CHAPTER 2
SOILS

REVISED AUGUST 2021
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Revised December 2004
BANNING LOADOUT PERMIT
Canyon Fuel Company, LLC - SOLDIER CREEK

CHAPTER 2

SOILS

R645-301-200. Soils
The regulations in R645-301-200 present the minimum requirements for information on soil resources which will be included in each permit application.

R645-301-210. Introduction

The Banning Loadout Facility is located approximately 10 miles from the base of the Bookcliff Range. The area receives from 7" to 9" of precipitation annually, the majority in the form of snow or catastrophic summer storms. The result is a poorly formed soil that has been heavily eroded. It has a high pH and low nutrient value and as such, supports a sparse cover of vegetation edifice to these conditions.

R645-301-211. The applicant will present a description of the premining soil resources as specified under R645-301-221. Topsoil and subsoil to be saved under R645-301-232 will be separately removed and segregated from other material.

R645-301-212. After removal, topsoil will be immediately redistributed in accordance with R645-301-242, stockpiled pending redistribution under R645-301-234, or if demonstrated that an alternative procedure will provide equal or more protection for the topsoil, the Division may, on a case-by-case basis, approve an alternative.

R645-301-220. Environmental Description

R645-301-221. Prime Farmland Investigation
All permit application, whether or not Prime Farmland is present, will include the results of a reconnaissance inspection of the proposed permit area to indicate whether Prime Farmland exists as given under R645-302-313.

The Applicant requested the SCS to review the status of the soils within and adjacent to the permit area to determine if said lands qualify for prime farmland status. The SCS determined that no prime or important farmland occurs in the area. A copy of this letter of negative determination is included in Appendix 2-1.

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R645-301-222. Soil Survey

The applicant will provide adequate soil survey information for those portions of the permit area to be affected by surface operations incident to UNDERGROUND COAL MINING and RECLAMATION ACTIVITIES and for the permit area of SURFACE COAL MINING and RECLAMATION ACTIVITIES consisting of the following:

R645-301-222.100. Delineating different soils;

A map provided by the Soil Conservation Service delineating different soils occurring in and around the permit area is included as Exhibit 3-1.

R645-301-222.200. Soil Identification

One soil complex, the Ravola-Slickspots complex, (Map Unit #93) has been mapped by the SCS as occurring within the permit boundary. However, because the surface of the area had been previously disturbed and a majority of the area is covered by coal, buildings, and/or roads, it was not possible to delineate the Ravola from the Slickspots. Data from the soil test pits and laboratory analysis (Appendix 2-2) indicates that the Ravola series underlies the site. The Slickspots series is not present within the confines of the permit area.

Other soil map units which occur in proximity to the permit area are the Billings-Gullied Land Complex (Map Unit #9), which occurs in the small riparian area located along the northwest boundary of the permit area, and the Moffat, Fine Sandy Loam (Map Unit #68), which occurs on the higher ground to the southeast of the permit area.

R645-301-222.300. Soil Description; and

SCS Map Unit descriptions of the Ravola-Slickspots Complex, the Billings-Gullied Land Complex, and the Moffat Fine Sandy Loam are included in Appendix 2-3. The SCS soil series descriptions of the Ravola, Billings and Moffat series are included in Appendix 2-4. Exhibit 3-1 indicates the general location of soil types present within the site.

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The SCS has determined from field data that the normal productivity (air dried weight) for the Ravola series soil is 550 pounds per acre, 800 pounds per acre and 1,000 pounds per acre in dry, normal and wet years, respectively. These productivity data are for non-irrigated rangeland which are typical of the Banning Loadout area.

Field and laboratory data indicate that the soil resources have not been lost or otherwise destroyed. As can be seen from the physical and chemical data previously presented, the loadout has had little unalterable affect upon the soil resources. With the exception of compaction, which can be easily altered after the facility has been abandoned, the capability and potential productivity are equal to that of the contiguous Ravola soil which is located outside of the permit area.

The future potential productivity is not expected to change. The low moisture availability, high salt concentrations, and native plant species are not conducive to greater productivity. Nor is it practicable to install extensive remedial programs because of the severe limitations of the soils capability.

The information present is a result of field investigations and a perusal of existing data obtained from the USDA-Soil Conservation Service (SCS). Soil studies were conducted in accordance with current guidelines issued by the Utah Division of Oil, Gas, and Mining (DOGM), and according to the standards of the National Cooperative Soil Survey and the procedures set forth by the USDA (Handbooks No. 436, Soil Taxonomy, 1975 and No. 18, Soil Survey Manual, 1951). Locations for
soil test pits were predetermined by DOGM and the Applicant (Exhibit 3-1).

This study was initiated by garnering all available, pertinent data including geologic, topographic, climatic, vegetative and edaphic information. SCS field sheets were compared to aerial photographs.

Delineated soils mapping units were field verified at the Banning Loadout and map unit boundaries modified where required to reflect on-site conditions.

This work was authorized by Soldier Creek Coal Company and completed by Randolph B. Gainer, EarthFax Engineering, Inc., Salt Lake City, Utah.

R645-301-224. Substitute Topsoil
Where the applicant proposes to use selected overburden materials as a supplement or substitute for topsoil, the application will include results of analyses, trials, and tests as described under R645-301-232.100 through R645-301-232.600, R645-301-234, R645-301-242, and R645-301-243. The Division may also require the results of field-site trials or greenhouse tests as required under R645-301-233.

The Soldier Creek Coal Company does not anticipate the need to use selected overburden materials as a supplement or substitute for topsoil. Should that need arise, Soldier Creek Coal Company will submit a Request for Permit Amendment to that effect, and will comply with all applicable Division regulations.

R645-301-230. Operation Plan

R645-301-231. General Requirements. Each permit application will include a:

R645-301-231.100. Description of the methods for removing and storing topsoil, subsoil, and other materials;

Regulations governing coal loadout facilities had not been promulgated when the Banning Loadout was constructed. Therefore, construction at Banning Loadout did not include the separating and segregation of
topsoil material. The soils were graded throughout the site to achieve desired elevations for specific needs or specific structure requirements. Analyses of the soils at the loadout (Appendix 2-2) indicate that the soil resources have not been lost or otherwise destroyed. Except for compaction, the capability and potential productivity are equal to that of the contiguous Ravola soil.

Soil that will be disturbed during the construction of drainage control structures will be used as part of the berms, dikes or sedimentation pond. Topsoil will be removed and used as the outslope material for the berms and dikes. The outslopes of the sedimentation pond and all disturbed area associated with pond construction will be revegetated as stated in Chapter 3. This will reduce the potential hazard of wind and water erosion, and lessen the chance of impairing the long-term productivity of the soil resource.

**R645-301-231.200. Demonstration of the suitability of topsoil substitutes or supplements;**

The typical structure for the Ravola soil series is in place within the Banning Loadout permit area. Therefore, no substitute topsoil is required or recommended. The values for the chemical parameters indicate that the site can be successfully revegetated with a seed mix of native plant species. Both nitrogen and the organic matter content will need to be supplemented to aid in sustaining the plants. While the pH, Sodium Absorption Ratio (SAR), and sodium values are relatively high, the recommended plant species are tolerant of these parameters. To ensure the success of the proposed reclamation plan, a test plot will be utilized.

The permittee will utilize these sediment materials from the Dugout Mine during final reclamation as top dressing over the sodic soils found in the vicinity of test pits TP-2 and TP-3 (Exhibit 3-1). Refer to Section R645-301-233 for additional information.
R645-301-231.300. Testing plan for evaluating the results of topsoil handling and reclamation procedures related to revegetation; and

DOGM and the Applicant have agreed to a test plot area which will be located approximately 200 feet south of the fenced area along the railroad tracks. This area, underlain by the Ravola soil, was used as a loadout area several years ago. It has been subjected to surface disturbance and vehicular traffic. Therefore, it will serve as a model test plot to allow observation of the success of the proposed reclamation plan as set out by R645-301-240, R645-301-340, and R645-301-540. The efficacy of the program will be monitored on a regular basis.

The test plot will be prepared, fertilized, seeded and mulched in the same manner as called for in the previously mentioned reclamation plan. In particular, the soil will be ripped to a depth of 18 inches and then disced until the average clod size of the surface is less than 1 inch. The recommended seed mix and plant nutrients will be applied to the prepared seed bed. The entire area will then be covered by 2,000 pounds per acre of alfalfa or native grass hay and crimp-dised into the soil.

The test plot will be prepared, fertilized, seeded and mulched in the same manner as called for in the previously mentioned reclamation plan. In particular, the soil will be ripped to a depth of 18 inches and gouged leaving the surface in a roughened state. The recommended seed mix and plant nutrients will be applied to the prepared seed bed. The entire area will then be covered by 2,000 pounds per acre of alfalfa or native grass hay and incorporated into the soil.

The test plot location is indicated on Exhibit 3-1.
Narrative that describes the construction, modification, use and maintenance of topsoil handling and storage areas.

As noted in R645-301-231.100, construction at Banning Loadout did not include the separation, segregation and storage of topsoil. Instead, topsoil was graded throughout the site to achieve desired elevations for specific needs or specific structure requirements.

Soil that has been disturbed during the construction of drainage control structures will be used as part of the berms, dikes, or sedimentation pond.

Soils stored in this manner will be redistributed to achieve final reclamation contours and soil depths.

The locations of these in-place topsoil storage areas are not delineated. Construction plans for future topsoil storage areas are detailed in Chapter 5 (Engineering).

Topsoil and Subsoil Removal

All topsoil will be removed as a separate layer from the area to be disturbed, and segregated.

Where the topsoil is of insufficient quantity or poor quality for sustaining vegetation;

No further surface disturbance is anticipated at the Banning Loadout. Should additional surface disturbance be required, Soldier Creek Coal Company will submit the appropriate application for permit change and will remove topsoil and subsoil as necessary in accordance with R645-301-232.100 through R645-301-232.700.

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R645-301-232.300. If topsoil is less than six inches thick, the operator may remove the topsoil and the unconsolidated materials immediately below the topsoil and treat the mixture as topsoil.

R645-301-232.400. The Division may not require the removal of topsoil for minor disturbances which:

R645-301-232.410. Occur at the site of small structures, such as power poles, signs, or fence lines; or

R645-301-232.420. Will not destroy the existing vegetation and will not cause erosion.


R645-301-232.700. Topsoil and subsoil removal under adverse conditions. An exception to the requirements of R645-301-232 to remove topsoil or subsoils in a separate layer from an area to be disturbed by surface operations may be granted by the Division where the operator can demonstrate;

R645-301-232.710. The removal of soils in a separate layer from the area by the use of conventional machines would be unsafe or impractical because of the slope or other condition of the terrain or because of the rockiness or limited depth of the soils; and

R645-301-232.720. That the requirements of R645-301-233 have been or will be fulfilled with regard to the use of substitute soil materials unless no available substitute material can be made suitable for achieving the revegetation standards of R645-301-356, in which event the operator will, as a condition of the permit, be required to import soil material of the quality and quantity necessary to achieve such revegetation standards.

Not applicable at this time. If future disturbance is implemented, all of the above be will then addressed.

R645-301-233. Topsoil Substitutes and Supplements.

R645-301-233.100. Through R645-301-233.400 Selected overburden materials may be substituted for, or used as a supplement to topsoil if the operator demonstrates to the Division that the resulting soil medium is equal to, or more suitable for sustaining vegetation on nonprime farmland areas than the existing topsoil, has a greater productive capacity than that which existed prior to mining for prime farmland reconstruction, and results in a soil medium that is the best available in the permit area to support revegetation.

The current approved reclamation plan for the Banning Loadout facility calls for the topsoil, some of which has been compacted and some of which has been graded throughout the site, to be ripped to a depth of 18 inches. Some additional topsoil supplements are anticipated to be required, as set out by R645-301-231.200.
In the event that topsoil substitutes are found to be necessary, the Soldier Creek Coal Company will submit the appropriate application for permit change, and will conduct analyses of the thickness of soil horizons, total depth, texture, percent coarse fragments, pH, and areal extent of the different kinds of soils, and will submit the results of physical and chemical analyses to the Division to demonstrate to the Division that the resulting soil medium is equal to or more suitable for sustaining revegetation than the available topsoil, as required by R645-301-233.

All analyses, field-site trials, or greenhouse tests required by the Division will be certified by an approved laboratory in accordance with R645-301-233.300.

The permittee transported approximately 717 cubic yards of sediment from the Dugout Canyon Mine sediment pond to the Banning Loadout in August 2001. The material is stored in the equipment storage area (233 cu yds) and within the disturbed area of ASCA Area #2 (484 cu yds) (Exhibit 5-2). The vegetative test plot within this ASCA area was removed from this permit by amendment C/007/034-AM01B in June 2001. Prior to sediment placement, all coal was removed from the ground surface. A small berm was built in the area where the pond sediment is stored for protection of the material. Exhibit 5-2 was updated to depict the dimensions and features of the sediment storage sites.

A sample of the material stored in the Dugout Canyon Mine sedimentation pond was obtained in March 2001 and analyzed for the parameters listed in Table 2 of the Division's "Guidelines for Management of Topsoil and Overburden for Underground and
Surface Coal Mining" (Leatherwood, 1988). Analysis results indicated the sediment from the pond would be acceptable for use as growth media.

The results of the analysis are included in Appendix 2-2 of this permit. An additional composite sample of the sediment was obtained and analyzed in accordance with the above referenced guidelines after placement at the loadout to affirm the material is suitable for use as growth media. The results of the composite sample analysis are included in Appendix 2-2 of this permit. Analysis results indicated the sediment rated fair to good in all of the parameters listed in Table 2 (referenced above) and had a TOC of 7.4%. The permittee will utilize these sediment materials during final reclamation of the loadout as growth media.

The sediment is stored in piles no greater than 2 feet thick. Additionally, the surface of the stockpile shall be roughened by deep and seeded with the reclamation seed mix presented in Table 3-3 gouging of Chapter 3 of this permit. In the future, the permittee will not bring any additional sedimentation pond material to the loadout.

R645-301.234 Topsoil Storage

R645-301-234.100 Through R645-301-234.320

The Banning site was constructed pre-law and as such no original topsoil was stockpiled.

A map showing the location of soil resources is given as Exhibit 3-1. Any further stockpiling or other distribution of topsoils will be in accordance with R645-301-234.100 through R645-301-320.
R645-301-240. Reclamation Plan

R645-301-241. General Requirements
Each permit application will include plans for redistribution of soils, use of soil nutrients and amendments and stabilization of soils.

The first step in the reclamation plan is removal of loose coal material. This will begin a year prior to the closure of the operation. The operator will start to scrape the outlying areas removing as much coal as possible and will continue inward toward the area above the vibrating feeders. The coal will be loaded out and the surface will be left relatively free of debris. The soil will then be ripped to a depth of 18 inches and subsequently disked to eliminate the deleterious effects of compaction. The resulting mixture of coal to soil will not exceed 50% coal.

Soils previously used in grading to achieve desired elevations for specific needs and/or structure requirements, along with soils stored as noted in R645-301-231.400 and detailed in Chapter 5, will be redistributed to achieve final reclamation contours (Exhibit 5-6).

All areas affected by the loadout facilities within the permit area, except the designated portion of the haulage road, will be returned to a final surface configuration that closely resembles premining conditions. This configuration will conform to the drainage pattern of the surrounding terrain. The final contours will be achieved by backfilling and grading existing soils and any future stored soil. All minor amounts of coal and debris left on site will be covered with soil during the grading. Any rills or gullies deeper than 9 inches will be filled, graded or otherwise stabilized and the affected area will be reseeded.

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The final grading and shaping of the affected areas will produce as many depressions or moisture retention surfaces as possible with slopes of a moderate grade. All grading will be completed in a controlled manner to suppress or eliminate erosion and sedimentation problems. Grading will take place along the contour as long as safety consideration and areal conditions permit. Graded surfaces will be left in shape and will be ripped to produce the proper seedbed conditions. Smooth compacted surfaces will be avoided throughout the process.

Material will be taken first from the truck ramp and used to build up the higher relief areas. Following this, the central drainage channel will be roughed in and the soil distributed to the higher relief areas. Next, the drainage channels and associated road will be regraded to final contours. The road will be built to closely approximate the need of right-of-way specifications. Last, the area will be graded to final contours and inspected and certified by the engineer-in-charge.

The soil structure for the Ravola soil series is in place within the Banning Loadout permit area. Therefore, no substitute topsoil is required or recommended. Remedial measures will be required to rehabilitate the insitu soil. At present the data indicate that 40 pounds per acre of sulfur coated urea (45-0-0) will need to be added as a nutrient. However, immediately Prior to reclaiming the area a soil test will be conducted to determine the current requirements for soil nutrients and amendments.

Soil stabilization will be accomplished through contouring and revegetation.

Revegetation will be as described in the revegetation reclamation plan in Chapter 5.

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R645-301-242. Soil Redistribution

R645-301-242.100. Topsoil materials removed under R645-301-232.100, R645-301-232.200, and R645-301-232.300 and stored under R645-301-234 will be redistributed in a manner that:

R645-301-242.110. Achieves an approximately uniform, stable thickness consistent with the approved postmining land use, contours, and surface-waters drainage systems;

R645-301-242.120. Prevents excess compaction of the materials; and

R645-301-242.130. Protects the materials from wind and water erosion before and after seeding and planting.

Any future topsoil materials removed under R645-301-232.100, R645-301-232.200, and R645-301-232.300 and stored under R645-301-234 will be redistributed as indicated in R645-301-241, and in a manner consistent with R645-301-242.100 through R645-301-242.130.

This will incorporate 1500 pounds of wood fiber with 60 pounds of tac per acre oversprayed on an interim seed mix. The tac and mulch will minimize soil and water erosion until intermediate vegetation becomes established. An earthen berm will be constructed around the storage area, so as to prevent any soil loss during construction.

R645-301-242.200. Before redistribution of the materials removed under R645-301-232 the regraded land will be treated if necessary to reduce potential slippage of the redistributed material and to promote root penetration. If no harm will be caused to the redistributed material and reestablished vegetation, such treatment may be conducted after such material is replaced.

Redistribution of any materials removed under R645-301-232 will be in accordance with the provisions of R645-301-242.200. Current plans call for the ripping of the compacted soil to a depth of 18 inches and subsequent tillage until the average soil clods on the surface are less than 1 inch in size. Materials stored as berms, dikes, and sedimentation pond embankments will be mixed with this soil and redistributed to final reclamation contours and soil depths.

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R645-301-242.300. The Division may not require the redistribution of topsoil or topsoil substitutes on the approved postmining embankments of permanent impoundments or roads if it determines that:

R645-302-242.310. Placement of topsoil or topsoil substitutes on such embankments is inconsistent with the requirement to use the best technology currently available to prevent sedimentation, and

R645-301-242.320. Such embankments will be otherwise stabilized.

Soldier Creek Coal Company will comply with the recommendations of the appropriate agencies relative to the best technology currently available in regard to the pond embankments. At present, this will be accomplished through intermediate revegetation.

Nutrients and soil amendments will be applied to the initially redistributed material when necessary to establish the vegetative cover.

Soil nutrients and amendments will be applied to the initially redistributed material as shown to be necessary by a soil analysis to be performed by a qualified laboratory at the onset of final reclamation.

R645-301-244. Soil Stabilization.

R645-301-244.100. All exposed surface areas will be protected and stabilized to effectively control erosion and air pollution attendant to erosion.

R645-301-244.200. Suitable mulch and other soil stabilizing practices will be used on all areas that have been regraded and covered by topsoil or topsoil substitutes. The Division may waive this requirement if seasonal, soil, or slope factors result in a condition where mulch and other soil stabilizing practices are not necessary to control erosion and to promptly establish an effective vegetative cover.

The requirements of R645-301-244.100 and R645-301-244.200 will be met by revegetation, mulching, and tacifying as indicated in R645-301-340, and contouring as indicated in R645-301-241.
R645-301-244.300. Rills and gullies, which form in areas that have been regraded and topsoiled and which either:

R645-301-244.310. Disrupt the approved postmining land use or the reestablishment of the vegetative cover, or

R645-301-244.320. Cause or contribute to a violation of water quality standards for receiving streams will be filled, regraded, or otherwise stabilized; topsoil will be replaced; and the areas will be reseeded or replanted.

Soldier Creek Coal Company will fill, regrade, or otherwise stabilize, replace topsoil, and reseed or replant any rills and gullies in excess of 6 inches in depth which form in areas that have been regraded and topsoiled and which either disrupt the approved postmining land use or the reestablishment of the vegetative cover, or cause or contribute to a violation of water quality standards for receiving streams for the duration of its reclamation bond liability period.

645-301-250. Performance Standards

645-301-251. All topsoil, subsoil and topsoil substitutes or supplements will be removed, maintained and redistributed according to the plan given under R645-301-230 and R645-301-240.

Soldier Creek Coal Company will remove, maintain, and redistribute all future topsoil, subsoil, and topsoil substitutes or supplements according to the plan given under R645-301-230 and R645-301-240.

R645-301-252. All stockpiled topsoil, subsoil and topsoil substitutes or supplements will be located, maintained and redistributed according to plans given under R645-301-230 and R645-301-240.

Soldier Creek Coal Company will locate, maintain, and redistribute all future stockpiled topsoil, subsoil, and topsoil substitutes or supplements according to plans given under R645-301-230 and R645-301-240.
APPENDIX 2-1

SCS DETERMINATION OF PRIME FARM LAND
Christopher P. Allen
Soldier Creek Coal Co.
P.O. Box 1
Price, Utah

Dear Mr. Allen:

Attached are the results of the prime and important farmland investigation for the Ranning Loadout. This investigation shows that no prime or important farmland occurs in this area.

Sincerely,

[Signature]

FERRIS P. ALLGOOD
State Soil Scientist
DATE: September 3, 1987

TO: FERRIS P. ALLGOOD, SSS, SCS, SLC, UT

REFERENCE: Soldier Creek Coal Co.

P.O. Box 1

Price, Utah 84501

After site investigation, the Soil Conservation Service has determined that no prime farmland or important farmland occurs on:

Sections 15, 16, 21 and 22 Township 15 S Range 12 E

for the following reason(s):

1. Soil mapping units, Carbon Survey, MCC (68), TDA (93) are in the aridic or torric moisture regime.

2. No irrigation water is available.

3. 

Location map is enclosed.

REMARKS: MCC (68) Moffat fine sandy loam, 3 to 6% slopes
TDA (93) Ravola-Slickspots Complex

Keith E. Beardall
District Conservationist
APPENDIX 2-2

SOIL LABORATORY ANALYSIS RESULTS
# SOIL LABORATORY ANALYSIS RESULTS

## BANNING LOADOUT

### Saturation Extract

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- **CEC** = Cation exchange capacity
- **TN** = Nitrogen (Total Kjeldahl)
- **NO$_3$N** = Nitrate Nitrogen
- **P** = Phosphorus
- **K** = Potassium
- **Se** = Selenium (Hot Water Extract)
- **B** = Boron
- **Cl** = Chloride
- **HCO$_3$** = Bicarbonate
- **Na** = Sodium
- **Ca** = Calcium
- **Mg** = Magnesium
- **K** = Magnesium

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12/23/87

6-7
# Banning Loadout

## Soil Laboratory Analysis Results

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<tr>
<th>TP</th>
<th>Depth</th>
<th>pH</th>
<th>EC_e</th>
<th>SAR</th>
<th>OM</th>
<th>AWC</th>
<th>SP</th>
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</table>

EC_e - Electrical conductivity in mmhos/cm of saturate extract  
SAR - Sodium Adsorption Ratio  
OM - Percent Organic Matter  
AWC - Available Water Capacity in percent  
SP - Saturation Percentage  

12/23/87  
6-6
APPENDIX 2-3

SOIL MAP UNIT DESCRIPTIONS
This map unit is on alluvial fans and flood plains. It is in the vicinity of Sunnyside Junction, in drainageways extending from Helper to Wellington, and in the Miller Creek area. Slopes are 1 to 3 percent, 200 to 300 feet long, and are concave to convex. Elevation is 5,300 to 5,900 feet. the average annual precipitation is 6 to 8 inches; the average freeze-free period is 115 to 140 days.

This unit is 70 percent Ravola load, alkali, 1 to 3 percent slopes, eroded; 20 percent Slickspots; and 10 percent other soils. The Slickspots are irregularly shaped. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit is about 10 percent Billings silty clay loam.

The Ravola soil is very deep and well drained. It formed in alluvium derived dominantly from sandstone and shale. The present vegetation in most areas is mainly greasewood, alkali sacaton, pricklypear, Russian thistle, galleta, and Indian ricegrass. Typically, the surface layer is light brownish gray loam about 8 inches thick. The underlying layer to a depth of 60 inches or more is light brownish gray loam. This soil is strongly alkaline below a depth of 20 inches.

Permeability of the Ravola soil is moderate. Available water capacity is about 7.5 to 10.5 inches. The water supplying capacity is 4 to 5 inches in areas not irrigated. Effective rooting depth is 60 inches or more. The organic matter content of the surface layer is 1 to 3 percent. Runoff is medium, and the hazard of water erosion is moderate. Runoff from adjacent areas formed gullies in some areas of this soil. The gullies are V-shaped, 4 to 5 feet deep, and in some areas 100 to 400 feet apart. The hazard of soil blowing is moderate.

Slickspots are barren or nearly barren areas. They have a very strongly alkaline, nearly impervious surface layer of loam about 4 inches thick. The underlying layer is light grayish brown loam and silt loam. This layer is strongly saline and is moderately alkali or strongly alkali.

Most areas of this unit are used as rangeland and wildlife habitat. A few areas are used for urban and homesite development.

The potential plant community of the Ravola soil is 60 percent grasses, 10 percent forbs, and 30 percent shrubs. Among the important plants are alkali sacaton, galleta, seepweed, and black greasewood.

Management practices that maintain or improve the rangeland vegetation include proper grazing use, a planned grazing system, and proper location of water developments. Severe drought may
adversely affect the production of the perennial vegetation. Partial or total removal of livestock from the range may be necessary.

It is not practical to revegetate large areas of the Ravola soil because of the low annual precipitation and the content of alkali in the soil. For critical erosion control, small areas can be mechanically treated and seeded. Plants that may be suitable for critical area seedings are adapted native plant, prostrate kochia, and Russian wildrye.

This map unit is in capability subclass VIIe, nonirrigated. The Ravola soil is in the Alkali Flat range site. Slickspots are not placed in a range site.

9--Billings-Gullied land complex.

This map unit is on alluvial fans and valley floors, mainly south of Price City and Wellington, along the Carbon-Emery County line. It formed in alluvium derived dominantly from alkaline, gypsiferous marine shale. Slopes are 1 to 6 percent; they are about 300 feet long and are plane to slightly concave. The present vegetation in most areas is mainly shadscale and galleta with black greasewood in some areas. Elevation is 5,200 to 5,700 feet. The average annual precipitation is 6 to 8 inches, the average annual air temperature is 48 to 50 degrees F, and the average freeze-free period is 115 to 140 days.

This unit is 70 percent Billings silty clay loam, 1 to 6 percent slopes; 15 percent Gullied land; and 15 percent other soils. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit is about 10 percent Ravola loam, alkali. Also included are small areas of Ravola loam and a soil that is similar to the Billings soil but has a gravelly silty clay loam surface layer.

The Billings soil is very deep and well drained. Typically, the surface layer is light brownish gray silty clay loam about 11 inches thick. the upper 31 inches of the underlying material is light brownish gray silty clay loam, and the lower part to a depth of 60 inches or more is strongly saline, light brownish gray silty clay loam.

Permeability of this Billings soil is slow. Available water capacity is about 4.5 to 9.0 inches. Water supplying capacity is 4 to 5 inches. Effective rooting depth is about 42 inches for plants that are not salt tolerant. The organic matter content of the surface layer is 1 to 2 percent. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is moderate.
Gullied land consists of eroded areas intermingled with areas of the Billings soil. Runoff from adjacent areas is concentrated in the gullies. Gullies are V-shaped, 3 to 10 feet deep, and 100 to 500 feet apart.

This unit is used mainly as rangeland and wildlife habitat. It is also used for irrigated crops.

The potential plant community on the Billings soil is 60 percent grasses, 10 percent forbs, and 30 percent shrubs. Among the important plants are galleta, Indian ricegrass, shadscale, and black greasewood.

Management practices that maintain or improve the rangeland vegetation include proper grazing use, a planned grazing system, and proper location of water developments. Severe drought may adversely affect the production of the perennial vegetation; partial or total removal of livestock from the range may be necessary.

It is not practical to revegetate large areas of the Billings soil because of low annual precipitation. For critical erosion control, small areas can be mechanically treated and seeded. Plants that may be suitable for critical area seedings are adapted native plants.

The Billings soil is in capability subclass Vlle, nonirrigated, and in the Alkali Flat range site. Gullied land is in capability subclass Vlle. It is not placed in a range site.

68--Moffat fine sandy loam, 3 to 6 percent slopes.

This very deep, well drained soil is on alluvial fans and benches. It is east of Sunnyside Junction. It formed in alluvium derived dominantly from sandstone and shale. Slopes are 200 to 400 feet long and are convex. The present vegetation in mist areas is mainly Indian ricegrass, shadscale, galleta, threeawn, and winterfat. Elevation is 5,400 to 5,600 feet. The average annual precipitation is 6 to 8 inches, the average annual air temperature is 48 to 50 degrees F, and the average freeze-free period is 115 to 140 days.

Typically, the surface layer is brown fine sandy loam 2 inches thick. The subsoil is brown fine sandy loam 7 inches thick. The substratum to a depth of 60 inches or more is pink and pinkish white fine sandy loam. A layer of carbonate accumulation is at a depth of about 9 inches.

Included in this unit are about 10 percent soils that are similar to this Moffat soil but have more than 35 percent pebbles below a depth of about 30 inches and 5 percent soils that are similar to this Moffat soil but have more than 18 percent clay between depths of 10 and 40 inches and have a loam surface layer.
Permeability of this Moffat soil is moderately rapid. Available water capacity is about 6.5 to 8.5 inches. Water supplying capacity is 4 to 5 inches. Effective rooting depth is 60 inches or more. The organic matter content of the surface layer is 0.5 to 1.0 percent. Runoff is slow, and the hazard of water erosion is moderate. The hazard of soil blowing is moderate.

This unit is used as rangeland and wildlife habitat.

The potential plant community on the Moffat soil is 50 percent grasses, 10 percent forbs, and 40 percent shrubs. Among the important plants are galleta, Indian ricegrass, shadscale, and winterfat.

Management practices that maintain or improve the rangeland vegetation include proper grazing use, a planned grazing system, and proper location of water developments. Severe drought may adversely affect the production of the perennial vegetation. Partial or total removal of livestock from the range may be necessary.

It is not practical to revegetate large areas of this unit because of the low annual precipitation. For critical erosion control, small areas can be mechanically treated and seeded. Plants that may be suitable for critical area seedings are adapted native plants.

This map unit is in capability subclass VIle, nonirrigated. It is in the Desert Sandy Loam range site.
APPENDIX 2-4

SOIL SERIES DESCRIPTIONS
Ravola Series

The Ravola series consists of very deep, well drained, moderately permeable soils on alluvial fans and narrow valley floors. These soils formed in alluvium derived from shale and sandstone. Slope is 1 to 6 percent. Elevation is 5,300 to 6,000 feet. Average annual precipitation is 6 to 8 inches, and average annual air temperature is 48 to 50 degrees F.

These soils are fine-silty, mixed (calcareous), mesic Typic Torrifluvents.

Typical pedon of Ravola loam, 1 to 6 percent slopes, eroded; about 5 miles northeast of Wellington; about 400 feet west and 1,800 feet south of the northeast corner of Sec. 14, T. 14 S., R. 11 E.

A1-- 0 to 2 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; moderate thick platy structure; soft, friable, sticky and plastic; few very fine, fine, and medium roots; moderately calcareous; disseminated calcium carbonate; moderately alkaline (pH 8.2); abrupt wavy boundary.

C2-- 23 to 41 inches; light brownish gray (2.5Y 6/2) silt loam, grayish brown (2.5Y 5/2) moist; massive; slightly hard, friable, sticky and plastic; few very fine roots; many very fine pores, common fine pores, and few medium and coarse pores; moderately calcareous; disseminated calcium carbonate; moderately alkaline (pH 8.4); gradual smooth boundary.

C3-- 41 to 60 inches; light brownish gray (2.5Y 6/2) silt loam, grayish brown (2.5Y 5/2) moist; massive; hard, firm, sticky and plastic; few very fine pores and few fine, medium, and coarse pores; moderately calcareous; disseminated calcium carbonate; moderately alkaline (pH 8.2).

The profile has hue of 2.5Y or 5Y, value of 6 or 7 when dry and 4 or 5 when moist, and chroma of 2 to 4. Calcium carbonate equivalent is 5 to 25 percent. The 10- to 40-inch particle-size control section is loam, silt loam, or very fine sandy loam; it is 18 to 27 percent clay.

A Horizon: Texture is loam or silty clay loam. Reaction is mildly alkaline or moderately alkaline.

C Horizon: Texture is loam or silt loam. Clay content is 18 to 27 percent. Reaction is mildly alkaline to strongly alkaline.
Billings Series

The Billings series consists of very deep, well drained, slowly permeable soils on alluvial fans, flood plains, and narrow alluvial valley floors. These soils formed in alluvium derived dominantly from alkaline gypsiferous marine shale and mixed sedimentary rocks. Slope is 0 to 6 percent. Elevation is 5,200 to 5,700 feet. Average annual precipitation is 6 to 8 inches, and average annual air temperature is 48 to 50 degrees F.

These soils are fine-silty, mixed (calcareous), mesic Typic Torrifluvents.

Typical pedon of Billings silty clay loam, 1 to 3 percent slopes, about 1.5 miles east of Huntington, Utah, about 600 feet north and 2,000 feet west of the southeast corner of sec. 20, T. 17 S., R. 9 E.

Ap1- 0 to 3 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak medium granular structure; hard, firm, sticky and plastic; many medium roots; common medium pores; strongly calcareous; moderately alkaline (pH 7.9); clear smooth boundary.

Ap2- 3 to 11 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak medium subangular blocky structure; hard, firm, sticky and plastic; many medium roots; common fine pores; strongly calcareous; moderately alkaline (pH 8.0); clear smooth boundary.

C1- 11 to 18 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak medium subangular blocky structure; hard, firm, sticky and plastic; few fine roots; few fine pores; strongly calcareous; mildly alkaline (pH 7.8); gradual wavy boundary.

C2- 18 to 42 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak coarse subangular blocky structure; hard, firm, sticky and plastic; few fine roots; few fine pores; strongly calcareous; mildly alkaline (pH 7.6); diffuse wavy boundary.

C3sa 42 to 60 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, firm, sticky and plastic; few fine roots; few fine pores; few fine grayish brown (10YR 6/2) soft gypsum nodules; strongly saline; strongly calcareous; moderately alkaline (pH 8.0).

A1 or Ap Horizon: Hue is 2.5Y or 5Y, value is 6 or 7 when dry and 4 or 5 when moist, and chroma is 2 to 4.

C Horizon: Hue is 2.5Y or 5Y, value is 6 or 7 when dry and 4 or 5 when moist, and chroma is 2 to 4. Clay content is 27 to 35
percent. In the lower part, gypsum content is 0.5 to 10.0 percent. Calcium carbonate equivalent is 5 to 25 percent. This horizon is slightly saline to very strongly saline and is mildly alkaline to very strongly alkaline.

**Moffat Series**

The Moffat series consists of very deep, well drained, moderately rapidly permeable soils on alluvial fans and benches. These soils formed in alluvium derived from sandstone and shale. Slope is 3 to 6 percent. Elevation is 5,400 to 5,800 feet. Average annual precipitation is 6 to 8 inches, and average annual air temperature is 48 to 50 degrees F.

These soils are coarse-loamy, mixed, mesic Typic Calciorthids.

Typical pedon of Moffat fine sandy loam, 3 to 6 percent slopes, about 1,800 feet north and 2,400 feet east of the southwest corner of sec. 23, T. 15 S., R. 12 E.

A1-- 0 to 2 inches; brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; weak fine granular structure; soft, friable; few fine and medium roots; many very fine, common fine, and few medium pores; moderately calcareous; moderately alkaline (pH 8.4); abrupt smooth boundary.

B2-- 2 to 9 inches; brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; soft, friable; few fine and medium roots; many very fine, common fine, and few medium pores; moderately calcareous; moderately alkaline (pH 8.4); abrupt smooth boundary.

C1ca 9 to 21 inches; pink (7.5YR 7/4) fine sandy loam; brown (7.5YR 5/4) moist; moderate medium subangular blocky structure; hard, firm; few very fine, fine, and medium roots; many very fine and common fine pores; strongly calcareous; coatings of calcium carbonate on faces of peds; strongly alkaline (pH 8.8); clear smooth boundary.

C2ca 21 to 29 inches; pinkish white (7.5YR 8/2) fine sandy loam, pink (7.5YR 7/4) moist; moderate medium subangular blocky structure; hard, firm; few very fine and fine roots; common very fine and few fine pores; strongly calcareous; disseminated calcium carbonate; strongly alkaline (pH 9.0); gradual wavy boundary.

C3-- 29 to 60 inches; pink (7.5YR 8/4) fine sandy loam, light brown (7.5YR 6/4) moist; massive; very hard, very firm; few very fine and fine roots; common very fine and few fine pores; 5 percent pebbles and 5 percent cobbles; strongly calcareous; disseminated calcium carbonate; strongly alkaline (pH 9.0).

Secondary calcium carbonate is at a depth of 9 to 15 inches.
CCa Horizon: Value is 6 to 8 when dry and 5 to 7 when moist, and chroma is 2 to 4. Calcium carbonate equivalent is 20 to 35 percent.