | ARTRV |
| Antelope bitterbrush | *Purshia tridentata* | Maybell | PUTR2 |
| Serviceberry | *Amelanchier alnifolia* | | AMAL2 |
| Snowberry | *Symphoricarpos oreophilus* | Maybell | SYOR2 |
| | *S. albus* | | SYAL |
| ***Forbs*** | | | |
| Arrowleaf balsamroot | *Balsamorhiza sagittata* | | BASA |
| American vetch | *Vicia americana* | | VIAM |
| Lupine | *Lupinus sericeus* | | LUSE4 |
| Blanketflower | *Gaillardia aristata* | | GAAR |
| Western yarrow | *Achillea millefolium* var. *occidentalis* | Yakima | ACMI2 |
| Balsam groundsel | *Packera paupercula* | | PAPA20 |
| Bluebells | *Mertensia* spp. | | MERTE |
| Hood's phlox | *Phlox hoodii* | | PHHO |
| Rocky Mountain penstemon | *Penstemon strictus* | | PEST |
| Nuttall's violet | *Viola nuttallii* | | VINU2 |
| Sagebrush buttercup | *Ranunculus glaberrimus* | | RAGL |
| Agoseris | *Agoseris glauca* | | AGGL |
| Sulfur-flower buckwheat | *Eriogonum umbellatum* | | ERUM |

**Exhibit IV**

**Loamy Overflow 10-14 inch Ecological Site Description**

**Adapted from NRCS (2011)**

Site-specific conditions for loamy overflow 10-14 inch ecological sites in the CCSM Phase I Site were characterized using data collected at four monitoring locations (Figure 1, Table 1). Long-term monitoring reference sites for loamy overflow 10-14 inch ecological sites have been established in coordination with the BLM Authorized Officer (AO). Any additional monitoring site that is used for ecological site characterization that is located 100 meters outside of the CCSM Phase I limits of disturbance (LODs) may be suitable as a long-term monitoring reference site for loamy overflow 10-14 inch ecological site and may be used for future reclamation success monitoring purposes.

**Table 1. Representative transects for loamy overflow 10-14 inch ecological sites in the CCSM Phase I Site.**

| Transect Number | Record Date | Latitude | Longitude | Altitude | Transect Bearing |
|---|---|---|---|---|---|
| LO_1014_01 | 7/2/2014 | 41.50011 | -107.27445 | 7,172 | 80 |
| LO_1014_02 | 7/27/2014 | 41.51643 | -107.26434 | 7,156 | 225 |
| LO_1014_03 | 7/27/2014 | 41.48819 | -107.27870 | 7,241 | 235 |
| LO_1014_04 | 6/29/2014 | 41.61496 | -107.13921 | 6,834 | 160 |

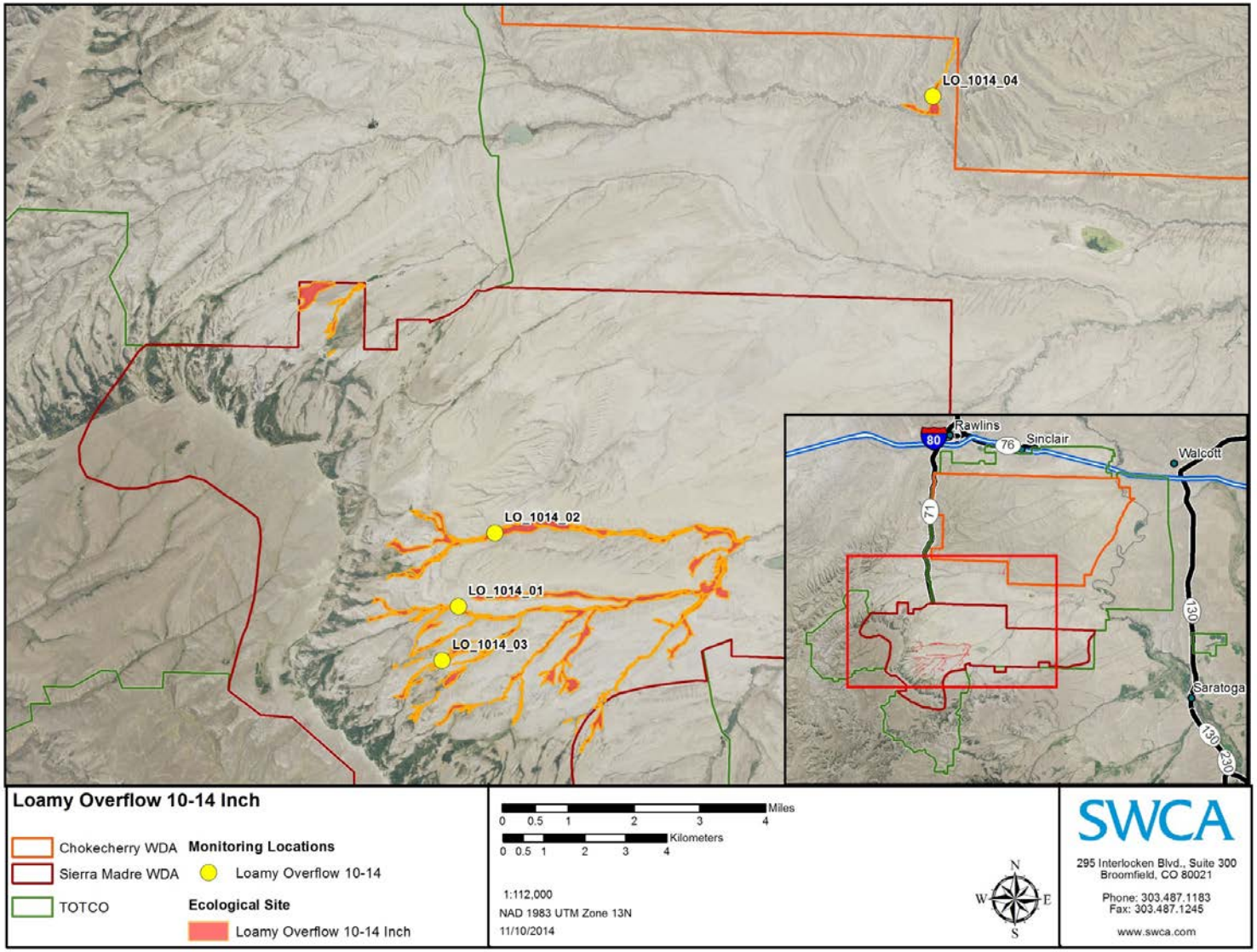


**Figure 1. Locations of reference sites used to characterize loamy overflow 10-14 inch ecological sites in the CCSM Phase I Site.**

**Site Characteristics**

## Climate

The mean annual precipitation at these sites is 11.5 inches (ranges from 10-14 inches), with peaks observed in May and the lowest totals recorded in the winter months. Average snow fall often exceeds 20 inches annually. Wide fluctuations do occur and result in more dry years than normal years (NRCS 2011). Due to the high elevations and dry air, temperatures at loamy overflow 10-14 inch ecological sites range significantly between summer and winter and daily maximum and minimums. The average annual air temperature is 42.2 °F (30.4 °F Avg. Min. to 53.9 °F Avg. Max.). Extreme minimum temperatures can occur during the winter months when cold air outbreaks and winter storms move rapidly from northwest to southeast.

## Abiotic Landscape Features

Loamy overflow 10-14 inch ecological sites in the CCSM Phase I Site occur on gently sloping to moderately sloping flood plains, canyons, and small valley bottoms along intermittent streams. The site is found on all exposures. Elevation is variable and ranges between 7,000 feet and 7,500 feet in the CCSM Phase I Site.

## Soil Characteristics

Loamy overflow 10-14 inch ecological sites within the CCSM Phase I Site have deep soils with textures ranging from fine sandy loams to silty clays.

Topsoil depth averages 6.4 ± 1.05 inches in depth. Lower soil horizon depths generally exceed 13.3 inches. Topsoil textures are characterized by fine sandy loams to clay loams. Subsoil textures range from sandy loams to silty clays.

Loamy overflow 10-14 inch ecological sites in the CCSM Phase I Site are characterized by soils with moderate to rapid infiltration and moderate to high runoff potential. Infiltration rates are highest, and runoff rates lowest where ground cover exceeds 75%. Rills and gullies are typically present and surface water flow patterns are often distinguishable (NRCS 2011). Chemical and physical crusts are rare to non-existent at these sites (NRCS 2011).

Soils are slightly to strongly alkaline with pH values of ranging from 8.21 to 8.98 and non-saline electrical conductivities of 0.06 to 012 dS/m. Where soil pH ranges exceed 8.4, soils may have LRP and may need to be evaluated for potential soil treatment. Soils are non-effervescent to strongly effervescent indicating presence of weakly to strongly covalent carbonates.

Figures 2 and 3 illustrate the soil surface and soil profile characteristics of a typical loamy overflow 10-14 inch site in the CCSM Phase I Site.

**Table 2. Soil characteristics typical of loamy overflow 10-14 inch ecological sites.**

| Soil Characteristics | Description |
|---|---|
| **Parent Material (Kind)** | Alluvium, residuum |
| **Parent Material (Origin)** | Sedimentary |
| **Topsoil Depth[1]** | 6.4 ± 1.05 inches |
| **Topsoil Texture** | Fine sandy loam to clay loam |
| **Subsoil Depth[2]** | 13.3 ± 1.05 inches |
| **Subsoil Texture** | Sandy loam to silty clay |
| **Topsoil Fragments** | 0-10% volume, sedimentary, coarse gravel, subrounded |
| **Subsoil Fragments** | 0-10% volume, sedimentary, medium gravel, rounded |
| **Electrical Conductivity (Topsoil)** | 0.07-0.12 dS/m |
| **Salinity Class (Topsoil)** | Non-saline |
| **Electrical Conductivity (Subsoil)** | 0.06-0.11 dS/m |
| **Salinity Class (Subsoil)** | Non-saline |
| **Soil Reaction (Topsoil)** | 8.21-8.88 |
| **pH Class (Topsoil)** | Moderately to strongly alkaline |
| **Soil Reaction (Subsoil)** | 8.28-8.98 |
| **pH Class (Subsoil)** | Moderately to strongly alkaline |
| **Carbonate Equivalent (Topsoil)** | Slightly to strongly effervescent |
| **Carbonate Equivalent (Subsoil)** | Non-effervescent to strongly effervescent |

[1]Topsoil depth determined by depth of A Horizon.
[2]Subsoil depth determined by B and C horizons to a maximum of 20 inches depth including topsoil.

**Figure 2. Representative soil surface and ground cover for loamy overflow 10-14 inch sites in the CCSM Phase I Site (LO_1014_02)**

**Figure 3. Representative soil profile for loamy overflow 10-14 inch sites in the CCSM Phase I Site (LO_1014_02).**

## Vegetation Characteristics

Plant communities associated with loamy overflow 10-14 inch ecological sites in the CCSM Phase I Site are characterized by vegetated surfaces with 10%–35% basal cover (Tables 3 and 4). The remaining soil surface is characterized primarily by litter (17%–56%) and unprotected soils (27%–48%). Figure 4 illustrates representative vegetation communities associated with loamy overflow 10-14 inch ecological sites in the CCSM Phase I Site.

When loamy overflow 10-14 inch ecological sites are subjected to frequent and severe grazing pressure, woody species such as big sagebrush (*Artemisia tridentata)* and rabbitbrush (*Chrysothamnus* and *Ericameria* spp.) increase, and cool season grasses such as bluebunch wheatgrass (*Pseudoroegneria spicata), slender wheatgrass (Elymus trachycaulus*) and Indian rice grass (*Achnatherum hymenoides*) decrease in productivity, converting the community to a sagebrush/rabbitbrush state.

The BLM pick list in Table 5 (BLM 2011) and the species composition and cover (Tables 3 and 4) observed for loamy overflow 10-14 inch ecological sites will be used to guide the selection of appropriate seed mixes and application rates for revegetation. Final seed mixes will be determined based on seed availability at the time of revegetation efforts and in coordination with the BLM AO.

**Table 3. Vegetation characteristics typical of loamy overflow 10-14 inch ecological sites.**

| | | |
|---|---|---|
| Basal Vegetative Cover (LPI*) | 10%–35% | |
| Biological Soil Crust and Lichen (LPI*) | 0%–2% | |
| Litter Cover (LPI*) | 17%–56% | |
| Surface Fragment/Rock Cover (LPI*) | 0% | |
| Unprotected Soil(LPI*) | 27% – 48% | |
| Representative Species and Top-Canopy Cover* | *Salix boothii* | 38.0% average |
| | *Artemisia tridentata* ssp. *tridentata* | 33.5% average |
| | *Leymus cinereus* | 14.3% average |
| | *Artemisia cana* | 10.5% average |
| | *Bromus tectorum* | 8.0% average |
| | *Machaeranthera* sp. | 7.7% average |

* Line point intercept

**Table 4. Species commonly associated with loamy overflow 10-14 inch ecological sites.**

| | |
|---|---|
| *Achillea millefolium* | *Iva axillaris* |
| *Agrostis gigantea* | *Juncus balticus* |
| *Allium textile* | *Krascheninnikovia lanata* |
| *Alyssum desertorum* | *Leymus cinereus* |
| *Artemisia cana* | *Lomatium grayi* |
| *Artemisia tridentata ssp. tridentata* | *Lomatium sp.* |
| *Artemisia tridentata ssp. vaseyana* | *Machaeranthera sp.* |
| *Astragalus bisulcatus* | *Melica spectabilis* |
| *Astragalus sp.* | *Mertensia sp.* |
| *Atriplex confertifolia* | *Opuntia polyacantha* |
| *Atriplex gardneri* | *Pascopyrum smithii* |
| *Balsamorhiza sagittata* | *Phleum pratense* |
| *Bromus tectorum* | *Phlox hoodii* |
| *Cardaria draba* | *Poa fendleriana* |
| *Castilleja linariifolia* | *Poa pratensis* |
| *Ceratocephala testiculata* | *Poa secunda* |
| *Chrysothamnus viscidiflorus* | *Pseudoroegneria spicata* |
| *Cirsium eatonii* | *Rosa woodsii* |
| *Cirsium sp.* | *Salix boothii* |
| *Cordylanthus ramosus* | *Salix exigua* |
| *Delphinium geyeri* | *Salix lutea* |
| *Descurainia pinnata* | *Sarcobatus vermiculatus* |
| *Elymus elymoides* | *Symphoricarpos albus* |
| *Ericameria nauseosa* | *Taraxacum officinale* |
| *Gilia aggregata* | *Xylorhiza glabriuscula* |

**Figure 4. Characteristic vegetation communities associated with loamy overflow 10-14 inch sites in the CCSM Phase I Site (LY_1014_02)**

**Table 5. Recommended seed pick list for loamy overflow ecological sites (BLM 2011).**

| **Name** | ***Scientific*** | **Variety** | **SYMBOL** |
|---|---|---|---|
| ***Grasses*** | | | |
| Western wheatgrass | *Pascopyrum smithii* | Rosana | PASM |
| Thickspike wheatgrass | *Elymus lanceolatus* | Critana | ELLA3 |
| Green needlegrass | *Nassella viridula* | Lordon | NAVI4 |
| Bottlebrush squirreltail | *Elymus elymoides* | Sand hollow | ELEL |
| Big bluegrass | *Poa fendleriana* | | POFE |
| Basin wildrye | *Leymus cinereus* | Trailhead, Magnar | LECI |
| ***Shrubs*** | | | |
| Wyoming big sagebrush | *Artemisia tridentata* ssp. *wyomingensis* | | ARTRW8 |
| Mountain big sagebrush | *Artemisia tridentata* ssp. *vaseyana* | | ARTRV |
| Antelope bitterbrush | *Purshia tridentata* | | PUTR2 |
| Snowberry | *Symphoricarpos* spp. | Maybell | SYOR2 |
| Woods' rose | *Rosa woodsii* | | ROWO |
| White sagebrush | *Artemisia ludoviciana* | | ARLU |
| Serviceberry | *Amelanchier alnifolia* | | AMAL2 |
| ***Forbs*** | | | |
| American vetch | *Vicia americana* | | VIAM |
| Lupine | *Lupinus sericeus* | | LUSE4 |
| Blanketflower | *Gaillardia aristata* | | GAAR |
| Western yarrow | *Achillea millefolium* var. *occidentalis* | | ACMI2 |
| Tapertip onion | *Allium acuminatum* | | ALAC4 |
| Longleaf phlox | *Phlox longifolia* | | PHLO2 |
| Sagebrush buttercup | *Ranunculus glaberrimus* | | RAGL |
| Nuttall's violet | *Viola nuttallii* | | VINU2 |
| Prairie golden banner | *Thermopsis rhombifolia* | | THRH |
| Bluebells | *Mertensia* spp. | | MERTE |
| Penstemon | *Penstemon* spp. | | PENST |
| Agoseris | *Agoseris glauca* | | AGGL |
| Arrowleaf balsamroot | *Balsamorhiza sagittata* | | BASA3 |
| Balsam groundsel | *Packera paupercula* | | PAPA20 |

**Exhibit IV**

**Aspen 15-19 inch Ecological Site Description**

**Adapted from NRCS (2011)**

Site-specific conditions for aspen 15-19 inch ecological sites were characterized using data collected at three monitoring locations (Table 1, Figure 1). Long-term monitoring reference sites for aspen 15-19 inch ecological sites have been established in coordination with the BLM Authorized Officer (AO). Any additional monitoring site that is used for ecological site characterization and is located 100 meters outside of the CCSM Phase I limits of disturbance (LODs) may be suitable as a long-term monitoring reference site for clayey 7-9 inch ecological sites and may be used for future reclamation success monitoring purposes.

**Table 1. Representative transects for aspen 15-19 inch ecological sites in the CCSM Phase I Site.**

| Transect Number | Record Date | Latitude | Longitude | Altitude | Transect Bearing |
|---|---|---|---|---|---|
| AS_1519_01 | 7/25/2014 | 41.52899 | -107.31170 | 8,077 | 345 |
| AS_1519_02 | 7/29/2014 | 41.48365 | -107.32586 | 8,130 | 100 |
| AS_1519_03 | 7/29/2014 | 41.44189 | -107.24368 | 7,740 | 165 |

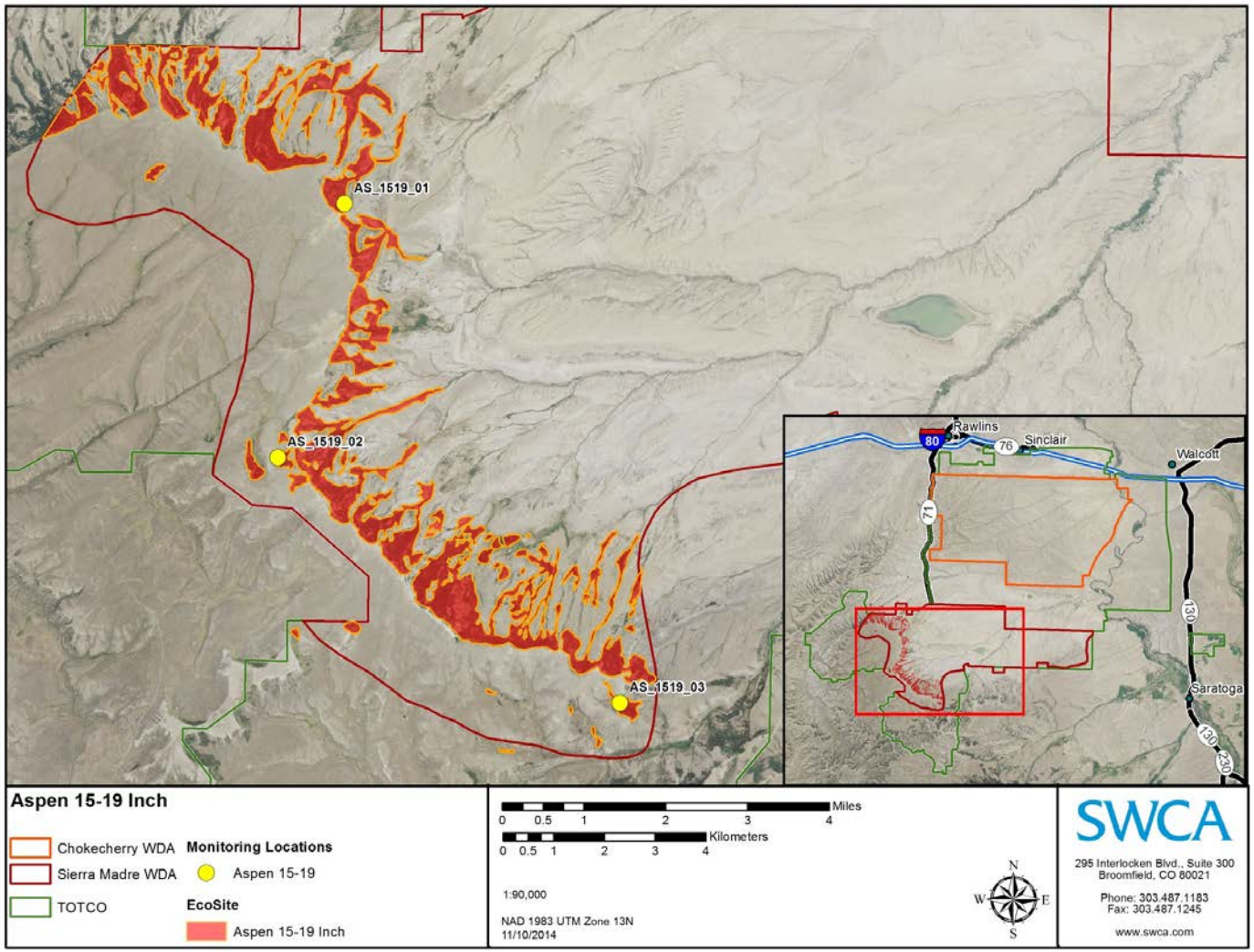


**Figure 1. Location of reference sites used to characterize aspen 15-19 inch ecological sites in the CCSM Phase I Site.**

**Site Characteristics**

## Climate

Mean annual precipitation at these sites is 18.1 inches, and is spread pretty evenly throughout the year. Wide fluctuations in precipitation may occur resulting in more dry years than normal years. Due to the high elevations and dry air, temperatures at aspen woodland 15-19 inch ecological sites range significantly between summer and winter and daily maximum and minimums. The average annual air temperature is 36.5°F (22.1°F Avg. Min. to 50.9°F Avg. Max.). Extreme minimum temperatures can occur during the winter months when cold air outbreaks and winter storms move rapidly from northwest to southeast. Winds speeds are lower than other areas of the state (NRCS 2011).

## Abiotic Landscape Features

Aspen 15-19 inch ecological sites in the CCSM Phase I Site typically occur on moderate to steep mountain slopes, with slopes ranging from 15-70%. Examples of landforms found in this ecological site include base and side slopes of hills. Elevation is variable and ranges between 7,200 feet and 8,400 feet in the CCSM Phase I Site.

## Soil Characteristics

Aspen 15-19 inch ecological sites within the CCSM Phase I Site are characterized by moderately deep to very deep, well drained soils with slow to moderately slow permeability.

Topsoil depths average 12 ± 1.38 inches. Lower soil horizon depths generally exceed 23 inches (58cm). Surface soils range from sandy loam to loam textures while lower soil horizons are characterized by silty clay loam textures. Infiltration and water movement is good and root penetration is deep.

Aspen 15-19 inch ecological sites in the CCSM Phase I Site are characterized by soils with moderate to rapid infiltration and low to moderate runoff potential (NRCS 2011). Infiltration rates are highest, and runoff rates lowest where ground cover exceeds 75%. Rills and gullies are typically not present and surface water flow patterns are often indistinguishable (NRCS 2011). Chemical and physical crusts are rare to non-existent at these sites (NRCS 2011).

Soils are neutral to slightly alkaline with pH values range from 6.90 to 7.65 and non-saline soils with electrical conductivities ranging between 0.01 to 0.16 dS/m. Soils are non-effervescent indicating presence of weakly covalent carbonates.

Figures 2 and 3 illustrate the soil surface and soil profile characteristics of a typical Aspen Woodland 15-19 inch ecological site in the CCSM Phase I Site.

**Table 2. Soil characteristics typical of aspen 15-19 inch ecological sites.**

| Soil Characteristics | Description |
|---|---|
| **Parent Material (Kind)** | Residuum, colluvium |
| **Parent Material (Origin)** | Sedimentary, igneous |
| **Topsoil Depth[1]** | 7.6 ± 0.70 inches |
| **Topsoil Texture** | Fine sandy loam to loam |
| **Subsoil Depth[2]** | 12.1 ± 0.70 inches |
| **Subsoil Texture** | Sandy loam to sandy clay loam |
| **Topsoil Fragments** | None |
| **Subsoil Fragments** | 0%–15% volume, mixed rock, medium to coarse gravel, subrounded to rounded |
| **Electrical Conductivity (Topsoil)** | 0.03-0.16 dS/m |
| **Salinity Class (Topsoil)** | Non-saline |
| **Electrical Conductivity (Subsoil)** | 0.01-0.05 dS/m |
| **Salinity Class (Subsoil)** | Non-saline |
| **Soil Reaction (Topsoil)** | 6.99-7.40 |
| **pH Class (Topsoil)** | Neutral to slightly alkaline |
| **Soil Reaction (Subsoil)** | 6.90-7.65 |
| **pH Class (Subsoil)** | Neutral to slightly alkaline |
| **Carbonate Equivalent (Topsoil)** | Non-effervescent |
| **Carbonate Equivalent (Subsoil)** | Non-effervescent |

**Figure 2. Representative soil surface and ground cover for aspen 15-19 inch ecological sites in the CCSM Phase I Site (AS_1519_02).**

**Figure 3. Representative soil profile for aspen 15-19 inch sites in the CCSM Phase I Site (AS_1519_01).**

## Vegetation Characteristics

Plant communities associated with aspen 15-19 inch ecological sites in the CCSM Phase I Site are characterized by sparsely vegetated surfaces with 7%–12% basal cover (Table 3 and 4). The remaining soil surface is characterized by litter cover (84%–91%). Figure 4 illustrates representative vegetation communities associated with aspen 15-19 inch sites in the CCSM Phase I Site.

When aspen 15-19 inch are subjected to severe grazing pressure, species such as mountain big sagebrush (*Artemisia tridentata*), common snowberry (*Symphoricarpo*s *albus*) and wood's rose (*Rosa woodsii*) will increase. Cool season grasses such as basin wildrye (*Leymus cinereus*), Sandberg bluegrass (*Poa secunda)* and slender wheatgrass (*Elymus trachycaulus*) will decline. Moderate and continuous grazing will convert the site to a mountain big sagebrush/Idaho fescue state.

The BLM pick list in Table 5 (BLM 2011) and the species composition and cover (Tables 3 and 4) observed for aspen 15-19 inch ecological sites will be used to guide the selection of appropriate seed mixes and application rates for revegetation. Final seed mixes will be determined based on seed availability at the time of revegetation efforts and in coordination with the BLM AO.

**Table 3. Vegetation characteristics typical of aspen 15-19 inch ecological sites.**

| | | |
|---|---|---|
| Basal Vegetative Cover (LPI*) | 7% – 12% | |
| Biological Soil Crust and Lichen (LPI*) | 0% | |
| Litter Cover (LPI*) | 84%–91% | |
| Surface Fragment/Rock Cover (LPI*) | 0% | |
| Unprotected Soil(LPI*) | 0% – 5% | |
| Representative Species and Top-Canopy Cover* | *Populus tremuloides* | 76.7% average |
| | *Ligusticum porteri* | 5.5% average |
| | *Achnatherum nelsonii* | 5.0% average |
| | *Bromus marginatus* | 5.0% average |
| | *Symphoricarpos albus* | 4.0% average |

* Line point intercept

**Table 4. Species commonly associated with aspen 15-19 inch ecological sites.**

| | |
|---|---|
| *Acer glabrum* | *Hordeum brachyantherum* |
| *Achillea millefolium* | *Juniperus communis* |
| *Agrostis gigantea* | *Ligusticum porteri* |
| *Agrostis humilis* | *Lupinus spp.* |
| *Agrostis sp.* | *Machaeranthera sp.* |
| *Allium geyeri var. tenerum* | *Mahonia repens* |
| *Amelanchier sp.* | *Maianthemum sp.* |
| *Antennaria sp.* | *Osmorhiza depauperata* |
| *Aquilegia coerulea* | *Pascopyrum smithii* |
| *Arenaria congesta* | *Phleum pratense* |
| *Arnica cordifolia* | *Phlox multiflora* |
| *Artemisia cana* | *Poa pratensis* |
| *Artemisia tridentata ssp. vaseyana* | *Poa sp.* |
| *Betula occidentalis* | *Populus tremuloides* |
| *Bromus marginatus* | *Potentilla pensylvanica* |
| *Carex athrostachya* | *Prosartes trachycarpa* |
| *Carex geyeri* | *Pyrola sp.* |
| *Carex illota* | *Ribes sp.* |
| *Carex nebrascensis* | *Rorippa sp.* |
| *Cirsium centaureae* | *Rosa woodsii* |
| *Cirsium eatonii* | *Rubus sp.* |
| *Cornus sericea* | *Salix drummondiana* |
| *Elymus glaucus* | *Silene sp.* |
| *Eriogonum flavum* | *Symphoricarpos albus* |
| *Fragaria vesca* | *Taraxacum officinale* |
| *Frasera speciosa* | *Thalictrum sp.* |
| *Gallium boreale* | *Viola sp.* |
| *Geranium sp.* | |

**Figure 4. Characteristic vegetation communities associated with aspen woodland 15-19 inch sites in the CCSM Phase I Site (AS_1519_01)**

**Table 5. Recommended seed pick list for mountain shrub sites (BLM 2011).**

| Name | *Scientific* | Variety | SYMBOL |
|---|---|---|---|
| ***Grasses*** | | | |
| Idaho fescue | *Festuca idahoensis* | | FEID |
| Columbia needlegrass | *Achnatherum nelsonii* | | ACNE9 |
| Mountain brome | *Bromus marginatus* | Garnet | BRMA |
| Blue wildrye | *Elymus glabriflorus* | | ELGL |
| Oniongrass | *Melica bulbosa* | | MEBU |
| Elk sedge | *Carex geyeri* | | CAGE2 |
| ***Shrubs*** | | | |
| Serviceberry | *Amelanchier alnifolia* | | AMAL2 |
| Chokecherry | *Prunus virginiana* | | PRVI |
| Snowberry | *Symphoricarpos oreophilus* | Maybell | SYOR2 |
| | *S. albus* | | SYAL |
| Russet buffaloberry | *Shepherdia canadensis* | | SHCA |
| Scouler willow | *Salix scouleriana* | | SASC |
| Woods' rose | *Rosa woodsii* | | ROWO |
| Twinberry honeysuckle | *Lonicera involucrata* | | LOIN5 |
| ***Forbs*** | | | |
| Arrowleaf balsamroot | *Balsamorhiza sagittata* | | BASA |
| American vetch | *Vicia americana* | | VIAM |
| Lupine | *Lupinus sericeus* | | LUSE4 |
| Western yarrow | *Achillea millefolium* var. *occidentalis* | Yakima | ACMI2 |
| Sulfur-flower buckwheat | *Eriogonum umbellatum* | | ERUM |
| Bluebells | *Mertensia* spp. | | MERTE |
| Nuttall's violet | *Viola nuttallii* | | VINU2 |
| Sagebrush buttercup | *Ranunculus glaberrimus* | | RAGL |
| Geranium | *Geranium* spp. | | GERAN |
| Porter's licorice-root | *Ligusticum porteri* | | LIPO |
| Elkweed | *Frasera speciosa* | | FRSP |
| Bedstraw | *Galium boreale* | | GABO2 |
| Columbine | *Aquilegia* spp. | | AQUIL |
| Sweetroot | *Osmorhiza depauperata* | | OSDE |
| Heartleaf arnica | *Arnica cordifolia* | | ARCO9 |

**Exhibit VI**

**Wet Fresh Meadow 15-19 inch Ecological Site Description**

**Adapted from NRCS (2011)**

Site-specific conditions for wet fresh meadow 15-19 inch ecological sites in the CCSM Phase I Site were characterized using data collected at three monitoring locations (Table 1, Figure 1). Long-term monitoring reference sites for wet fresh meadow 15-19 inch ecological sites have been established in coordination with the BLM Authorized Officer (AO). Any additional monitoring site that is used for ecological site characterization that is located 100 meters outside of the CCSM Phase I limits of disturbance (LODs) may be suitable as a long-term monitoring reference site for wet fresh meadow 15-19 inch ecological site and may be used for future reclamation success monitoring purposes.

**Table 1. Representative transects for wet fresh meadow 15-19 inch ecological sites in the CCSM Phase I Site.**

| Transect Number | Record Date | Latitude | Longitude | Altitude | Transect Bearing |
|---|---|---|---|---|---|
| WFM_1519_01 | 7/26/2014 | 41.52307 | -107.35041 | 8,169 | 150 |
| WFM_1519_02 | 8/6/2014 | 41.49452 | -107.32750 | 8,018 | 290 |
| WFM_1519_03 | 8/7/2014 | 41.49002 | -107.32986 | 8,031 | 210 |

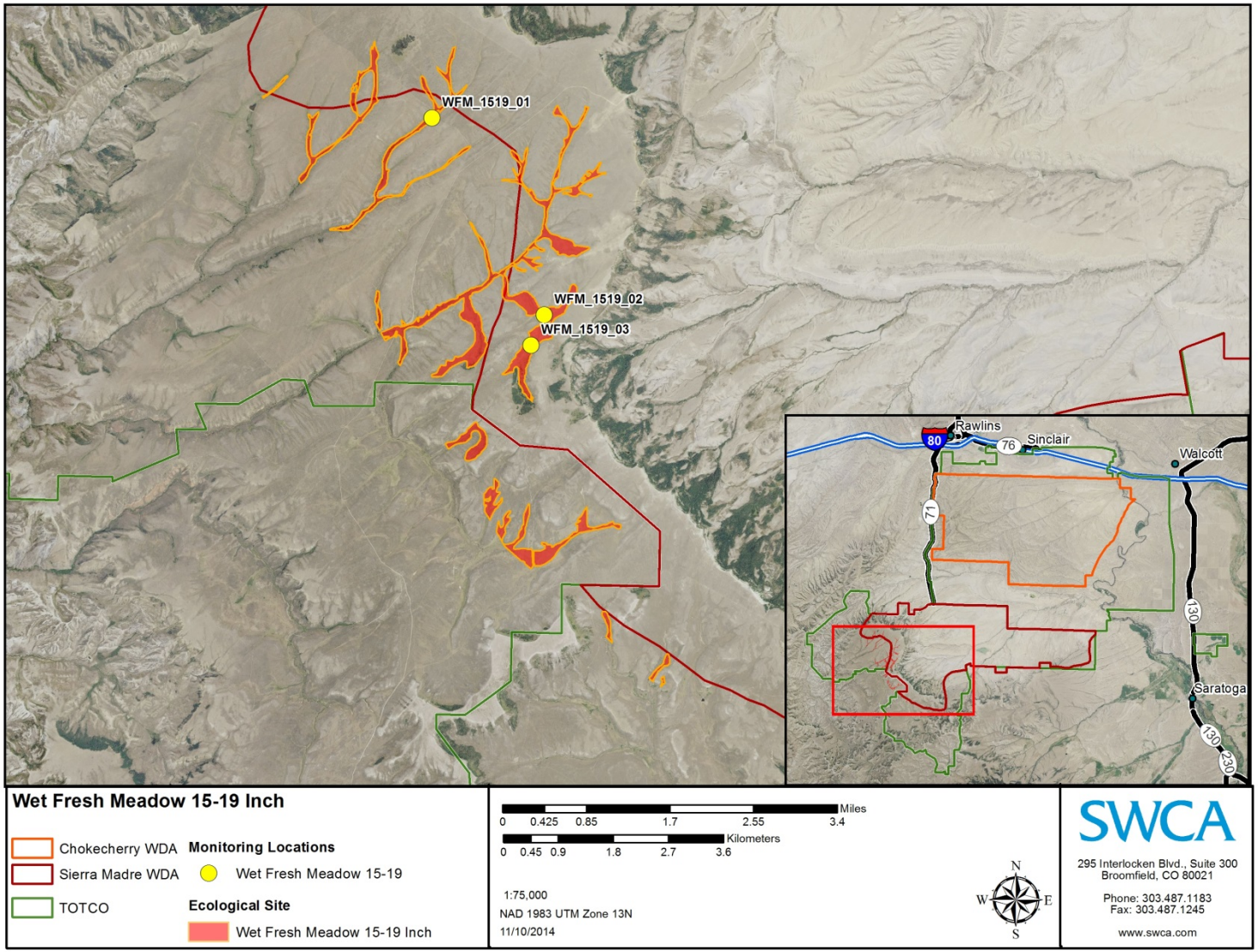


**Figure 1. Locations of reference sites used to characterize wet fresh meadow 15-19 inch ecological sites in the CCSM Phase I Site.**

**Site Characteristics**

*Climate*

The mean annual precipitation at these sites is 16.0 inches, with peaks observed in August and the lowest totals recorded in the winter months. Wide fluctuations do occur and result in more dry years than normal years (NRCS 2011). Due to the high elevations and dry air, temperatures at wet fresh meadow 15-19 inch ecological sites range significantly between summer and winter and daily maximum and minimums. The average annual air temperature is 44.7°F (ranging from 32.1°F Avg. Min. to 57.2°F Avg. Max). Extreme minimum temperatures can occur during the winter months when cold air outbreaks and winter storms move rapidly from northwest to southeast.

*Abiotic Landscape Features*

Wet fresh meadow 15-19 inch ecological sites in the CCSM Phase I Site occur on benches, cuestas, toeslopes, and fans of foothills in landslide areas and in valleys. Slopes range from nearly level to 50%. Elevation is variable and ranges between 7,300 feet and 8,400 feet in the CCSM Phase I Site.

*Soil Characteristics*

Wet fresh meadow 15-19 inch ecological sites within the CCSM Phase I Site are deep to very deep, and well drained. Topsoil textures are characterized by very loams to clay loams. Subsoils are similar in texture and range from sandy loams to clay loams.

Topsoil depth averages 6.6 ± 0.60 inches. Lower soil horizon depths often exceed 13.1 inches. Wet fresh meadow 15-19 inch ecological sites in the CCSM Phase I Site are characterized by soils with low runoff potential and low erosion hazard.

Soils are moderately to strongly alkaline with a pH of 7.60 to 8.60 and non-saline to very slightly saline with electrical conductivities ranging between 0.03 and 0.21 dS/m. Where soil pH ranges exceed 8.4 soils may have limited reclamation potential may need to be evaluated for potential soil treatment. Soils are non-effervescent to slightly effervescent indicating presence of weakly covalent carbonates.

Figures 2 and 3 illustrate the soil surface and soil profile characteristics of a typical wet fresh meadow 15-19 inch site in the CCSM Phase I Site.

**Table 2. Soil characteristics typical of wet fresh meadow 15-19 inch ecological sites.**

| Soil Characteristics | Description |
|---|---|
| **Parent Material (Kind)** | Alluvium, residuum |
| **Parent Material (Origin)** | Sedimentary, igneous |
| **Topsoil Depth[1]** | 6.6 ± 0.60 inches |
| **Topsoil Texture** | Loam |
| **Subsoil Depth[2]** | 13.1 ± 0.60 inches |
| **Subsoil Texture** | Sandy clay loam to clay loam |
| **Topsoil Fragments** | None |
| **Subsoil Fragments** | None |
| **Electrical Conductivity (Topsoil)** | 0.03-0.21 dS/m |
| **Salinity Class (Topsoil)** | Non-saline |
| **Electrical Conductivity (Subsoil)** | 0.08-0.10 dS/m |
| **Salinity Class (Subsoil)** | Non-saline |
| **Soil Reaction (Topsoil)** | 8.04-8.40 |
| **pH Class (Topsoil)** | Moderately alkaline |
| **Soil Reaction (Subsoil)** | 7.60-8.60 |
| **pH Class (Subsoil)** | Slightly to strongly alkaline |
| **Carbonate Equivalent (Topsoil)** | Non-effervescent to slightly effervescent |
| **Carbonate Equivalent (Subsoil)** | Non-effervescent to very slightly effervescent |

[1]Topsoil depth determined by depth of A Horizon.
[2]Subsoil depth determined by B and C horizons to a maximum of 20 inches depth including topsoil.

**Figure 2. Representative soil surface and ground cover for wet fresh meadow 15-19 inch sites in the CCSM Phase I Site (WFM_1519_02).**

**Figure 3. Representative soil profile for wet fresh meadow 15-19 inch sites in the CCSM Phase I Site. (WFM_1519_02).**

*Vegetation Characteristics*

Plant communities associated with wet fresh meadow 15-19 inch ecological sites in the CCSM Phase I Site are characterized by highly vegetated surfaces with 36%–46% basal cover (Tables 3 and 4). The remaining soil surface is characterized by litter cover (50%–63%), with very little unprotected soils (0%–3%). Figure 4 illustrates representative vegetation communities associated with wet fresh meadow 15-19 inch ecological sites in the CCSM Phase I Site.

Wet fresh meadow 15-19 inch ecological sites subjected to frequent and palatable sedges, grasses, and forbs decrease, while rushes, arrowgrass, foxtail barley, and unpalatable forbs increase.

The BLM pick list in Table 5 (BLM 2011) and the species composition and cover (Tables 3 and 4) observed for wet fresh meadow 15-19 inch ecological sites will be used to guide the selection of appropriate seed mixes and application rates for revegetation. Final seed mixes will be determined based on seed availability at the time of revegetation efforts and in coordination with the BLM AO.

**Table 3. Vegetation characteristics typical of wet fresh meadow 15-19 inch ecological sites.**

| | | |
|---|---|---|
| Basal Vegetative Cover (LPI*) | 36%–46% | |
| Biological Soil Crust and Lichen (LPI*) | 0%–1% | |
| Litter Cover (LPI*) | 50%–63% | |
| Surface Fragment/Rock Cover (LPI*) | 0% | |
| Unprotected Soil(LPI*) | 0% – 3% | |
| Representative Species and Top-Canopy Cover* | *Phleum pratense* | 37.3% average |
| | *Juncus balticus* | 16.7% average |
| | *Agrostis gigantea* | 12.3% average |
| | *Poa pratensis* | 11.7% average |
| | *Carex illota* | 9.0% average |
| | *Dasiphora fruticosa* | 5.0% average |

* Line point intercept

**Table 4. Species commonly associated with wet fresh meadow 15-19 inch ecological sites.**

| | |
|---|---|
| *Achillea millefolium* | *Hordeum brachyantherum* |
| *Agrostis gigantea* | *Iris missouriensis* |
| *Antennaria microphylla* | *Juncus balticus* |
| *Argentina anserina* | *Juncus nevadensis* |
| *Artemisia cana* | *Mentha arvensis* |
| *Astragalus agrestis* | *Nassella viridula* |
| *Bromus marginatus* | *Nothocalais sp.* |
| *Carex athrostachya* | *Phleum pratense* |
| *Carex illota* | *Plantago eriopoda* |
| *Carex nebrascensis* | *Poa pratensis* |
| *Carex praegracilis* | *Populus tremuloides* |
| *Carex utriculata* | *Potentilla bipinnatifida* |
| *Cirsium foliosum* | *Potentilla gracilis* |
| *Cirsium scariosum* | *Potentilla pensylvanica* |
| *Danthonia sp.* | *Potentilla sp.* |
| *Dasiphora fruticosa* | *Puccinellia nuttalliana* |
| *Dodecatheon pulchellum* | *Ranunculus repens* |
| *Eleocharis palustris* | *Ranunculus sp.* |
| *Elymus repens* | *Salix lutea* |
| *Epilobium ciliatum* | *Silene sp.* |
| *Equisetum laevigatum* | *Sisyrinchium sp.* |
| *Erigeron glabellus* | *Symphyotrichum eatonii* |
| *Fragaria vesca* | *Symphyotrichum lanceolatum* |
| *Gallium boreale* | *Taraxacum officinale* |
| *Gentiana affinis* | *Trifolium repens* |
| *Geum aleppicum* | *Trisetum wolfii* |
| *Geum macrophyllum* | *Viola sp.* |
| *Helianthella quinquenervis* | *Zigadenus elegans* |

**Figure 4. Characteristic vegetation communities associated with wet fresh meadow 15-19 inch sites in the CCSM Phase I Site (LY_1519_01)**

**Table 5. Recommended seed pick list for wet fresh meadow ecological sites (BLM 2011).**

| **Name** | ***Scientific*** | **Variety** | **SYMBOL** |
|---|---|---|---|
| ***Grasses*** | | | |
| Tufted hairgrass | *Deschampsia cespitosa* | | DECE |
| Nebraska sedge | *Carex nebrascensis* | | CANE2 |
| Flat stemmed rush | *Juncus ensifolius* | | JUEN |
| Meadow barley | *Hordeum brachyantherum* | | HOBR2 |
| Redtop | *Agrostis gigantea* | | AGGI2 |
| Northern reedgrass | *Calamagrostis stricta* | | CASTI3 |
| ***Shrubs*** | | | |
| Silver sagebrush | *Artemisia cana* | | ARCA13 |
| Shrubby cinquefoil | *Dasiphora fruticosa* | | DAFR6 |
| Woods' rose | *Rosa woodsii* | | ROWO |
| Golden currant | *Ribes aureum* | | RIAU |
| ***Forbs*** | | | |
| Slender cinquefoil | *Potentilla gracilis* | | POGR9 |
| Blue-eyed grass | *Sisyrinchium*. spp. | | SISYR |
| American licorice | *Glycyrrhiza lepidota* | | GLLE3 |
| Helianthella | *Helianthella quinquenervis* | | HEQU2 |
| White panicle aster | *Symphyotrichum lanceolatum* | | SYLA6 |

**Exhibit VII**

**Wetland/Riparian Ecological Site Description**

**Adapted from NRCS (2011)**

Site-specific conditions for wetland and riparian 10-14 inch ecological sites in the CCSM Phase I Site were characterized using data collected at three monitoring locations (Table 1, Figure 1). Long-term monitoring reference sites for wetland and riparian 10-14 inch ecological sites will be determined in coordination with the BLM Authorized Officer (AO). Any monitoring site that was used for ecological site characterization that is located 100 meters outside of the CCSM Phase I limits of disturbance (LODs) may be suitable as a long-term monitoring reference site for wetland and riparian 10-14 inch ecological site and may be used for future reclamation success monitoring purposes.

**Table 1. Representative transects for wetland and riparian 10-14 inch ecological sites in the CCSM Phase I Site.**

| Transect Number | Record Date | Latitude | Longitude | Altitude | Transect Bearing |
|---|---|---|---|---|---|
| WET_1014_01 | 7/23/2014 | 41.50754 | -107.28945 | 7,297 | 90 |
| WET_1014_02 | 7/28/2014 | 41.49008 | -107.27295 | 7,218 | 80 |
| WET_1014_03 | 7/28/2014 | 41.48566 | -107.27525 | 7,260 | 60 |

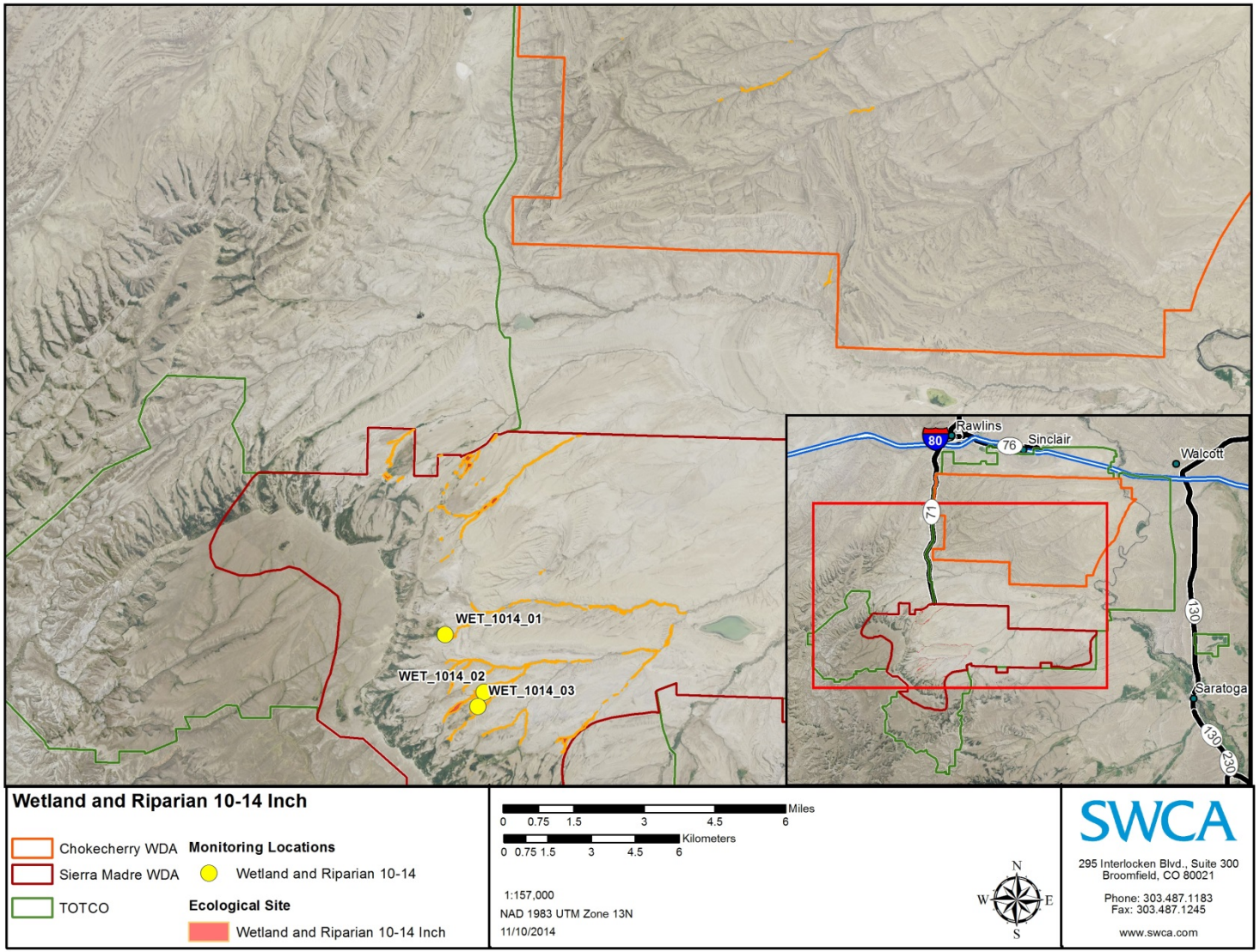


**Figure 1. Locations of reference sites used to characterize wetland and riparian 10-14 inch ecological sites in the CCSM Phase I Site.**

**Site Characteristics**

## Climate

Mean annual precipitation is 10.5 inches (ranges from 10-14 inches per year), with peaks observed in May and the lowest totals recorded in the winter months. Average snow fall often exceeds 20 inches annually. Wide fluctuations do occur and result in more dry years than normal years (NRCS 2011). Due to the high elevations and dry air, temperatures at wetland and riparian 10-14 inch ecological sites range significantly between summer and winter and daily maximum and minimums. The average annual air temperature is 46.2 °F (30.1 °F Avg. Min. to 62.3 °F Avg. Max.). Extreme minimum temperatures can occur during the winter months when cold air outbreaks and winter storms move rapidly from northwest to southeast.

## Abiotic Landscape Features

Wetland and riparian 10-14 inch ecological sites in the CCSM Phase I Site occur in lowland positions on level to gently sloping bottomlands, near springs, seeps, and sloughs. Slopes vary, but are typically less than 10%. Examples of landforms found in this ecological site include drainageways, oxbows, and stream terraces. Elevation is variable and ranges between 7,000 feet and 7,500 feet in the CCSM Phase I Site.

## Soil Characteristics

Wetland and riparian 10-14 inch ecological sites within the CCSM Phase I Site are moderately deep organic and deep loamy or silty soils with a seasonal high water table at or very near the surface. They are on nearly level to slightly depressed areas with poor surface drainage. Textures range from loams to clays (Table 2).

Topsoil depth averages 7.7 ± 0.39 inches. Lower soil horizon depths generally exceed 11.9 inches. Topsoil soil textures range from loam to silty clay loam. Subsoil textures are characterized by silty clays to clays. Subsoils are usually mottled or gleyed.

Soils are moderately to very strongly alkaline with pH values between 7.54 and 9.01 and non-saline to slightly electrical conductivities ranging between 0.23 and 1.5 dS/m. Where soil pH ranges exceed 8.40, soils may have limited reclamation potential (LRP) and may need to be evaluated for potential soil treatment (see Reclamation Procedures and Best Management Practices). Soils are slightly effervescent, indicating presence of weakly covalent carbonates.

Figures 2 and 3 illustrate the soil surface and soil profile characteristics of a typical wetland and riparian 10-14 inch site in the CCSM Phase I Site.

**Table 2. Soil characteristics typical of wetland and riparian 10-14 inch ecological sites.**

| Soil Characteristics | Description |
|---|---|
| **Parent Material (Kind)** | Alluvium, residuum |
| **Parent Material (Origin)** | Sedimentary |
| **Topsoil Depth[1]** | 7.7 ± 0.39 inches |
| **Topsoil Texture** | Loam to silty clay loam |
| **Subsoil Depth[2]** | 11.9 ± 0.39 inches |
| **Subsoil Texture** | Silty clay to clay |
| **Topsoil Fragments** | None |
| **Subsoil Fragments** | 0-15% volume, mixed rock, medium gravel, rounded |
| **Electrical Conductivity (Topsoil)** | 0.23-0.58 dS/m |
| **Salinity Class (Topsoil)** | Non-saline to very slightly saline |
| **Electrical Conductivity (Subsoil)** | 0.25-1.5 dS/m |
| **Salinity Class (Subsoil)** | Non-saline to slightly saline |
| **Soil Reaction (Topsoil)** | 7.93-9.01 |
| **pH Class (Topsoil)** | Moderately to very strongly alkaline |
| **Soil Reaction (Subsoil)** | 7.54-8.75 |
| **pH Class (Subsoil)** | Slightly to strongly alkaline |
| **Carbonate Equivalent (Topsoil)** | Slightly effervescent |
| **Carbonate Equivalent (Subsoil)** | Slightly effervescent |

[1]Topsoil depth determined by depth of A Horizon.
[2]Subsoil depth determined by B and C horizons to a maximum of 20 inches depth including topsoil.

**Figure 2. Representative soil surface and ground cover for wetland and riparian 10-14 inch sites in the CCSM Phase I Site (WET_1014_02).**

**Figure 3. Representative soil profile for wetland and riparian 10-14 inch sites in the CCSM Phase I Site (WET_1014_02).**

## Vegetation Characteristics

Plant communities associated with wetland and riparian 10-14 inch ecological sites in the CCSM Phase I Site are characterized by vegetated surfaces with 30%–36% basal cover (Tables 3 and 4). The remaining soil surface is characterized primarily by litter (48–67%) and unprotected soils (0–16%). Figure 4 illustrates representative vegetation communities associated with wetland and riparian 10-14 inch ecological sites in the CCSM Phase I Site.

As this site deteriorates species such as Baltic rush (*Juncus balticus*), low growing sedges, and forbs replace more desirable species (NRCS 2011). Production and density of native bunchgrasses are greatly reduced. Willows (*Salix* spp.) may become decadent as a result of heavy browsing and the site becomes vulnerable to noxious weed invasion. Heavy inundation will convert this community to a bulrush (*Schoenoplectus* spp.) plant community and continuous grazing and hoof compaction will convert the plant community to Baltic rush and annual forbs (NRCS 2011).

Wetland and riparian 10-14 inch ecological sites will be reclaimed and/or mitigated following standards and guidance outlined in the 404 permit process for the CCSM Phase I Site under the federal Clean Water Act (CWA).

**Table 3. Vegetation characteristics typical of wetland and riparian 10-14 inch ecological sites.**

| | | |
|---|---|---|
| Basal Vegetative Cover (LPI*) | 30%–36% | |
| Biological Soil Crust and Lichen (LPI*) | 0%–2% | |
| Litter Cover (LPI*) | 48%–67% | |
| Surface Fragment/Rock Cover (LPI*) | 0% | |
| Unprotected Soil(LPI*) | 0% – 16% | |
| Representative Species and Top-Canopy Cover* | *Salix exigua* | 54.0% average |
| | *Juncus balticus* | 48.3% average |
| | *Carex praegracilis* | 11.5% average |
| | *Carex nebrascensis* | 11.5% average |
| | *Agrostis* sp. | 5.0% average |
| | *Rosa woodsii* | 2.0% average |

* Line point intercept

**Table 4. Species commonly associated with wetland and riparian 10-14 inch ecological sites.**

| | |
|---|---|
| *Achillea millefolium* | *Melilotus officinalis* |
| *Agrostis gigantea* | *Mentha arvensis* |
| *Agrostis sp.* | *Muhlenbergia asperifolia* |
| *Allium geyeri var. tenerum* | *Pedicularis crenulata* |
| *Beckmannia syzigachne* | *Phleum pratense* |
| *Bromus inermis* | *Plantago eriopoda* |
| *Cardaria draba* | *Poa pratensis* |
| *Carex nebrascensis* | *Polygonum sp.* |
| *Carex praegracilis* | *Potentilla pensylvanica* |
| *Cicuta sp.* | *Potentilla sp.* |
| *Cirsium arvense* | *Rosa woodsii* |
| *Dodecatheon pulchellum* | *Rumex salicifolius* |
| *Eleocharis palustris* | *Rumex sp.* |
| *Elymus repens* | *Salix exigua* |
| *Erigeron sp.* | *Salix lutea* |
| *Geum sp.* | *Senecio crassulus* |
| *Hordeum brachyantherum* | *Senecio hydrophilus* |
| *Hordeum jubatum* | *Sisyrinchium sp.* |
| *Iris missouriensis* | *Symphoricarpos albus* |
| *Juncus balticus* | *Symphyotrichum eatonii* |
| *Juncus interior* | *Taraxacum officinale* |
| *Juncus longistylis* | *Trifolium pratense* |
| *Machaeranthera sp.* | *Triglochin maritima* |
| *Maianthemum sp.* | |

**Figure 4. Characteristic vegetation communities associated with wetland and riparian 10-14 inch sites in the CCSM Phase I Site (WET_1014_02).**

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# ATTACHMENT D

## Shallow Ecological Site Class Reclamation Implementation Plan

## and

## Shallow Ecological Site Descriptions

## for

## Phase I of the Chokecherry and Sierra Madre Wind Energy Project

## Introduction

This Shallow Ecological Site Class Reclamation Implementation Plan describes the common and ecological site-specific characteristics, reclamation practices, and BMPs that will be applied within the CCSM Project Site. Ecological sites in the CCSM Project Site were established cooperatively with the BLM and are a result of robust soil and vegetation sampling, landform analysis, and precipitation zone evaluation. The ecological sites are consistent with the Cool Central Desertic Basins and Plateaus (Major Land Resource Area [MLRA] – 34A) and Southern Rocky Mountain Foothills (MLRA – 49) MLRAs (Natural Resources Conservation Service [NRCS] 2006) and are primarily located in the Wyoming Basin Province of the Rocky Mountain System (NRCS 2011).

Based on common reclamation characteristics, individual ecological sites were grouped into similar ecological site classes (shallow, clay, loam, saline, and sand). Grouping similar ecological sites into a common ecological site class will increase efficiency and effectiveness of reclamation efforts as many of these common sites will have identical or very similar measures for soil handling, site preparation, and revegetation.

The following reclamation implementation plan describes the reclamation procedures and BMPs that will be applied to the ecological sites within the Shallow ecological site class. The Shallow ecological site class includes the following ecological sites:

- Very Shallow 7-9 Inch (see Exhibit I)
- Shallow Loamy 7-9 Inch (see Exhibit II)
- Shallow Loamy 10-14 Inch (see Exhibit III)
- Shallow Loamy 15-19 Inch (see Exhibit IV)
- Shallow Sandy 10-14 Inch (see Exhibit V)
- Mountain Windswept Ridge 10-14 Inch (see Exhibit VI)

## Reclamation Procedures and Best Management Practices

Site-specific reclamation procedures and BMPs have been developed for this Shallow Ecological Site Class Reclamation Implementation Plan. Many of the reclamation procedures and BMPs will be implemented across all shallow ecological sites in the CCSM Project while other measures will be specific to an individual ecological site or smaller group of ecological sites within the Shallow ecological site class.

Reclamation procedures and BMPs account for abiotic landscape features, soil characteristics, and vegetation characteristics and were designed to mitigate impacts to the abiotic and biotic factors characteristic of each ecological site and increase reclamation success. These procedures were developed in accordance with the CCSM Project Master Reclamation Plan (BLM 2012a), BLM Wyoming Reclamation Policy (2012b), management directives presented in the Rawlins Field Office (RFO) Resource Management Plan (RMP) (BLM 2008), RFO Reclamation Guidance (BLM 2011), Wyoming Department of Environmental Quality (WDEQ) Land Quality Division reclamation guidelines (WDEQ 2007), Wyoming Reclamation and Restoration Center (WRRC) Handbook of Western Reclamation Techniques (WRRC 2006), State of Wyoming's reclamation guidance for wind development, and in coordination with BLM staff. This Shallow Ecological Site Class Reclamation Implementation Plan is intended to be adaptive and to take

into account changing conditions and technologies. PCW, with concurrence from the BLM AO, may update, modify, or change the procedures contained in this plan if warranted due to site conditions or other factors.

In accordance with the guidance described above, reclamation practices and BMPS have been developed to address abiotic landscape features, soil handling, site preparation, and vegetation handling and revegetation. The following sections describe the practices specific to shallow ecological sites in Phase I of the CCSM Project.

**Soil Handling and Site Preparation**

Soil associated with each ecological site will be managed in accordance with the BLM Wyoming Reclamation Policy (2012b) and as detailed in the CCSM Project Master Reclamation Plan (2012a) and the site-specific reclamation plan for Phase I of the CCSM Project. Provisions are included below for segregating and marking stockpiles, as well as requirements to protect stockpiled material from erosion, contamination and degradation. Site-specific soil handling and site preparation measures for shallow ecological sites are listed below:

*Soil handling practices and BMPs for* ***all shallow ecological sites***[1]*. These measures would be applied to all shallow ecological sites.*

- Ridge (roughen) topsoil stockpiles to maximize surface area.
- Apply mulch and/or soil tackifiers to assist in mitigating stockpile wind erosion and contribute organic materials.
- When practicable, use growth and till cycles to maintain biological activity, reduce compaction, and incorporate native organic matter and seed sources, in soil stockpiles that are stored for more than two years.
- Seed long-term stockpiles with appropriate vegetation to maintain biological activity and prevent wind erosion.
- Trap moisture during winter months through the use of snow fences, if appropriate.
- Include native vegetation into salvaged topsoil to include organic matter and maintain native seedbank.
- When applicable, locate stockpiles within disturbed areas to reduce additional surface disturbance to native topsoil.

[1] Clayey Ecological Sites include Clayey 7-9 Inch, Clayey 10-14 Inch, Clayey Overflow 7-9 Inch, Deep Shale 7-9 Inch, Deep Shale 10-14 Inch, and Shale 10-14 Inch

*Site preparation practices and BMPs for **all shallow ecological sites**. These measures would be applied to all shallow ecological sites.*

- Supplement topsoil from suitable ecological sites (i.e., similar physical and chemical attirbutes) to provide a minimum of 6 inches of topsoil dressing, if necessary and if supplies are available, with approval of BLM AO.
- Till across slope or perpendicular to the prevailing wind to reduce erosion.
- If necessary, add soil amendments to ameliorate physical, biological, and chemical attributes that may limit reclamation potential, to meet fair to good topsoil suitability criteria (BLM 2011), as approved by the BLM AO.
- Inspect the soil surface for ponding or gullying.
- Suspend construction activities when soils are wet and rutting exceeds 4 inches, as appropriate.

*Additional soil handling and site preparation practices and BMPs for the **Very Shallow 7-9 inch** ecological site. These measures would be applied in addition to those described above for all shallow ecological sites.*

- No site-specific BMPs for soil handling have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

*Additional soil handling and site preparation practices and BMPs for the **Shallow Loamy 7-9 inch** ecological site. These measures would be applied in addition to those described above for all shallow ecological sites.*

- No site-specific BMPs for soil handling have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

*Additional soil handling and site preparation practices and BMPs for the **Shallow Loamy 10-14 inch** ecological site. These measures would be applied in addition to those described above for all shallow ecological sites.*

- No site-specific BMPs for soil handling have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

*Additional soil handling and site preparation practices and BMPs for the **Shallow Loamy 15-19 inch** ecological site. These measures would be applied in addition to those described above for all shallow ecological sites.*

- No site-specific BMPs for soil handling have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

*Additional soil handling and site preparation practices and BMPs for the **Shallow Sandy 10-14 inch** ecological site. These measures would be applied in addition to those described above for all shallow ecological sites.*

- No site-specific BMPs for soil handling have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

*Additional soil handling and site preparation practices and BMPs for the **Mountain Windswept Ridge 15-19 inch** ecological site. These measures would be applied in addition to those described above for all shallow ecological sites.*

- Rip and aerate prior to mulching.
- Apply wood straw to improve soil aggregation, increase porosity and permeability, and improve aeration and drainage, for stockpiles stored for more than two years.
- Deep rip subsoils prior to application of topsoil to improve drainage.

**Vegetation Handling**

The primary objective of revegetation is to establish the species composition, diversity, structure, and total ground cover appropriate for the desired plant community (BLM 2012b). In accordance with BLM Wyoming Reclamation Policy (2012b), proper seeding mixtures will be used to reclaim disturbed areas on federal lands with native vegetation, as detailed in the CCSM Project Master Reclamation Plan (2012a) and the site-specific reclamation plan for Phase I of the CCSM Project. Soil conditioning, de-compaction, and topsoil protection measures will be implemented to reestablish topsoil properties and to protect the seeding surface, as presented in Table 2 and described in the CCSM Project Master Reclamation Plan (BLM 2012a), the site-specific reclamation plan for Phase I of the CCSM Project, and in compliance with BLM Wyoming Reclamation Policy (2012b).

Seed mixtures will be tailored to establish species diversity, composition, and ground cover appropriate for the desired plant community that has been documented for each ecological site in the CCSM Project Site. Seed mixtures may be refined based on soil management, wildlife, or rangeland needs. Seed mixtures will be designed for each ecological site based on the RFO ecological site specific pick lists combined with site-specific vegetation characteristics (BLM 2008, 2011). The use of non-native species on federal lands will only be considered as the result of the documented failure to revegetate any area with native species and will be implemented in coordination with the BLM AO. BMPs and reclamation measures will be refined for site-specific characteristics and implemented as necessary in coordination with the BLM AO.

Recommended BMPs and protective measures for successfully reestablishing site vegetation are listed below:

*Revegetation practices and BMPs for **all shallow ecological sites***

- For each ecological site, using BLM pick lists (BLM 2011) contained in Exhibits I-V, design ecological site-specific seed mixes for reclamation to achieve species composition and diversity for the desired plant community, ecological setting, and current soil

properties based on pre-disturbance vegetation characteristics. Final selection of seed mixes will be dependent on seed availability and will be coordinated with the BLM AO.

- Increase seeding rate for critical areas where germination is inhibited by low soil quality, as necessary.
- Reduce seeding rates in areas where a viable seed bank remains in the topsoil, as approved by BLM AO.
- Broadcast seed after disking.
- Harrow or rake broadcast seed to increase germination, if necessary.
- Hydromulch on steep slopes after seeding, if necessary.
- Use snow fences to trap additional soil moisture, if necessary.
- Exclude livestock from reclaimed areas, as practicable, until appropriate levels of site stabilization and revegetation are achieved.

*Additional revegetation practices and BMPs for the **Very Shallow 7-9 inch** ecological site. These measures would be applied in addition to those described above for all shallow ecological sites.*

- No site-specific BMPs for revegetation have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

*Additional revegetation practices and BMPs for the **Shallow Loamy 7-9 inch** ecological site. These measures would be applied in addition to those described above for all shallow ecological sites.*

- Create furrows or pits to roughen the soil surface, increase moisture infiltration, capture blowing snow, and slow the surface velocity of wind and water to reduce erosion and sedimentation, as appropriate.

*Additional revegetation practices and BMPs for the **Shallow Loamy 10-14 inch** ecological site. These measures would be applied in addition to those described above for all shallow ecological sites.*

- Create furrows or pits to roughen the soil surface, increase moisture infiltration, capture blowing snow, and slow the surface velocity of wind and water to reduce erosion and sedimentation, as appropriate.

*Additional revegetation practices and BMPs for the **Shallow Loamy 15-19 inch** ecological site. These measures would be applied in addition to those described above for all shallow ecological sites.*

- Create furrows or pits to roughen the soil surface, increase moisture infiltration, capture blowing snow, and slow the surface velocity of wind and water to reduce erosion and sedimentation, as appropriate.

*Additional revegetation practices and BMPs for the **Shallow Sandy 10-14 inch** ecological site. These measures would be applied in addition to those described above for all shallow ecological sites.*

- No site-specific BMPs for revegetation have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

*Additional revegetation practices and BMPs for the **Mountain Windswept Ridge 15-19 inch** ecological site. These measures would be applied in addition to those described above for all shallow ecological sites.*

- Hydromulch on steep slopes after seeding, if necessary.
- Create furrows or pits to roughen the soil surface, increase moisture infiltration, capture blowing snow, and slow the surface velocity of wind and water to reduce erosion and sedimentation, as appropriate.

**Exhibit I**

**Very Shallow 7-9 inch Ecological Site Description**

**Adapted from NRCS (2011)**

Site-specific conditions for very shallow 7-9 inch ecological sites in the CCSM Project Site were characterized using data collected at three monitoring locations (Figure 1, Table 1). Long-term monitoring reference sites for very shallow 7-9 inch ecological sites have been established in coordination with the BLM Authorized Officer (AO). Any additional monitoring site that is used for ecological site characterization that is located 100 meters outside of the CCSM Project limits of disturbance (LODs) may be suitable as a long-term monitoring reference site for very shallow 7-9 inch ecological site and may be used for future reclamation success monitoring purposes.

**Table 1. Representative transects for very shallow 7-9 inch ecological sites in the CCSM Project Site.**

| Transect Number | Record Date | Latitude | Longitude | Altitude | Transect Bearing |
|---|---|---|---|---|---|
| VS_79_01 | 6/13/2014 | 41.71951 | -107.16200 | 7,116 | 20 |
| VS_79_02 | 6/19/2014 | 41.72730 | -107.11210 | 7,198 | 90 |
| VS_79_03 | 7/16/2014 | 41.72717 | -107.16135 | 6,946 | 240 |

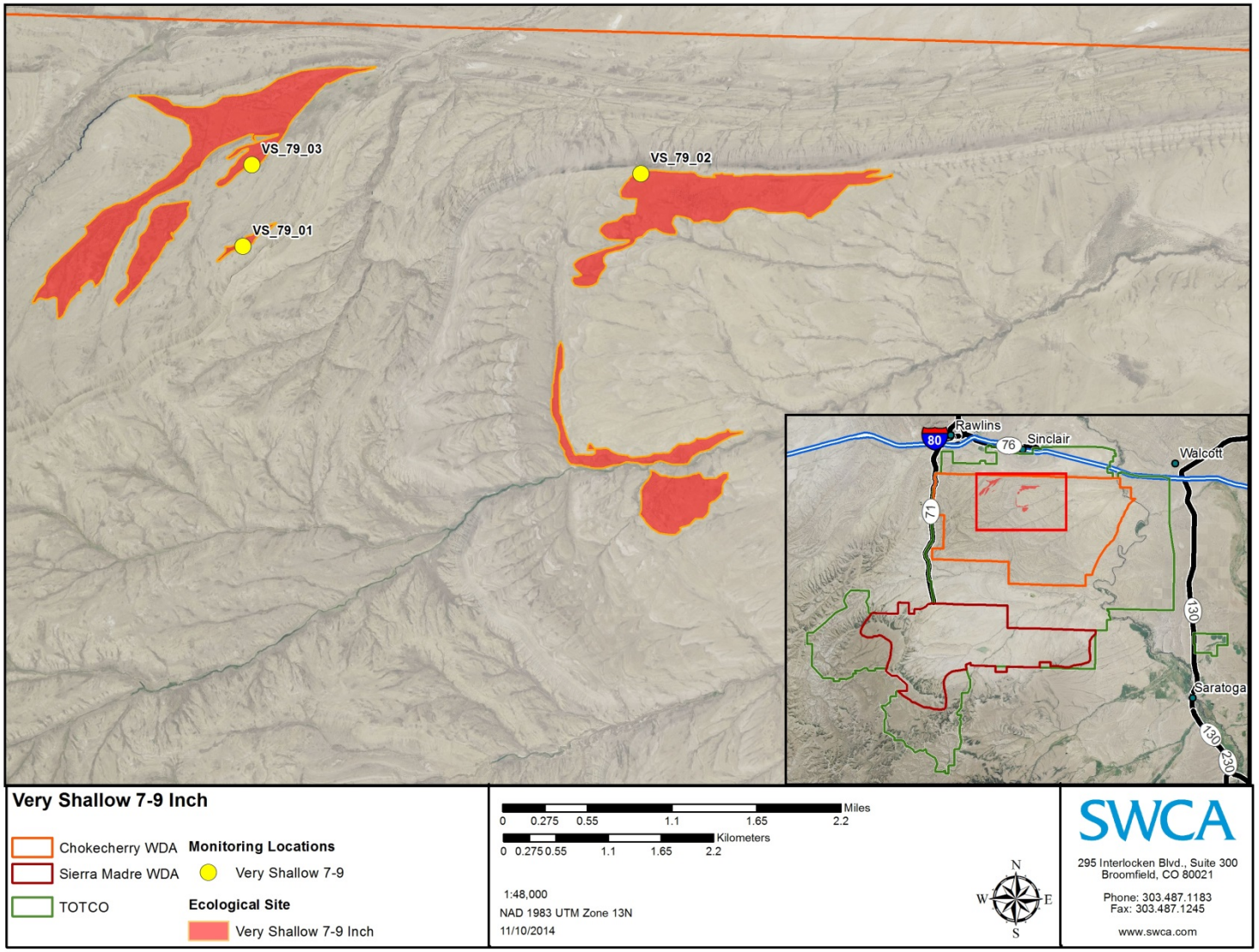


**Figure 1. Locations of reference sites used to characterize very shallow 7-9 inch ecological sites in the CCSM Project Site.**

**Site Characteristics**

## Climate

Mean annual precipitation is 8.0 inches (ranges from 7-9 inches per year), with peaks observed in May and the lowest totals recorded in the winter months. Average snow fall often exceeds 20 inches annually. Wide fluctuations do occur and result in more dry years than normal years (NRCS 2011). Due to the high elevations and dry air, temperatures at loamy 10-14 inch ecological sites range significantly between summer and winter and daily maximum and minimums. The average annual air temperature is 41.9 °F (25.6 °F Avg. Min. to 58.1 °F Avg. Max.). Extreme minimum temperatures can occur during the winter months when cold air outbreaks and winter storms move rapidly from northwest to southeast. Chinook winds can occur in winter bringing rapid rises in temperature. Winds speeds are lower than other areas of the state. Daytime winds are stronger than nighttime with some strong gusts associated with the passage of winter storms (NRCS 2011).

## Abiotic Landscape Features

Very shallow 7-9 inch ecological sites in the CCSM Project Site occur on rolling to steep sloping land. Examples of landforms found in this ecological site include hills, ridges, and escarpments. Elevation is variable and ranges between 6,800 feet and 7,300 feet in the CCSM Project Site (NRCS 2011).

## Soil Characteristics

Very shallow 7-9 inch ecological sites within the CCSM Project Site are shallow to either soft or hard sedimentary bedrock and may have noticeable gravel or channer content. Soils are well drained shallow soils or deeper soils with restricted root growth and moderately slow to moderate permeability.

Topsoil averages 5.8 ± 0.47 inches. Topsoil soil textures range from loamy fine sand to loam. Subsoil textures are characterized by fine sands to fine sandy loams (NRCS 2011).

Very shallow 7-9 inch ecological sites in the CCSM Project Site are characterized by soils with low infiltration when soils are wet due to shallow depth to bedrock and/or an impervious subsurface layer. Runoff potential for this ecological site ranges from high to moderate depending on soil depth, bedrock type and ground cover. Rills and gullies are typically not present and surface water flow patterns are often indistinguishable (NRCS 2011). Chemical and physical crusts are rare to non-existent at these sites (NRCS 2011).

Soils are slightly to very strongly alkaline with pH values between 7.77 and 9.49 and non-saline to very slightly saline electrical conductivities ranging between 0.08 and 0.49 dS/m. Where soil pH ranges exceed 8.40, soils may have limited reclamation potential and may need to be evaluated for potential soil treatment. Soils are non-effervescent to strongly effervescent indicating presence of weakly and strongly covalent carbonates.

Figures 2 and 3 illustrate the soil surface and soil profile characteristics of a typical very shallow 7-9 inch site in the CCSM Project Site.

**Table 2. Soil characteristics typical of very shallow 7-9 inch ecological sites in the CCSM Project Site.**

| Soil Characteristics | Description |
|---|---|
| **Parent Material (Kind)** | Residuum, eolian |
| **Parent Material (Origin)** | Sedimentary |
| **Topsoil Depth[1]** | 5.8 ± 0.47 inches |
| **Topsoil Texture** | Fine sand to fine sandy loam |
| **Subsoil Depth[2]** | None |
| **Subsoil Texture** | None |
| **Topsoil Fragments** | 0-10% volume, sedimentary, fine gravel, subangular |
| **Subsoil Fragments** | None |
| **Electrical Conductivity (Topsoil)** | 0.08-0.49 dS/m |
| **Salinity Class (Topsoil)** | Non-saline to very slightly saline |
| **Electrical Conductivity (Subsoil)** | None |
| **Salinity Class (Subsoil)** | None |
| **Soil Reaction (Topsoil)** | 7.77-9.49 |
| **pH Class (Topsoil)** | Slightly to very strongly alkaline |
| **Soil Reaction (Subsoil)** | None |
| **pH Class (Subsoil)** | None |
| **Carbonate Equivalent (Topsoil)** | Very slightly to strongly effervescent |
| **Carbonate Equivalent (Subsoil)** | None |

[1]Topsoil depth determined by depth of A Horizon.
[2]Subsoil depth determined by B and C horizons to a maximum of 20 inches depth including topsoil.

**Figure 2. Representative soil surface and ground cover for very shallow 7-9 inch sites in the CCSM Project Site (VS_79_02).**

**Figure 3. Representative soil profile for very shallow 7-9 inch sites in the CCSM Project Site (VS_79_01).**

## Vegetation Characteristics

Plant communities associated with very shallow 7-9 inch ecological sites in the CCSM Project Site are characterized by vegetated surfaces with 7–27% basal cover (Table 3 and 4). The remaining soil surface is characterized primarily by rock fragments (27–68%), unprotected soils (6–35%), and litter (4–27%). Figure 4 illustrates representative vegetation communities associated with very shallow 7-9 inch ecological sites in the CCSM Project Site.

When very shallow 7-9 inch ecological sites begin to deteriorate, species such as rabbitbrush (*Chrysothamnus* spp.) and big sagebrush (*Artemisia tridentata*) will increase. Cool season bunchgrasses such as bluebunch wheatgrass (*Pseudoroegneria spicata*), needleandthread (*Hesperostipa comata*), and Indian ricegrass (*Achnatherum hymenoides*) will decrease in frequency and abundance (NRCS 2011). This site has relatively low productivity potential, and is not well suited to grazing improvement practices unless treated as a part of a larger unit containing more productive areas (NRCS 2011). Continuous season-long grazing will cause a transition to a black sagebrush/rhizomatous wheatgrass community (NRCS 2011).

The BLM pick list in Table 5 (BLM 2011) and the species composition and cover (Tables 3 and 4) observed for very shallow 7-9 inch ecological sites will be used to guide the selection of appropriate seed mixes and application rates for revegetation. Final seed mixes will be determined based on seed availability at the time of revegetation efforts and in coordination with the BLM AO.

**Table 3. Vegetation characteristics typical of very shallow 7-9 inch ecological sites.**

| | | |
|---|---|---|
| Basal Vegetative Cover (LPI*) | 7%–27% | |
| Biological Soil Crust and Lichen (LPI*) | 0% | |
| Litter Cover (LPI*) | 4%–27% | |
| Surface Fragment/Rock Cover (LPI*) | 27%–68% | |
| Unprotected Soil(LPI*) | 6% – 35% | |
| Representative Species and Top-Canopy Cover* | *Elymus trachycaulus* | 9.3% average |
| | *Poa secunda* | 5.7% average |
| | *Pseudoroegneria spicata* | 5.7% average |
| | *Artemisia tridentata* ssp. *wyomingensis* | 5.5% average |
| | *Purshia tridentata* | 5.0% average |

* Line point intercept

**Table 4. Species associated with very shallow 7-9 inch ecological sites in the CCSM Project Site.**

| | |
|---|---|
| *Achnatherum hymenoides* | *Eriogonum sp.* |
| *Agoseris glauca* | *Grayia spinosa* |
| *Allium textile* | *Hesperostipa comata* |
| *Alyssum desertorum* | *Heterotheca villosa* |
| *Amelanchier sp.* | *Koeleria macrantha* |
| *Arenaria hookeri* | *Lappula occidentalis var. cupulata* |
| *Artemisia frigida* | *Lewisia rediviva* |
| *Artemisia nova* | *Linanthus pungens* |
| *Artemisia pedatifida* | *Lomatium grayi* |
| *Artemisia tridentata ssp. wyomingensis* | *Lomatium sp.* |
| *Astragalus sp.* | *Machaeranthera grindelioides* |
| *Astragalus spatulatus* | *Opuntia polyacantha* |
| *Atriplex confertifolia* | *Paronychia sessiliflora* |
| *Atriplex gardneri* | *Pascopyrum smithii* |
| *Bromus tectorum* | *Penstemon eriantherus* |
| *Carex filifolia* | *Penstemon sp.* |
| *Castilleja linariifolia* | *Phlox hoodii* |
| *Chrysothamnus viscidiflorus* | *Phlox sp.* |
| *Cryptantha sp.* | *Poa secunda* |
| *Cymopterus bulbosus* | *Pseudoroegneria spicata* |
| *Delphinium geyeri* | *Purshia tridentata* |
| *Delphinium nuttallii* | *Rhus trilobata* |
| *Descurainia pinnata* | *Ribes cereum* |
| *Draba sp.* | *Rosa woodsii* |
| *Elymus elymoides* | *Sarcobatus vermiculatus* |
| *Elymus trachycaulus* | *Sedum lanceolatum* |
| *Ericameria nauseosa* | *Sphaeralcea coccinea* |
| *Erigeron caespitosus* | *Stenotus acaulis* |
| *Erigeron engelmannii* | *Stenotus armerioides* |
| *Eriogonum brevicaule* | *Symphoricarpos albus* |
| *Eriogonum flavum* | *Trifolium gymnocarpon* |
| *Eriogonum ovalifolium* | |

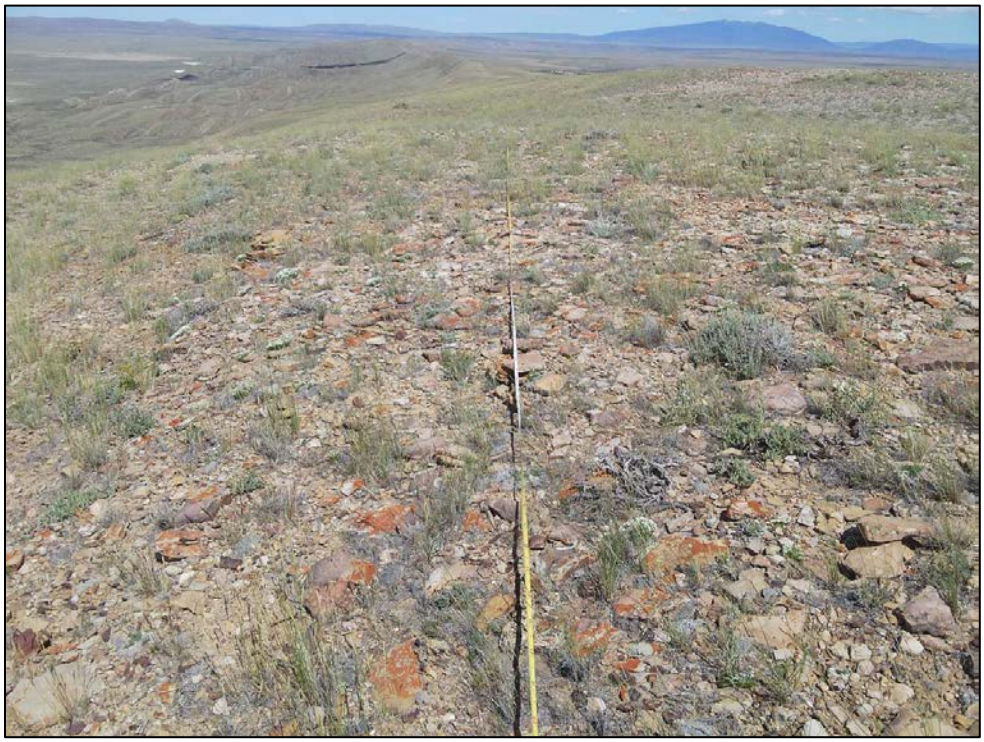

**Figure 4. Characteristic vegetation communities associated with very shallow 7-9 inch sites in the CCSM Project Site (VS_79_02).**

**Table 5. Recommended seed pick list for dry loamy ecological sites (BLM 2011).**

| **Name** | ***Scientific*** | **Variety** | **SYMBOL** |
|---|---|---|---|
| ***Grasses*** | | | |
| Streambank wheatgrass | *Elymus lanceolatus* | Sodar | ELLA |
| Thickspike wheatgrass | *Elymus lanceolatus* | Critana | ELLA3 |
| Western wheatgrass | *Pascopyrum smithii* | Rosana | PASM |
| Indian ricegrass | *Achnatherum hymenoides* | Rimrock (Nez Par) | ACHY |
| Bottlebrush squirreltail | *Elymus elymoides* | Sand hollow | ELEL |
| Slender wheatgrass | *Elymus trachycaulus* | Pryor (San Luis) | ELTR |
| Little bluegrass "Sandberg" | *Poa secunda* | High Plains | POSE |
| Bluebunch wheatgrass | *Pseudoroegneria spicata* | Secor | PSSP6 |
| Galleta grass | *Pleuraphis jamesii* | Viva | PLJA |
| ***Shrubs*** | | | |
| Wyoming big sagebrush | *Artemisia tridentata* ssp. *wyomingensis* | | ARTRW8 |
| Gardner's saltbush | *Atriplex gardneri* | | ATGA |
| Fourwing saltbush | *Atriplex canaescens* | Wytana | ATCA2 |
| Shadscale | *Atriplex confertifolia* | | ATCO |
| Green rabbitbrush | *Ericameria nauseosa* | | ERNA10 |
| Yellow rabbitbrush | *Chrysothamnus viscidiflorus* | | CHVI8 |
| Winterfat | *Krascheninnikovia lanata* | Open Range | KRLA |
| ***Forbs*** | | | |
| Lewis' flax | *Linum lewisii* | | LILI |
| Rocky Mountain beeplant | *Cleome serrulata* | Appar | CLSE |
| Western yarrow | *Achillea millefolium* var. *occidentalis* | | ACMI2 |
| Firecracker penstemon | *Penstemon eatonii* | Yakima | PEEA |
| Textile onion | *Allium textile* | | ALTE |
| Scarlet globemallow | *Sphaeralcea coccinea* | | SPCO |
| Western wallflower | *Erysium capitatum* | | ERCA14 |
| Scarlet gilia | *Ipomopsis aggregata* | | IPAGA3 |
| Spiny phlox | *Phlox hoodii* | | PHHO |
| Desert biscuitroot | *Lomatium foeniculaceum* | | LOFO |
| Dotted gayfeather | *Liatris punctata* | | LIPU |

**Exhibit II**

**Shallow Loamy 7-9 inch Ecological Site Description**

**Adapted from NRCS (2011)**

Site-specific conditions for shallow loamy 7-9 inch ecological sites in the CCSM Project Site were characterized using data collected at six monitoring locations (Figure 1, Table 1). Long-term monitoring reference sites for shallow loamy 7-9 inch ecological sites have been established in coordination with the BLM Authorized Officer (AO). Any additional monitoring site that is used for ecological site characterization that is located 100 meters outside of the CCSM Project limits of disturbance (LODs) may be suitable as a long-term monitoring reference site for shallow loamy 7-9 inch ecological site and may be used for future reclamation success monitoring purposes.

**Table 1. Representative transects for shallow loamy 7-9 inch ecological sites in the CCSM Project Site.**

| Transect Number | Record Date | Latitude | Longitude | Altitude | Transect Bearing |
|---|---|---|---|---|---|
| SHLY_79_01 | 13-Jun-14 | 41.71106574 | -107.1461263 | 2214 | 220 |
| SHLY_79_02 | 16-Jun-14 | 41.71363342 | -107.190047 | 2202 | 40 |
| SHLY_79_03 | 19-Jun-14 | 41.73229952 | -107.0637826 | 2039 | 100 |
| SHLY_79_04 | 11-Jun-14 | 41.70200197 | -107.1071791 | 2130 | 235 |
| SHLY_79_05 | 12-Jun-14 | 41.71986126 | -107.1131562 | 2151 | 230 |
| SHLY_79_06 | 16-Jun-14 | 41.73176557 | -107.1736294 | 2164 | 130 |

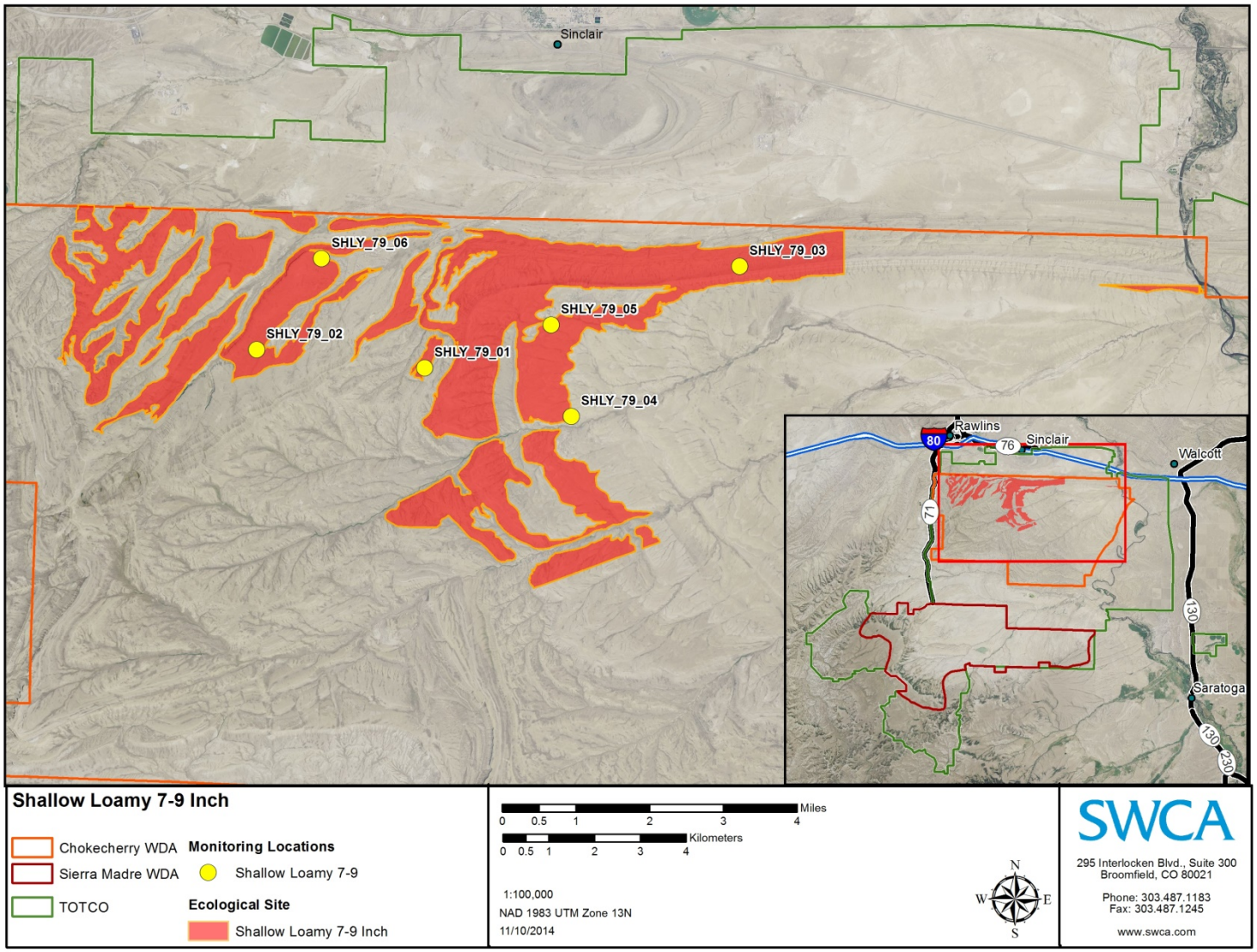


**Figure 1. Locations of reference sites used to characterize shallow loamy 7-9 inch ecological sites in the CCSM Project Site.**

**Site Characteristics**

## Climate

Mean annual precipitation is 8.0 inches (ranges from 7-9 inches per year), with peaks observed in May and the lowest totals recorded in the winter months. Average snow fall often exceeds 20 inches annually. Wide fluctuations do occur and result in more dry years than normal years (NRCS 2011). Due to the high elevations and dry air, temperatures at loamy 10-14 inch ecological sites range significantly between summer and winter and daily maximum and minimums. The average annual air temperature is 41.9 °F (25.6 °F Avg. Min. to 58.1 °F Avg. Max.). Extreme minimum temperatures can occur during the winter months when cold air outbreaks and winter storms move rapidly from northwest to southeast. Chinook winds can occur in winter bringing rapid rises in temperature. Winds speeds are lower than other areas of the state. Daytime winds are stronger than nighttime with some strong gusts associated with the passage of winter storms (NRCS 2011).

## Abiotic Landscape Features

Shallow loamy 7-9 inch ecological sites in the CCSM Project Site occur on rolling to steep sloping land. Examples of landforms found in this ecological site include hills, ridges, and escarpments. Elevation is variable and ranges between 6,600 feet and 7,700 feet in the CCSM Project Site (NRCS 2011).

## Soil Characteristics

Shallow loamy 7-9 inch ecological sites within the CCSM Project Site are shallow to either soft or hard sedimentary bedrock and may have noticeable gravel or channer content. Soils are well drained shallow soils or deeper soils with restricted root growth and moderately slow to moderate permeability. Surface textures range from loams to sandy loams (NRCS 2011).

Topsoil averages 6.0 ± 0.77 inches. Lower soil horizon depths are approximately 5.1 inches. Topsoil soil textures range from loamy fine sand to loam. Subsoil textures are characterized by Fine sandy loam to silty clay loam (NRCS 2011).

Shallow loamy 7-9 inch ecological sites in the CCSM Project Site are characterized by soils with low infiltration when soils are wet due to shallow depth to bedrock and/or an impervious subsurface layer. Runoff potential for this ecological site ranges from high to moderate depending on soil depth, bedrock type and ground cover. Rills and gullies are typically not present and surface water flow patterns are often indistinguishable (NRCS 2011). Chemical and physical crusts are rare to non-existent at these sites (NRCS 2011).

Soils are moderately to very strongly alkaline with pH values between 7.44 and 9.16 and non-saline electrical conductivities ranging between 0.03 and 0.14 dS/m. Where soil pH ranges exceed 8.4, soils may have limited reclamation potential and may need to be evaluated for potential soil treatment. Soils are non-effervescent to strongly effervescent indicating presence of weakly and strongly covalent carbonates.

Figures 2 and 3 illustrate the soil surface and soil profile characteristics of a typical shallow loamy 7-9 inch site in the CCSM Project Site.

**Table 2. Soil characteristics typical of shallow loamy 7-9 inch ecological sites in the CCSM Project Site.**

| Soil Characteristics | Description |
|---|---|
| **Parent Material (Kind)** | Alluvium, residuum, eolian deposits |
| **Parent Material (Origin)** | Sedimentary |
| **Topsoil Depth[1]** | 6.0 ± 0.77 inches |
| **Topsoil Texture** | Loamy fine sand to loam |
| **Subsoil Depth[2]** | 5.1 ± 0.32 inches |
| **Subsoil Texture** | Fine sandy loam to silty clay loam |
| **Topsoil Fragments** | 0%–40% volume, sedimentary, medium gravel to channers, angular to subangular |
| **Subsoil Fragments** | 0%–50% volume, sedimentary, channers, angular |
| **Electrical Conductivity (Topsoil)** | 0.03-0.14 dS/m |
| **Salinity Class (Topsoil)** | Non-saline |
| **Electrical Conductivity (Subsoil)** | 0.08-0.09 dS/m |
| **Salinity Class (Subsoil)** | Non-saline |
| **Soil Reaction (Topsoil)** | 7.44-9.16 |
| **pH Class (Topsoil)** | Moderately to very strongly alkaline |
| **Soil Reaction (Subsoil)** | 7.72-8.35 |
| **pH Class (Subsoil)** | Slightly to moderately alkaline |
| **Carbonate Equivalent (Topsoil)** | Noneffervescent to strongly effervescent |
| **Carbonate Equivalent (Subsoil)** | Slightly effervescent |

[1]Topsoil depth determined by depth of A Horizon.
[2]Subsoil depth determined by B and C horizons to a maximum of 20 inches depth including topsoil.

**Figure 2. Representative soil surface and ground cover for shallow loamy 7-9 inch sites in the CCSM Project Site (SHLY_79_03).**

**Figure 3. Representative soil profile for shallow loamy 7-9 inch sites in the CCSM Project Site (SHLY_79_03).**

## Vegetation Characteristics

Plant communities associated with shallow loamy 7-9 inch ecological sites in the CCSM Project Site are characterized by vegetated surfaces with 13–38% basal cover (Table 3 and 4). The remaining soil surface is characterized primarily by rock fragments (26–39%), unprotected soils (20–37%), and litter (3–24%). Figure 4 illustrates representative vegetation communities associated with shallow loamy 7-9 inch ecological sites in the CCSM Project Site.

When shallow loamy 7-9 inch ecological sites begin to deteriorate, species such as rabbitbrush (*Chrysothamnus* spp.) and big sagebrush (*Artemisia tridentata*) will increase. Cool season bunchgrasses such as bluebunch wheatgrass (*Pseudoroegneria spicata*), needleandthread (*Hesperostipa comata*), and Indian ricegrass (*Achnatherum hymenoides*) will decrease in frequency and abundance (NRCS 2011). This site has relatively low productivity potential, and is not well suited to grazing improvement practices unless treated as a part of a larger unit containing more productive areas (NRCS 2011). Continuous season-long grazing will cause a transition to a black sagebrush/rhizomatous wheatgrass community (NRCS 2011).

The BLM pick list in Table 5 (BLM 2011) and the species composition and cover (Tables 3 and 4) observed for shallow loamy 7-9 inch ecological sites will be used to guide the selection of appropriate seed mixes and application rates for revegetation. Final seed mixes will be determined based on seed availability at the time of revegetation efforts and in coordination with the BLM AO.

**Table 3. Vegetation characteristics typical of shallow loamy 7-9 inch ecological sites.**

| | | |
|---|---|---|
| Basal Vegetative Cover (LPI*) | 13% – 38% | |
| Biological Soil Crust and Lichen (LPI*) | 0% – 2% | |
| Litter Cover (LPI*) | 3% – 24% | |
| Surface Fragment/Rock Cover (LPI*) | 26% – 39% | |
| Unprotected Soil(LPI*) | 20% – 37% | |
| Representative Species and Top-Canopy Cover* | *Poa secunda* | 11.0% average |
| | *Elymus trachycaulus* | 10.8% average |
| | *Artemisia tridentata ssp. wyomingensis* | 7.5% average |
| | *Pseudoroegneria spicata* | 6.0% average |
| | *Artemisia nova* | 5.7% average |

* Line point intercept

**Table 4. Species associated with shallow loamy 7-9 inch ecological sites in the CCSM Project Site.**

| Associated species | |
|---|---|
| *Agoseris glauca* | *Penstemon eriantherus* |
| *Pseudoroegneria spicata* | *Calochortus nuttallii* |
| *Poa secunda* | *Alyssum desertorum* |
| *Elymus trachycaulus* | *Agropyron cristatum* |
| *Elymus elymoides* | *Hesperostipa comata* |
| *Achnatherum hymenoides* | *Balsamorhiza sagittata* |
| *Trifolium gymnocarpon* | *Castilleja linariifolia* |
| *Descurainia pinnata* | *Eriogonum ovalifolium* |
| *Erigeron sp.* | *Penstemon sp.* |
| *Astragalus purshii* | *Pascopyrum smithii* |
| *Cymopterus bulbosus* | *Erigeron caespitosus* |
| *Cryptantha sp.* | *Cryptantha celosioides* |
| *Astragalus sp.* | *Lappula occidentalis var. cupulata* |
| *Amelanchier sp.* | *Stenotus armerioides* |
| *Artemisia nova* | *Nothocalais sp.* |
| *Erigeron engelmannii* | *Xylorhiza glabriuscula* |
| *Eriogonum sp.* | *Machaeranthera grindelioides* |
| *Phlox sp.* | *Tetradymia nuttallii* |
| *Lewisia rediviva* | *Artemisia pedatifida* |
| *Artemisia frigida* | *Atriplex gardneri* |
| *Artemisia tridentata ssp. wyomingensis* | *Krascheninnikovia lanata* |
| *Atriplex confertifolia* | *Allium textile* |
| *Chrysothamnus viscidiflorus* | *Bromus tectorum* |
| *Opuntia polyacantha* | *Koeleria macrantha* |
| *Sarcobatus vermiculatus* | *Bassia americana* |
| *Grayia spinosa* | *Picrothamnus desertorum* |
| *Arenaria hookeri* | *Lygodesmia juncea* |
| *Phlox hoodii* | *Carex filifolia* |
| *Stenotus acaulis* | *Viola sp.* |
| *Sphaeralcea coccinea* | |

**Figure 4. Characteristic vegetation communities associated with shallow loamy 7-9 inch sites in the CCSM Project Site (SHLY_79_03).**

**Table 5. Recommended seed pick list for dry loamy ecological sites (BLM 2011).**

| **Name** | ***Scientific*** | **Variety** | **SYMBOL** |
|---|---|---|---|
| ***Grasses*** | | | |
| Streambank wheatgrass | *Elymus lanceolatus* | Sodar | ELLA |
| Thickspike wheatgrass | *Elymus lanceolatus* | Critana | ELLA3 |
| Western wheatgrass | *Pascopyrum smithii* | Rosana | PASM |
| Indian ricegrass | *Achnatherum hymenoides* | Rimrock (Nez Par) | ACHY |
| Bottlebrush squirreltail | *Elymus elymoides* | Sand hollow | ELEL |
| Slender wheatgrass | *Elymus trachycaulus* | Pryor (San Luis) | ELTR |
| Little bluegrass "Sandberg" | *Poa secunda* | High Plains | POSE |
| Bluebunch wheatgrass | *Pseudoroegneria spicata* | Secor | PSSP6 |
| Galleta grass | *Pleuraphis jamesii* | Viva | PLJA |
| ***Shrubs*** | | | |
| Wyoming big sagebrush | *Artemisia tridentata* ssp. *wyomingensis* | | ARTRW8 |
| Gardner's saltbush | *Atriplex gardneri* | | ATGA |
| Fourwing saltbush | *Atriplex canaescens* | Wytana | ATCA2 |
| Shadscale | *Atriplex confertifolia* | | ATCO |
| Green rabbitbrush | *Ericameria nauseosa* | | ERNA10 |
| Yellow rabbitbrush | *Chrysothamnus viscidiflorus* | | CHVI8 |
| Winterfat | *Krascheninnikovia lanata* | Open Range | KRLA |
| ***Forbs*** | | | |
| Lewis' flax | *Linum lewisii* | | LILI |
| Rocky Mountain beeplant | *Cleome serrulata* | Appar | CLSE |
| Western yarrow | *Achillea millefolium* var. *occidentalis* | | ACMI2 |
| Firecracker penstemon | *Penstemon eatonii* | Yakima | PEEA |
| Textile onion | *Allium textile* | | ALTE |
| Scarlet globemallow | *Sphaeralcea coccinea* | | SPCO |
| Western wallflower | *Erysium capitatum* | | ERCA14 |
| Scarlet gilia | *Ipomopsis aggregata* | | IPAGA3 |
| Spiny phlox | *Phlox hoodii* | | PHHO |
| Desert biscuitroot | *Lomatium foeniculaceum* | | LOFO |
| Dotted gayfeather | *Liatris punctata* | | LIPU |

**Exhibit III**

**Shallow Loamy 10-14 inch Ecological Site Descriptions**

**Adapted from NRCS (2011)**

Site-specific conditions for shallow loamy 10-14 inch ecological sites in the CCSM Phase I Site were characterized using data collected at one monitoring location (Figure 1, Table 1). Long-term monitoring reference sites for shallow loamy 10-14 inch ecological sites have been established in coordination with the BLM Authorized Officer (AO). Any additional monitoring site that is used for ecological site characterization that is located outside of the CCSM Phase I limits of disturbance (LODs) may be suitable as a long-term monitoring reference site for shallow loamy 10-14 inch ecological site and may be used for future reclamation success monitoring purposes.

**Table 1. Representative transects for shallow loamy 10-14 inch ecological sites in the CCSM Phase I Site.**

| Transect Number | Record Date | Latitude | Longitude | Altitude | Transect Bearing |
|---|---|---|---|---|---|
| SHLY_1014_01 | 6/17/2014 | 41.68280 | -107.21509 | 7,736 | 100 |
| SHLY_1014_02 | 6/17/2014 | 41.68736 | -107.17256 | 7,349 | 270 |
| SHLY_1014_03 | 9/16/2014 | 41.70459 | -107.24542 | 7,467 | 198 |

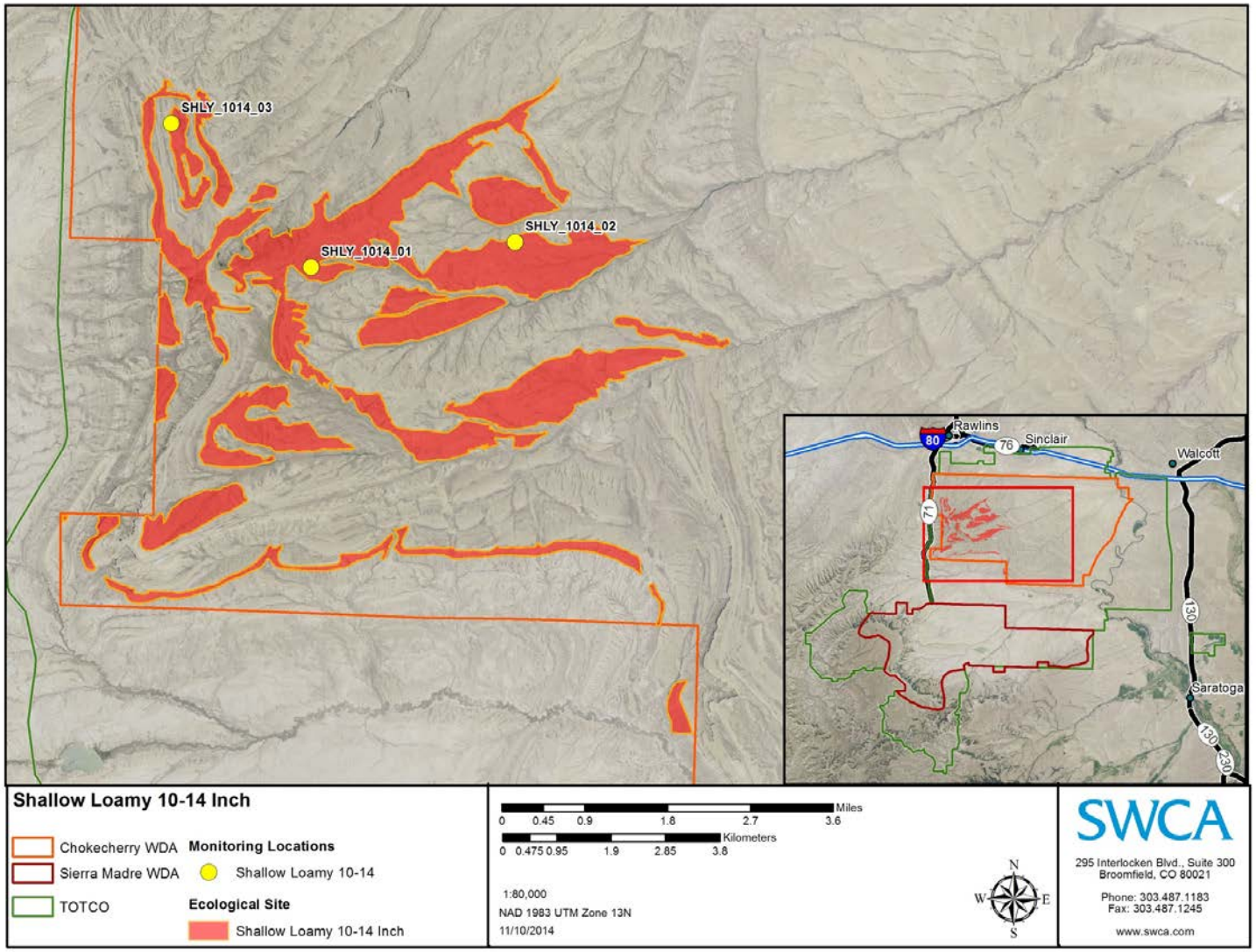


**Figure 1. Locations of reference sites used to characterize shallow loamy 10-14 inch ecological sites in the CCSM Phase I Site.**

**Site Characteristics**

## Climate

The mean annual precipitation at these sites is 11.5 inches (29 cm), with peaks observed in May and the lowest totals recorded in the winter months. Average snow fall often exceeds 20 inches annually. Wide fluctuations do occur and result in more dry years than normal years (NRCS 2011). Due to the high elevations and dry air, temperatures at shallow loamy 10-14 inch ecological sites range significantly between summer and winter and daily maximum and minimums. The average annual air temperature is 42.2 °F (30.4 °F Avg. Min. to 53.9 °F Avg. Max.). Extreme minimum temperatures can occur during the winter months when cold air outbreaks and winter storms move rapidly from northwest to southeast. Chinook winds can occur in winter bringing rapid rises in temperature. Winds speeds are lower than other areas of the state. Daytime winds are stronger than nighttime with some strong gusts associated with the passage of winter storms (NRCS 2011).

## Abiotic Landscape Features

Shallow loamy 10-14 inch ecological sites in the CCSM Phase I Site typically occur on upland positions on south and west facing slopes. Slopes vary, but are typically between 0% and 45% on hills, ridges and escarpments. Elevation is variable and ranges between 7,200 feet and 8,100 feet in the CCSM Phase I Site.

## Soil Characteristics

Shallow loamy 10-14 inch ecological sites within the CCSM Phase I Site are well drained, typically shallow over sedimentary bedrock. Textures range from very sandy loams to clay loams.

Topsoil depths are approximately 4.1 ± 0.60 inches in depth. Topsoils have sandy loam to sandy clay loam textures. Subsurface horizons if present have sandy loam to clay loam textures. Gravel modifiers are generally present in the topsoil although the volume of rock fragments is generally very low in both horizons. Shallow loamy 10-14 inches ecological sites are typically not limited by restrictive layers in subsurface horizons; however, an increased volume of gravel and rock modifiers (greater than 15% volume) may increase limitations for vegetation establishment and growth.

Shallow loamy 10-14 inch ecological sites in the CCSM Phase I Site are characterized by soils with low infiltration rates particularly when soils is wet due to the shallow depth to bedrock and/or an impervious subsurface layer (NRCS 2011); runoff rates vary from moderate to high depending on soil depth, bedrock type and ground cover. Rills and gullies are typically not present and surface water flow patterns are often indistinguishable (NRCS 2011). Chemical and physical crusts are rare to non-existent at these sites (NRCS 2011).

Soils are moderately to strongly alkaline with a pH range from 8.21 to 8.88 and non-saline with an electrical conductivity around 0.05 to 0.11 dS/m. Where soil pH ranges exceed 8.4, soils may have limited reclamation potential and may need to be evaluated for potential soil treatment. Soils are non-effervescent to violently effervescent indicating presence of weak to strongly covalent carbonates.

Figures 2 and 3 illustrate the soil surface and soil profile characteristics of a shallow loamy 10-14 inch site in the CCSM Phase I Site.

**Table 2. Soil characteristics typical of shallow loamy 10-14 inch ecological sites.**

| Soil Characteristics | Description |
|---|---|
| **Parent Material (Kind)** | Residuum |
| **Parent Material (Origin)** | Sedimentary |
| **Topsoil Depth[1]** | 4.1 ± 0.60 inches |
| **Topsoil Texture** | Sandy loam to sandy clay loam |
| **Subsoil Depth[2]** | 8.9 ± 1.83 inches |
| **Subsoil Texture** | Sandy loam to clay loam |
| **Topsoil Fragments** | 0-10% volume, sedimentary, fine to medium gravel, subangular |
| **Subsoil Fragments** | 0-45% volume, sedimentary, fine gravel to channers, angular subangular |
| **Electrical Conductivity (Topsoil)** | 0.06-0.11 dS/m |
| **Salinity Class (Topsoil)** | Non-saline |
| **Electrical Conductivity (Subsoil)** | 0.05-0.09 dS/m |
| **Salinity Class (Subsoil)** | Non-saline |
| **Soil Reaction (Topsoil)** | 8.21-8.81 |
| **pH Class (Topsoil)** | Moderately to strongly alkaline |
| **Soil Reaction (Subsoil)** | 8.63-8.88 |
| **pH Class (Subsoil)** | Strongly alkaline |
| **Carbonate Equivalent (Topsoil)** | Non-effervescent to strongly effervescent |
| **Carbonate Equivalent (Subsoil)** | Non-effervescent to violently effervescent |

[1]Topsoil depth determined by depth of A Horizon.
[2]Subsoil depth determined by B and C horizons to a maximum of 20 inches depth including topsoil.

**Figure 2. Representative soil surface and ground cover for shallow loamy 10-14 inch sites in the CCSM Phase I Site (SHLY_1014_01)**

**Figure 3. Representative soil profile for shallow loamy 10-14 inch sites in the CCSM Phase I Site (SHLY_1014_03).**

## Vegetation Characteristics

Plant communities associated with shallow loamy 10-14 inch ecological sites in the CCSM Phase I Site are characterized by vegetated surfaces with 18%–29% basal cover (Table 3). The remaining soil surface is characterized primarily by unprotected soils (14% – 34), litter (23%–29%), and rock fragments (8%–40%). Figure 4 illustrates representative vegetation communities associated with shallow loamy 10-14 inch ecological sites in the CCSM Phase I Site.

When shallow loamy 10-14 inch ecological sites are subjected to frequent and severe grazing, woody species such as big sagebrush (*Artemisia tridentata*) and rabbitbrush (*Chrysothamnus* and *Ericameria* spp.) increase. Cool season bunchgrasses such as bluebunch wheatgrass (*Pseudoroegneria spicata*) and Sandberg bluegrass (*Poa secunda*) begin to decline. Severe ground disturbance and/or continuous heavy grazing will convert this community to a big sagebrush/cheatgrass state.

The BLM pick list in Table 5 (BLM 2011) and the species composition and cover (Tables 3 and 4) observed for shallow loamy 10-14 inch ecological sites will be used to guide the selection of appropriate seed mixes and application rates for revegetation. Final seed mixes will be determined based on seed availability at the time of revegetation efforts and in coordination with the BLM AO.

**Table 3. Vegetation characteristics typical of shallow loamy 10-14 inch ecological sites.**

| | | |
|---|---|---|
| Basal Vegetative Cover (LPI*) | 18%–29% | |
| Biological Soil Crust and Lichen (LPI*) | 0%–4% | |
| Litter Cover (LPI*) | 23%–29% | |
| Surface Fragment/Rock Cover (LPI*) | 8%–40% | |
| Unprotected Soil(LPI*) | 14% – 34% | |
| Representative Species and Top-Canopy Cover* | *Poa fendleriana* | 16.5% average |
| | *Pseudoroegneria spicata* | 11.3% average |
| | *Artemisia tridentata* ssp. *wyomingensis* | 10.0% average |
| | *Elymus trachycaulus* | 7.3% average |
| | *Poa secunda* | 6.7% average |

* Line point intercept

**Table 4. Species commonly associated with shallow loamy 10-14 inch ecological sites.**

| | |
|---|---|
| *Achnatherum hymenoides* | *Erigeron engelmannii* |
| *Agoseris glauca* | *Erigeron sp.* |
| *Allium textile* | *Eriogonum brevicaule* |
| *Alyssum desertorum* | *Eriogonum flavum* |
| *Antennaria microphylla* | *Eriogonum ovalifolium* |
| *Arenaria hookeri* | *Eriogonum sp.* |
| *Artemisia frigida* | *Hesperostipa comata* |
| *Artemisia nova* | *Koeleria macrantha* |
| *Artemisia pedatifida* | *Krascheninnikovia lanata* |
| *Artemisia tridentata ssp. wyomingensis* | *Linanthus pungens* |
| *Astragalus purshii* | *Machaeranthera grindelioides* |
| *Astragalus sp.* | *Mertensia sp.* |
| *Atriplex confertifolia* | *Opuntia polyacantha* |
| *Balsamorhiza sagittata* | *Oxytropis sp.* |
| *Bassia americana* | *Penstemon sp.* |
| *Bromus tectorum* | *Phlox hoodii* |
| *Carex filifolia* | *Phlox sp.* |
| *Ceratocephala testiculata* | *Poa fendleriana* |
| *Chrysothamnus viscidiflorus* | *Poa secunda* |
| *Cryptantha sp.* | *Pseudoroegneria spicata* |
| *Cymopterus bulbosus* | *Sarcobatus vermiculatus* |
| *Descurainia pinnata* | *Stanleya pinnata* |
| *Draba sp.* | *Stenotus acaulis* |
| *Elymus elymoides* | *Symphoricarpos albus* |
| *Elymus trachycaulus* | *Trifolium gymnocarpon* |

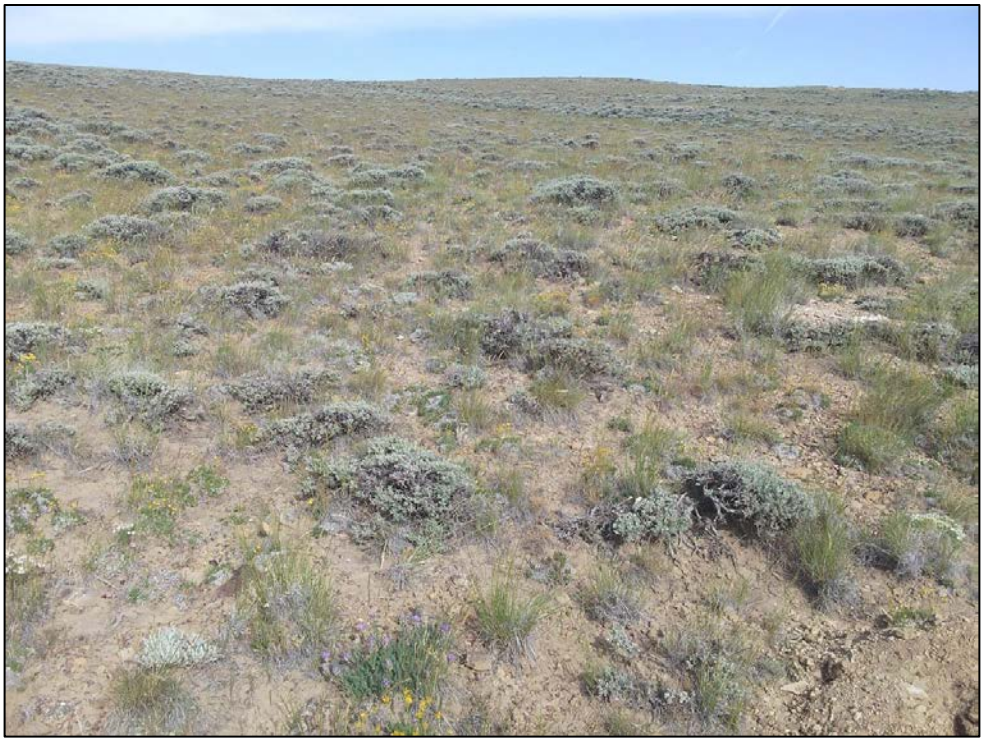

**Figure 4. Characteristic vegetation communities associated with shallow loamy 10-14 inch sites in the CCSM Phase I Site (SHLY_1014_01)**

**Table 5. Recommended seed pick list for shallow loamy ecological sites.**

| **Name** | ***Scientific*** | **Variety** | **SYMBOL** |
|---|---|---|---|
| ***Grasses*** | | | |
| Western wheatgrass | *Pascopyrum smithii* | Rosana | PASM |
| Thickspike wheatgrass | *Elymus lanceolatus* | Critana | ELLA3 |
| Indian ricegrass | *Achnatherum hymenoides* | Rimrock (Nez Par) | ACHY |
| Green needlegrass | *Nassella viridula* | Lordon | NAVI4 |
| Prairie junegrass | *Koeleria macrantha* | | KOMA |
| Bottlebrush squirreltail | *Elymus elymoides* | Sand hollow | ELEL |
| Mutton bluegrass | *Poa fendleriana* | | POFE |
| Bluebunch wheatgrass | *Pseudoroegneria spicata* | Secor | PSSP6 |
| Basin wildrye | *Leymus cinereus* | Trailhead, Magnar | LECI |
| Galleta grass | *Pleuraphis jamesii* | Viva | PLJA |
| Idaho fescue | *Festuca idahoensis* | Nezperce, Joseph | FEID |
| Mountain brome | *Bromus marginatus* | Garnet | BRMA4 |
| ***Shrubs*** | | | |
| Wyoming big sagebrush | *Artemisia tridentata* ssp. *wyomingensis* | | ARTRW8 |
| Mountain big sagebrush | *Artemisia tridentata* ssp. *vaseyana* | | ARTRV |
| Fourwing saltbush | *Atriplex canaescens* | Wytana | ATCA2 |
| Antelope bitterbrush | *Purshia tridentata* | | PUTR2 |
| Snowberry | *Symphoricarpos* spp. | Maybell | SYOR2 |
| Winterfat | *Krascheninnikovia lanata* | Open Range | KRLA |
| Shadscale saltbush | *Atriplex confertifolia* | | ATCO |
| Mountain mahogany | *Cercocarpus montanus* | Montane | CEMO2 |
| White sagebrush | *Artemisia ludoviciana* | | ARLU |
| ***Forbs*** | | | |
| Lewis' flax | *Linum lewisii* | | LILI |
| Scarlet globemallow | *Sphaeralcea coccinea* | | SPCO |
| American vetch | *Vicia americana* | | VIAM |
| Lupine | *Lupinus sericeus* | | LUSE4 |
| Blanketflower | *Gaillardia aristata* | | GAAR |
| Western yarrow | *Achillea millefolium* var. *occidentalis* | | ACMI2 |
| Firecracker penstemon | *Penstemon eatonii* | Richfield | PEER |
| Giant evening primrose | *Oenothera hookeri* | | OEELH |
| Textile onion | *Allium textile* | | ALTE |
| Arrowleaf balsamroot | *Balsamorhiza sagittata* | | BASA3 |

| **Name** | ***Scientific*** | **Variety** | **SYMBOL** |
|---|---|---|---|
| Balsam groundsel | *Packera paupercula* | | PAPA20 |
| Dotted Gayfeather | *Liatris punctata* | | LIPU |

**Exhibit IV**

**Shallow Loamy 15-19 inch Ecological Site Description**

**Adapted from NRCS (2011)**

Site-specific conditions for shallow loamy 15-19 inch ecological sites were characterized using data collected at three monitoring locations (Table 1, Figure 1). Long-term monitoring reference sites for shallow loamy 15-19 inch ecological sites have been established in coordination with the BLM Authorized Officer (AO). Any additional monitoring site that is used for ecological site characterization that is located 100 meters outside of the CCSM Phase I limits of disturbance (LODs) may be suitable as a long-term monitoring reference site for shallow loamy 15-19 inch ecological site and may be used for future reclamation success monitoring purposes.

**Table 1. Representative transects for shallow loamy 15-19 inch ecological sites.**

| Transect Number | Record Date | Latitude | Longitude | Altitude | Transect Bearing |
|---|---|---|---|---|---|
| SHLY_1519_01 | 7/24/2014 | 41.53422 | -107.31707 | 8,301 | 85 |
| SHLY_1519_02 | 8/13/2014 | 41.46504 | -107.29799 | 8,153 | 320 |
| SHLY_1519_03 | 8/13/2014 | 41.45657 | -107.28906 | 8,133 | 310 |

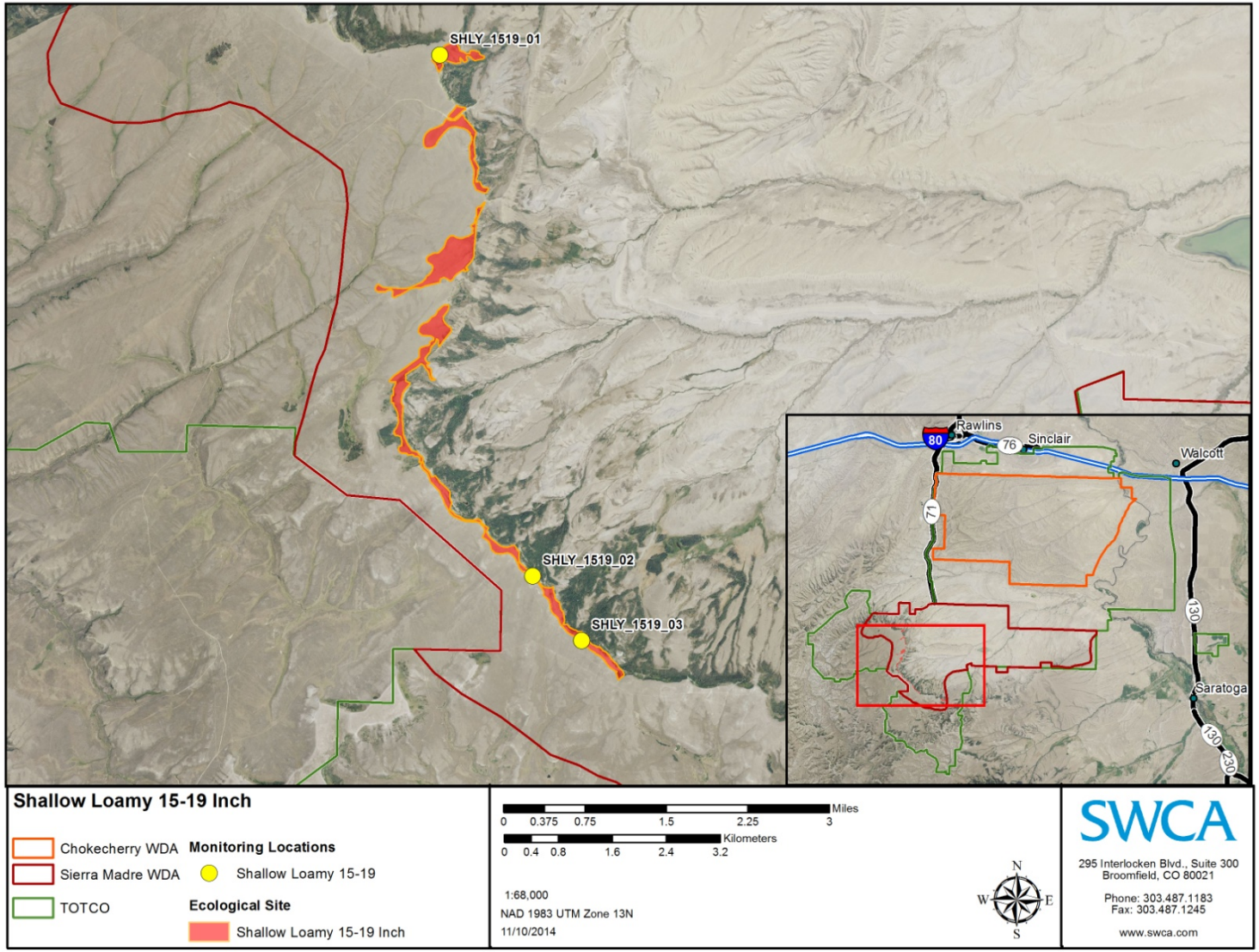


**Figure 1. Locations of reference sites used to characterize shallow loamy 15-19 inch ecological sites.**

**Site Characteristics**

## Climate

The mean annual precipitation in this zone is 14.90 inches, with June generally being the wettest month but July, August and September being dry. Snowfall may be heavy with an average of 150 inches. Temperatures at shallow loamy 15-19 inch sites average 38.16°F (21.88° F Avg. Min. to 54.66° F Avg. Max.) (NRCS 2011).

## Abiotic Landscape Features

Shallow loamy 15-19 inch ecological sites typically occur on most slopes and along ridge tops, slopes generally vary from 20-45%. Elevation is variable and ranges between 7,700 feet and 8,400 feet in the CCSM Phase I Site.

## Soil Characteristics

Shallow loamy 15-19 inch ecological sites are mostly shallow and are well-drained with rapid permeability.

Topsoil averages 6.3 ± 0.67 inches in depth. Topsoil textures range from loamy very fine sands to very fine sandy loams. Bedrock materials are variable but are all virtually impenetrable to plant root, limiting vegetation establishment and growth.

Shallow loamy 15-19 inch ecological sites are characterized by soils with moderate to high infiltration rates. Runoff potential is high due to easily saturated soils, shallow soil depths and poor water holding capacity. Rills and gullies are typically not present and surface water flow patterns should be indistinguishable (NRCS 2011). Chemical and physical crusts are rare to non-existent at these sites.

Soils are slightly to moderately alkaline with pH from 7.77 to 8.05 and non-saline with electrical conductivity of 0.01 to 0.08 dS/m. Soils are non-effervescent indicating presence of weakly and weakly covalent carbonates.

Figures 2 and 3 illustrate the soil surface and soil profile characteristics of a typical shallow loamy 15-19 inch site in the CCSM Phase I Site.

**Table 2. Soil characteristics typical of shallow loamy 15-19 inch ecological sites.**

| Soil Characteristics | Description |
|---|---|
| **Parent Material (Kind)** | Residuum, eolian |
| **Parent Material (Origin)** | Sedimentary, igneous |
| **Topsoil Depth[1]** | 6.3 ± 0.67 inches |
| **Topsoil Texture** | Loamy very fine sand to very fine sandy loam |
| **Subsoil Depth[2]** | None |
| **Subsoil Texture** | None |
| **Topsoil Fragments** | 10-40% volume, mixed rock, fine to medium gravel, subangular to subrounded |
| **Subsoil Fragments** | None |
| **Electrical Conductivity (Topsoil)** | 0.01-0.08 dS/m |
| **Salinity Class (Topsoil)** | Non-saline |
| **Electrical Conductivity (Subsoil)** | None |
| **Salinity Class (Subsoil)** | None |
| **Soil Reaction (Topsoil)** | 7.77-8.05 |
| **pH Class (Topsoil)** | Slightly to moderately alkaline |
| **Soil Reaction (Subsoil)** | None |
| **pH Class (Subsoil)** | None |
| **Carbonate Equivalent (Topsoil)** | Non-effervescent |
| **Carbonate Equivalent (Subsoil)** | None |

[1]Topsoil depth determined by depth of A Horizon.
[2]Subsoil depth determined by B and C horizons to a maximum of 20 inches depth including topsoil.

**Figure 2. Representative soil surface and ground cover for shallow loamy 15-19 inch ecological sites (SHLY_1519_03).**

**Figure 3. Representative soil profile for shallow loamy 15-19 inch ecological sites (SHLY_1519_03).**

## Vegetation Characteristics

Plant communities associated with shallow loamy 15-19 inch ecological sites in the CCSM Phase I Site are characterized by sparsely vegetated surfaces with 22%–35% basal cover (Tables 3 and 4). The remaining soil surface is characterized by rock fragments (40%–50%), unprotected soils (0% – 30%), and litter (7%–22%). Figure 4 illustrates representative vegetation communities associated with shallow loamy 15-19 inch ecological sites in the CCSM Phase I Site.

Shallow loamy 15-19 inch ecological sites subjected to frequent and severe grazing increases species such as bluegrasses and big sagebrush (*Artemisia tridentata)* while cool season grasses such as bluebunch wheatgrass (*Pseudoroegneria spicata)* will decrease in frequency and production. Under heavy continuous season-long grazing this site will convert to the bluebunch wheatgrass/mixed shrub plant community (NRCS 2011).

The BLM pick list in Table 5 (BLM 2011) and the species composition and cover (Tables 3 and 4) observed for shallow loamy 15-19 inch ecological sites will be used to guide the selection of appropriate seed mixes and application rates for revegetation. Final seed mixes will be determined based on seed availability at the time of revegetation efforts and in coordination with the BLM AO.

**Table 3. Vegetation characteristics typical of shallow loamy 15-19 inch ecological sites.**

| | | |
|---|---|---|
| Basal Vegetative Cover (LPI*) | 22%–35% | |
| Biological Soil Crust and Lichen (LPI*) | 0% | |
| Litter Cover (LPI*) | 7%–22% | |
| Surface Fragment/Rock Cover (LPI*) | 40%–50% | |
| Unprotected Soil(LPI*) | 0% – 30% | |
| Representative Species and Top-Canopy Cover* | *Pseudoroegneria spicata* | 22.3% average |
| | *Koeleria macrantha* | 10.0% average |
| | *Poa secunda* | 8.0% average |
| | *Stenotus acaulis* | 5.5% average |
| | *Astragalus* sp. | 5.5% average |
| | *Artemisia nova* | 4.0% average |

* Line point intercept

**Table 4. Species commonly associated with shallow loamy 15-19 inch ecological sites.**

| | |
|---|---|
| *Agoseris glauca* | *Lewisia rediviva* |
| *Allium cernuum* | *Linanthus pungens* |
| *Allium textile* | *Lithospermum sp.* |
| *Antennaria microphylla* | *Lomatium sp.* |
| *Antennaria sp.* | *Lygodesmia juncea* |
| *Arenaria congesta* | *Mertensia sp.* |
| *Arenaria hookeri* | *Nothocalais sp.* |
| *Artemisia frigida* | *Opuntia polyacantha* |
| *Artemisia nova* | *Oxytropis lagopus* |
| *Artemisia tridentata ssp. tridentata* | *Oxytropis sericea* |
| *Artemisia tridentata ssp. vaseyana* | *Oxytropis sp.* |
| *Astragalus purshii* | *Penstemon eriantherus* |
| *Astragalus sp.* | *Phlox hoodii* |
| *Astragalus spatulatus* | *Phlox hoodii ssp. muscoides* |
| *Carex rossii* | *Phlox longifolia* |
| *Castilleja linariifolia* | *Phlox sp.* |
| *Chrysothamnus viscidiflorus* | *Poa pratensis* |
| *Comandra umbellata* | *Poa secunda* |
| *Erigeron caespitosus* | *Pseudoroegneria spicata* |
| *Erigeron compositus* | *Sedum lanceolatum* |
| *Erigeron engelmannii* | *Senecio sp.* |
| *Erigeron sp.* | *Stenotus acaulis* |
| *Eriogonum flavum* | *Stenotus armerioides* |
| *Eriogonum ovalifolium* | *Symphoricarpos albus* |
| *Eriogonum sp.* | *Symphyotrichum eatonii* |
| *Eriogonum umbellatum* | *Tetradymia canescens* |
| *Festuca idahoensis* | *Townsendia sp.* |
| *Hesperostipa comata* | *Xylorhiza glabriuscula* |
| *Koeleria macrantha* | |

**Figure 4. Characteristic vegetation communities associated with shallow loamy 15-19 inch ecological sites in the CCSM Phase I Site (SHLY_1519_03).**

**Table 5. Recommended seed pick list for shallow loamy ecological sites.**

| **Name** | ***Scientific*** | **Variety** | **SYMBOL** |
|---|---|---|---|
| ***Grasses*** | | | |
| Western wheatgrass | *Pascopyrum smithii* | Rosana | PASM |
| Thickspike wheatgrass | *Elymus lanceolatus* | Critana | ELLA3 |
| Indian ricegrass | *Achnatherum hymenoides* | Rimrock (Nez Par) | ACHY |
| Green needlegrass | *Nassella viridula* | Lordon | NAVI4 |
| Prairie junegrass | *Koeleria macrantha* | | KOMA |
| Bottlebrush squirreltail | *Elymus elymoides* | Sand hollow | ELEL |
| Mutton bluegrass | *Poa fendleriana* | | POFE |
| Bluebunch wheatgrass | *Pseudoroegneria spicata* | Secor | PSSP6 |
| Basin wildrye | *Leymus cinereus* | Trailhead, Magnar | LECI |
| Galleta grass | *Pleuraphis jamesii* | Viva | PLJA |
| Idaho fescue | *Festuca idahoensis* | Nezperce, Joseph | FEID |
| Mountain brome | *Bromus marginatus* | Garnet | BRMA4 |
| ***Shrubs*** | | | |
| Wyoming big sagebrush | *Artemisia tridentata* ssp. *wyomingensis* | | ARTRW8 |
| Mountain big sagebrush | *Artemisia tridentata* ssp. *vaseyana* | | ARTRV |
| Fourwing saltbush | *Atriplex canaescens* | Wytana | ATCA2 |
| Antelope bitterbrush | *Purshia tridentata* | | PUTR2 |
| Snowberry | *Symphoricarpos* spp. | Maybell | SYOR2 |
| Winterfat | *Krascheninnikovia lanata* | Open Range | KRLA |
| Shadscale saltbush | *Atriplex confertifolia* | | ATCO |
| Mountain mahogany | *Cercocarpus montanus* | Montane | CEMO2 |
| White sagebrush | *Artemisia ludoviciana* | | ARLU |
| ***Forbs*** | | | |
| Lewis' flax | *Linum lewisii* | | LILI |
| Scarlet globemallow | *Sphaeralcea coccinea* | | SPCO |
| American vetch | *Vicia americana* | | VIAM |
| Lupine | *Lupinus sericeus* | | LUSE4 |
| Blanketflower | *Gaillardia aristata* | | GAAR |
| Western yarrow | *Achillea millefolium* var. *occidentalis* | | ACMI2 |
| Firecracker penstemon | *Penstemon eatonii* | Richfield | PEER |
| Giant evening primrose | *Oenothera hookeri* | | OEELH |

| **Name** | ***Scientific*** | **Variety** | **SYMBOL** |
|---|---|---|---|
| Textile onion | *Allium textile* | | ALTE |
| Arrowleaf balsamroot | *Balsamorhiza sagittata* | | BASA3 |
| Balsam groundsel | *Packera paupercula* | | PAPA20 |
| Dotted Gayfeather | *Liatris punctata* | | LIPU |

**Exhibit IV**

**Shallow Sandy 10-14 inch Ecological Site Description**

**Adapted from NRCS (2011)**

Site-specific conditions for shallow sandy 10-14 inch ecological sites in the CCSM Phase I Site were characterized using data collected at one monitoring location (Figure 1, Table 1). Long-term monitoring reference sites for shallow sandy 10-14 inch ecological sites have been established in coordination with the BLM Authorized Officer (AO). Any additional monitoring site that is used for ecological site characterization that is located outside of the CCSM Phase I limits of disturbance (LODs) may be suitable as a long-term monitoring reference site for shallow sandy 10-14 inch ecological site and may be used for future reclamation success monitoring purposes.

**Table 1. Representative transects for shallow sandy 10-14 inch ecological sites in the CCSM Phase I Site.**

| Transect Number | Record Date | Latitude | Longitude | Altitude | Transect Bearing |
|---|---|---|---|---|---|
| SHSA_1014_01 | 7/26/2014 | 41.64684 | -107.18615 | 7,474 | 275 |
| SHSA_1014_02 | 6/27/2014 | 41.63807 | -107.13793 | 7,346 | 240 |
| SHSA_1014_03 | 7/16/2014 | 41.64518 | -107.13931 | 7,293 | 120 |

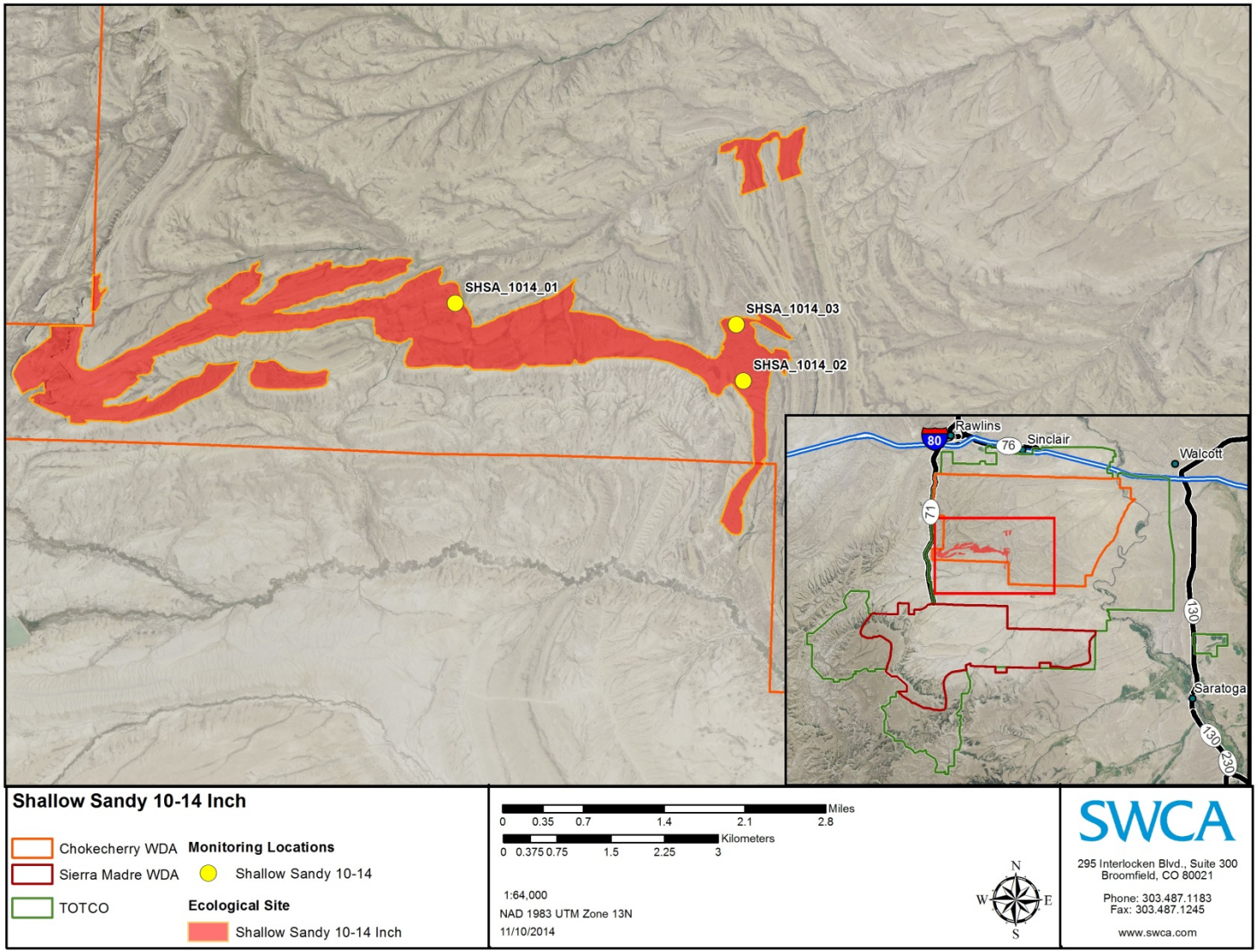


**Figure 1. Locations of reference sites used to characterize shallow sandy 10-14 inch ecological sites in the CCSM Phase I Site.**

**Site Characteristics**

## Climate

The mean annual precipitation at these sites is 11.5 inches (29 cm), with peaks observed in May and the lowest totals recorded in the winter months. Average snow fall often exceeds 20 inches annually. Wide fluctuations do occur and result in more dry years than normal years (NRCS 2011). Due to the high elevations and dry air, temperatures at shallow sandy 10-14 inch ecological sites range significantly between summer and winter and daily maximum and minimums. The average annual air temperature is 42.2 °F (30.4 °F Avg. Min. to 53.9 °F Avg. Max.). Extreme minimum temperatures can occur during the winter months when cold air outbreaks and winter storms move rapidly from northwest to southeast. Chinook winds can occur in winter bringing rapid rises in temperature. Winds speeds are lower than other areas of the state. Daytime winds are stronger than nighttime with some strong gusts associated with the passage of winter storms (NRCS 2011).

## Abiotic Landscape Features

Shallow sandy 10-14 inch ecological sites in the CCSM Phase I Site typically occur on upland positions on south and west facing slopes. Slopes vary, but are typically between 0% and 45% on hills, ridges and escarpments. Elevation is variable and ranges between 7,200 feet and 7,900 feet in the CCSM Phase I Site.

## Soil Characteristics

Shallow sandy 10-14 inch ecological sites within the CCSM Phase I Site are well drained, typically shallow over sedimentary bedrock. Textures range from very sandy loams to clay loams.

Topsoil depths are approximately 9.4 ± 0.19 inches in depth. Topsoils have fine sand to fine sandy loam textures. Gravel modifiers are generally present in the topsoil although the volume of rock fragments is generally very low in both horizons. Shallow sandy 10-14 inches ecological sites are typically not limited by restrictive layers in subsurface horizons; however, an increased volume of gravel and rock modifiers (greater than 15% volume) may increase limitations for vegetation establishment and growth.

Shallow sandy 10-14 inch ecological sites in the CCSM Phase I Site are characterized by soils with low infiltration rates particularly when soils is wet due to the shallow depth to bedrock and/or an impervious subsurface layer (NRCS 2011); runoff rates vary from moderate to high depending on soil depth, bedrock type and ground cover. Rills and gullies are typically not present and surface water flow patterns are often indistinguishable (NRCS 2011). Chemical and physical crusts are rare to non-existent at these sites (NRCS 2011).

Soils are neutral to strongly alkaline with a pH range from 7.33 to 8.60 and non-saline to very slightly saline with an electrical conductivity around 0.02 to 0.42 dS/m. Where soil pH ranges exceed 8.4, soils may have limited reclamation potential and may need to be evaluated for potential soil treatment. Soils are non-effervescent to strongly effervescent indicating presence of weak to strongly covalent carbonates.

Figures 2 and 3 illustrate the soil surface and soil profile characteristics of a shallow sandy 10-14 inch site in the CCSM Phase I Site.

**Table 2. Soil characteristics typical of shallow sandy 10-14 inch ecological sites.**

| Soil Characteristics | Description |
|---|---|
| **Parent Material (Kind)** | Residuum, eolian |
| **Parent Material (Origin)** | Sedimentary |
| **Topsoil Depth[1]** | 9.4 ± 0.19 inches |
| **Topsoil Texture** | Fine sand to fine sandy loam |
| **Subsoil Depth[2]** | None |
| **Subsoil Texture** | None |
| **Topsoil Fragments** | 0-20% volume, sedimentary, channers, subangular |
| **Subsoil Fragments** | None |
| **Electrical Conductivity (Topsoil)** | 0.02-0.42 dS/m |
| **Salinity Class (Topsoil)** | Non-saline to very slightly saline |
| **Electrical Conductivity (Subsoil)** | None |
| **Salinity Class (Subsoil)** | None |
| **Soil Reaction (Topsoil)** | 7.33-8.60 |
| **pH Class (Topsoil)** | Neutral to strongly alkaline |
| **Soil Reaction (Subsoil)** | None |
| **pH Class (Subsoil)** | None |
| **Carbonate Equivalent (Topsoil)** | Non-effervescent to strongly effervescent |
| **Carbonate Equivalent (Subsoil)** | None |

[1]Topsoil depth determined by depth of A Horizon.
[2]Subsoil depth determined by B and C horizons to a maximum of 20 inches depth including topsoil.

**Figure 2. Representative soil surface and ground cover for shallow sandy 10-14 inch sites in the CCSM Phase I Site (SHSA_1014_03)**

**Figure 3. Representative soil profile for shallow sandy 10-14 inch sites in the CCSM Phase I Site (SHSA_1014_02).**

## Vegetation Characteristics

Plant communities associated with shallow sandy 10-14 inch ecological sites in the CCSM Phase I Site are characterized by vegetated surfaces with 13%–17% basal cover (Table 3). The remaining soil surface is characterized primarily by unprotected soils (27% – 44%), litter (10%–22%), and rock fragments (18%–44%). Figure 4 illustrates representative vegetation communities associated with shallow sandy 10-14 inch ecological sites in the CCSM Phase I Site.

When shallow sandy 10-14 inch ecological sites are subjected to frequent and severe grazing, woody species such as big sagebrush (*Artemisia tridentata*) and rabbitbrush (*Chrysothamnus* and *Ericameria* spp.) increase. Cool season bunchgrasses such as bluebunch wheatgrass (*Pseudoroegneria spicata*) and Sandberg bluegrass (*Poa secunda*) begin to decline. Severe ground disturbance and/or continuous heavy grazing will convert this community to a big sagebrush/cheatgrass state.

The BLM pick list in Table 5 (BLM 2011) and the species composition and cover (Tables 3 and 4) observed for shallow sandy 10-14 inch ecological sites will be used to guide the selection of appropriate seed mixes and application rates for revegetation. Final seed mixes will be determined based on seed availability at the time of revegetation efforts and in coordination with the BLM AO.

**Table 3. Vegetation characteristics typical of shallow sandy 10-14 inch ecological sites.**

| | | |
|---|---|---|
| Basal Vegetative Cover (LPI*) | 13%–17% | |
| Biological Soil Crust and Lichen (LPI*) | 0%–3% | |
| Litter Cover (LPI*) | 10%–22% | |
| Surface Fragment/Rock Cover (LPI*) | 18%–44% | |
| Unprotected Soil(LPI*) | 27% – 44% | |
| Representative Species and Top-Canopy Cover* | *Pseudoroegneria spicata* | 15.3% average |
| | *Poa secunda* | 8.5% average |
| | *Bromus tectorum* | 7.0% average |
| | *Artemisia nova* | 7.0% average |
| | *Heterotheca villosa* | 6.0% average |
| | *Arenaria hookeri* | 4.0% average |
| | *Artemisia tridentata* ssp. *wyomingensis* | 4.0% average |

* Line point intercept

**Table 4. Species commonly associated with shallow sandy 10-14 inch ecological sites.**

| | |
|---|---|
| *Achillea millefolium* | *Heterotheca villosa* |
| *Achnatherum hymenoides* | *Koeleria macrantha* |
| *Agoseris glauca* | *Krascheninnikovia lanata* |
| *Allium textile* | *Lappula occidentalis var. cupulata* |
| *Alyssum desertorum* | *Linanthus pungens* |
| *Arenaria hookeri* | *Lygodesmia juncea* |
| *Artemisia frigida* | *Machaeranthera grindelioides* |
| *Artemisia nova* | *Machaeranthera sp.* |
| *Artemisia tridentata ssp. vaseyana* | *Mertensia sp.* |
| *Artemisia tridentata ssp. wyomingensis* | *Nothocalais sp.* |
| *Astragalus purshii* | *Opuntia polyacantha* |
| *Astragalus sp.* | *Paronychia sessiliflora* |
| *Bromus tectorum* | *Pascopyrum smithii* |
| *Carex filifolia* | *Penstemon eriantherus* |
| *Castilleja linariifolia* | *Penstemon sp.* |
| *Chrysothamnus viscidiflorus* | *Phlox hoodii* |
| *Cryptantha sp.* | *Phlox sp.* |
| *Delphinium geyeri* | *Physaria acutifolia* |
| *Descurainia pinnata* | *Poa secunda* |
| *Elymus elymoides* | *Pseudoroegneria spicata* |
| *Elymus trachycaulus* | *Sedum lanceolatum* |
| *Ericameria nauseosa* | *Sphaeralcea coccinea* |
| *Erigeron caespitosus* | *Stenotus acaulis* |
| *Eriogonum brevicaule* | *Stenotus armerioides* |
| *Eriogonum flavum* | *Tragopogon dubius* |
| *Eriogonum ovalifolium* | *Trifolium gymnocarpon* |
| *Eriogonum sp.* | *Zigadenus sp.* |
| *Hesperostipa comata* | |

**Figure 4. Characteristic vegetation communities associated with shallow sandy 10-14 inch sites in the CCSM Phase I Site (SHLY_1014_02)**

**Table 5. Recommended seed pick list for shallow sandy ecological sites.**

| **Name** | ***Scientific*** | **Variety** | **SYMBOL** |
|---|---|---|---|
| ***Grasses*** | | | |
| Western wheatgrass | *Pascopyrum smithii* | Rosana | PASM |
| Thickspike wheatgrass | *Elymus lanceolatus* | Critana | ELLA3 |
| Blowout grass | *Redfieldia flexuosa* | | REFL |
| Prairie sandreed | *Calamovilfa longifolia* | Goshen | CALO |
| Indian ricegrass | *Achnatherum hymenoides* | Rimrock (Nez Par) | ACHY |
| Green needlegrass | *Nassella viridula* | | NAVI4 |
| Needleandthread | *Hesperostipa comata* | | HECO26 |
| Mutton bluegrass | *Poa fendleriana* | | POFE |
| Sand dropseed | *Sporobolus cryptandrus* | Borden County | SPCR |
| Canby bluegrass | *Poa secunda* | Canbar | POSE |
| Galleta grass | *Pleuraphis jamesii* | Viva | PLJA |
| Idaho fescue | *Festuca idahoensis* | Nezperce/Joseph | FEID |
| Mountain brome | *Bromus marginatus* | Garnet | BRMA4 |
| Prairie Junegrass | *Koeleria macrantha* | | KOMA |
| Spike muhly | *Muhlenbergia wrightii* | El Vado | MUWR |
| ***Shrubs*** | | | |
| Silver sagebrush | *Artemisia cana* | | ARCA13 |
| Fourwing saltbush | *Atriplex canescens* | Wytana | ATCA2 |
| Antelope bitterbrush | *Purshia tridentata* | | PUTR2 |
| Winterfat | *Krascheninnikovia lanata* | Open Range | KRLA |
| White sagebrush | *Artemisia ludoviciana* | | ARLU |
| Spiny hopsage | *Grayia spinosa* | | GRSP |
| Wyoming big sagebrush | *Artemisia tridentata* ssp. *wyomingensis* | | ARTRW8 |
| Basin big sagebrush | *Artemisia tridentata* ssp. *tridentata* | | ARTRT |
| ***Forbs*** | | | |
| Firecracker penstemon | *Penstemon eatonii* | | PEEA |
| Lewis' flax | *Linum lewisii* | Appar | LILI |
| Rocky Mountain beeplant | *Cleome serrulata* | | CLSE |
| Western yarrow | *Achillea millefolium* L. var. *occidentalis* | | ACMI |
| Slimflower scurfpea | *Psoralidium tenuiflorum* | | PSTE5 |

| **Name** | ***Scientific*** | **Variety** | **SYMBOL** |
|---|---|---|---|
| Dotted gayfeather | *Liatris punctata* | | LIPU |

**Exhibit VI**

**Mountain Windswept Ridge 15-19 inch Ecological Site Description**

**Adapted from NRCS (2011)**

Site-specific conditions for mountain windswept ridge 15-19 inch ecological sites in the CCSM Phase I Site were characterized using data collected at three monitoring locations (Table 1, Figure 1). Long-term monitoring reference sites for mountain windswept ridge 15-19 inch ecological sites have been established in coordination with the BLM Authorized Officer (AO). Any additional monitoring site that is used for ecological site characterization that is located 100 meters outside of the CCSM Phase I limits of disturbance (LODs) may be suitable as a long-term monitoring reference site for mountain windswept ridge 15-19 inch ecological site and may be used for future reclamation success monitoring purposes.

**Table 1. Representative transects for mountain windswept ridge 15-19 inch ecological sites in the CCSM Phase I Site.**

| Transect Number | Record Date | Latitude | Longitude | Altitude | Transect Bearing |
|---|---|---|---|---|---|
| MWR_1519_01 | 7/24/2014 | 41.53485 | -107.31808 | 8,353 | 275 |
| MWR_1519_02 | 7/24/2014 | 41.52748 | -107.31541 | 8,268 | 330 |
| MWR_1519_03 | 7/25/2014 | 41.54280 | -107.35106 | 8,432 | 60 |

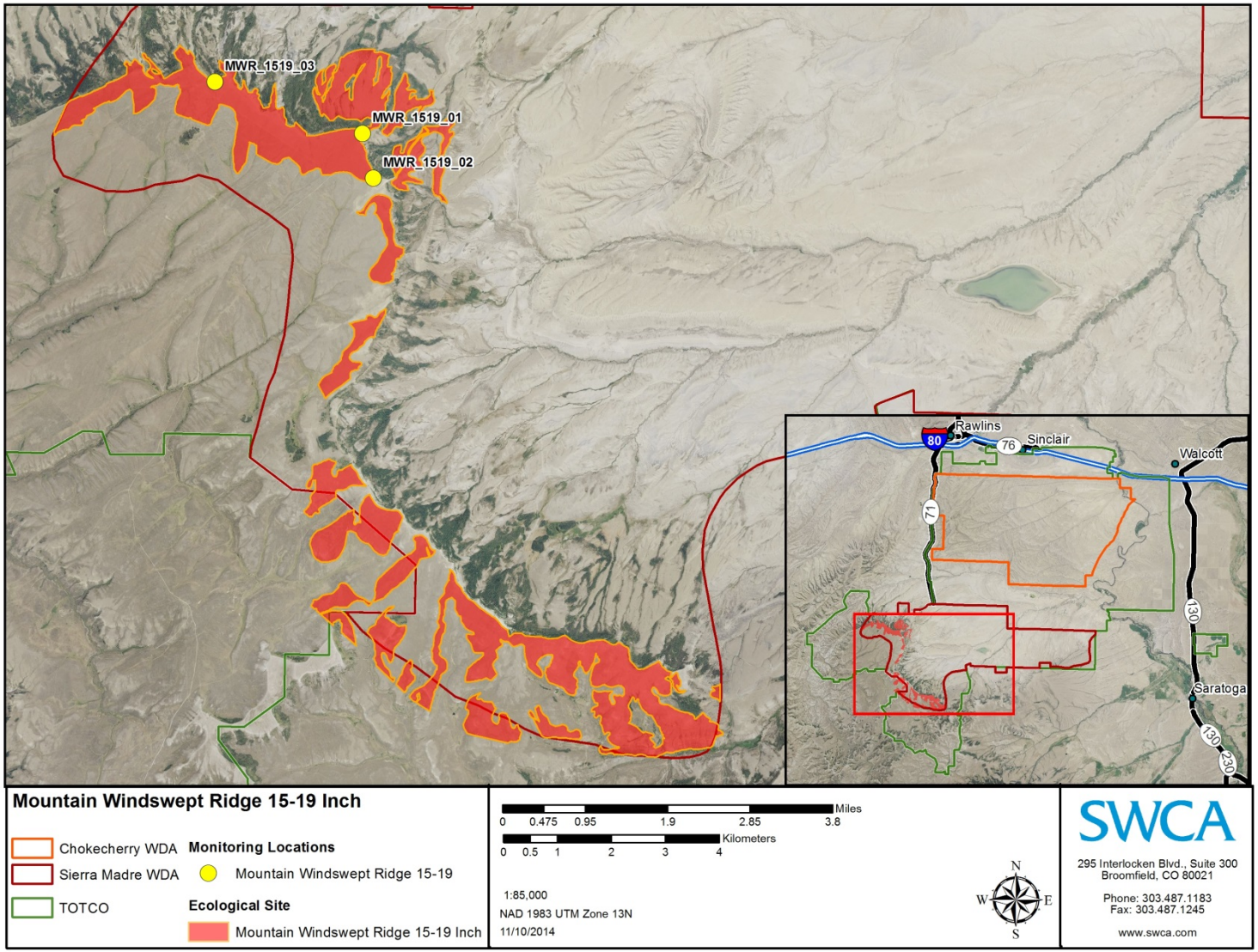


**Figure 1. Locations of reference sites used to characterize mountain windswept ridge 15-19 inch ecological sites in the CCSM Phase I Site.**

**Site Characteristics**

*Climate*

The mean annual precipitation at these sites is 16.0 inches, with peaks observed in August and the lowest totals recorded in the winter months. Wide fluctuations do occur and result in more dry years than normal years (NRCS 2011). Due to the high elevations and dry air, temperatures at mountain windswept ridge 15-19 inch ecological sites range significantly between summer and winter and daily maximum and minimums. The average annual air temperature is 44.7°F (ranging from 32.1°F Avg. Min. to 57.2°F Avg. Max). Extreme minimum temperatures can occur during the winter months when cold air outbreaks and winter storms move rapidly from northwest to southeast.

*Abiotic Landscape Features*

Mountain windswept ridge 15-19 inch ecological sites in the CCSM Phase I Site occur on benches, ridges, toeslopes, and fans of foothills in landslide areas and in valleys. Slopes range from nearly level to 50%. Elevation is variable and ranges between 7,300 feet and 8,500 feet in the CCSM Phase I Site.

*Soil Characteristics*

Mountain windswept ridge 15-19 inch ecological sites within the CCSM Phase I Site are deep to moderately deep, and well drained and often greater than 20 inches to bedrock. Topsoil textures are characterized by very fine sandy loams. Subsoils are similar in texture and range from fine sandy loams to sandy clay loams.

Topsoil depth averages 4.6 ± 0.21 inches. Lower soil horizon depths often exceed 15.1 inches. Mountain windswept ridge 15-19 inch ecological sites in the CCSM Phase I Site are characterized by soils with slow to medium runoff potential with moderate erosion hazard.

Soils are moderately to strongly alkaline with a pH of 7.90 to 8.50 and non-saline to very non-saline with electrical conductivities ranging between 0.02 and 0.05 dS/m. Soils are non-effervescent indicating low presence of weakly covalent carbonates.

Figures 2 and 3 illustrate the soil surface and soil profile characteristics of a typical mountain windswept ridge 15-19 inch site in the CCSM Phase I Site.

**Table 2. Soil characteristics typical of mountain windswept ridge 15-19 inch ecological sites.**

| Soil Characteristics | Description |
|---|---|
| **Parent Material (Kind)** | Residuum, colluvium |
| **Parent Material (Origin)** | Sedimentary, igneous |
| **Topsoil Depth[1]** | 4.6 ± 0.21 inches |
| **Topsoil Texture** | Very fine sandy loam |
| **Subsoil Depth[2]** | 15.1 ± 0.21 inches |
| **Subsoil Texture** | Fine sandy loam to sandy clay loam |
| **Topsoil Fragments** | 0-25% volume, mixed rock, fine gravel, subrounded |
| **Subsoil Fragments** | 0-50% volume, mixed rock, fine gravel, subrounded |
| **Electrical Conductivity (Topsoil)** | 0.02-0.05 dS/m |
| **Salinity Class (Topsoil)** | Non-saline |
| **Electrical Conductivity (Subsoil)** | 0.02-0.03 dS/m |
| **Salinity Class (Subsoil)** | Non-saline |
| **Soil Reaction (Topsoil)** | 7.90-8.23 |
| **pH Class (Topsoil)** | Moderately alkaline |
| **Soil Reaction (Subsoil)** | 7.90-8.50 |
| **pH Class (Subsoil)** | Moderately to strongly alkaline |
| **Carbonate Equivalent (Topsoil)** | Non-effervescent |
| **Carbonate Equivalent (Subsoil)** | Non-effervescent |

[1]Topsoil depth determined by depth of A Horizon.
[2]Subsoil depth determined by B and C horizons to a maximum of 20 inches depth including topsoil.

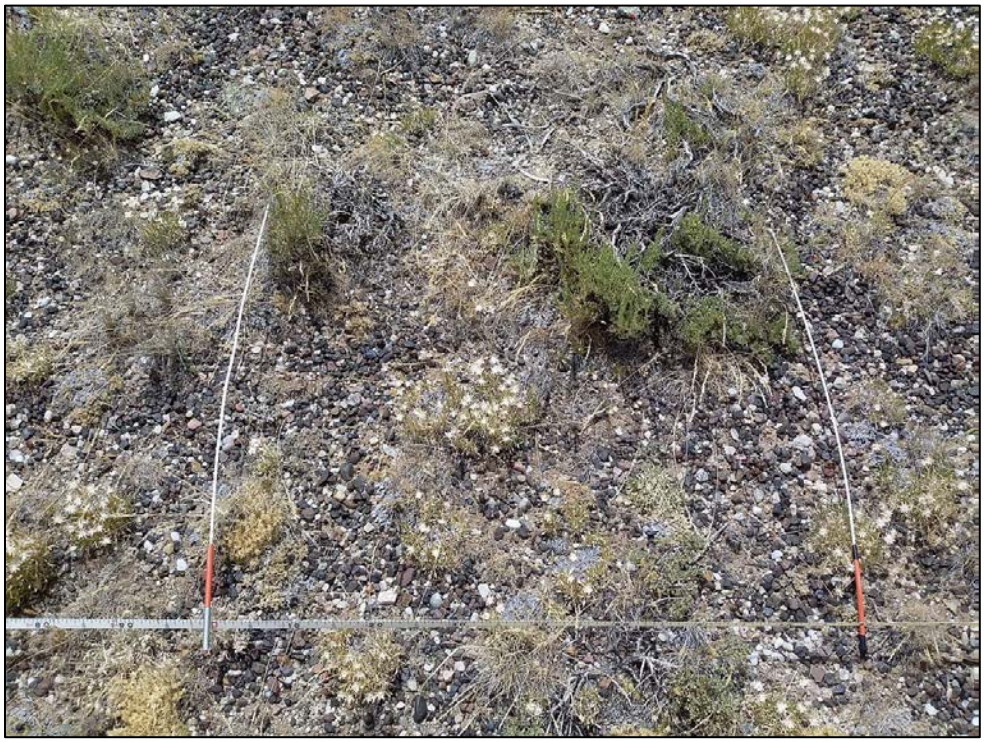

**Figure 2. Representative soil surface and ground cover for mountain windswept ridge 15-19 inch sites in the CCSM Phase I Site (MWR_1519_02).**

**Figure 3. Representative soil profile for mountain windswept ridge 15-19 inch sites in the CCSM Phase I Site. (MWR_1519_02).**

*Vegetation Characteristics*

Plant communities associated with mountain windswept ridge 15-19 inch ecological sites in the CCSM Phase I Site are characterized by highly vegetated surfaces with 21%–38% basal cover (Tables 3 and 4). The remaining soil surface is characterized by surface rock fragment (45%–54%), unprotected soils (4%–18%), and litter cover (3%–16%). Figure 4 illustrates representative vegetation communities associated with mountain windswept ridge 15-19 inch ecological sites in the CCSM Phase I Site.

Mountain windswept ridge 15-19 inch ecological sites subjected to frequent and severe grazing increases the woody species component such as black sagebrush (*Artemisia nova*) and low rabbitbrush (*Chrysothamnus viscidiflorus*), and herbaceous species component of bluebunch wheatgrass (*Pseudoroegneria spicata*). Following fire, this community would transition from a black sagebrush and Idaho fescue community to a plant community dominated by low rabbitbrush and annual forbs and grasses.

The BLM pick list in Table 5 (BLM 2011) and the species composition and cover (Tables 3 and 4) observed for mountain windswept ridge 15-19 inch ecological sites will be used to guide the selection of appropriate seed mixes and application rates for revegetation. Final seed mixes will be determined based on seed availability at the time of revegetation efforts and in coordination with the BLM AO.

**Table 3. Vegetation characteristics typical of mountain windswept ridge 15-19 inch ecological sites.**

| | | |
|---|---|---|
| Basal Vegetative Cover (LPI*) | 21%–38% | |
| Biological Soil Crust and Lichen (LPI*) | 0% | |
| Litter Cover (LPI*) | 3%–16% | |
| Surface Fragment/Rock Cover (LPI*) | 45%–54% | |
| Unprotected Soil(LPI*) | 4% – 18% | |
| Representative Species and Top-Canopy Cover* | *Poa secunda* | 11.7% average |
| | *Pseudoroegneria spicata* | 11.7% average |
| | *Koeleria macrantha* | 8.5% average |
| | *Poa fendleriana* | 7.0% average |
| | *Artemisia frigida* | 5.3% average |
| | *Artemisia nova* | 3.7% average |

* Line point intercept

**Table 4. Species commonly associated with mountain windswept ridge 15-19 inch ecological sites.**

| | |
|---|---|
| *Achillea millefolium* | *Lithospermum incisum* |
| *Antennaria microphylla* | *Lithospermum sp.* |
| *Antennaria sp.* | *Lupinus argenteus* |
| *Arenaria congesta* | *Nassella viridula* |
| *Artemisia nova* | *Orthocarpus luteus* |
| *Artemisia tridentata ssp. tridentata* | *Oxytropis sericea* |
| *Artemisia tridentata ssp. vaseyana* | *Oxytropis sp.* |
| *Astragalus agrestis* | *Pascopyrum smithii* |
| *Astragalus bisulcatus* | *Penstemon caespitosus* |
| *Astragalus purshii* | *Penstemon sp.* |
| *Astragalus sp.* | *Phleum pratense* |
| *Bromus marginatus* | *Phlox hoodii* |
| *Carex geyeri* | *Phlox multiflora* |
| *Carex rossii* | *Poa ampla* |
| *Castilleja linariifolia* | *Poa fendleriana* |
| *Chrysothamnus viscidiflorus* | *Poa pratensis* |
| *Cirsium scariosum* | *Poa secunda* |
| *Cirsium sp.* | *Potentilla gracilis* |
| *Cordylanthus ramosus* | *Pseudoroegneria spicata* |
| *Elymus glaucus* | *Puccinellia nuttalliana* |
| *Erigeron sp.* | *Purshia tridentata* |
| *Eriogonum flavum* | *Rosa woodsii* |
| *Eriogonum sp.* | *Sedum lanceolatum* |
| *Eriogonum umbellatum* | *Senecio sp.* |
| *Festuca idahoensis* | *Silene parryi* |
| *Geranium richardsonii* | *Sphaeralcea coccinea* |
| *Hesperostipa comata* | *Symphoricarpos albus* |
| *Juniperus communis* | *Symphyotrichum eatonii* |
| *Koeleria macrantha* | *Symphyotrichum lanceolatum* |
| *Leucopoa kingii* | *Taraxacum officinale* |
| *Linanthus pungens* | *Trifolium gymnocarpon* |
| *Lithophragma tenellum* | |

**Figure 4. Characteristic vegetation communities associated with mountain windswept ridge 15-19 inch sites in the CCSM Phase I Site (MWR_1519_02)**

**Table 5. Recommended seed pick list for mountain windswept ridge ecological sites (BLM 2011).**

| **Name** | ***Scientific*** | **Variety** | **SYMBOL** |
|---|---|---|---|
| ***Grasses*** | | | |
| Western wheatgrass | *Pascopyrum smithii* | Rosana | PASM |
| Thickspike wheatgrass | *Elymus lanceolatus* | Critana | ELLA3 |
| Indian ricegrass | *Achnatherum hymenoides* | Rimrock (Nez Par) | ACHY |
| Green needlegrass | *Nassella viridula* | Lordon | NAVI4 |
| Prairie junegrass | *Koeleria macrantha* | | KOMA |
| Bottlebrush squirreltail | *Elymus elymoides* | Sand hollow | ELEL |
| Mutton bluegrass | *Poa fendleriana* | | POFE |
| Bluebunch wheatgrass | *Pseudoroegneria spicata* | Secor | PSSP6 |
| Basin wildrye | *Leymus cinereus* | Trailhead, Magnar | LECI |
| Galleta grass | *Pleuraphis jamesii* | Viva | PLJA |
| Idaho fescue | *Festuca idahoensis* | Nezperce, Joseph | FEID |
| Mountain brome | *Bromus marginatus* | Garnet | BRMA4 |
| ***Shrubs*** | | | |
| Wyoming big sagebrush | *Artemisia tridentata* ssp. *wyomingensis* | | ARTRW8 |
| Mountain big sagebrush | *Artemisia tridentata* ssp. *vaseyana* | | ARTRV |
| Fourwing saltbush | *Atriplex canaescens* | Wytana | ATCA2 |
| Antelope bitterbrush | *Purshia tridentata* | | PUTR2 |
| Snowberry | *Symphoricarpos* spp. | Maybell | SYOR2 |
| Winterfat | *Krascheninnikovia lanata* | Open Range | KRLA |
| Shadscale saltbush | *Atriplex confertifolia* | | ATCO |
| Mountain mahogany | *Cercocarpus montanus* | Montane | CEMO2 |
| White sagebrush | *Artemisia ludoviciana* | | ARLU |
| ***Forbs*** | | | |
| Lewis' flax | *Linum lewisii* | | LILI |
| Scarlet globemallow | *Sphaeralcea coccinea* | | SPCO |
| American vetch | *Vicia americana* | | VIAM |
| Lupine | *Lupinus sericeus* | | LUSE4 |
| Blanketflower | *Gaillardia aristata* | | GAAR |
| Western yarrow | *Achillea millefolium* var. *occidentalis* | | ACMI2 |
| Firecracker penstemon | *Penstemon eatonii* | Richfield | PEER |
| Giant evening primrose | *Oenothera hookeri* | | OEELH |
| Textile onion | *Allium textile* | | ALTE |

| **Name** | ***Scientific*** | **Variety** | **SYMBOL** |
|---|---|---|---|
| Arrowleaf balsamroot | *Balsamorhiza sagittata* | | BASA3 |
| Balsam groundsel | *Packera paupercula* | | PAPA20 |
| Dotted Gayfeather | *Liatris punctata* | | LIPU |

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# ATTACHMENT E

## Saline Ecological Site Class Reclamation Implementation Plan

## and

## Saline Ecological Site Descriptions

## for

## Phase I of the Chokecherry and Sierra Madre Wind Energy Project

## Introduction

This Saline Ecological Site Class Reclamation Implementation Plan describes the common and ecological site-specific characteristics, reclamation practices, and BMPs that will be applied within the CCSM Project Site. Ecological sites in the CCSM Project Site were established cooperatively with the BLM and are a result of robust soil and vegetation sampling, landform analysis, and precipitation zone evaluation. The ecological sites are consistent with the Cool Central Desertic Basins and Plateaus (Major Land Resource Area [MLRA] – 34A) and Southern Rocky Mountain Foothills (MLRA – 49) MLRAs (Natural Resources Conservation Service [NRCS] 2006) and are primarily located in the Wyoming Basin Province of the Rocky Mountain System (NRCS 2011).

Based on common reclamation characteristics, individual ecological sites were grouped into similar ecological site classes (saline, clay, loam, shallow , and sand). Grouping similar ecological sites into a common ecological site class will increase efficiency and effectiveness of reclamation efforts as many of these common sites will have identical or very similar measures for soil handling, site preparation, and revegetation.

The following reclamation implementation plan describes the reclamation procedures and BMPs that will be applied to the ecological sites within the Saline ecological site class. The Saline ecological site class includes the following ecological sites:

- Deep Shale 7-9 Inch (see Exhibit I)
- Deep Shale 10-14 Inch (see Exhibit II)
- Saline Lowland 7-9 Inch (see Exhibit III)
- Saline Upland 7-9 Inch (see Exhibit IV)
- Saline Upland 10-14 Inch (see Exhibit V)
- Shale 10-14 Inch (see Exhibit VI)

## Reclamation Procedures and Best Management Practices

Site-specific reclamation procedures and BMPs have been developed for this Saline Ecological Site Class Reclamation Implementation Plan. Many of the reclamation procedures and BMPs will be implemented across all saline ecological sites in the CCSM Project while other measures will be specific to an individual ecological site or smaller group of ecological sites within the Saline ecological site class.

Reclamation procedures and BMPs account for abiotic landscape features, soil characteristics, and vegetation characteristics and were designed to mitigate impacts to the abiotic and biotic factors characteristic of each ecological site and increase reclamation success. These procedures were developed in accordance with the CCSM Project Master Reclamation Plan (BLM 2012a), BLM Wyoming Reclamation Policy (2012b), management directives presented in the Rawlins Field Office (RFO) Resource Management Plan (RMP) (BLM 2008), RFO Reclamation Guidance (BLM 2011), Wyoming Department of Environmental Quality (WDEQ) Land Quality Division reclamation guidelines (WDEQ 2007), Wyoming Reclamation and Restoration Center (WRRC) Handbook of Western Reclamation Techniques (WRRC 2006), State of Wyoming's reclamation guidance for wind development, and in coordination with BLM staff. This Saline Ecological Site Class Reclamation Implementation Plan is intended to be adaptive and to take

into account changing conditions and technologies. PCW, with concurrence from the BLM AO, may update, modify, or change the procedures contained in this plan if warranted due to site conditions or other factors.

In accordance with the guidance described above, reclamation practices and BMPS have been developed to address abiotic landscape features, soil handling, site preparation, and vegetation handling and revegetation. The following sections describe the practices specific to saline ecological sites in Phase I of the CCSM Project.

## Soil Handling and Site Preparation

Soil associated with each ecological site will be managed in accordance with the BLM Wyoming Reclamation Policy (2012b) and as detailed in the CCSM Project Master Reclamation Plan (2012a) and the site-specific reclamation plan for Phase I of the CCSM Project. Provisions are included below for segregating and marking stockpiles, as well as requirements to protect stockpiled material from erosion, contamination and degradation. Site-specific soil handling and site preparation measures for saline ecological sites are listed below:

*Soil handling practices and BMPs for **all saline ecological sites**[1]. These measures would be applied to all saline ecological sites.*

- Soil will be handled as saline/sodic soil type and will not be used as fill on any other ecological sites or stockpiled outside of the ecological site boundaries.
- Apply mulch and/or soil tackifiers to assist in mitigating stockpile wind erosion and contribute organic materials.
- As necessary, rip and aerate prior to mulching.
- As necessary, apply wood straw to improve soil aggregation, increase porosity and permeability, and improve aeration and drainage, for stockpiles stored for more than two years.
- Limit topsoil stripping and salvage.
- When practicable, use growth and till cycles to maintain biological activity, reduce compaction, and incorporate native organic matter and seed sources, in soil stockpiles that are stored for more than two years.
- Seed long-term stockpiles with appropriate vegetation to maintain biological activity and prevent wind erosion.
- Trap moisture during winter months through the use of snow fences, if appropriate.
- Include native vegetation into salvaged topsoil to include organic matter and maintain native seedbank.
- When applicable, locate stockpiles within disturbed areas to reduce additional surface disturbance to native topsoil.

[1] Saline Ecological Sites include Saline Lowland 7-9 Inch, Saline Upland 7-9 Inch, and Saline Upland 10-14 Inch

*Site preparation practices and BMPs for **all saline ecological sites**. These measures would be applied to all saline ecological sites.*

- Deep rip subsoils prior to application of topsoil to improve drainage.
- Perform secondary tillage of topsoil to break up clods; secondary tillage will be no deeper than the depth of the replaced topsoil.
- Till across slope or perpendicular to the prevailing wind to reduce erosion.
- Create good surface and internal drainage through the use of directional flow and open ditches to increase drainage, as appropriate.
- If necessary, add soil amendments to ameliorate physical, biological, and chemical attributes that may limit reclamation potential, to meet fair to good topsoil suitability criteria (BLM 2011), as approved by the BLM AO.
- Add soil amendments to reduce salt and/or sodium content, if necessary.
- Inspect the soil surface for ponding or gullying.
- Suspend construction activities when soils are wet and rutting exceeds 4 inches, as appropriate.

*Additional soil handling and site preparation practices and BMPs for the **Deep Shale 7-9 inch** ecological site. These measures would be applied in addition to those described above for all clayey ecological sites.*

- No site-specific BMPs for revegetation have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

*Additional soil handling and site preparation practices and BMPs for the **Deep Shale 10-14 inch** ecological site. These measures would be applied in addition to those described above for all clayey ecological sites.*

- No site-specific BMPs for revegetation have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

*Additional soil handling and site preparation practices and BMPs for the **Saline Lowland 7-9 inch** ecological site. These measures would be applied in addition to those described above for all saline ecological sites.*

- No site-specific BMPs for soil handling have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

*Additional soil handling and site preparation practices and BMPs for the **Saline Upland 7-9 inch** ecological site. These measures would be applied in addition to those described above for all saline ecological sites.*

- No site-specific BMPs for soil handling have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

*Additional soil handling and site preparation practices and BMPs for the **Saline Upland 10-14 inch** ecological site. These measures would be applied in addition to those described above for all saline ecological sites.*

- No site-specific BMPs for soil handling have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

*Additional soil handling and site preparation practices and BMPs for the **Shale 10-14 inch** ecological site. These measures would be applied in addition to those described above for all clayey ecological sites.*

- Supplement topsoil from suitable ecological sites (i.e., similar physical and chemical attirbutes) to provide a minimum of 6 inches of topsoil dressing, if necessary and if supplies are available.

## Vegetation Handling

The primary objective of revegetation is to establish the species composition, diversity, structure, and total ground cover appropriate for the desired plant community (BLM 2012b). In accordance with BLM Wyoming Reclamation Policy (2012b), proper seeding mixtures will be used to reclaim disturbed areas on federal lands with native vegetation, as detailed in the CCSM Project Master Reclamation Plan (2012a) and the site-specific reclamation plan for Phase I of the CCSM Project. Soil conditioning, de-compaction, and topsoil protection measures will be implemented to reestablish topsoil properties and to protect the seeding surface, as presented in Table 2 and described in the CCSM Project Master Reclamation Plan (BLM 2012a), the site-specific reclamation plan for Phase I of the CCSM Project, and in compliance with BLM Wyoming Reclamation Policy (2012b).

Seed mixtures will be tailored to establish species diversity, composition, and ground cover appropriate for the desired plant community that has been documented for each ecological site in the CCSM Project Site. Seed mixtures may be refined based on soil management, wildlife, or rangeland needs. Seed mixtures will be designed for each ecological site based on the RFO ecological site specific pick lists combined with site-specific vegetation characteristics (BLM 2008, 2011). The use of non-native species on federal lands will only be considered as the result of the documented failure to revegetate any area with native species and will be implemented in coordination with the BLM AO. BMPs and reclamation measures will be refined for site-specific characteristics and implemented as necessary in coordination with the BLM AO.

Recommended BMPs and protective measures for successfully reestablishing site vegetation are listed below:

*Revegetation practices and BMPs for **all saline ecological sites***

- For each ecological site, using BLM pick lists (BLM 2011) contained in Exhibits I-III, design ecological site-specific seed mixes for reclamation to achieve species composition and diversity for the desired plant community, ecological setting, and current soil properties based on pre-disturbance vegetation characteristics. Final selection of seed mixes will be dependent on seed availability and will be coordinated with the BLM AO.
- Revegetate with salt tolerant plant species (e.g., western wheatgrass, saltbush species, winterfat, alkali sacaton, greasewood).
- Increase seeding rate for critical areas where germination is inhibited by low soil quality, as necessary.
- Broadcast seed after disking.
- Use snow fences to trap additional soil moisture, if necessary.
- Exclude livestock from reclaimed areas, as practicable, until appropriate levels of site stabilization and revegetation are achieved.

*Additional revegetation practices and BMPs for the **Deep Shale 7-9 inch** ecological site. These measures would be applied in addition to those described above for all clayey ecological sites.*

- Drill seed after tillage.

*Additional revegetation practices and BMPs for the **Deep Shale 10-14 inch** ecological site. These measures would be applied in addition to those described above for all clayey ecological sites.*

- Drill seed after tillage.

*Additional revegetation practices and BMPs for the **Saline Lowland 7-9 inch** ecological site. These measures would be applied in addition to those described above for all saline ecological sites.*

- No site-specific BMPs for revegetation have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

*Additional revegetation practices and BMPs for the **Saline Upland 7-9 inch** ecological site. These measures would be applied in addition to those described above for all saline ecological sites.*

- No site-specific BMPs for soil handling have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

*Additional revegetation practices and BMPs for the **Saline Upland 10-14 inch** ecological site. These measures would be applied in addition to those described above for all saline ecological sites.*

- No site-specific BMPs for soil handling have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

*Additional revegetation practices and BMPs for the **Shale 10-14 inch** ecological site. These measures would be applied in addition to those described above for all clayey ecological sites.*

- Harrow or rake broadcast seed to increase germination, if necessary.
- Hydromulch on steep slopes after seeding, if necessary.

**Exhibit I**

**Deep Shale 7-9 inch Ecological Site Description**

**Adapted from NRCS (2011)**

Site-specific conditions for deep shale 7-9 inch ecological sites in the CCSM Phase I Site were characterized using data collected at seven monitoring locations (Table 1, Figure 1). Long-term monitoring reference sites for deep shale 7-9 inch ecological sites have been established in coordination with the BLM Authorized Officer (AO). Any additional monitoring site that is used for ecological site characterization that is located 100 meters outside of the CCSM Phase I limits of disturbance (LODs) may be suitable as a long-term monitoring reference site for deep shale 7-9 inch ecological sites and may be used for future reclamation success monitoring purposes.

**Table 1. Representative transects for deep shale 7-9 inch ecological sites in the CCSM Phase I Site.**

| Transect Number | Record Date | Latitude | Longitude | Altitude | Transect Bearing |
|---|---|---|---|---|---|
| DS_79_01 | 6/6/2014 | 41.74508 | -107.09863 | 6,516 | 75 |
| DS_79_02 | 6/29/2014 | 41.52949 | -107.19521 | 6,995 | 70 |
| DS_79_03 | 6/29/2014 | 41.56312 | -107.15861 | 6,890 | 54 |
| DS_79_04 | 7/1/2014 | 41.52275 | -107.21650 | 7,083 | 340 |
| DS_79_05 | 7/10/2014 | 41.56316 | -107.21979 | 7,005 | 80 |
| DS_79_06 | 7/11/2014 | 41.55041 | -107.25088 | 7,126 | 250 |
| DS_79_07 | 7/2/2014 | 41.56202 | -107.26279 | 7,126 | 250 |

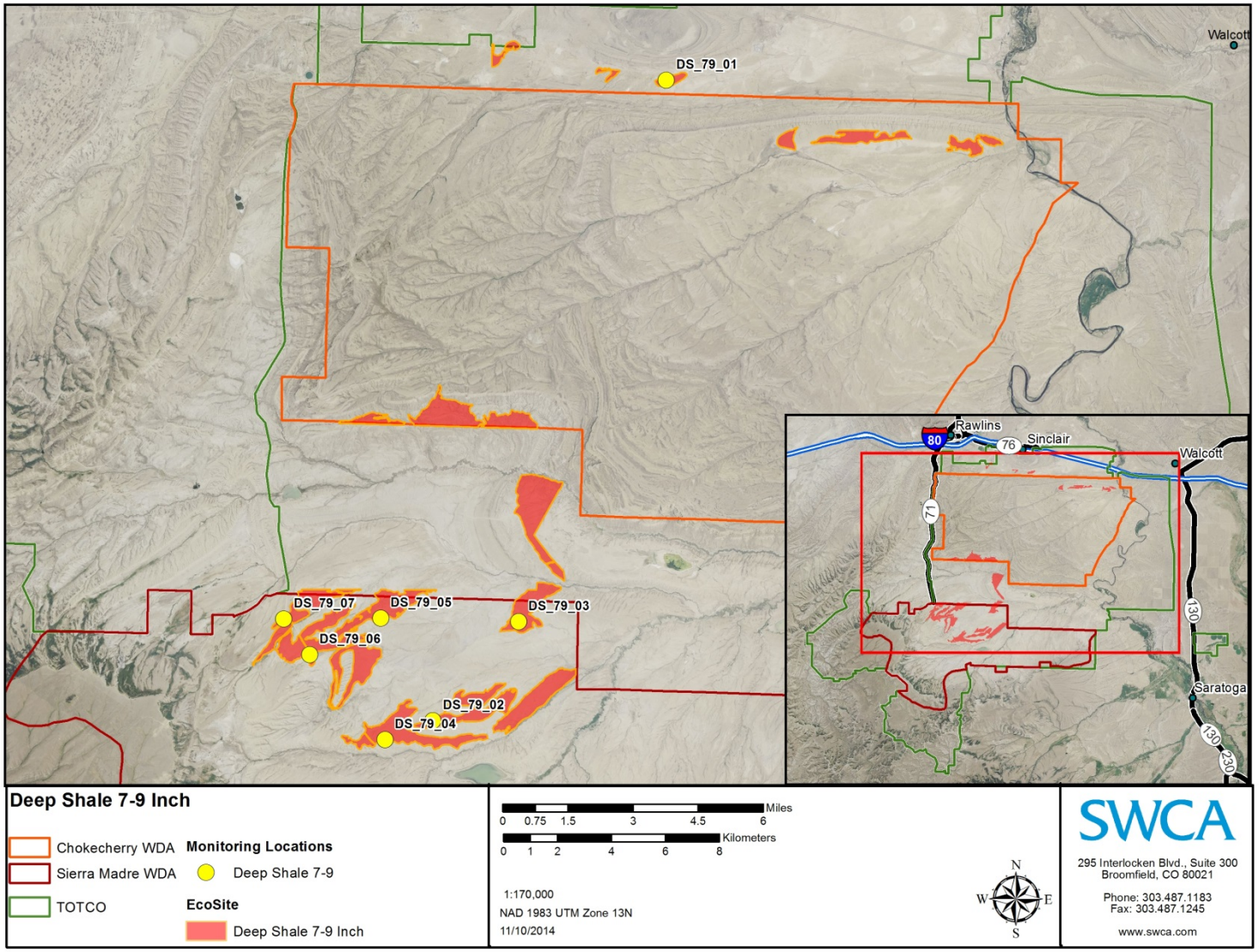


**Figure 1. Location of vegetation transects and soil samples used to characterize deep shale 7-9 inch ecological sites in the CCSM Phase I Site.**

**Site Characteristics**

## Climate

Mean annual precipitation is 8.0 inches (ranges from 7-9 inches per year), with peaks observed in May and the lowest totals recorded in the winter months. Average snow fall often exceeds 20 inches annually. Wide fluctuations do occur and result in more dry years than normal years (NRCS 2011). Due to the high elevations and dry air, temperatures at deep shale 7-9 inch ecological sites range significantly between summer and winter and daily maximum and minimums. The average annual air temperature is 41.9 °F (25.7 °F Avg. Min. to 58.1 °F Avg. Max.). Extreme minimum temperatures can occur during the winter months when cold air outbreaks and winter storms move rapidly from northwest to southeast.

## Abiotic Landscape Features

Deep shale 7-9 inch ecological sites in the CCSM Phase I Site occur on all exposures along nearly level terraces and plateau tops. Slopes vary, but are typically between 0% and 3%. Examples of landforms found in this ecological site include plains and rises, mesas, knolls and hillslopes and alluvial fans. Elevation is variable and ranges between 6,500 feet and 7,300 feet in the CCSM Phase I Site.

## Soil Characteristics

Deep shale 7-9 inch ecological sites within the CCSM Phase I Site are characterized by moderately deep to very deep fine-textured soils that are well drained with moderately slow to slow permeability. Soil cracking (not severe) occurs during the dry summer months, especially where the plant cover has been reduced. Root penetration is somewhat restricted due to the fine textures, clay structures in the subsurface layers and reduced depth of moisture penetration.

Topsoil depth averages 5.8 ± 0.62 inches. Lower soil horizons generally exceed 13.8 inches. Topsoil soil textures are generally fine sandy loams to clay loams. Subsoil textures are characterized by sandy clay loams to clay loams. Sodic horizons, that are typical of this soil type, could form a restrictive layer that impedes air and water movement. Sodicity of the surface soil is likely to cause dispersion of surface aggregates, resulting in surface crusts that inhibit infiltration.

Soils are moderately to very strongly alkaline with pH values between 8.02 and 9.02 and non-saline to strongly saline with electrical conductivities ranging between 0.07 and 2.4 dS/m (Table 2). A gypsiferous layer is generally encountered in subsoil horizons (greater than 15 inches depth) that have elevated salt content and increased salinity. Where soil pH ranges exceed 8.4 soils may have limited reclamation potential (LRP) may need to be evaluated for potential soil treatment. Soils are slightly to violently effervescent indicating weakly to very strongly covalent carbonates.

Figures 2 and 3 illustrate the soil surface and soil profile characteristics of a typical deep shale 7-9 inch site in the CCSM Phase I Site.

**Table 2. Soil characteristics typical of deep shale 7-9 inch ecological sites.**

| Soil Characteristics | Description |
|---|---|
| **Parent Material (Kind)** | Alluvium, residuum |
| **Parent Material (Origin)** | Sedimentary |
| **Topsoil Depth[1]** | 5.8 ± 0.62 inches |
| **Topsoil Texture** | Fine sandy loam to clay loam |
| **Subsoil Depth[2]** | 13.8 ± 0.62 inches |
| **Subsoil Texture** | Sandy clay loam to clay loam |
| **Topsoil Fragments** | 0-15% volume, sedimentary, medium gravel, subangular to subrounded |
| **Subsoil Fragments** | 0-30% volume, mixed rock, fine gravel to channers, angular to subangular |
| **Electrical Conductivity (Topsoil)** | 0.07-0.36 dS/m |
| **Salinity Class (Topsoil)** | Non-saline |
| **Electrical Conductivity (Subsoil)** | 0.10-2.4 dS/m |
| **Salinity Class (Subsoil)** | Non-saline to strongly saline |
| **Soil Reaction (Topsoil)** | 8.02-9.02 |
| **pH Class (Topsoil)** | Moderately to very strongly alkaline |
| **Soil Reaction (Subsoil)** | 8.10-8.85 |
| **pH Class (Subsoil)** | Moderately to strongly alkaline |
| **Carbonate Equivalent (Topsoil)** | Slightly to violently effervescent |
| **Carbonate Equivalent (Subsoil)** | Very slightly to violently effervescent |

[1]Topsoil depth determined by depth of A Horizon.
[2]Subsoil depth determined by B and C horizons to a maximum of 20 inches depth including topsoil.

**Figure 2. Representative soil surface and ground cover for deep shale 7-9 inch ecological sites in the CCSM Phase I Site (DS_79_05).**

**Figure 3. Representative soil profile for deep shale 7-9 inch sites in the CCSM Phase I Site (DS_79_05).**

## Vegetation Characteristics

Plant communities associated with deep shale 7-9 inch ecological sites in the CCSM Phase I Site are characterized by moderately vegetated surfaces with 8%–33% basal cover (Tables 3 and 4). The remaining soil surface is characterized primarily by unprotected soils (36–65%), rock fragments (0–25%), and litter (0–17%). Figure 4 illustrates representative vegetation communities associated with deep shale 7-9 inch ecological sites in the CCSM Phase I Site.

The BLM pick list in Table 5 (BLM 2011) and the species composition and cover (Tables 3 and 4) observed for deep shale 7-9 inch ecological sites will be used to guide the selection of appropriate seed mixes and application rates for revegetation. Final seed mixes will be determined based on seed availability at the time of revegetation efforts and in coordination with the BLM AO.

**Table 3. Vegetation characteristics typical of deep shale 7-9 inch ecological sites.**

| | | |
|---|---|---|
| Basal Vegetative Cover (LPI*) | 8%–33% | |
| Biological Soil Crust and Lichen (LPI*) | 0%–1% | |
| Litter Cover (LPI*) | 0%–17% | |
| Surface Fragment/Rock Cover (LPI*) | 0%–25% | |
| Unprotected Soil(LPI*) | 36% – 65% | |
| Representative Species and Top-Canopy Cover* | *Pseudoroegneria spicata* | 8.5% average |
| | *Poa secunda* | 8.2% average |
| | *Atriplex gardneri* | 7.0% average |
| | *Descurainia pinnata* | 5.7% average |
| | *Artemisia pedatifida* | 5.3% average |
| | *Atriplex confertifolia* | 4.3% average |

* Line point intercept

**Table 4. Species commonly associated with deep shale 7-9 inch ecological sites.**

| | |
|---|---|
| *Achnatherum hymenoides* | *Lappula occidentalis var. cupulata* |
| *Agoseris glauca* | *Lygodesmia sp.* |
| *Allium textile* | *Machaeranthera grindelioides* |
| *Alyssum desertorum* | *Nothocalais sp.* |
| *Arenaria hookeri* | *Opuntia polyacantha* |
| *Artemisia nova* | *Oxytropis lagopus* |
| *Artemisia pedatifida* | *Oxytropis sp.* |
| *Artemisia tridentata ssp. wyomingensis* | *Pascopyrum smithii* |
| *Astragalus purshii* | *Penstemon eriantherus* |
| *Astragalus sp.* | *Phlox hoodii* |
| *Atriplex confertifolia* | *Phlox sp.* |
| *Atriplex gardneri* | *Picrothamnus desertorum* |
| *Chorispora tenella* | *Pleuraphis jamesii* |
| *Chrysothamnus viscidiflorus* | *Pleuraphis sp.* |
| *Cryptantha cana* | *Poa secunda* |
| *Cryptantha sp.* | *Pseudoroegneria spicata* |
| *Cymopterus bulbosus* | *Sphaeralcea coccinea* |
| *Descurainia pinnata* | *Stanleya pinnata* |
| *Elymus elymoides* | *Stenotus acaulis* |
| *Elymus trachycaulus* | *Stenotus armerioides* |
| *Eriogonum brevicaule* | *Symphoricarpos albus* |
| *Eriogonum ovalifolium* | *Tetradymia nuttallii* |
| *Eriogonum sp.* | *Trifolium gymnocarpon* |
| *Krascheninnikovia lanata* | *Xylorhiza glabriuscula* |

**Figure 4. Characteristic vegetation communities associated with deep shale 7-9 inch ecological sites in the CCSM Phase I Site (DS_79_05).**

**Table 5. Recommended seed pick list for dry, fine-textured ecological sites (BLM 2011).**

| **Name** | ***Scientific*** | **Variety** | **SYMBOL** |
|---|---|---|---|
| ***Grasses*** | | | |
| Thickspike wheatgrass | *Elymus lanceolatus* | Sodar, Critana | ELLA3 |
| Western wheatgrass | *Pascopyrum smithii* | Rosana | PASM |
| Indian ricegrass | *Achnatherum hymenoides* | Rimrock (Nez Par) | ACHY |
| Bottlebrush squirreltail | *Elymus elymoides* | Sand hollow | ELEL |
| Slender wheatgrass | *Elymus trachycaulus* | Pryor (San Luis) | ELTR |
| Little bluegrass "Sandberg" | *Poa secunda* | High Plains | POSE |
| Bluebunch wheatgrass | *Pseudoroegneria spicata* | Secor | PSSP6 |
| Galleta grass | *Pleuraphis jamesii* | Viva | PLJA |
| ***Shrubs*** | | | |
| Wyoming big sagebrush | *Artemisia tridentata* ssp. *wyomingensis* | | ARTRW8 |
| Gardner's saltbush | *Atriplex gardneri* | | ATGA |
| Fourwing saltbush | *Atriplex canaescens* | Wytana | ATCA2 |
| Shadscale saltbush | *Atriplex confertifolia* | | ATCO |
| Green rabbitbrush | *Ericameria nauseosa* | | ERNA10 |
| Yellow rabbitbrush | *Chrysothamnus viscidiflorus* | | CHVI8 |
| Winterfat | *Krascheninnikovia lanata* | Open Range | KRLA |
| ***Forbs*** | | | |
| Rocky Mountain beeplant | *Cleome serrulata* | Appar | CLSE |
| Textile onion | *Allium textile* | | ALTE |
| Scarlet globemallow | *Sphaeralcea coccinea* | | SPCO |
| Scarlet gilia | *Ipomopsis aggregata* | | IPAGA3 |
| Spiny phlox | *Phlox hoodii* | | PHHO |
| Desert biscuitroot | *Lomatium foeniculaceum* | | LOFO |
| Desert princesplume | *Stanleya pinnata* | | STPI |

**Exhibit II**

**Deep Shale 10-14 inch Ecological Site Description**

**Adapted from NRCS (2011)**

Site-specific conditions for deep shale 10-14 inch ecological sites in the CCSM Phase I Site were characterized using data collected at four monitoring locations (Table 1, Figure 1). Long-term monitoring reference sites for deep shale 10-14 inch ecological sites have been established in coordination with the BLM Authorized Officer (AO). Any additional monitoring site that is used for ecological site characterization that is located 100 meters outside of the CCSM Phase I limits of disturbance (LODs) may be suitable as a long-term monitoring reference site for deep shale 10-14 inch ecological sites and may be used for future reclamation success monitoring purposes.

**Table 1. Representative transects for deep shale 10-14 inch ecological sites in the CCSM Phase I Site.**

| Transect Number | Record Date | Latitude | Longitude | Altitude | Transect Bearing |
|---|---|---|---|---|---|
| DS_1014_01 | 6/24/2014 | 41.50859 | -107.25395 | 7,228 | 65 |
| DS_1014_02 | 7/1/2014 | 41.50803 | -107.23286 | 7,110 | 290 |
| DS_1014_03 | 7/9/2014 | 41.51204 | -107.20233 | 7,044 | 220 |
| DS_1014_04 | 7/8/2014 | 41.48563 | -107.20205 | 7,034 | 280 |

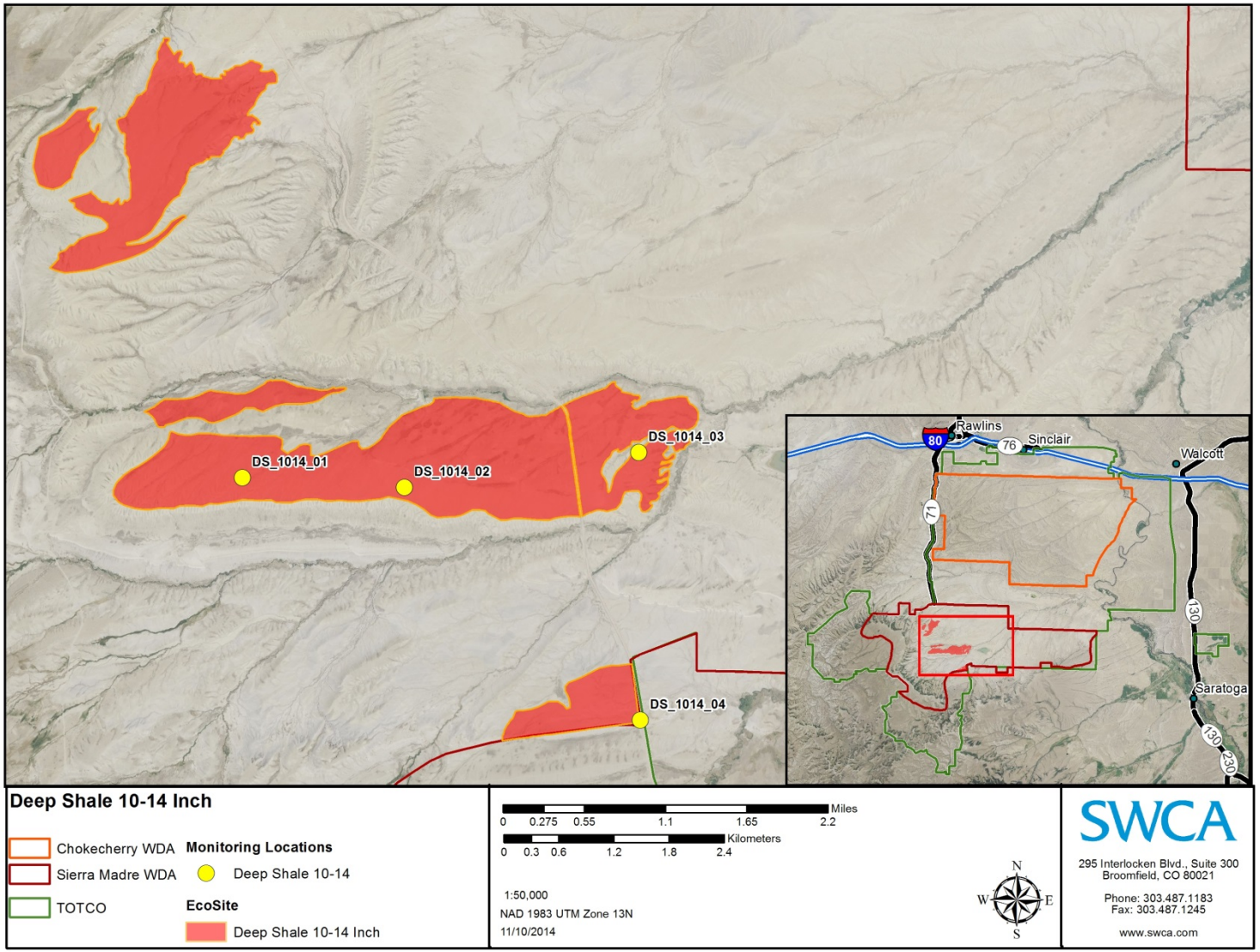


**Figure 1. Location of vegetation transects and soil samples used to characterize deep shale 10-14 inch ecological sites in the CCSM Phase I Site.**

**Site Characteristics**

## Climate

Mean annual precipitation is 10.5 inches (ranges from 10-14 inches per year), with peaks observed in May and the lowest totals recorded in the winter months. Average snow fall often exceeds 20 inches annually. Wide fluctuations do occur and result in more dry years than normal years (NRCS 2011). Due to the high elevations and dry air, temperatures at deep shale 10-14 inch ecological sites range significantly between summer and winter and daily maximum and minimums. The average annual air temperature is 46.2 °F (30.1 °F Avg. Min. to 62.3 °F Avg. Max.). Extreme minimum temperatures can occur during the winter months when cold air outbreaks and winter storms move rapidly from northwest to southeast.

## Abiotic Landscape Features

Deep shale 10-14 inch ecological sites in the CCSM Phase I Site occur on all exposures along nearly level terraces and plateau tops. Slopes vary, but are typically between 0% and 3%. Examples of landforms found in this ecological site include mesas, knolls and hillslopes, and outwash fans. Elevation is variable and ranges between 6,900 feet and 7,600 feet in the CCSM Phase I Site.

## Soil Characteristics

Deep shale 10-14 inch ecological sites within the CCSM Phase I Site are characterized by moderately deep to very deep fine-textured soils that are well drained with moderately slow to slow permeability. Soil cracking (not severe) occurs during the dry summer months, especially where the plant cover has been reduced. Root penetration is somewhat restricted due to the fine textures, clay structures in the subsurface layers and reduced depth of moisture penetration.

Topsoil depth averages 8.0 ± 1.03 inches. Lower soil horizons generally exceed 11.7 inches. Topsoil soil textures are generally loams to clay loams. Subsoil textures are characterized by silty clay loams to clays. Sodic horizons, that are typical of this soil type, could form a restrictive layer that impedes air and water movement. Sodicity of the surface soil is likely to cause dispersion of surface aggregates, resulting in surface crusts that inhibit infiltration.

Soils are slightly to strongly alkaline with pH values between 7.83 and 8.59 and non-saline to very strongly saline with electrical conductivities ranging between 0.09 and 3.6 dS/m (Table 2). A gypsiferous layer is generally encountered in subsoil horizons (greater than 15 inches depth) that have elevated salt content and increased salinity. Where soil pH ranges exceed 8.4 soils may have limited reclamation potential may need to be evaluated for potential soil treatment. Soils are slightly to violently effervescent indicating weakly to very strongly covalent carbonates.

Figures 2 and 3 illustrate the soil surface and soil profile characteristics of a typical clayey 10-14 inch site in the CCSM Phase I Site.

**Table 2. Soil characteristics typical of deep shale 10-14 inch ecological sites.**

| Soil Characteristics | Description |
|---|---|
| **Parent Material (Kind)** | Alluvium, residuum |
| **Parent Material (Origin)** | Sedimentary |
| **Topsoil Depth[1]** | 8.0 ± 1.03 inches |
| **Topsoil Texture** | Loam to clay loam |
| **Subsoil Depth[2]** | 11.7 ± 1.03 inches |
| **Subsoil Texture** | Silty clay loam to clay |
| **Topsoil Fragments** | 0-20% volume, sedimentary, fine to medium gravel, subangular |
| **Subsoil Fragments** | 0-40% volume, sedimentary, fine gravel, angular |
| **Electrical Conductivity (Topsoil)** | 0.09-1.1 dS/m |
| **Salinity Class (Topsoil)** | Non-saline to slightly saline |
| **Electrical Conductivity (Subsoil)** | 0.14-3.6 dS/m |
| **Salinity Class (Subsoil)** | Non-saline to very strongly saline |
| **Soil Reaction (Topsoil)** | 8.02-8.59 |
| **pH Class (Topsoil)** | Slightly to strongly alkaline |
| **Soil Reaction (Subsoil)** | 7.83-8.35 |
| **pH Class (Subsoil)** | Slightly to moderately alkaline |
| **Carbonate Equivalent (Topsoil)** | Slightly to strongly effervescent |
| **Carbonate Equivalent (Subsoil)** | Slightly to violently effervescent |

[1]Topsoil depth determined by depth of A Horizon.
[2]Subsoil depth determined by B and C horizons to a maximum of 20 inches depth including topsoil.

**Figure 2. Representative soil surface and ground cover for deep shale 10-14 inch ecological sites in the CCSM Phase I Site (DS_1014_01).**

**Figure 3. Representative soil profile for deep shale 10-14 inch sites in the CCSM Phase I Site (DS_1014_01).**

## Vegetation Characteristics

Plant communities associated with deep shale 10-14 inch ecological sites in the CCSM Phase I Site are characterized by moderately vegetated surfaces with 14%–28% basal cover (Tables 3 and 4). The remaining soil surface is characterized primarily by unprotected soils (49–55%), rock fragments (9–18%), and litter (10–16%). Figure 4 illustrates representative vegetation communities associated with deep shale 10-14 inch ecological sites in the CCSM Phase I Site.

The BLM pick list in Table 5 (BLM 2011) and the species composition and cover (Tables 3 and 4) observed for deep shale 10-14 inch ecological sites will be used to guide the selection of appropriate seed mixes and application rates for revegetation. Final seed mixes will be determined based on seed availability at the time of revegetation efforts and in coordination with the BLM AO.

**Table 3. Vegetation characteristics typical of deep shale 10-14 inch ecological sites.**

| | | |
|---|---|---|
| Basal Vegetative Cover (LPI*) | 14%–28% | |
| Biological Soil Crust and Lichen (LPI*) | 0%–2% | |
| Litter Cover (LPI*) | 10%–16% | |
| Surface Fragment/Rock Cover (LPI*) | 9%–18% | |
| Unprotected Soil(LPI*) | 49% – 55% | |
| Representative Species and Top-Canopy Cover* | *Pseudoroegneria spicata* | 24.3% average |
| | *Atriplex gardneri* | 6.5% average |
| | *Poa secunda* | 6.3% average |
| | *Artemisia tridentata* ssp. *wyomingensis* | 6.3% average |
| | *Atriplex confertifolia* | 5.3% average |

* Line point intercept

**Table 4. Species commonly associated with deep shale 10-14 inch ecological sites.**

| | |
|---|---|
| *Achnatherum hymenoides* | *Hesperostipa comata* |
| *Agoseris glauca* | *Krascheninnikovia lanata* |
| *Allium textile* | *Lappula occidentalis var. cupulata* |
| *Alyssum desertorum* | *Machaeranthera grindelioides* |
| *Arenaria hookeri* | *Opuntia polyacantha* |
| *Artemisia pedatifida* | *Oxytropis sp.* |
| *Artemisia tridentata ssp. vaseyana* | *Phlox hoodii* |
| *Artemisia tridentata ssp. wyomingensis* | *Phlox sp.* |
| *Astragalus purshii* | *Picrothamnus desertorum* |
| *Astragalus sp.* | *Poa fendleriana* |
| *Atriplex confertifolia* | *Poa secunda* |
| *Atriplex gardneri* | *Pseudoroegneria spicata* |
| *Chorispora tenella* | *Sarcobatus vermiculatus* |
| *Chrysothamnus viscidiflorus* | *Sphaeralcea coccinea* |
| *Descurainia pinnata* | *Stanleya pinnata* |
| *Elymus elymoides* | *Stenotus acaulis* |
| *Eriogonum brevicaule* | *Tetradymia nuttallii* |
| *Eriogonum flavum* | *Townsendia sp.* |
| *Eriogonum ovalifolium* | *Trifolium gymnocarpon* |
| *Eriogonum sp.* | *Xylorhiza glabriuscula* |

**Figure 4. Characteristic vegetation communities associated with deep shale 10-14 inch ecological sites in the CCSM Phase I Site (DS_1014_01).**

**Table 5. Recommended seed pick list for dry, fine-textured ecological sites (BLM 2011).**

| **Name** | ***Scientific*** | **Variety** | **SYMBOL** |
|---|---|---|---|
| ***Grasses*** | | | |
| Western wheatgrass | *Pascopyrum smithii* | Rosana | PASM |
| Thickspike wheatgrass | *Elymus lanceolatus* | Critana | ELLA3 |
| Indian ricegrass | *Achnatherum hymenoides* | Rimrock (Nez Par) | ACHY |
| Green needlegrass | *Nassella viridula* | Lordon | NAVI4 |
| Prairie junegrass | *Koeleria macrantha* | | KOMA |
| Bottlebrush squirreltail | *Elymus elymoides* | Sand hollow | ELEL |
| Mutton bluegrass | *Poa fendleriana* | | POFE |
| Bluebunch wheatgrass | *Pseudoroegneria spicata* | Secor | PSSP6 |
| Basin wildrye | *Leymus cinereus* | Trailhead, Magnar | LECI |
| Galleta grass | *Pleuraphis jamesii* | Viva | PLJA |
| ***Shrubs*** | | | |
| Wyoming big sagebrush | *Artemisia tridentata* ssp. *wyomingensis* | | ARTRW8 |
| Mountain big sagebrush | *Artemisia tridentata* ssp. *vaseyana* | | ARTRV |
| Fourwing saltbush | *Atriplex canaescens* | Wytana | ATCA2 |
| Antelope bitterbrush | *Purshia tridentata* | | PUTR2 |
| Snowberry | *Symphoricarpos* spp. | Maybell | SYOR2 |
| Winterfat | *Krascheninnikovia lanata* | Open Range | KRLA |
| Shadscale saltbush | *Atriplex confertifolia* | | ATCO |
| Mountain mahogany | *Cercocarpus montanus* | Montane | CEMO2 |
| White sagebrush | *Artemisia ludoviciana* | | ARLU |
| ***Forbs*** | | | |
| Scarlet globemallow | *Sphaeralcea coccinea* | | SPCO |
| American vetch | *Vicia americana* | | VIAM |
| Lupine | *Lupinus sericeus* | | LUSE4 |
| Blanketflower | *Gaillardia aristata* | | GAAR |
| Western yarrow | *Achillea millefolium* var. *occidentalis* | | ACMI2 |
| Giant evening primrose | *Oenothera hookeri* | | OEELH |
| Textile onion | *Allium textile* | | ALTE |
| Arrowleaf balsamroot | *Balsamorhiza sagittata* | | BASA3 |
| Balsam groundsel | *Packera paupercula* | | PAPA20 |
| Hoods phlox | *Phlox hoodii* | | PHHO |
| Agoseris | *Agoseris glauca* | | AGGL |

**Exhibit III**

**Saline Lowland 7-9 inch Ecological Site Description**

**Adapted from NRCS (2011)**

Site-specific conditions for saline lowland 7-9 inch ecological sites in the CCSM Phase I Site were characterized using data collected at three monitoring locations (Figure 1, Table 1). Long-term monitoring reference sites for saline lowland 7-9 inch ecological sites have been established in coordination with the BLM Authorized Officer (AO). Any additional monitoring site that is used for ecological site characterization that is located 100 meters outside of the CCSM Phase I limits of disturbance (LODs) may be suitable as a long-term monitoring reference site for clayey 7-9 inch ecological sites and may be used for future reclamation success monitoring purposes.

**Table 1. Representative transects for saline lowland 7-9 inch ecological sites in the CCSM Phase I Site.**

| Transect Number | Record Date | Latitude | Longitude | Altitude | Transect Bearing |
|---|---|---|---|---|---|
| SL_79_01 | 6/5/2014 | 41.74966 | -107.15296 | 6,637 | 195 |
| SL_79_02 | 6/5/2014 | 41.74949 | -107.05850 | 6,467 | 260 |
| SL_79_03 | 7/1/2014 | 41.55923 | -107.18883 | 6,870 | 240 |

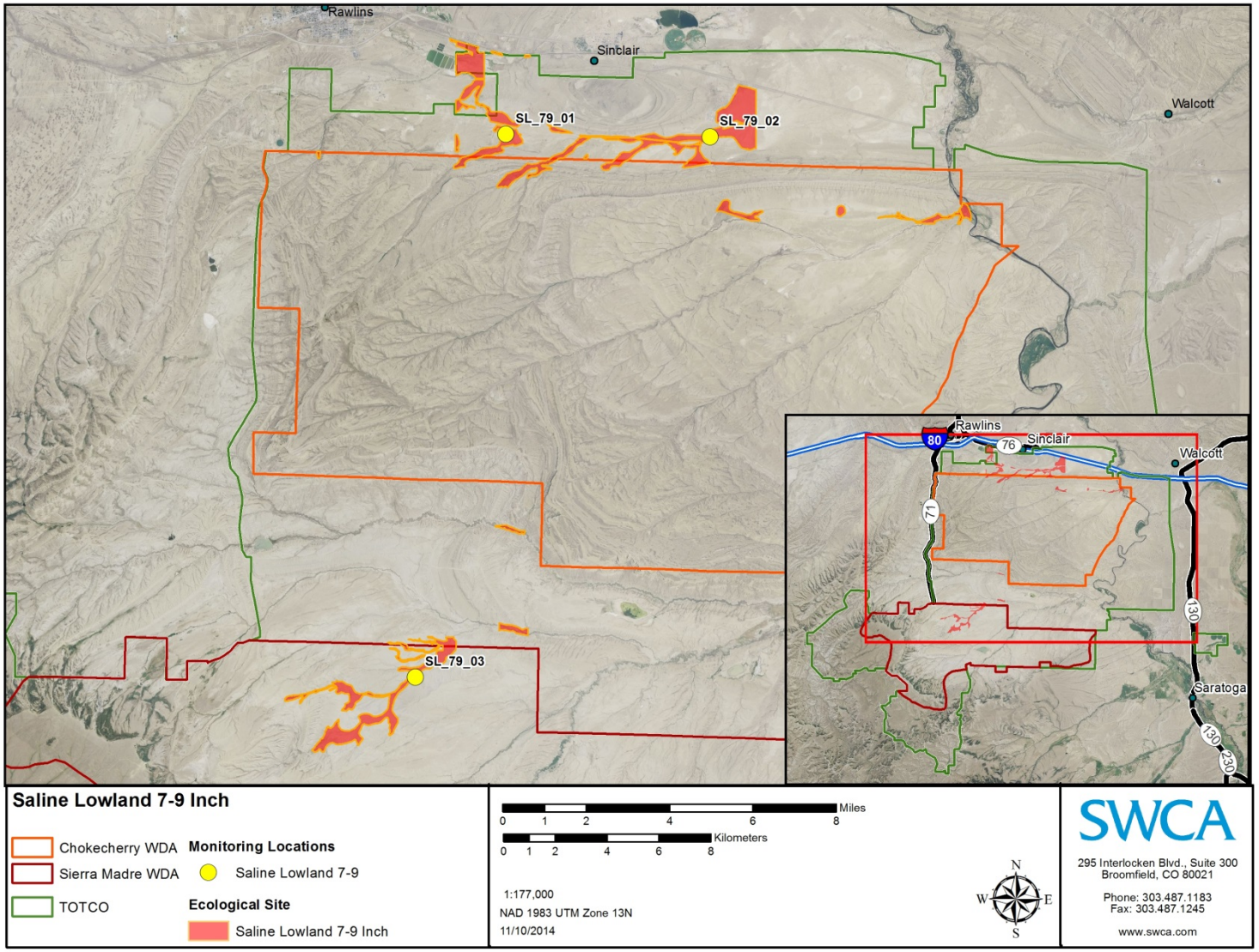


**Figure 1. Locations of reference sites used to characterize saline lowland 7-9 inch ecological sites in the CCSM Phase I Site.**

**Site Characteristics**

## Climate

Mean annual precipitation is 8.0 inches (ranges from 7-9 inches per year), with peaks observed in May and the lowest totals recorded in the winter months. Average snow fall often exceeds 20 inches annually. Wide fluctuations do occur and result in more dry years than normal years (NRCS 2011). Due to the high elevations and dry air, temperatures at saline lowland 7-9 inch ecological sites range significantly between summer and winter and daily maximum and minimums. The average annual air temperature is 41.9 °F (25.7 °F Avg. Min. to 58.1 °F Avg. Max.). Extreme minimum temperatures can occur during the winter months when cold air outbreaks and winter storms move rapidly from northwest to southeast.

## Abiotic Landscape Features

Saline lowland 7-9 inch ecological sites in the CCSM Phase I Site occur on near level to gently undulating rolling land. Slopes vary, but are typically less than 5% (NRCS 2011). Examples of landforms found in this ecological site include basin floors, floodplains, and bottomlands. Elevation is variable and ranges between 6,500 feet and 7,100 feet in the CCSM Phase I Site.

## Soil Characteristics

Saline lowland 7-9 inch ecological sites within the CCSM Phase I Site are deep to very deep and moderately well to well-drained, and moderately slow to moderately permeable. Textures range from silty clay loams to clays (NRCS 2011).

Topsoil averages 3.7 ± 0.65 inches. Lower soil horizon depths generally exceed 16.0 inches. Topsoil soil textures range from silty clay loams to clay loams. Subsoil textures are characterized by clay loams to clays. Sodic horizons, that are typical of this soil type, could form a restrictive layer that impedes air and water movement. Sodicity of the surface soil is likely to cause dispersion of surface aggregates, resulting in surface crusts that inhibit infiltration.

Saline lowland 7-9 inch ecological sites in the CCSM Phase I Site are characterized by soils with slow to moderate infiltration and moderate to high runoff potential. Infiltration rates are highest, and runoff rates lowest where ground cover exceeds 75%. Rills and gullies are typically present and surface water flow patterns are generally distinguishable if at all present (NRCS 2011). Chemical and physical crusts may be present at these sites (NRCS 2011).

Soils are moderately to very strongly alkaline with pH values between 8.15 and 9.27 and non-saline to very strongly saline electrical conductivities ranging between 0.23 and 7.1 dS/m. Where soil pH ranges exceed 8.40 and salinity exceeds 4.0 dS/m, soils may have limited reclamation potential and may need to be evaluated for potential soil treatment. Soils are very slightly to strongly effervescent indicating presence of weakly and strongly covalent carbonates.

Figures 2 and 3 illustrate the soil surface and soil profile characteristics of a typical saline lowland 7-9 inch site in the CCSM Phase I Site.

**Table 2. Soil characteristics typical of saline lowland 7-9 inch ecological sites.**

| Soil Characteristics | Description |
|---|---|
| **Parent Material (Kind)** | Alluvium, residuum |
| **Parent Material (Origin)** | Sedimentary |
| **Topsoil Depth[1]** | 3.7 ± 0.65 inches |
| **Topsoil Texture** | Silty clay loam to clay loam |
| **Subsoil Depth[2]** | 16.0 ± 0.65 inches |
| **Subsoil Texture** | Clay loam to clay |
| **Topsoil Fragments** | None |
| **Subsoil Fragments** | 0-20% volume, mixed rock, medium gravel, subangular |
| **Electrical Conductivity (Topsoil)** | 0.23-1.6 dS/m |
| **Salinity Class (Topsoil)** | Non-saline to moderately saline |
| **Electrical Conductivity (Subsoil)** | 3.3-7.1 dS/m |
| **Salinity Class (Subsoil)** | Very strongly saline |
| **Soil Reaction (Topsoil)** | 8.21-9.27 |
| **pH Class (Topsoil)** | Moderately to very strongly alkaline |
| **Soil Reaction (Subsoil)** | 8.15-8.94 |
| **pH Class (Subsoil)** | Moderately to strongly alkaline |
| **Carbonate Equivalent (Topsoil)** | Slightly to strongly effervescent |
| **Carbonate Equivalent (Subsoil)** | Very slightly to strongly effervescent |

[1]Topsoil depth determined by depth of A Horizon.
[2]Subsoil depth determined by B and C horizons to a maximum of 20 inches depth including topsoil.

**Figure 2. Representative soil surface and ground cover for saline lowland 7-9 inch sites in the CCSM Phase I Site (SL_79_02).**

**Figure 3. Representative soil profile for saline lowland 7-9 inch sites in the CCSM Phase I Site (SL_79_02).**

## Vegetation Characteristics

Plant communities associated with saline lowland 7-9 inch ecological sites in the CCSM Phase I Site are characterized by vegetated surfaces with 12%–36% basal cover (Table 3 and 4). The remaining soil surface is characterized primarily by unprotected soils (54–80%) and litter (8–19%). Figure 4 illustrates representative vegetation communities associated with saline lowland 7-9 inch ecological sites in the CCSM Phase I Site.

When saline lowland 7-9 inch ecological sites are subjected to improper grazing management, species such as greasewood (*Sarcobatus vermiculatus)*, halogeton, and annual forbs will increase (NRCS 2011). Indian ricegrass (*Achnatherum hymenoides)*, Wyoming big sagebrush (*Artemisia tridentata* Nutt. ssp. *wyomingensis)*, and Gardner's saltbush (*Atriplex gardneri)* will decrease in frequency and production. Heavy continuous season long grazing will convert this plant community to a Greasewood/Gardner's saltbush vegetation state (NRCS 2011).

The BLM pick list in Table 5 (BLM 2011) and the species composition and cover (Tables 3 and 4) observed for saline lowland 7-9 inch ecological sites will be used to guide the selection of appropriate seed mixes and application rates for revegetation. Final seed mixes will be determined based on seed availability at the time of revegetation efforts and in coordination with the BLM AO.

**Table 3. Vegetation characteristics typical of saline lowland 7-9 inch ecological sites.**

| | | |
|---|---|---|
| Basal Vegetative Cover (LPI*) | 12%–36% | |
| Biological Soil Crust and Lichen (LPI*) | 0% | |
| Litter Cover (LPI*) | 8%–19% | |
| Surface Fragment/Rock Cover (LPI*) | 0%–3% | |
| Unprotected Soil(LPI*) | 54% – 80% | |
| Representative Species and Top-Canopy Cover* | *Atriplex gardneri* | 15.3% average |
| | *Sarcobatus vermiculatus* | 13.0% average |
| | *Pascopyrum smithii* | 6.0% average |
| | *Elymus elymoides* | 6.0% average |
| | *Descurainia pinnata* | 4.7% average |
| | *Poa secunda* | 3.3% average |

* Line point intercept

**Table 4. Vegetation community of saline lowland 7-9 inch ecological sites.**

| | |
|---|---|
| *Allium textile* | *Lomatium macrocarpum* |
| *Alyssum alyssoides* | *Opuntia polyacantha* |
| *Artemisia pedatifida* | *Pascopyrum smithii* |
| *Astragalus bisulcatus* | *Penstemon sp.* |
| *Atriplex gardneri* | *Phlox hoodii* |
| *Bassia americana* | *Picrothamnus desertorum* |
| *Chrysothamnus viscidiflorus* | *Poa secunda* |
| *Cymopterus bulbosus* | *Pseudoroegneria spicata* |
| *Descurainia pinnata* | *Sarcobatus vermiculatus* |
| *Elymus elymoides* | *Sphaeralcea coccinea* |
| *Lepidium perfoliatum* | *Tetradymia nuttallii* |
| *Lomatium grayi* | *Xylorhiza glabriuscula* |

**Figure 4. Characteristic vegetation communities associated with saline lowland 7-9 inch sites in the CCSM Phase I Site (SL_79_02).**

**Table 5. Recommended seed pick list for saline lowland ecological sites (BLM 2011).**

| **Name** | ***Scientific Name*** | **Variety** | **SYMBOL** |
|---|---|---|---|
| ***Grasses*** | | | |
| Western wheatgrass | *Pascopyrum smithii* | Rosana | PASM |
| Little bluegrass "Sandberg" | *Poa Secunda* | High Plains | POSE |
| Alkali sacaton | *Sporobolus airoides* | | SPAI |
| Inland saltgrass | *Distichlis spicata* | | DIST |
| Basin wildrye | *Leymus cinereus* | Trailhead, Magnar | LECI |
| Bottlebrush squirreltail | *Elymus elymoides* | | ELEL5 |
| Prairie cordgrass | *Spartina pectinata* | | SPPE |
| ***Shrubs*** | | | |
| Fourwing saltbush | *Atriplex canescens* | Wytana | ATCA2 |
| Greasewood | *Sarcobatus vermiculatus* | | SAVE |
| Gardner's saltbush | *Atriplex gardneri* | | ATGA |
| Shadscale saltbush | *Atriplex confertifolia* | | ATCO |
| ***Forbs*** | | | |
| Textile onion | *Allium textile* | | ALTE |
| Desert biscuitroot | *Lomatium foeniculaceum* | | LOFO |
| Bulbous springparsley | *Cymopterus bulbosus* | | CYBU |
| Hoods phlox | *Phlox hoodii* | | PHHO |

**Exhibit IV**

**Saline Upland 7-9 inch Ecological Site Description**

**Adapted from NRCS (2011)**

Site-specific conditions for saline upland 7-9 inch ecological sites in the CCSM Phase I Site were characterized using data collected at five monitoring locations (Figure 1, Table 1). Long-term monitoring reference sites for saline upland 7-9 inch ecological sites have been established in coordination with the BLM Authorized Officer (AO). Any additional monitoring site that is used for ecological site characterization that is located 100 meters outside of the CCSM Phase I limits of disturbance (LODs) may be suitable as a long-term monitoring reference site for clayey 7-9 inch ecological sites and may be used for future reclamation success monitoring purposes.

**Table 1. Representative transects for saline upland 7-9 inch ecological sites in the CCSM Phase I Site.**

| Transect Number | Record Date | Latitude | Longitude | Altitude | Transect Bearing |
|---|---|---|---|---|---|
| SU_79_01 | 6-Jun-14 | 41.74573898 | -107.0769348 | 1967 | 250 |
| SU_79_02 | 29-Jun-14 | 41.55270639 | -107.182285 | 2129 | 140 |
| SU_79_03 | 5-Aug-14 | 41.55801773 | -107.2198868 | 2126 | 80 |
| SU_79_04 | 9-Jun-14 | 41.72451705 | -107.0069174 | 2008 | 255 |
| SU_79_05 | 29-Jun-14 | 41.56631851 | -107.1483664 | 2104 | 310 |

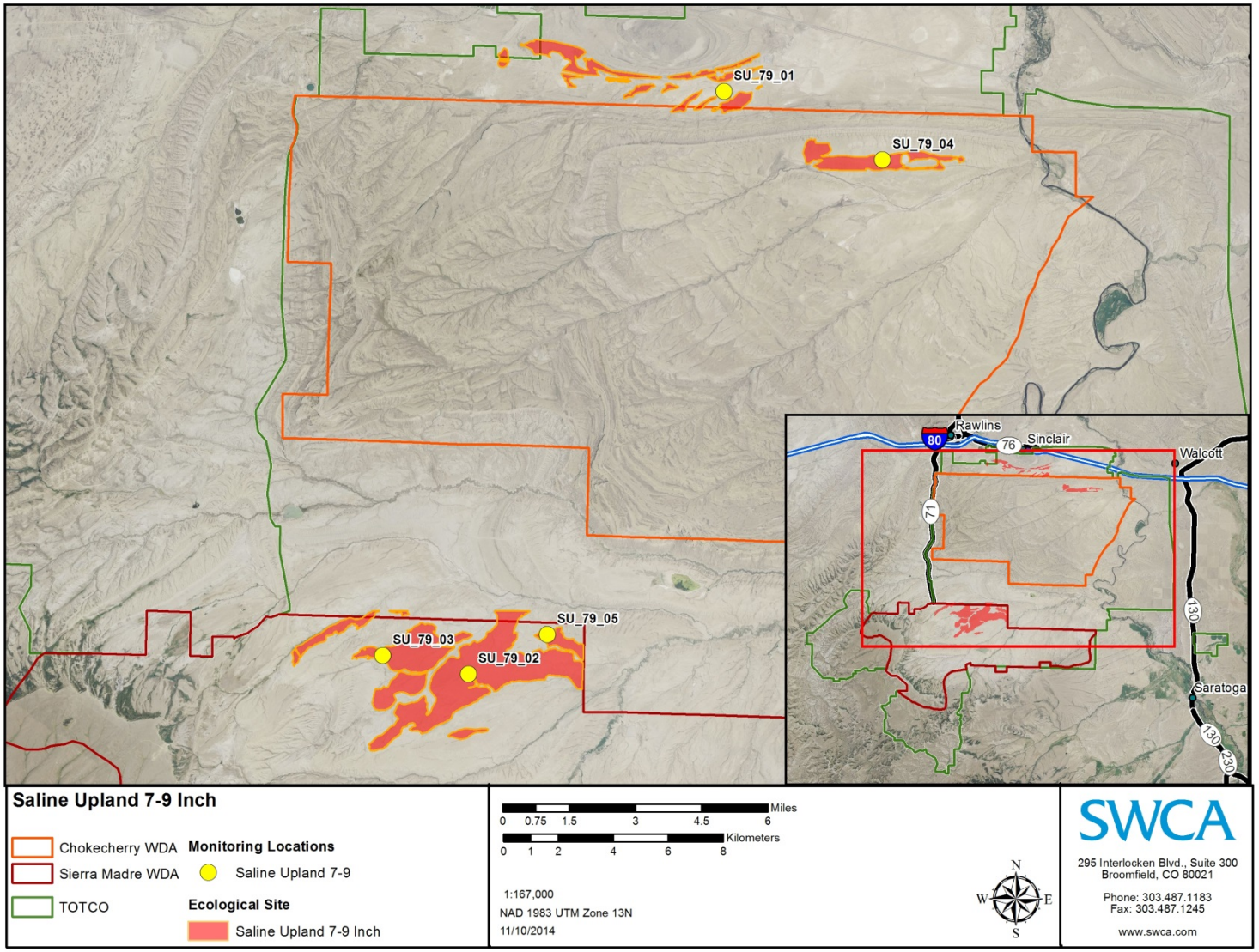


**Figure 1. Locations of reference sites used to characterize saline upland 7-9 inch ecological sites in the CCSM Phase I Site.**

**Site Characteristics**

## Climate

Mean annual precipitation is 8.0 inches (ranges from 7-9 inches per year), with peaks observed in May and the lowest totals recorded in the winter months. Average snow fall often exceeds 20 inches annually. Wide fluctuations do occur and result in more dry years than normal years (NRCS 2011). Due to the high elevations and dry air, temperatures at saline upland 7-9 inch ecological sites range significantly between summer and winter and daily maximum and minimums. The average annual air temperature is 41.9 °F (25.7 °F Avg. Min. to 58.1 °F Avg. Max.). Extreme minimum temperatures can occur during the winter months when cold air outbreaks and winter storms move rapidly from northwest to southeast.

## Abiotic Landscape Features

Saline upland 7-9 inch ecological sites in the CCSM Phase I Site occur on near level to gently undulating rolling land. Slopes vary, but are typically less than 10% (NRCS 2011). Examples of landforms found in this ecological site include basin floors, alluvial fans, and hillslopes. Elevation is variable and ranges between 6,500 feet and 7,200 feet in the CCSM Phase I Site.

## Soil Characteristics

Saline upland 7-9 inch ecological sites within the CCSM Phase I Site are deep to very deep and moderately well to well-drained, and moderately slow to moderately permeable. Textures range from clay loams to clays (NRCS 2011).

Topsoil averages 4.9 ± 0.66 inches. Lower soil horizon depths generally exceed 14.8 inches. Topsoil soil textures range from clay loam to silty clay. Subsoil textures are characterized by silty clay to clay. Sodic horizons, that are typical of this soil type, could form a restrictive layer that impedes air and water movement. Sodicity of the surface soil is likely to cause dispersion of surface aggregates, resulting in surface crusts that inhibit infiltration.

Saline upland 7-9 inch ecological sites in the CCSM Phase I Site are characterized by soils with slow to moderate infiltration and moderate to high runoff potential. Infiltration rates are highest, and runoff rates lowest where ground cover exceeds 75%. Rills and gullies are typically not present and surface water flow patterns are barely distinguishable if at all present (NRCS 2011). Chemical and physical crusts may be present at these sites (NRCS 2011).

Soils are moderately to strongly alkaline with pH values between 7.95 and 8.78 and non-saline to strongly saline electrical conductivities ranging between 0.10 and 2.7 dS/m. Where soil pH ranges exceed 8.40, soils may have limited reclamation potential (LRP) and may need to be evaluated for potential soil treatment. Soils are non-effervescent to violently effervescent indicating presence of weakly and strongly covalent carbonates.

Figures 2 and 3 illustrate the soil surface and soil profile characteristics of a typical saline upland 7-9 inch site in the CCSM Phase I Site.

**Table 2. Soil characteristics typical of saline upland 7-9 inch ecological sites.**

| Soil Characteristics | Description |
|---|---|
| **Parent Material (Kind)** | Alluvium, residuum |
| **Parent Material (Origin)** | Sedimentary |
| **Topsoil Depth[1]** | 4.9 ± 0.66 inches |
| **Topsoil Texture** | Clay loam to silty clay |
| **Subsoil Depth[2]** | 14.8 ± 0.66 inches |
| **Subsoil Texture** | Silty clay to clay |
| **Topsoil Fragments** | None |
| **Subsoil Fragments** | 0%–50% volume, shale, channers, subangular |
| **Electrical Conductivity (Topsoil)** | 0.10-1.90 dS/m |
| **Salinity Class (Topsoil)** | Non-saline to moderately saline |
| **Electrical Conductivity (Subsoil)** | 0.34-2.70 dS/m |
| **Salinity Class (Subsoil)** | Non-saline to strongly saline |
| **Soil Reaction (Topsoil)** | 7.95-8.78 |
| **pH Class (Topsoil)** | Moderately to strongly alkaline |
| **Soil Reaction (Subsoil)** | 8.04-8.42 |
| **pH Class (Subsoil)** | Moderately alkaline |
| **Carbonate Equivalent (Topsoil)** | Strongly to violently effervescent |
| **Carbonate Equivalent (Subsoil)** | Noneffervescent to violently effervescent |

[1]Topsoil depth determined by depth of A Horizon.
[2]Subsoil depth determined by B and C horizons to a maximum of 20 inches depth including topsoil.

**Figure 2. Representative soil surface and ground cover for saline upland 7-9 inch sites in the CCSM Phase I Site (SU_79_05).**

**Figure 3. Representative soil profile for saline upland 7-9 inch sites in the CCSM Phase I Site (SU_79_05).**

## Vegetation Characteristics

Plant communities associated with saline upland 7-9 inch ecological sites in the CCSM Phase I Site are characterized by vegetated surfaces with 5%–37% basal cover (Table 3 and 4). The remaining soil surface is characterized primarily by unprotected soils (55–84%), rock fragments (1–7%), and litter (1–5%). Figure 4 illustrates representative vegetation communities associated with saline upland 7-9 inch ecological sites in the CCSM Phase I Site.

When saline upland 7-9 inch ecological sites are subjected to severe grazing pressure, weedy annuals (e.g. *Halogeton glomeratus*) will begin to invade and Indian ricegrass (*Achnatherum hymenoides*), bud sagebrush (*Picrothamnus desertorum*), and Gardner's saltbush (*Atriplex gardneri*) will begin to decrease (NRCS 2011). Severe ground disturbance will convert this plant community to a halogeton state. Heavy continuous season long grazing will convert this plant community to a Gardner's saltbush/annual forb vegetation state (NRCS 2011).

The BLM pick list in Table 5 (BLM 2011) and the species composition and cover (Tables 3 and 4) observed for saline upland 7-9 inch ecological sites will be used to guide the selection of appropriate seed mixes and application rates for revegetation. Final seed mixes will be determined based on seed availability at the time of revegetation efforts and in coordination with the BLM AO.

**Table 3. Vegetation characteristics typical of saline upland 7-9 inch ecological sites.**

| | | |
|---|---|---|
| Basal Vegetative Cover (LPI*) | 5% – 37% | |
| Biological Soil Crust and Lichen (LPI*) | 0% | |
| Litter Cover (LPI*) | 1% – 5% | |
| Surface Fragment/Rock Cover (LPI*) | 1% – 7% | |
| Unprotected Soil(LPI*) | 55% – 84% | |
| Representative Species and Top-Canopy Cover* | *Atriplex gardneri* | 15.4% average |
| | *Descurainia pinnata* | 12.7% average |
| | *Picrothamnus desertorum* | 11.0% average |
| | *Artemisia pedatifida* | 6.5% average |
| | *Lappula occidentalis var. cupulata* | 4.0% average |

* Line point intercept

**Table 4. Vegetation community of saline upland 7-9 inch ecological sites.**

| **Associated species** | |
|---|---|
| *Achnatherum hymenoides* | *Lappula occidentalis var. cupulata* |
| *Allium textile* | *Lomatium grayi* |
| *Arenaria hookeri* | *Lomatium macrocarpum* |
| *Artemisia pedatifida* | *Pascopyrum smithii* |
| *Astragalus sp.* | *Penstemon eriantherus* |
| *Atriplex gardneri* | *Phlox hoodii* |
| *Cardaria draba* | *Phlox sp.* |
| *Delphinium geyeri* | *Picrothamnus desertorum* |
| *Descurainia pinnata* | *Poa secunda* |
| *Elymus elymoides* | *Tetradymia nuttallii* |
| *Eriogonum gordonii* | *Xylorhiza glabriuscula* |
| *Krascheninnikovia lanata* | |

**Figure 4. Characteristic vegetation communities associated with saline upland 7-9 inch sites in the CCSM Phase I Site (SU_79_05).**

**Table 5. Recommended seed pick list for saline upland ecological sites (BLM 2011).**

| **Name** | ***Scientific Name*** | **Variety** | **SYMBOL** |
|---|---|---|---|
| ***Grasses*** | | | |
| Western wheatgrass | *Pascopyrum smithii* | Rosana | PASM |
| Little bluegrass "Sandberg" | *Poa Secunda* | High Plains | POSE |
| Prairie cordgrass | *Spartina pectinata* | | SPPE |
| Slender wheatgrass | *Elymus trachycaulus* | Pryor (Revenue) | ELTR |
| Bottlebrush squirreltail | *Elymus elymoides* | | ELEL5 |
| Indian ricegrass | *Achnatherum hymenoides* | Rimrock (Nez Par) | ACHY |
| ***Shrubs*** | | | |
| Fourwing saltbush | *Atriplex canescens* | Wytana | ATCA2 |
| Spiny horsebrush | *Tetradymia spinosa* | | TESP2 |
| Gardner's saltbush | *Atriplex gardneri* | | ATGA |
| Shadscale saltbush | *Atriplex confertifolia* | | ATCO |
| ***Forbs*** | | | |
| Textile onion | *Allium textile* | | ALTE |
| Desert biscuitroot | *Lomatium foeniculaceum* | | LOFO |
| Bulbous springparsley | *Cymopterus bulbosus* | | CYBU |
| Hoods phlox | *Phlox hoodii* | | PHHO |

**Exhibit V**

**Saline Upland 10-14 inch Ecological Site Description**

**Adapted from NRCS (2011)**

Site-specific conditions for saline upland 10-14 inch ecological sites in the CCSM Phase I Site were characterized using data collected at three monitoring locations (Figure 1, Table 1). Long-term monitoring reference sites for saline upland 10-14 inch ecological sites have been established in coordination with the BLM Authorized Officer (AO). Any additional monitoring site that is used for ecological site characterization that is located 100 meters outside of the CCSM Phase I limits of disturbance (LODs) may be suitable as a long-term monitoring reference site for saline upland 10-14 inch ecological site and may be used for future reclamation success monitoring purposes.

**Table 1. Representative transects for saline upland 10-14 inch ecological sites in the CCSM Phase I Site.**

| Transect Number | Record Date | Latitude | Longitude | Altitude | Transect Bearing |
|---|---|---|---|---|---|
| SU_1014_01 | 7/8/2014 | 41.49425 | -107.19984 | 7,067 | 55 |
| SU_1014_02 | 7/9/2014 | 41.49675 | -107.20737 | 7,021 | 215 |
| SU_1014_03 | 7/27/2014 | 41.48461 | -107.26817 | 7,244 | 65 |

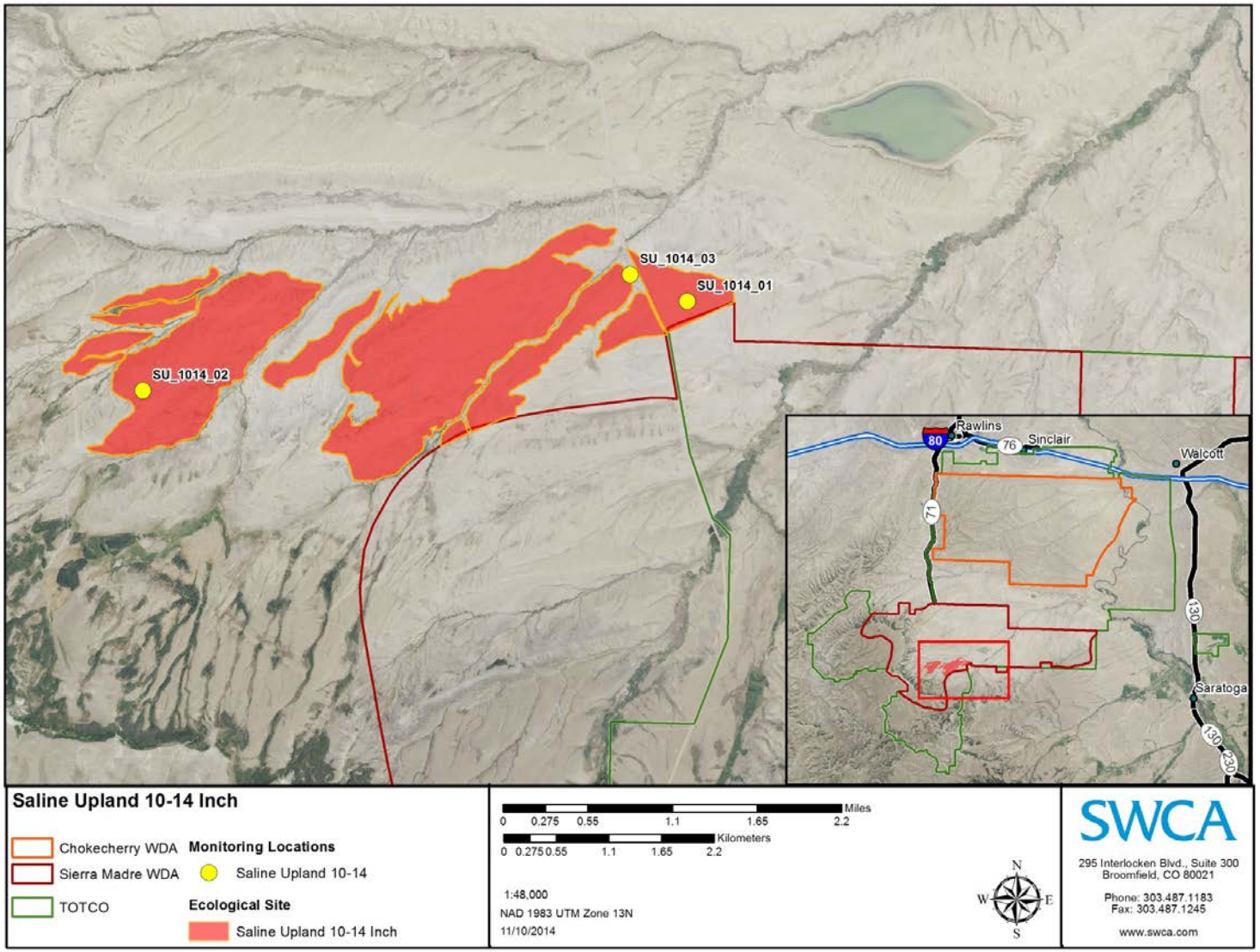


**Figure 1. Locations of vegetation transects and soil samples used to characterize saline upland 10-14 inch ecological sites in the CCSM Phase I Site.**

**Site Characteristics**

*Climate*

The mean annual precipitation at these sites is 12.4 inches, with peaks observed in May and the lowest totals recorded in the winter months. Average snow fall often exceeds 20 inches annually. Wide fluctuations do occur and result in more dry years than normal years (NRCS 2011). Due to the high elevations and dry air, temperatures at upland saline (10-14 inch) ecological sites range significantly between summer and winter and daily maximum and minimums. The average annual air temperature is 46.2 °F (30.1 °F Avg. Min. to 62.3 °F Avg. Max.). Extreme minimum temperatures can occur during the winter months when cold air outbreaks and winter storms move rapidly from northwest to southeast. Chinook winds can occur in winter bringing rapid rises in temperature. Winds speeds are lower than other areas of the state. Daytime winds are stronger than nighttime with some strong gusts associated with the passage of winter storms (NRCS 2011).

*Abiotic Landscape Features*

Saline upland 10-14 inch ecological sites in the CCSM Phase I Site occur on nearly level to moderately sloping land. Slopes vary, but are typically between 1% and 3%. Elevation is variable and ranges between 7,100 feet and 7,400 feet in the CCSM Phase I Site.

*Soil Characteristics*

Saline upland 10-14 inch ecological sites within the CCSM Phase I Site are characterized by mineral soils with little to no organic material. Soils are moderately deep to very deep and well drained. They have moderate to slow permeability.

Topsoil averages 6.0 ± 0.65 inches in depth. Lower soil horizon depths generally exceed 13.6 inches. Topsoil textures are characterized by silty clay loams to silty clays. Lower soil horizons are characterized by sandy clay loams to clays. Sodic horizons, that are typical of this soil type, could form a restrictive layer that impedes air and water movement. Sodicity of the surface soil is likely to cause dispersion of surface aggregates, resulting in surface crusts that inhibit infiltration.

Saline upland 10-14 inch ecological sites in the CCSM Phase I Site are characterized by soils with slow to moderate infiltration and moderate to high runoff potential. Infiltration rates are highest, and runoff rates lowest where ground cover exceeds 75%. Rills and gullies are typically not present and surface water flow patterns are often indistinguishable (NRCS 2011). Chemical and physical crusts may be present at these sites (NRCS 2011).

Soils are moderately to very strongly alkaline with pH values between 8.13 and 8.41 and moderately to very strongly saline with electrical conductivities ranging between 1.8 and 8.0 dS/m with salinity increasing with soil depth. Soils are very slightly to strongly effervescent indicating presence of weakly to strongly covalent carbonates. Where soil salinity exceeds 4.0 dS/m, soils may have limited reclamation potential (LRP) may need to be evaluated for potential soil treatment.

Figures 2 and 3 illustrate the soil surface and soil profile characteristics of a typical saline upland ecological site in the CCSM Phase I Site.

**Table 2. Soil characteristics typical of saline upland 10-14 inch ecological sites.**

| Soil Characteristics | Description |
|---|---|
| **Parent Material (Kind)** | Alluvium, residuum |
| **Parent Material (Origin)** | Sedimentary |
| **Topsoil Depth[1]** | 6.0 ± 0.65 inches |
| **Topsoil Texture** | Silty clay loam to silty clay |
| **Subsoil Depth[2]** | 13.6 ± 0.65 inches |
| **Subsoil Texture** | Sandy clay loam to clay |
| **Topsoil Fragments** | None |
| **Subsoil Fragments** | 0-60% volume, sedimentary, channers, subangular |
| **Electrical Conductivity (Topsoil)** | 1.8-2.2 dS/m |
| **Salinity Class (Topsoil)** | Moderately saline |
| **Electrical Conductivity (Subsoil)** | 2.1-8.0 dS/m |
| **Salinity Class (Subsoil)** | Moderately to very strongly saline |
| **Soil Reaction (Topsoil)** | 7.88-8.32 |
| **pH Class (Topsoil)** | Moderately alkaline |
| **Soil Reaction (Subsoil)** | 7.13-8.41 |
| **pH Class (Subsoil)** | Neutral to moderately alkaline |
| **Carbonate Equivalent (Topsoil)** | Strongly effervescent |
| **Carbonate Equivalent (Subsoil)** | Very slightly to strongly effervescent |

[1]Topsoil depth determined by depth of A Horizon.
[2]Subsoil depth determined by B and C horizons to a maximum of 20 inches depth including topsoil.

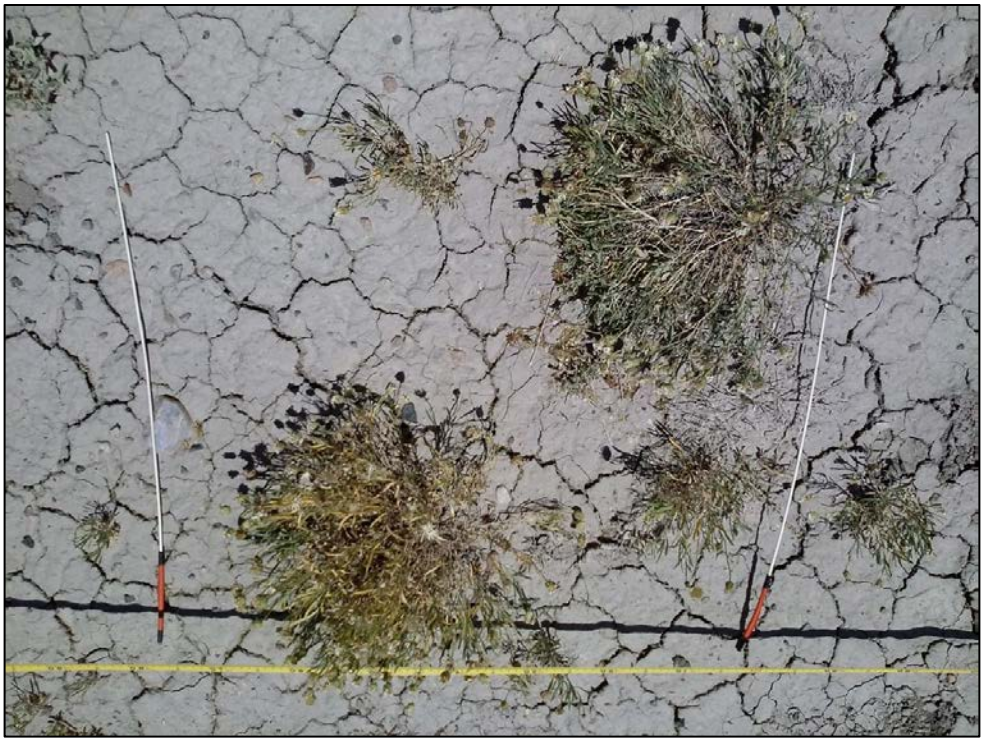

**Figure 2. Representative soil surface and ground cover for saline upland 10-14 inch sites in the CCSM Phase I Site (SU_1014_01)**

**Figure 3. Representative soil profile for saline upland 10-14 inch sites in the CCSM Phase I Site (SU_1014_01).**

*Vegetation Characteristics*

Plant communities associated with saline upland 10-14 inch ecological sites in the CCSM Phase I Site are characterized by sparsely vegetated surfaces with 11%–17% basal cover (Tables 3 and 4). The remaining soil surface is characterized primarily by unprotected soils (76% – 86%). Figure 4 illustrates representative vegetation communities associated with saline upland 10-14 inch ecological sites in the CCSM Phase I Site.

When saline upland 10-14 inch ecological sites are subjected to improper grazing management, species such as Gardner's saltbush (*Atriplex gardneri)*, halogeton and annual forbs will increase (NRCS 2011). Indian ricegrass (*Achnatherum hymenoides)* and big sagebrush (*Artemisia tridentata)* will decrease in frequency and production. Severe ground disturbance will convert this plant community to a halogeton state. Heavy continuous season long grazing will convert this plant community to a Gardner's saltbush/annual forb vegetation state (NRCS 10-14).

**Table 3. Vegetation characteristics typical of saline upland 10-14 inch ecological sites.**

| | | |
|---|---|---|
| Basal Vegetative Cover (LPI*) | 11%–17% | |
| Biological Soil Crust and Lichen (LPI*) | 0% | |
| Litter Cover (LPI*) | 0%–4% | |
| Surface Fragment/Rock Cover (LPI*) | 0%–3% | |
| Unprotected Soil(LPI*) | 76% – 86% | |
| Representative Species and Top-Canopy Cover* | *Atriplex gardneri* | 23.0% average |
| | *Monolepis nuttalliana* | 3.0% average |
| | *Xylorhiza glabriuscula* | 1.0% average |
| | *Eriogonum gordonii* | 1.0% average |

* Line point intercept

**Table 4. Species commonly associated with saline upland 10-14 inch ecological sites.**

| | |
|---|---|
| *Achnatherum hymenoides* | *Lappula occidentalis var. cupulata* |
| *Allium textile* | *Monolepis nuttalliana* |
| *Alyssum desertorum* | *Opuntia polyacantha* |
| *Arenaria hookeri* | *Phlox hoodii* |
| *Artemisia tridentata ssp. wyomingensis* | *Phlox sp.* |
| *Atriplex confertifolia* | *Picrothamnus desertorum* |
| *Atriplex gardneri* | *Poa secunda* |
| *Chrysothamnus viscidiflorus* | *Pseudoroegneria spicata* |
| *Descurainia pinnata* | *Sphaeralcea coccinea* |
| *Elymus elymoides* | *Stanleya pinnata* |
| *Eriogonum gordonii* | *Stenotus acaulis* |
| *Eriogonum sp.* | *Tetradymia nuttallii* |
| *Hesperostipa comata* | *Xylorhiza glabriuscula* |
| *Krascheninnikovia lanata* | |

**Figure 4. Characteristic vegetation communities associated with saline upland 10-14 inch sites in the CCSM Phase I Site (SU_1014_01)**

**Table 5. Recommended seed pick list for saline upland ecological sites.**

| **Name** | ***Scientific Name*** | **Variety** | **USDA Code** |
|---|---|---|---|
| ***Grasses*** | | | |
| Indian ricegrass | *Achnatherum hymenoides* | Rimrock (Nez Par) | ACHY |
| Little bluegrass "Sandberg" | *Poa Secunda* | High Plains | POSE |
| Bottlebrush squirreltail | *Elymus elymoides* | | ELEL5 |
| Western wheatgrass | *Pascopyrum smithii* | Rosana | PASM |
| ***Shrubs*** | | | |
| Fourwing saltbush | *Atriplex canescens* | Wytana | ATCA |
| Shadscale | *Atriplex confertifolia* | | ATCO |
| Gardner's saltbush | *Atriplex gardneri* | | ATGA |
| Spiny horsebrush | *Tetradymia spinosa* | | TESP2 |
| ***Forbs*** | | | |
| Textile onion | *Allium textile* | | ALTE |
| Desert biscuitroot | *Lomatium foeniculaceum* | | LOFO |
| Hoods phlox | *Phlox hoodii* | | PHHO |
| Bulbous springparsley | *Cymopterus bulbosus* | | CYBU |

**Exhibit VI**

**Shale 10-14 inch Ecological Site Description**

**Adapted from NRCS (2011)**

Site-specific conditions for shale 10-14 inch ecological sites in the CCSM Phase I Site were characterized using data collected at three monitoring locations (Table 1, Figure 1). Long-term monitoring reference sites for shale 10-14 inch ecological sites have been established in coordination with the BLM Authorized Officer (AO). Any additional monitoring site that is used for ecological site characterization that is located 100 meters outside of the CCSM Phase I limits of disturbance (LODs) may be suitable as a long-term monitoring reference site for shale 10-14 inch ecological site and may be used for future reclamation success monitoring purposes.

**Table 1. Representative transects for shale 10-14 inch ecological sites in the CCSM Phase I Site.**

| Transect Number | Record Date | Latitude | Longitude | Altitude | Transect Bearing |
|---|---|---|---|---|---|
| SH_1014_01 | 7/2/2014 | 41.50046 | -107.26985 | 7,270 | 100 |
| SH_1014_02 | 7/2/2014 | 41.51742 | -107.27582 | 7,372 | 65 |
| SH_1014_03 | 7/8/2014 | 41.49734 | -107.19996 | 7,096 | 270 |

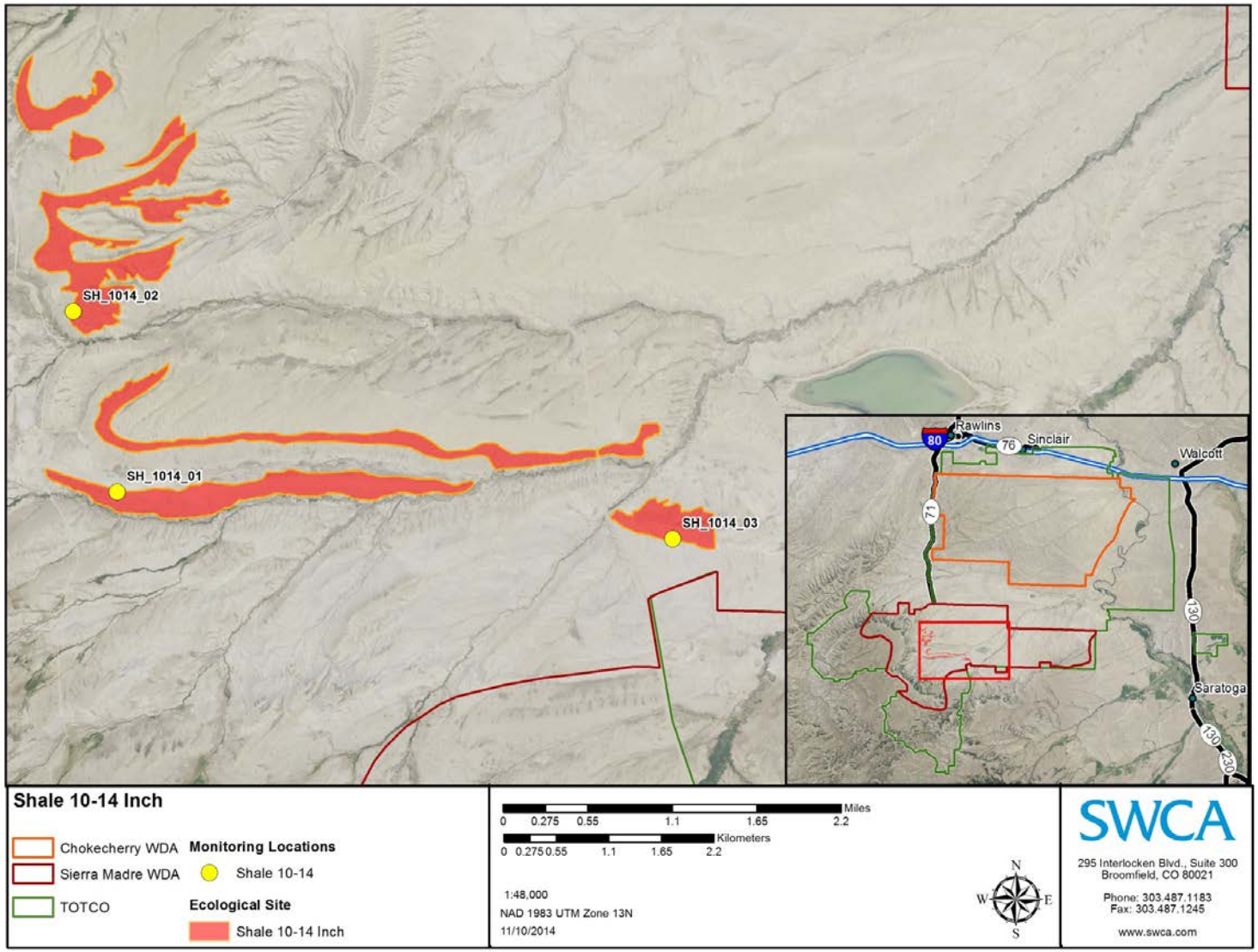


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**Figure 1. Locations of reference sites used to characterize shale 10-14 inch ecological sites in the CCSM Phase I Site.**

**Site Characteristics**

*Climate*

The mean annual precipitation at these sites is 11.5 inches, with peaks observed in May and the lowest totals recorded in the winter months. Average snow fall often exceeds 20 inches annually. Wide fluctuations do occur and result in more dry years than normal years (NRCS 2011). Due to the high elevations and dry air, temperatures at shale 10-14 inch ecological sites range significantly between summer and winter and daily maximum and minimums. The average annual air temperature is 42.2 °F (30.4 ° Avg. Min. to 53.9 °F Avg. Max.). Extreme minimum temperatures can occur during the winter months when cold air outbreaks and winter storms move rapidly from northwest to southeast

*Abiotic Landscape Features*

Shale 10-14 inch ecological sites in the CCSM Phase I Site occur on upland positions, with variable slopes from 1 to 70%, but typically between 5 to 25%. Elevation is variable and ranges between 7,000 feet and 7,600 feet in the CCSM Phase I Site.

*Soil Characteristics*

Shale 10-14 inch ecological sites within the CCSM Phase I Site have very shallow well drained soils formed from alluvium, residuum, and colluvium. The soils are prone to rapid run-off and severe erosion. Textures range from sandy clay loams to silty clays.

Topsoil averages 6.7± 1.61 inches in depth. Lower soil horizon depths generally exceed 10.2 inches. Topsoil textures are generally clay loams. Subsoil textures range from sandy clay loams to silty clays. Gravel modifiers are generally present in both topsoil and subsoil horizons although the volume of rock fragments is generally very low in both horizons. Shale 10-14 inch ecological sites are typically not limited by restrictive layers in subsurface horizons; however, an increased volume of gravel and rock modifiers (greater than 15% volume) may increase limitations for vegetation establishment and growth.

Shale 10-14 inch ecological sites in the CCSM Phase I Site are characterized by soils with slow to very slow infiltration and high to very high runoff potential (NRCS 2011). Rills, gullies and surface water flow patterns may be present but should be barely distinguishable (NRCS 2011). Chemical and physical crusts are sometimes present at these sites (NRCS 2011).

Soils are moderately to strongly alkaline to very strongly alkaline with pH values between 8.35 and 8.82 and non-saline moderately saline with electrical conductivities ranging between 0.12 and 1.8 dS/m. Where soil pH ranges exceed 8.4, soils may have limited reclamation potential and may need to be evaluated for potential soil treatment. Soils are strongly to violently effervescent indicating presence of strongly covalent carbonates.

Figures 2 and 3 illustrate the soil surface and soil profile characteristics of a typical shale 10-14 inch ecological site in the CCSM Phase I Site.

**Table 2. Soil characteristics typical of shale 10-14 inch ecological sites.**

| Soil Characteristics | Description |
|---|---|
| **Parent Material (Kind)** | Alluvium, residuum, colluvium |
| **Parent Material (Origin)** | Sedimentary |
| **Topsoil Depth[1]** | 6.7 ± 1.61 inches |
| **Topsoil Texture** | Clay loam |
| **Subsoil Depth[2]** | 10.2 ± 2.73 inches |
| **Subsoil Texture** | Sandy clay loam to silty clay |
| **Topsoil Fragments** | 0-50% volume, shale, channers, angular to subangular |
| **Subsoil Fragments** | 5-50% volume, shale, channers, subangular |
| **Electrical Conductivity (Topsoil)** | 0.12-1.6 dS/m |
| **Salinity Class (Topsoil)** | Non-saline to moderately saline |
| **Electrical Conductivity (Subsoil)** | 0.14-1.8 dS/m |
| **Salinity Class (Subsoil)** | Non-saline to moderately saline |
| **Soil Reaction (Topsoil)** | 8.35-8.82 |
| **pH Class (Topsoil)** | Moderately to strongly alkaline |
| **Soil Reaction (Subsoil)** | 8.43-8.62 |
| **pH Class (Subsoil)** | Strongly alkaline |
| **Carbonate Equivalent (Topsoil)** | Strongly effervescent |
| **Carbonate Equivalent (Subsoil)** | Strongly to violently effervescent |

[1]Topsoil depth determined by depth of A Horizon.
[2]Subsoil depth determined by B and C horizons to a maximum of 20 inches depth including topsoil.

**Figure 2. Representative soil surface and ground cover for shale 10-14 inch sites in the CCSM Phase I Site (SH_1014_03)**

**Figure 3. Representative soil profile for shale 10-14 inch sites in the CCSM Phase I Site (SH_1014_03).**

*Vegetation Characteristics*

Plant communities associated with shale 10-14 inch ecological sites in the CCSM Phase I Site are characterized by vegetated surfaces with 9%–16% basal cover (Table 3). The remaining soil surface is characterized primarily by rock fragments (46%–70%) and unprotected soils (14% – 38%). Figure 4 illustrates representative vegetation communities associated with shale 10-14 inch ecological sites in the CCSM Phase I Site.

Shale 10-14 inch ecological sites subjected to frequent and severe grazing causes the bare ground and annual forbs component to increase. The site is fragile with low productivity potential and under continuous grazing will convert to the bare ground/annual forb state.

The BLM pick list in Table 5 (BLM 2011) and the species composition and cover (Tables 3 and 4) observed for shale 10-14 inch ecological sites will be used to guide the selection of appropriate seed mixes and application rates for revegetation. Final seed mixes will be determined based on seed availability at the time of revegetation efforts and in coordination with the BLM AO.

**Table 3. Vegetation characteristics typical of shale 10-14 inch ecological sites.**

| | | |
|---|---|---|
| Basal Vegetative Cover (LPI*) | 9%–16% | |
| Biological Soil Crust and Lichen (LPI*) | 0% | |
| Litter Cover (LPI*) | 0%–5% | |
| Surface Fragment/Rock Cover (LPI*) | 46%–70% | |
| Unprotected Soil(LPI*) | 14% – 38% | |
| Representative Species and Top-Canopy Cover* | *Atriplex gardneri* | 6.0% average |
| | *Stenotus acaulis* | 5.5% average |
| | *Krascheninnikovia lanata* | 5.0% average |
| | *Eriogonum flavum* | 4.0% average |
| | *Eriogonum brevicaule* | 3.0% average |

* Line point intercept

**Table 4. Species commonly associated with shale 10-14 inch ecological sites.**

| | |
|---|---|
| *Achnatherum hymenoides* | *Eriogonum gordonii* |
| *Allium textile* | *Eriogonum ovalifolium* |
| *Arenaria hookeri* | *Eriogonum sp.* |
| *Artemisia pedatifida* | *Krascheninnikovia lanata* |
| *Astragalus bisulcatus* | *Linum lewisii* |
| *Astragalus purshii* | *Machaeranthera grindelioides* |
| *Astragalus sp.* | *Pascopyrum smithii* |
| *Atriplex confertifolia* | *Phlox hoodii* |
| *Atriplex gardneri* | *Phlox sp.* |
| *Calochortus nuttallii* | *Physaria sp.* |
| *Castilleja linariifolia* | *Poa secunda* |
| *Chaenactis sp.* | *Pseudoroegneria spicata* |
| *Crepis sp.* | *Stanleya pinnata* |
| *Cryptantha sp.* | *Stanleya viridiflora* |
| *Cymopterus bulbosus* | *Stenotus acaulis* |
| *Cymopterus sp.* | *Tetradymia canescens* |
| *Elymus elymoides* | *Tetradymia nuttallii* |
| *Erigeron sp.* | *Trifolium gymnocarpon* |
| *Eriogonum brevicaule* | *Xylorhiza glabriuscula* |
| *Eriogonum flavum* | |

**Figure 4. Characteristic vegetation communities associated with shale 10-14 inch sites in the CCSM Phase I Site (SH_1014_03)**

**Table 5. Recommended seed pick list for shale ecological sites.**

| **Name** | ***Scientific*** | **Variety** | **SYMBOL** |
|---|---|---|---|
| ***Grasses*** | | | |
| Thickspike wheatgrass | *Elymus lanceolatus* | Critana | ELLA3 |
| Western wheatgrass | *Pascopyrum smithii* | Rosana | PASM |
| Indian ricegrass | *Achnatherum hymenoides* | Rimrock (Nez Par) | ACHY |
| Bottlebrush squirreltail | *Elymus elymoides* | Sand hollow | ELEL |
| Slender wheatgrass | *Elymus trachycaulus* | Pryor (San Luis) | ELTR |
| Little bluegrass "Sandberg" | *Poa secunda* | High Plains | POSE |
| Bluebunch wheatgrass | *Pseudoroegneria spicata* | Secor | PSSP6 |
| Galleta grass | *Pleuraphis jamesii* | Viva | PLJA |
| ***Shrubs*** | | | |
| Gardner's saltbush | *Atriplex gardneri* | | ATGA |
| Fourwing saltbush | *Atriplex canaescens* | Wytana | ATCA2 |
| Shadscale | *Atriplex confertifolia* | | ATCO |
| Winterfat | *Krascheninnikovia lanata* | Open Range | KRLA |
| ***Forbs*** | | | |
| Rocky Mountain beeplant | *Cleome serrulata* | Appar | CLSE |
| Desert princesplume | *Stanleya pinnata* | | STPI |
| Textile onion | *Allium textile* | | ALTE |
| Scarlet globemallow | *Sphaeralcea coccinea* | | SPCO |
| Spiny phlox | *Phlox hoodii* | | PHHO |
| Bulbous springparsley | *Cymopterus bulbosus* | | CYBU |
| Desert biscuitroot | *Lomatium foeniculaceum* | | LOFO |

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# ATTACHMENT F

## Sand Ecological Site Class Reclamation Implementation Plan

## and

## Sandy Ecological Site Descriptions

## for

## Phase I of the Chokecherry and Sierra Madre Wind Energy Project

## Introduction

This Sand Ecological Site Class Reclamation Implementation Plan describes the common and ecological site-specific characteristics, reclamation practices, and BMPs that will be applied within the CCSM Project Site. Ecological sites in the CCSM Project Site were established cooperatively with the BLM and are a result of robust soil and vegetation sampling, landform analysis, and precipitation zone evaluation. The ecological sites are consistent with the Cool Central Desertic Basins and Plateaus (Major Land Resource Area [MLRA] – 34A) and Southern Rocky Mountain Foothills (MLRA – 49) MLRAs (Natural Resources Conservation Service [NRCS] 2006) and are primarily located in the Wyoming Basin Province of the Rocky Mountain System (NRCS 2011).

Based on common reclamation characteristics, individual ecological sites were grouped into similar ecological site classes (sand, clay, loam, shallow, and saline). Grouping similar ecological sites into a common ecological site class will increase efficiency and effectiveness of reclamation efforts as many of these common sites will have identical or very similar measures for soil handling, site preparation, and revegetation.

The following reclamation implementation plan describes the reclamation procedures and BMPs that will be applied to the ecological sites within the Sand ecological site class. The Sand ecological site class includes the following ecological sites:

- Sandy 7-9 Inch (see Exhibit I)
- Sandy 10-14 Inch (see Exhibit II)

## Reclamation Procedures and Best Management Practices

Site-specific reclamation procedures and BMPs have been developed for this Sand Ecological Site Class Reclamation Implementation Plan. Many of the reclamation procedures and BMPs will be implemented across all sandy ecological sites in the CCSM Project while other measures will be specific to an individual ecological site or smaller group of ecological sites within the Sand ecological site class.

Reclamation procedures and BMPs account for abiotic landscape features, soil characteristics, and vegetation characteristics and were designed to mitigate impacts to the abiotic and biotic factors characteristic of each ecological site and increase reclamation success. These procedures were developed in accordance with the CCSM Project Master Reclamation Plan (BLM 2012a), BLM Wyoming Reclamation Policy (2012b), management directives presented in the Rawlins Field Office (RFO) Resource Management Plan (RMP) (BLM 2008), RFO Reclamation Guidance (BLM 2011), Wyoming Department of Environmental Quality (WDEQ) Land Quality Division reclamation guidelines (WDEQ 2007), Wyoming Reclamation and Restoration Center (WRRC) Handbook of Western Reclamation Techniques (WRRC 2006), State of Wyoming's reclamation guidance for wind development, and in coordination with BLM staff. This Sand Ecological Site Class Reclamation Implementation Plan is intended to be adaptive and to take into account changing conditions and technologies. PCW, with concurrence from the BLM AO, may update, modify, or change the procedures contained in this plan if warranted due to site conditions or other factors.

In accordance with the guidance described above, reclamation practices and BMPS have been developed to address abiotic landscape features, soil handling, site preparation, and vegetation

handling and revegetation. The following sections describe the practices specific to sandy ecological sites in Phase I of the CCSM Project.

## Soil Handling and Site Preparation

Soil associated with each ecological site will be managed in accordance with the BLM Wyoming Reclamation Policy (2012b) and as detailed in the CCSM Project Master Reclamation Plan (2012a) and the site-specific reclamation plan for Phase I of the CCSM Project. Provisions are included below for segregating and marking stockpiles, as well as requirements to protect stockpiled material from erosion, contamination and degradation. Site-specific soil handling and site preparation measures for sandy ecological sites are listed below:

*Soil handling practices and BMPs for **all sandy ecological sites**[1]. These measures would be applied to all sandy ecological sites.*

- Apply mulch and/or soil tackifiers to assist in mitigating stockpile wind erosion and contribute organic materials.
- When practicable, use growth and till cycles to maintain biological activity, reduce compaction, and incorporate native organic matter and seed sources, in soil stockpiles that are stored for more than two years.
- Seed long-term stockpiles with appropriate vegetation to maintain biological activity and prevent wind erosion.
- Trap moisture during winter months through the use of snow fences, if appropriate
- Include native vegetation into salvaged topsoil to include organic matter and maintain native seedbank.
- When applicable, locate stockpiles within disturbed areas to reduce additional surface disturbance to native topsoil.

*Site preparation practices and BMPs for **all sandy ecological sites**. These measures would be applied to all sandy ecological sites.*

- Deep rip subsoils prior to application of topsoil to improve drainage.
- If necessary, add soil amendments to ameliorate physical, biological, and chemical attributes that may limit reclamation potential, to meet fair to good topsoil suitability criteria (BLM 2011), as approved by the BLM AO.
- Inspect the soil surface for ponding or gullying.
- Suspend construction activities when soils are wet and rutting exceeds 4 inches, as appropriate.

[1] Sandy Ecological Sites include Sandy 7-9 Inch and Sandy 10-14 Inch

*Additional soil handling and site preparation practices and BMPs for the **Sandy 7-9 inch** ecological site. These measures would be applied in addition to those described above for all sandy ecological sites.*

- No site-specific BMPs for soil handling have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

*Additional soil handling and site preparation practices and BMPs for the **Sandy 10-14 inch** ecological site. These measures would be applied in addition to those described above for all sandy ecological sites.*

- No site-specific BMPs for soil handling have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

## Vegetation Handling

The primary objective of revegetation is to establish the species composition, diversity, structure, and total ground cover appropriate for the desired plant community (BLM 2012b). In accordance with BLM Wyoming Reclamation Policy (2012b), proper seeding mixtures will be used to reclaim disturbed areas on federal lands with native vegetation, as detailed in the CCSM Project Master Reclamation Plan (2012a) and the site-specific reclamation plan for Phase I of the CCSM Project. Soil conditioning, de-compaction, and topsoil protection measures will be implemented to reestablish topsoil properties and to protect the seeding surface, as presented in Table 2 and described in the CCSM Project Master Reclamation Plan (BLM 2012a), the site-specific reclamation plan for Phase I of the CCSM Project, and in compliance with BLM Wyoming Reclamation Policy (2012b).

Seed mixtures will be tailored to establish species diversity, composition, and ground cover appropriate for the desired plant community that has been documented for each ecological site in the CCSM Project Site. Seed mixtures may be refined based on soil management, wildlife, or rangeland needs. Seed mixtures will be designed for each ecological site based on the RFO ecological site specific pick lists combined with site-specific vegetation characteristics (BLM 2008, 2011). The use of non-native species on federal lands will only be considered as the result of the documented failure to revegetate any area with native species and will be implemented in coordination with the BLM AO. BMPs and reclamation measures will be refined for site-specific characteristics and implemented as necessary in coordination with the BLM AO.

Recommended BMPs and protective measures for successfully reestablishing site vegetation are listed below:

*Revegetation practices and BMPs for* ***all sandy ecological sites***

- For each ecological site, using BLM pick lists (BLM 2011) contained in Exhibits I and II, design ecological site-specific seed mixes for reclamation to achieve species composition and diversity for the desired plant community, ecological setting, and current soil properties based on pre-disturbance vegetation characteristics. Final selection of seed mixes will be dependent on seed availability and will be coordinated with the BLM AO.
- Increase seeding rate for critical areas where germination is inhibited by low soil quality, as necessary.
- Reduce seeding rates in areas where a viable seed bank remains in the topsoil, as approved by BLM AO.
- Broadcast seed after disking.
- Use snow fences to trap additional soil moisture, if necessary.
- Exclude livestock from reclaimed areas, as practicable, until appropriate levels of site stabilization and revegetation are achieved.

*Additional revegetation practices and BMPs for the* ***Sandy 7-9 inch*** *ecological site. These measures would be applied in addition to those described above for all sandy ecological sites.*

- No site-specific BMPs for revegetation have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

*Additional revegetation practices and BMPs for the* ***Sandy 10-14 inch*** *ecological site. These measures would be applied in addition to those described above for all sandy ecological sites.*

- No site-specific BMPs for soil handling have been identified for this ecological site. If site-specific BMPs become available as a result of advancing technologies, site-specific BMPs will be implemented as approved by the BLM AO.

**Exhibit I**

**Sandy 7-9 inch Ecological Site Description**

**Adapted from NRCS (2011)**

Site-specific conditions for sandy 7-9 inch ecological sites in the CCSM Phase I Site were characterized using data collected at three monitoring locations (Figure 1, Table 1). Long-term monitoring reference sites for sandy 7-9 inch ecological sites have been established in coordination with the BLM Authorized Officer (AO). Any additional monitoring site that is used for ecological site characterization that is located 100 meters outside of the CCSM Phase I limits of disturbance (LODs) may be suitable as a long-term monitoring reference site for clayey 7-9 inch ecological sites and may be used for future reclamation success monitoring purposes.

**Table 1. Representative transects for sandy 7-9 inch ecological sites in the CCSM Phase I Site.**

| Transect Number | Record Date | Latitude | Longitude | Altitude | Transect Bearing |
|---|---|---|---|---|---|
| SA_79_01 | 4-Jun-14 | 41.74358368 | -107.0541229 | 1984 | 330 |
| SA_79_02 | 9-Jun-14 | 41.72612773 | -107.0626712 | 2050 | 180 |
| SA_79_03 | 11-Jun-14 | 41.72249782 | -106.9447423 | 1986 | 240 |

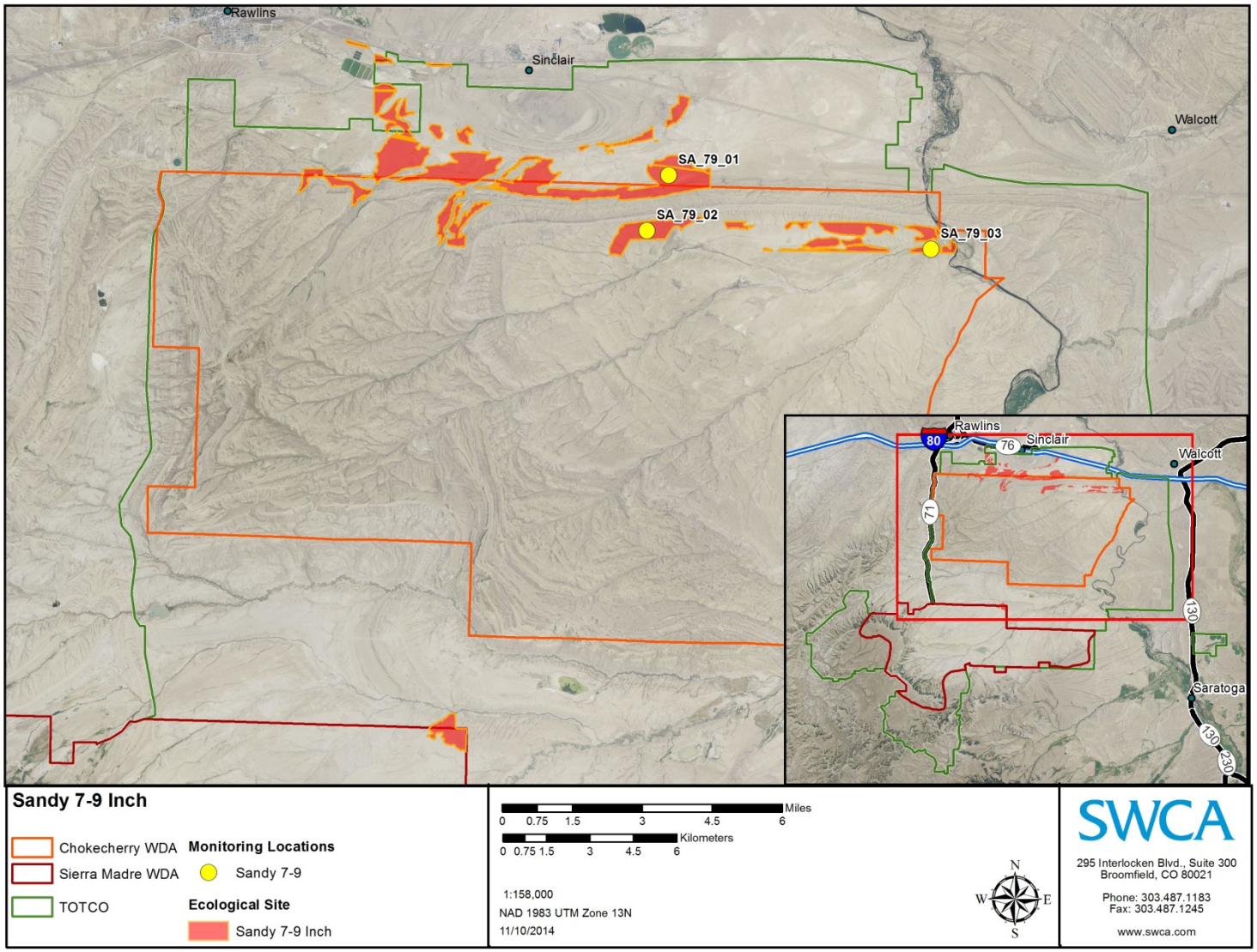


**Figure 1. Locations of reference sites used to characterize sandy 7-9 inch ecological sites in the CCSM Phase I Site.**

**Site Characteristics**

## Climate

Mean annual precipitation is 8.0 inches (ranges from 7-9 inches per year), with peaks observed in May and the lowest totals recorded in the winter months. Average snow fall often exceeds 20 inches annually. Wide fluctuations do occur and result in more dry years than normal years (NRCS 2011). Due to the high elevations and dry air, temperatures at loamy 10-14 inch ecological sites range significantly between summer and winter and daily maximum and minimums. The average annual air temperature is 41.9 °F (25.6 °F Avg. Min. to 58.1 °F Avg. Max.). Extreme minimum temperatures can occur during the winter months when cold air outbreaks and winter storms move rapidly from northwest to southeast.

## Abiotic Landscape Features

Sandy 7-9 inch ecological sites in the CCSM Phase I Site occur on relatively flat to moderately sloping land. Slopes vary, but are typically less than 20% (NRCS 2011). Examples of landforms found in this ecological site include alluvial fans, hillsides, plateaus, ridges and stream terraces. Elevation is variable and ranges between 6,000 feet and 7,200 feet in the CCSM Phase I Site.

## Soil Characteristics

Sandy 7-9 inch ecological sites within the CCSM Phase I Site are mostly deep and well-drained, and moderate to moderately rapid permeable. Textures range from fine sandy loam to loamy fine sand (NRCS 2011).

Topsoil averages 4.6 ± 0.70 inches. Lower soil horizon depths generally exceed 15.1 inches. Topsoil soil textures range from loamy sands to sandy loams. Subsoil textures are characterized by sandy loams to loams.

Sandy 7-9 inch ecological sites in the CCSM Phase I Site are characterized by soils with moderately rapid to rapid infiltration and low to moderate runoff potential. Infiltration rates are highest, and runoff rates lowest where ground cover exceeds 75%. Rills and gullies are typically not present and surface water flow patterns are barely distinguishable if at all present (NRCS 2008c). Chemical and physical crusts are rare to non-existent at these sites (NRCS 2011).

Soils are slightly to very strongly alkaline with pH values between 7.54 and 9.14 and non-saline electrical conductivities ranging between 0.03 and 0.19 dS/m. Where soil pH ranges exceed 8.4, soils may have limited reclamation potential (LRP) and may need to be evaluated for potential soil treatment (see Reclamation Procedures and Best Management Practices). Soils are non-effervescent to violently effervescent indicating presence of weakly and strongly covalent carbonates.

Figures 2 and 3 illustrate the soil surface and soil profile characteristics of a typical sandy 7-9 inch site in the CCSM Phase I Site.

**Table 2. Soil characteristics typical of sandy 7-9 inch ecological sites.**

| Soil Characteristics | Description |
|---|---|
| **Parent Material (Kind)** | Alluvium, eolian deposits |
| **Parent Material (Origin)** | Sedimentary |
| **Topsoil Depth[1]** | 4.6 ± 0.70 inches |
| **Topsoil Texture** | Loamy sand to sandy loam |
| **Subsoil Depth[2]** | 15.1 ± 0.70 inches |
| **Subsoil Texture** | Sandy loam to loam |
| **Topsoil Fragments** | 0%–20% volume, sedimentary, fine to medium gravel, subangular |
| **Subsoil Fragments** | 0%–20% volume, sedimentary, medium to coarse gravel, subangular to subrounded |
| **Electrical Conductivity (Topsoil)** | 0.04-0.16 dS/m |
| **Salinity Class (Topsoil)** | Non-saline |
| **Electrical Conductivity (Subsoil)** | 0.03-0.19 dS/m |
| **Salinity Class (Subsoil)** | Non-saline |
| **Soil Reaction (Topsoil)** | 7.54-8.91 |
| **pH Class (Topsoil)** | Slightly to strongly alkaline |
| **Soil Reaction (Subsoil)** | 7.78-9.14 |
| **pH Class (Subsoil)** | Slightly to very strongly alkaline |
| **Carbonate Equivalent (Topsoil)** | Noneffervescent to strongly effervescent |
| **Carbonate Equivalent (Subsoil)** | Noneffervescent to violently effervescent |

[1]Topsoil depth determined by depth of A Horizon.
[2]Subsoil depth determined by B and C horizons to a maximum of 20 inches depth including topsoil.

**Figure 2. Representative soil surface and ground cover for sandy 7-9 inch sites in the CCSM Phase I Site (SA_79_01).**

**Figure 3. Representative soil profile for sandy 7-9 inch sites in the CCSM Phase I Site (SA_79_01).**

## Vegetation Characteristics

Plant communities associated with sandy 7-9 inch ecological sites in the CCSM Phase I Site are characterized by vegetated surfaces with 14%–31% basal cover (Table 3 and 4). The remaining soil surface is characterized primarily by unprotected soils (31–59%), rock fragments (4–30%), litter (6–20%), and ground lichen (1–5%). Figure 4 illustrates representative vegetation communities associated with sandy 7-9 inch ecological sites in the CCSM Phase I Site.

When sandy 7-9 inch ecological sites are subjected to severe grazing pressure, woody species such as big sagebrush (*Artemisia tridentata ssp. wyomingensis)* and rabbitbrush (e.g., *Chrysothamnus viscidiflorus*) will increase. Bunchgrasses such as Indian ricegrass (*Achnatherum hymenoides*) and needleandthread (*Hesperostipa comata*) will decrease in frequency and production. Continuous season-long grazing will cause a transition to a big sagebrush/rhizomatous wheatgrass community (NRCS 2011).

The BLM pick list in Table 5 (BLM 2011) and the species composition and cover (Tables 3 and 4) observed for sandy 7-9 inch ecological sites will be used to guide the selection of appropriate seed mixes and application rates for revegetation. Final seed mixes will be determined based on seed availability at the time of revegetation efforts and in coordination with the BLM AO.

**Table 3. Vegetation characteristics typical of loamy 10-14 inch ecological sites.**

| | | |
|---|---|---|
| Basal Vegetative Cover (LPI*) | 14% – 31% | |
| Biological Soil Crust and Lichen (LPI*) | 1% – 5% | |
| Litter Cover (LPI*) | 6% – 20% | |
| Surface Fragment/Rock Cover (LPI*) | 4% – 30% | |
| Unprotected Soil(LPI*) | 31% – 59% | |
| Representative Species and Top-Canopy Cover* | *Carex filifolia* | 34.5 average |
| | *Elymus trachycaulus* | 11.5 average |
| | *Hesperostipa comata* | 8.0 average |
| | *Pleuraphis jamesii* | 6.0 average |
| | *Pseudoroegneria spicata* | 6.0 average |

* Line point intercept

**Table 4. Species found associated with sandy 7-9 inch ecological sites in the CCSM Phase I Site.**

| | |
|---|---|
| *Achnatherum hymenoides* | *Erigeron engelmannii* |
| *Agoseris glauca* | *Eriogonum ovalifolium* |
| *Agropyron cristatum* | *Grayia spinosa* |
| *Allium textile* | *Hesperostipa comata* |
| *Alyssum alyssoides* | *Krascheninnikovia lanata* |
| *Arenaria hookeri* | *Lygodesmia grandiflora* |
| *Artemisia tridentata ssp. wyomingensis* | *Opuntia polyacantha* |
| *Astragalus purshii* | *Pascopyrum smithii* |
| *Astragalus sp.* | *Penstemon eriantherus* |
| *Atriplex confertifolia* | *Phlox hoodii* |
| *Atriplex gardneri* | *Poa fendleriana* |
| *Castilleja linariifolia* | *Poa secunda* |
| *Chrysothamnus viscidiflorus* | *Pseudoroegneria spicata* |
| *Delphinium nuttallii* | *Sarcobatus vermiculatus* |
| *Descurainia pinnata* | *Sphaeralcea coccinea* |
| *Elymus elymoides* | *Stenotus acaulis* |
| *Elymus trachycaulus* | *Trifolium gymnocarpon* |

**Figure 4. Characteristic vegetation communities associated with sandy 7-9 inch sites in the CCSM Phase I Site (SA_79_01).**

**Table 5. Recommended seed pick list for dry sandy ecological sites (BLM 2011).**

| **Name** | ***Scientific*** | **Variety** | **SYMBOL** |
|---|---|---|---|
| ***Grasses*** | | | |
| Indian ricegrass | *Achnatherum hymenoides* | Rimrock (Nez Par) | ACHY |
| Needle and thread | *Hesperostipa comata* | | HECO26 |
| Slender wheatgrass | *Elymus trachycaulus* | Pryor (San Luis) | ELTR |
| Sandhill muhly | *Muhlenbergia pungens* | | MUPU |
| Western wheatgrass | *Pascopyrum smithii* | Rosana | PASM |
| Thickspike wheatgrass | *Elymus lanceolatus* | Critana | ELLA3 |
| Threadleaf sedge | *Carex filifolia* | | CAFI |
| Galleta grass | *Pleuraphis jamesii* | Viva | PLJA |
| ***Shrubs*** | | | |
| Green rabbitbrush | *Ericameria nauseosa* | | ERNA10 |
| Yellow rabbitbrush | *Chrysothamnus viscidiflorus* | | CHVI8 |
| Gardner's saltbush | *Atriplex gardneri* | | ATGA |
| Wyoming big sagebrush | *Artemisia tridentata* ssp. *wyomingensis* | | ARTRW8 |
| Spiny hopsage | *Grayia spinosa* | | GRSP |
| Fourwing saltbush | *Atriplex canescens* | Wytana | ATCA2 |
| Silver sagebrush | *Artemisia cana* | | ARCA13 |
| White sagebrush | *Artemisia ludoviciana* | | ARLU |
| ***Forbs*** | | | |
| Scarlet globemallow | *Sphaeralcea coccinea* | | SPCO |
| Lewis' flax | *Linum lewisii* | | LILI |
| Rocky Mountain beeplant | *Cleome serrulata* | Appar | CLSE |
| Western wallflower | *Erysium capitatum* | | ERCA14 |
| Scarlet gilia | *Ipomopsis aggregata* | | IPAGA3 |
| Textile onion | *Allium textile* | | ALTE |
| Dotted gayfeather | *Liatris punctata* | | LIPU |

**Exhibit II**

**Sandy 10-14 inch Ecological Site Description**

**Adapted from NRCS (2011)**

Site-specific conditions for sandy 10-14 inch ecological sites in the CCSM Phase I Site were characterized using data collected at three monitoring locations (Figure 1, Table 1). Long-term monitoring reference sites for sandy 10-14 inch ecological sites have been established in coordination with the BLM Authorized Officer (AO). Any additional monitoring site that is used for ecological site characterization that is located 100 meters outside of the CCSM Phase I limits of disturbance (LODs) may be suitable as a long-term monitoring reference site for clayey 7-9 inch ecological sites and may be used for future reclamation success monitoring purposes.

**Table 1. Representative transects for sandy 10-14 inch ecological sites in the CCSM Phase I Site.**

| Transect Number | Record Date | Latitude | Longitude | Altitude | Transect Bearing |
|---|---|---|---|---|---|
| SA_1014_01 | 6/20/2014 | 41.64990 | -107.17364 | 7,224 | 60 |
| SA_1014_02 | 6/20/2014 | 41.65042 | -107.13222 | 7,425 | 180 |
| SA_1014_03 | 7/22/2014 | 41.64710 | -107.14328 | 7,362 | 300 |

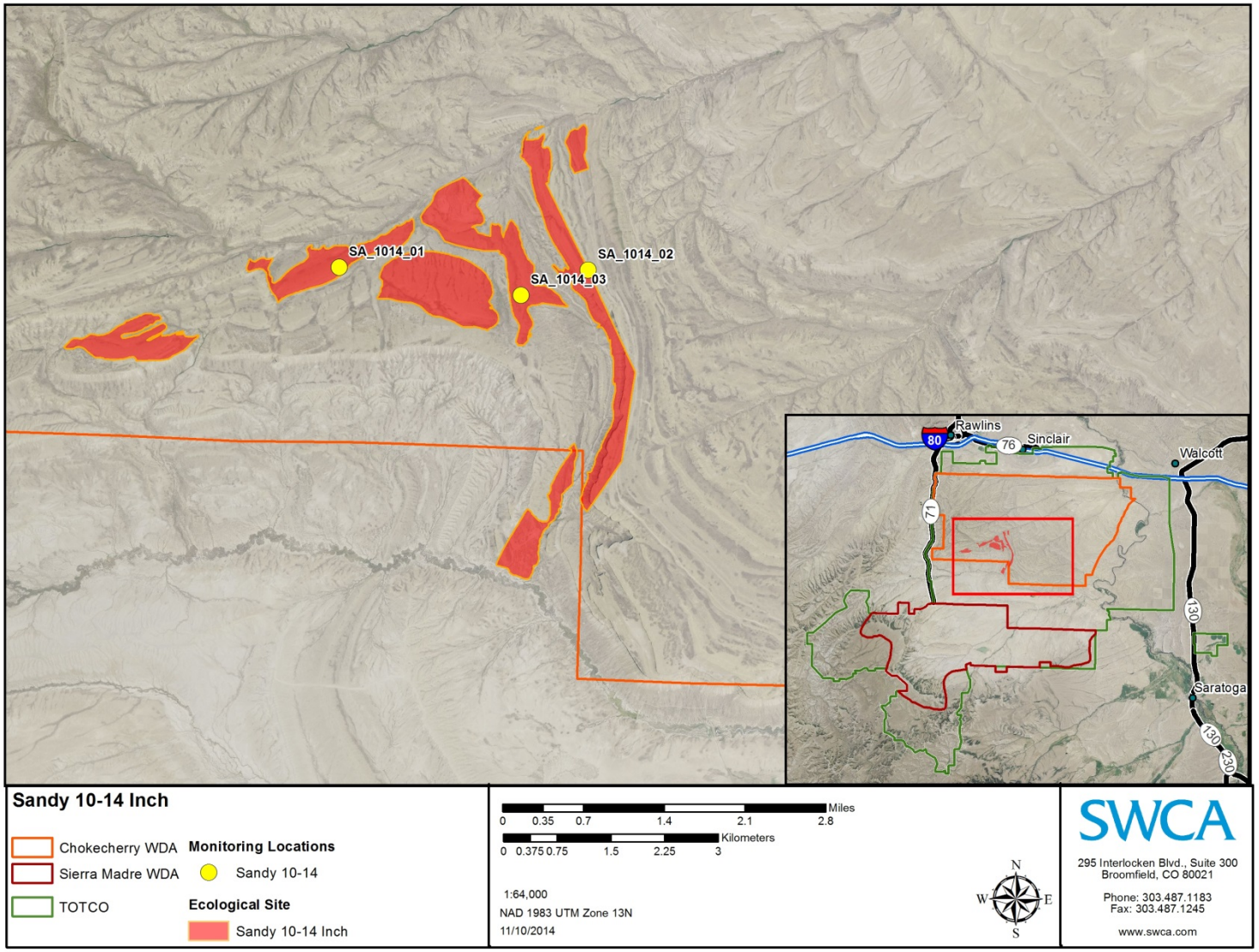


**Figure 1. Locations of reference sites used to characterize sandy 10-14 inch ecological sites in the CCSM Phase I Site.**

**Site Characteristics**

## Climate

Mean annual precipitation is 10.5 inches (ranges from 10-14 inches per year), with peaks observed in May and the lowest totals recorded in the winter months. Average snow fall often exceeds 20 inches annually. Wide fluctuations do occur and result in more dry years than normal years (NRCS 2011). Due to the high elevations and dry air, temperatures at loamy 10-14 inch ecological sites range significantly between summer and winter and daily maximum and minimums. The average annual air temperature is 41.9 °F (25.6 °F Avg. Min. to 58.1 °F Avg. Max.). Extreme minimum temperatures can occur during the winter months when cold air outbreaks and winter storms move rapidly from northwest to southeast.

## Abiotic Landscape Features

Sandy 10-14 inch ecological sites in the CCSM Phase I Site occur on relatively flat to moderately sloping land. Slopes vary, but are typically less than 20% (NRCS 2011). Examples of landforms found in this ecological site include alluvial fans, hillsides, plateaus, ridges and stream terraces. Elevation is variable and ranges between 6,900 feet and 7,300 feet in the CCSM Phase I Site.

## Soil Characteristics

Sandy 10-14 inch ecological sites within the CCSM Phase I Site are mostly deep and well-drained, and moderate to moderately rapid permeable. Textures range from fine sands to loamy fine sands (NRCS 2011).

Topsoil averages 5.2 ± 0.28 inches. Lower soil horizon depths generally exceed 14.4 inches. Topsoil soil textures range from loamy sands to sandy loams. Subsoil textures are characterized by sandy loams to loams.

Sandy 10-14 inch ecological sites in the CCSM Phase I Site are characterized by soils with moderately rapid to rapid infiltration and low to moderate runoff potential. Infiltration rates are highest, and runoff rates lowest where ground cover exceeds 75%. Rills and gullies are typically not present and surface water flow patterns are barely distinguishable if at all present (NRCS 2008c). Chemical and physical crusts are rare to non-existent at these sites (NRCS 2011).

Soils are neutral to very strongly alkaline with pH values between 7.38 and 9.10 and non-saline to very slightly saline electrical conductivities ranging between 0.08 and 0.50 dS/m. Where soil pH ranges exceed 8.40, soils may have limited reclamation potential and may need to be evaluated for potential soil treatment. Soils are non-effervescent to violently effervescent indicating presence of weakly and strongly covalent carbonates.

Figures 2 and 3 illustrate the soil surface and soil profile characteristics of a typical sandy 10-14 inch site in the CCSM Phase I Site.

**Table 2. Soil characteristics typical of sandy 10-14 inch ecological sites.**

| Soil Characteristics | Description |
|---|---|
| **Parent Material (Kind)** | Residuum, eolian |
| **Parent Material (Origin)** | Sedimentary |
| **Topsoil Depth[1]** | 5.2 ± 0.28 inches |
| **Topsoil Texture** | Fine sand to loamy fine sand |
| **Subsoil Depth[2]** | 14.4 ± 0.28 inches |
| **Subsoil Texture** | Fine sand to fine sandy loam |
| **Topsoil Fragments** | None |
| **Subsoil Fragments** | None |
| **Electrical Conductivity (Topsoil)** | 0.09-0.42 dS/m |
| **Salinity Class (Topsoil)** | Non-saline to very slightly saline |
| **Electrical Conductivity (Subsoil)** | 0.08-0.50 dS/m |
| **Salinity Class (Subsoil)** | Non-saline to very slightly saline |
| **Soil Reaction (Topsoil)** | 7.48-8.80 |
| **pH Class (Topsoil)** | Slightly to strongly alkaline |
| **Soil Reaction (Subsoil)** | 7.38-9.10 |
| **pH Class (Subsoil)** | Neutral to very strongly alkaline |
| **Carbonate Equivalent (Topsoil)** | Very slightly to strongly effervescent |
| **Carbonate Equivalent (Subsoil)** | Non-effervescent to violently effervescent |

[1]Topsoil depth determined by depth of A Horizon.
[2]Subsoil depth determined by B and C horizons to a maximum of 20 inches depth including topsoil.

**Figure 2. Representative soil surface and ground cover for sandy 10-14 inch sites in the CCSM Phase I Site (SA_1014_03).**

**Figure 3. Representative soil profile for sandy 10-14 inch sites in the CCSM Phase I Site (SA_1014_03).**

## Vegetation Characteristics

Plant communities associated with sandy 10-14 inch ecological sites in the CCSM Phase I Site are characterized by vegetated surfaces with 11%–17% basal cover (Table 3 and 4). The remaining soil surface is characterized primarily by unprotected soils (76%–86%). Figure 4 illustrates representative vegetation communities associated with sandy 10-14 inch ecological sites in the CCSM Phase I Site.

When sandy 10-14 inch ecological sites are subjected to severe grazing pressure, woody species such as big sagebrush (*Artemisia tridentata ssp. wyomingensis)* and rabbitbrush (e.g., *Chrysothamnus viscidiflorus*) will increase. Bunchgrasses such as Indian ricegrass (*Achnatherum hymenoides*) and needleandthread (*Hesperostipa comata*) will decrease in frequency and production. Continuous season-long grazing will cause a transition to a big sagebrush/rhizomatous wheatgrass community (NRCS 2011).

The BLM pick list in Table 5 (BLM 2011) and the species composition and cover (Tables 3 and 4) observed for sandy 10-14 inch ecological sites will be used to guide the selection of appropriate seed mixes and application rates for revegetation. Final seed mixes will be determined based on seed availability at the time of revegetation efforts and in coordination with the BLM AO.

**Table 3. Vegetation characteristics typical of loamy 10-14 inch ecological sites.**

| | | |
|---|---|---|
| Basal Vegetative Cover (LPI*) | 11%–17% | |
| Biological Soil Crust and Lichen (LPI*) | 0% | |
| Litter Cover (LPI*) | 0%–4% | |
| Surface Fragment/Rock Cover (LPI*) | 0%–3% | |
| Unprotected Soil(LPI*) | 76% – 86% | |
| Representative Species and Top-Canopy Cover* | *Poa secunda* | 12.3% average |
| | *Artemisia tridentata* ssp. *wyomingensis* | 9.7% average |
| | *Pseudoroegneria spicata* | 5.0% average |
| | *Elymus trachycaulus* | 4.7% average |
| | *Poa fendleriana* | 4.5% average |

* Line point intercept

**Table 4. Species found associated with sandy 10-14 inch ecological sites in the CCSM Phase I Site.**

| | |
|---|---|
| *Achnatherum hymenoides* | *Eriogonum sp.* |
| *Agoseris glauca* | *Hesperostipa comata* |
| *Allium textile* | *Koeleria macrantha* |
| *Alyssum desertorum* | *Krascheninnikovia lanata* |
| *Arenaria hookeri* | *Lappula occidentalis var. cupulata* |
| *Artemisia frigida* | *Lewisia rediviva* |
| *Artemisia nova* | *Machaeranthera grindelioides* |
| *Artemisia tridentata ssp. wyomingensis* | *Mertensia sp.* |
| *Astragalus purshii* | *Nothocalais sp.* |
| *Astragalus sp.* | *Opuntia polyacantha* |
| *Bromus tectorum* | *Oxytropis sp.* |
| *Carex filifolia* | *Pascopyrum smithii* |
| *Castilleja linariifolia* | *Penstemon sp.* |
| *Chrysothamnus viscidiflorus* | *Phlox hoodii* |
| *Cordylanthus ramosus* | *Phlox sp.* |
| *Delphinium geyeri* | *Poa fendleriana* |
| *Descurainia pinnata* | *Poa secunda* |
| *Elymus elymoides* | *Pseudoroegneria spicata* |
| *Elymus trachycaulus* | *Sphaeralcea coccinea* |
| *Ericameria nauseosa* | *Stenotus acaulis* |
| *Erigeron caespitosus* | *Stenotus armerioides* |
| *Erigeron engelmannii* | *Tetradymia canescens* |
| *Eriogonum brevicaule* | *Trifolium gymnocarpon* |
| *Eriogonum ovalifolium* | *Zigadenus sp.* |

**Figure 4. Characteristic vegetation communities associated with sandy 10-14 inch sites in the CCSM Phase I Site (SA_1014_03).**

**Table 5. Recommended seed pick list for dry sandy ecological sites (BLM 2011).**

| **Name** | ***Scientific*** | **Variety** | **SYMBOL** |
|---|---|---|---|
| ***Grasses*** | | | |
| Western wheatgrass | *Pascopyrum smithii* | Rosana | PASM |
| Thickspike wheatgrass | *Elymus lanceolatus* | Critana | ELLA3 |
| Blowout grass | *Redfieldia flexuosa* | | REFL |
| Prairie sandreed | *Calamovilfa longifolia* | Goshen | CALO |
| Indian ricegrass | *Achnatherum hymenoides* | Rimrock (Nez Par) | ACHY |
| Green needlegrass | *Nassella viridula* | | NAVI4 |
| Needleandthread | *Hesperostipa comata* | | HECO26 |
| Mutton bluegrass | *Poa fendleriana* | | POFE |
| Sand dropseed | *Sporobolus cryptandrus* | Borden County | SPCR |
| Canby bluegrass | *Poa secunda* | Canbar | POSE |
| Galleta grass | *Pleuraphis jamesii* | Viva | PLJA |
| Idaho fescue | *Festuca idahoensis* | Nezperce/Joseph | FEID |
| Mountain brome | *Bromus marginatus* | Garnet | BRMA4 |
| Prairie Junegrass | *Koeleria macrantha* | | KOMA |
| Spike muhly | *Muhlenbergia wrightii* | El Vado | MUWR |
| ***Shrubs*** | | | |
| Silver sagebrush | *Artemisia cana* | | ARCA13 |
| Fourwing saltbush | *Atriplex canescens* | Wytana | ATCA2 |
| Antelope bitterbrush | *Purshia tridentata* | | PUTR2 |
| Winterfat | *Krascheninnikovia lanata* | Open Range | KRLA |
| White sagebrush | *Artemisia ludoviciana* | | ARLU |
| Spiny hopsage | *Grayia spinosa* | | GRSP |
| Wyoming big sagebrush | *Artemisia tridentata* ssp. *wyomingensis* | | ARTRW8 |
| Basin big sagebrush | *Artemisia tridentata* ssp. *tridentata* | | ARTRT |
| ***Forbs*** | | | |
| Firecracker penstemon | *Penstemon eatonii* | | PEEA |
| Lewis' flax | *Linum lewisii* | Appar | LILI |
| Rocky Mountain beeplant | *Cleome serrulata* | | CLSE |
| Western yarrow | *Achillea millefolium* L. var. *occidentalis* | | ACMI |
| Slimflower scurfpea | *Psoralidium tenuiflorum* | | PSTE5 |

| **Name** | ***Scientific*** | **Variety** | **SYMBOL** |
|---|---|---|---|
| Dotted gayfeather | *Liatris punctata* | | LIPU |

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