Department of Energy
Washington, DC 20585

October 27, 2014

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Deputy Director
Mail Stop T8F5
Washington, DC 20555-0001

Subject: June 2014 Baseline Soil and Vegetation Characterization of the Rifle, Colorado, UMTRCA Title I Disposal Site

To Whom It May Concern:

Enclosed is a hard copy of the June 2014 *Baseline Soil and Vegetation Characterization of the Rifle, Colorado, UMTRCA Title I Disposal Site.*

Please call me at (970) 248-6073 or Dick Dayvault at (970) 248-6375 if you have any questions. Please send any correspondence to:

U.S. Department of Energy
Office of Legacy Management
2597 Legacy Way
Grand Junction, CO 81503

Sincerely,

Richard P. Bush
Site Manager

Enclosure

cc w/enclosure:
P. Adams, BLM
M. Cosby, CDHPE
D. Orlando, NRC

cc w/o enclosure:
D. Dayvault, Stoller (e)
File: RFL 0030.02 (rc grand junction)

Site\Rifle\10-23-14 June 2014 Baseline Soil and Vegetation Characterization to Ltr (NRC)

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Baseline Soil and Vegetation Characterization of the Rifle, Colorado, UMTRCA Title I Disposal Site

June 2014

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LMS/RFL/S11739

Baseline Soil and Vegetation Characterization of the Rifle, Colorado, UMTRCA Title I Disposal Site

June 2014

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1.0 Background

The U.S. Department of Energy (DOE) Office of Legacy Management is responsible for managing Uranium Mill Tailings Radiation Control Act (UMTRCA) Title I disposal sites in perpetuity (Title 10 *Code of Federal Regulations* Section 40.27). One of these sites, the Rifle, Colorado, Disposal Site, is located in western Colorado near the town of Rifle. DOE's management of the site includes maintaining the integrity of the disposal cell and caring for the land in a way that is consistent with the principles of ecosystem management and sustainable development (DOE Order 430.1B). Primary directives for maintaining and inspecting the site are outlined in DOE's *Guidance for Implementing the Long-Term Surveillance Program for UMTRCA Title I and Title II Disposal* Sites (DOE 2001) and, more specifically, in the *Long-Term Surveillance Plan for the Estes Gulch Disposal Site Near Rifle, Colorado* (LTSP) (DOE 1997).

The 2001 guidance document (DOE 2001) requires DOE to describe baseline environmental conditions at all of its disposal sites and to make comparisons to the baseline conditions over time, typically during annual inspections. The LTSP states that inspectors must be able to identify "significant changes or active modifying processes that potentially could adversely affect the disposal cell: gully formation, slope erosion, changes to the rock cover, ephemeral drainage channel changes, and significant modifications by humans, animals, or plants" (DOE 1997). In response to these requirements, scientists from The S.M. Stoller Corporation, a wholly owned subsidiary of Huntington Ingalls Industries (Stoller) and DOE's Legacy Management Support contractor, conducted a soil and vegetation baseline characterization of the Rifle disposal site on July 31 and August 1, 2013. They documented (1) plant species present and general vegetation composition, (2) basic soil characteristics, (3) erosional features, and (4) infestations of noxious weeds.

This report describes baseline conditions of soils and vegetation at the Rifle disposal site as recorded in 2013. Through this documentation, DOE will be able to better monitor changes in the health and sustainability of the site's plant cover, erosional features, and noxious weed populations over time. Although baseline (or "as built") conditions were recorded for the site after cell closure, the baseline did not include a characterization of soils and vegetation.

At the Rifle site, soil and vegetation baseline information is particularly important because of potential ecological changes resulting from cattle recently intruding onto the site from nearby U.S. Bureau of Land Management (BLM) pastures. Following is text from the 2013 Annual Site Inspection Report, which contains a description of the recent grazing impacts:

> During the past several years, inspectors had found no evidence of cattle or sheep grazing within the site boundaries, only evidence of deer and elk grazing. This changed dramatically in 2012 when heavy grazing by cattle was observed. This year, vegetation was heavily grazed again by cattle . . .
>
> Fence and fence post damage are associated with the cattle grazing . . . Tee-posts were bent in several locations but straightened during the inspection. Because of the increased impacts of cattle grazing on the site during the past two years, a white paper will be developed and will discuss potential impacts to the site and options for addressing this situation. Colorado is a fence out state. As such, recommendations must consider the possibility and usefulness versus expense of fencing the entire site, if no onsite grazing is to be allowed. Establishing a grazing agreement

with the permittee is another option (this option will require fencing). The BLM grazing permittee was contacted and additional discussions will be conducted with him.

2.0 Methods

During initial reconnaissance, Stoller scientists noted differences in landforms, soil characteristics, and vegetation composition throughout the Rifle disposal site. The site was then delineated into map units on an aerial photograph. Each map unit is composed of a particular landform, soil type, and associated vegetation community.

After initial surveillance, soils and vegetation were further characterized within each map unit. A Stoller soil scientist dug representative soil pits to determine soil characteristics, such as horizon development, texture, structure, color, and pH. Slope was estimated visually, texture was assessed by hand-texturing, moist colors were identified with a Munsell Soil Color Chart, and pH was determined with color indicators from a LaMotte soil test kit. These data were compared to general soils information on the U.S. Department of Agriculture's (USDA's) website, http://www.nrcs.usda.gov/wps/portal/nrcs/surveylist/soils/survey/state/?stateId=CO, that is associated with the soil survey of the *Rifle Area, Colorado, Parts of Garfield and Mesa Counties* (USDA 2014b).[1]

At representative sampling areas within each map unit, a Stoller botanist compiled a list of all observed plant species. Plant species recorded by the botanist during the annual site inspection on June 6, 2013, were also included in the data. The site inspection was less comprehensive than the vegetation baseline, but it included species visible in June that were not visible in July or August. Nomenclature follows the USDA Natural Resources Conservation Service PLANTS Database (USDA 2014a). In each sampling area, plant species were categorized as dominant, secondary, or trace, based on each species' estimated relative foliar cover (dominant = greater than 20 percent, secondary = between 5 and 20 percent, and trace = less than 5 percent).

3.0 Results

3.1 Soil-Vegetation Map Units

The reconnaissance identified eight different soil-vegetation map units at the Rifle disposal site. They are described in the following narrative and delineated in Figure 1. Appendix A provides representative photographs of the different map units.

DOE revegetated disturbed areas of the disposal site in 1996 (DOE 1997) and seeded them with an unknown mix. The vegetation baseline included both disturbed (revegetated) and undisturbed (native) areas. Seventy-two plant species were identified at the site. Table 1 lists each species and its growth form, growth duration, and origin. Growth forms included in Table 1 are trees (woody species that typically have one main stem), shrubs, subshrubs (shrubs generally less than

[1] Although general soil and vegetation information is often available for many of DOE's disposal sites in published soil survey manuscripts, these data are not mapped at a scale suitable for use in baseline characterizations and often are not representative of current conditions.

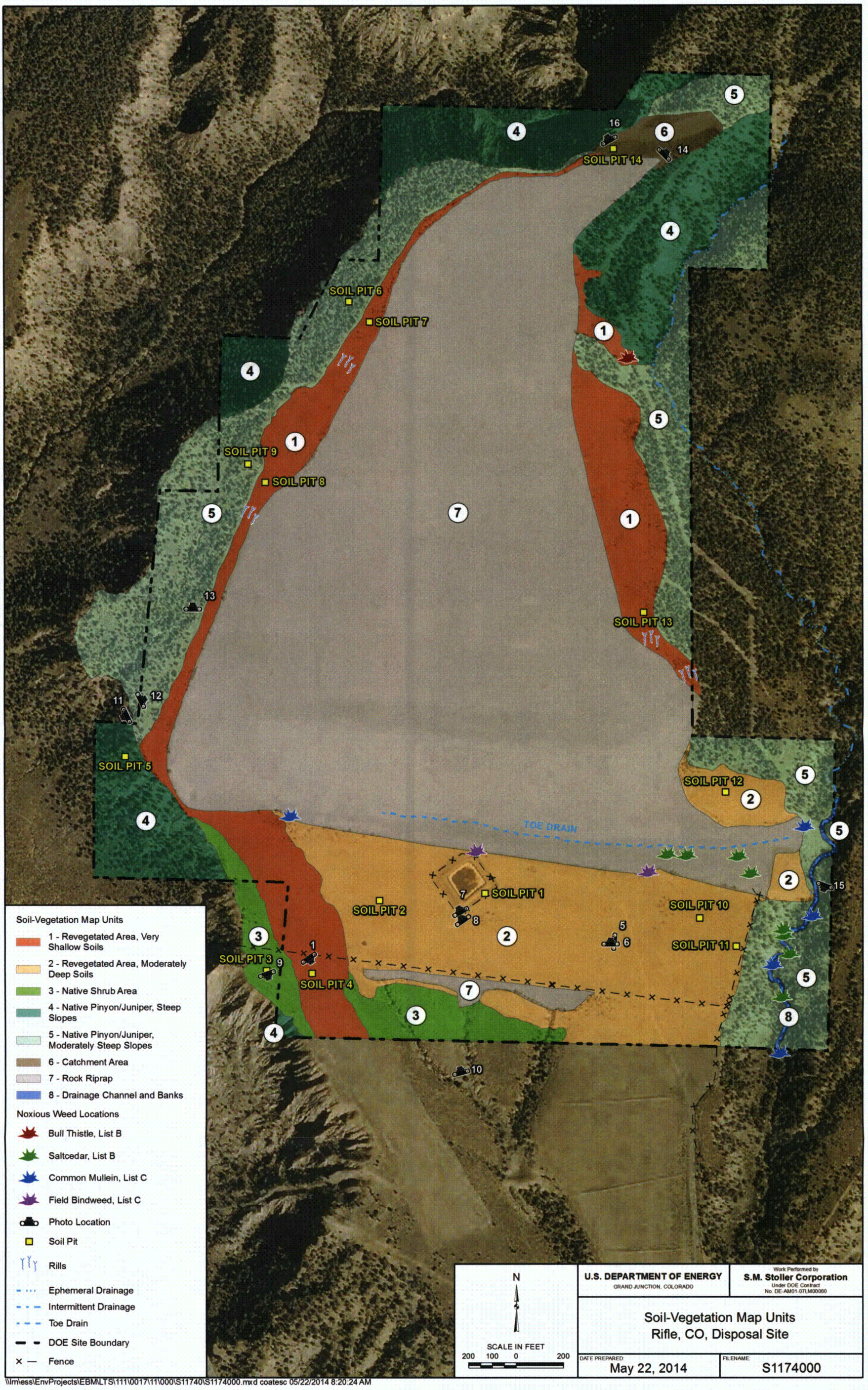

Figure 1. Soil-Vegetation Map Units, Rifle, Colorado, Disposal Site

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Table 1. Plant Species Identified at the Rifle Disposal Site in 2013

Scientific Name	Common Name	Growth Form	Duration	Origin
Achnatherum hymenoides (Roem. & Schult.) Barkworth	Indian ricegrass	Grass	Perennial	Native
Agropyron cristatum (L.) Gaertn.	Crested wheatgrass	Grass	Perennial	Introduced
Agrostis stolonifera L.	Creeping bentgrass	Grass	Perennial	Introduced
Alyssum desertorum Stapf	Desert madwort	Forb	Annual	Introduced
Amaranthus retroflexus L.	Redroot amaranth	Forb	Annual	Native weed
Apocynum sp.	Dogbane	Shrub	Perennial	Unknown
Artemisia campestris L.	Field sagewort	Forb	Perennial	Native
Artemisia tridentata Nutt.	Big sagebrush	Shrub	Perennial	Native
Asclepias subverticillata (A. Gray) Vail	Horsetail milkweed	Forb	Perennial	Native weed
Astragalus sp.	Milkvetch	Forb	Perennial	Unknown
Atriplex canescens (Pursh) Nutt.	Fourwing saltbush	Shrub	Perennial	Native
Atriplex confertifolia (Torr. & Frém.) S. Watson	Shadscale saltbush	Subshrub	Perennial	Native
Bassia scoparia (L.) A.J. Scott	Burningbush (kochia)	Forb	Annual	Introduced weed
Berteroa incana (L.) DC.	Hoary alyssum	Forb	Annual/ Perennial	Introduced
Bromus inermis Leyss.	Smooth brome	Grass	Perennial	Introduced
Bromus tectorum L.	Cheatgrass	Grass	Annual	Introduced noxious weed
Calochortus nuttallii Torr. & A. Gray	Sego lily	Forb	Perennial	Native
Cercocarpus montanus Raf.	Alderleaf mountain mahogany	Shrub	Perennial	Native
Chaetopappa ericoides (Torr.) G.L. Nesom	Rose heath	Forb	Perennial	Native
Chenopodium berlandieri Moq.	Pitseed goosefoot	Forb	Annual	Native weed
Cirsium ochrocentrum A. Gray	Yellowspine thistle	Forb	Perennial	Native
Cirsium vulgare (Savi) Ten.	Bull thistle	Forb	Biennial	Introduced noxious weed
Convolvulus arvensis L.	Field bindweed	Forb	Perennial	Introduced noxious weed
Cryptantha sp.	Cryptantha	Forb	Unknown	Unknown
Descurainia sophia (L.) Webb ex Prantl	Herb sophia	Forb	Annual/ Biennial	Introduced weed
Echinocereus triglochidiatus Engelm.	Kingcup (claret cup) cactus	Shrublike	Perennial	Native
Elymus trachycaulus (Link) Gould ex Shinners	Slender wheatgrass	Grass	Perennial	Native
Eremopyrum triticeum (Gaertn.) Nevski	Annual wheatgrass	Grass	Annual	Introduced
Ericameria nauseosa (Pall. ex Pursh) G.L. Nesom & Baird	Rubber rabbitbrush	Shrub	Perennial	Native
Eriogonum lonchophyllum Torr. & A. Gray	Spearleaf buckwheat	Subshrub	Perennial	Native
Erodium cicutarium (L.) L'Hér. ex Aiton	Redstem stork's bill	Forb	Annual/ Biennial	Introduced noxious weed
Grayia spinosa (Hook.) Moq.	Spiny hopsage	Subshrub	Perennial	Native
Gutierrezia sarothrae (Pursh) Britton & Rusby	Broom snakeweed	Subshrub	Perennial	Native
Helianthus annuus L.	Common sunflower	Forb	Annual	Native weed
Heterotheca villosa (Pursh) Shinners	Hairy false goldenaster	Forb	Perennial	Native

Table 1 (continued). Plant Species Identified at the Rifle Disposal Site in 2013

Scientific Name	Common Name	Growth Form	Duration	Origin
Hordeum jubatum L.	Foxtail barley	Grass	Perennial	Native weed
Ipomopsis aggregata (Pursh) V.E. Grant	Scarlet gilia	Forb	Perennial	Native
Juniperus osteosperma (Torr.) Little	Utah juniper	Tree	Perennial	Native
Lactuca serriola L.	Prickly lettuce	Forb	Annual/ Biennial	Introduced weed
Lepidium perfoliatum L.	Clasping pepperweed	Forb	Annual/ Biennial	Introduced
Machaeranthera canescens (Pursh) A. Gray	Hoary tansyaster	Forb	Perennial	Native
Malacothrix sp.	Desert dandelion	Forb	Perennial	Unknown
Melilotus officinalis (L.) Lam.	Sweetclover	Forb	Perennial	Introduced weed
Mirabilis multiflora (Torr.) A. Gray	Colorado four o'clock	Forb	Perennial	Native
Opuntia polyacantha Haw.	Plains pricklypear	Shrublike	Perennial	Native
Pascopyrum smithii (Rydb.) Á. Löve	Western wheatgrass	Grass	Perennial	Native
Penstemon sp.	Penstemon	Forb	Perennial	Unknown
Phlox andicola E.E. Nelson	Prairie phlox	Forb	Perennial	Native
Pinus edulis Engelm.	Twoneedle pinyon	Tree	Perennial	Native
Pleuraphis jamesii Torr.	James' galleta	Grass	Perennial	Native
Poa secunda J. Presl	Sandberg bluegrass	Grass	Perennial	Native
Pseudoroegneria spicata (Pursh) Á. Löve	Bluebunch wheatgrass	Grass	Perennial	Native
Psilostrophe bakeri Greene	Baker's paperflower	Forb	Perennial	Native
Rhus trilobata Nutt.	Skunkbush sumac	Shrub	Perennial	Native
Salsola tragus L.	Prickly russian thistle	Forb	Annual	Introduced weed
Sarcobatus vermiculatus (Hook.) Torr.	Greasewood	Shrub	Perennial	Native
Senecio sp.	Groundsel	Forb	Perennial	Unknown
Sisymbrium altissimum L.	Tall tumblemustard	Forb	Annual/ Biennial	Introduced weed
Sonchus asper (L.) Hill	Spiny sowthistle	Forb	Annual	Introduced weed
Sphaeralcea coccinea (Nutt.) Rydb.	Scarlet globemallow	Forb	Perennial	Native
Sporobolus airoides (Torr.) Torr.	Alkali sacaton	Grass	Perennial	Native
Sporobolus cryptandrus (Torr.) A. Gray	Sand dropseed	Grass	Perennial	Native
Tamarix ramosissima Ledeb.	Saltcedar (tamarisk)	Tree	Perennial	Introduced noxious weed
Tetradymia canescens DC.	Spineless horsebrush	Subshrub	Perennial	Native
Thinopyrum intermedium (Host) Barkworth & D.R. Dewey	Intermediate wheatgrass	Grass	Perennial	Introduced
Thlaspi arvense L.	Field pennycress	Forb	Annual	Introduced weed
Tragopogon dubius Scop.	Yellow salsify	Forb	Annual/ Biennial	Introduced weed
Verbascum thapsus L.	Common mullein	Forb	Biennial	Introduced noxious weed
Xanthisma grindelioides	Gumweed aster	Forb	Perennial	Native
Xanthium strumarium L.	Rough cocklebur	Forb	Annual	Native weed
Yucca sp.	Yucca	Shrublike	Perennial	Native
Zuckia brandegeei (A. Gray) S.L. Welsh & Stutz ex S.L. Welsh	Siltbush	Subshrub	Perennial	Native

1.5 feet [0.5 meter] in height), shrublikes (yucca and cacti), grasses, and forbs (herbaceous annuals, perennials, or biennials). Species labeled as native are believed to have partly or wholly originated in the United States, and introduced species originated elsewhere (e.g., Europe, Asia, Canada). Some species contain genetic material that is both native and introduced, and these species are listed as native. In Table 1, species are designated as noxious weeds if the State of Colorado lists them as noxious. They are designated as weeds if they are included in both *Weeds of the West* (Whitson et al. 1996) and *Weeds of the United States and Canada* (Southern Weed Science Society 1998), two works on invasive species used by USDA (USDA 2014).

Unit 1, Revegetated Area, Very Shallow Soils: This map unit, encompassing about 18 acres, is composed of soils that are less than 10 inches deep over highly weathered sedimentary rock. These areas were disturbed during remedial action and later reclaimed. Given the shallowness of the soils, some of the original soil profile was likely removed during remedial action activities. Soils are now classified as loamy or loamy-skeletal, mixed, mesic Ustic Torriorthents, which are relatively young, undeveloped soils found in aridic environments. Surface soil textures (USDA 1993) within this unit vary from non-gravelly to very-gravelly loams and silt loams, and subsurface horizons (e.g., the Crk horizons) are composed of weathered materials derived from the Wasatch Formation, which consists of siltstones, shales, and fine-grained sandstones (DOE 1997). Slopes range from 0–15 percent. A typical soil profile has the following horizons and characteristics (observed at Soil Pits 4, 7, 8, and 13, Figure 1):

- **Ak:** 0–4 inches; dark yellowish brown (10YR 4/4 moist) gravelly loam; weak, medium subangular blocky structure; slightly hard, friable; violently effervescent, disseminated; strongly alkaline (pH 8.6); abrupt boundary.
- **Crk:** 4–10+ inches; brown (7.5YR 5/4 moist) silty clay; massive breaking to strong fine and medium platy structure; very hard, firm; strongly effervescent, disseminated; strongly alkaline (pH 8.8).

At the time of the baseline characterization, total foliar cover in this unit ranged from 10 to 12 percent, with large patches of bare ground. Twenty-three species were identified in Unit 1. Of these, 30 percent were weedy, including three species of noxious weeds. Different plant species were found in the microhabitat next to the rock riprap–covered disposal cell than in the remainder of the unit, presumably because of different soil moisture conditions. Table 2 summarizes plant cover in Unit 1, and Photo 1 is a representative photo.

Table 2. Plant Species Within Unit 1, Revegetated Area, Very Shallow Soils

Scientific Name	Common Name	Relative Cover Category	
		Revegetated Areas	Edge of Disposal Cell
Achnatherum hymenoides	Indian ricegrass	Secondary	
Alyssum desertorum	Desert madwort	Trace	
Artemisia tridentata	Big sagebrush	Trace	
Bromus tectorum	Cheatgrass	Trace	
Chaetopappa ericoides	Rose heath		Trace
Cirsium vulgare	Bull thistle	Trace	
Erodium cicutarium	Redstem stork's bill	Secondary	
Gutierrezia sarothrae	Broom snakeweed	Dominant	

Table 2 (continued). Plant Species Within Unit 1, Revegetated Area, Very Shallow Soils

Scientific Name	Common Name	Relative Cover Category	
		Revegetated Areas	Edge of Disposal Cell
Helianthus annuus	Common sunflower	Trace	
Heterotheca villosa	Hairy false goldenaster		Trace
Ipomopsis aggregata	Scarlet gilia	Trace	
Juniperus osteosperma	Utah juniper		Dominant
Machaeranthera canescens	Hoary tansyaster	Trace	
Opuntia polyacantha	Plains pricklypear	Trace	
Pascopyrum smithii	Western wheatgrass	Secondary	
Penstemon sp.	Penstemon	Trace	
Pinus edulis	Twoneedle pinyon		Dominant
Poa secunda	Sandberg bluegrass	Trace	
Pseudoroegneria spicata	Bluebunch wheatgrass	Trace	
Psilostrophe bakeri	Baker's paperflower		Trace
Salsola tragus	Prickly russian thistle	Trace	
Sphaeralcea coccinea	Scarlet globemallow	Trace	
Tragopogon dubius	Yellow salsify	Trace	
Species Richness	**23**	**18**	**5**

Unit 2, Revegetated Area, Moderately Deep Soils: This unit, about 28 acres in size, is also composed of areas that were disturbed during remedial action and later reclaimed, but it is different from Unit 1 in that it is composed of soils having depths greater than 20 inches. Areas within Unit 2 were leveled by heavy equipment, as shown in historic aerial Photos 2 through 4 in Appendix A, but not to the depths of soils in Unit 1. Slopes are gentle and range from 0 to 8 percent.

Soil properties were examined at Soil Pits 1, 2, 10, 11, and 12 (Figure 1). In all but one of these pits, a loamy surface horizon (Ak) overlaid a clayey subhorizon (Ck), which is typical of a remediated area that has been graded and then backfilled with a topsoil-like material. Some of these soils likely contained a developed cambic or argillic (Bw or Bt) horizon before they were disturbed (USDA 2010, 2014b). Now, with no B horizons, they are classified as fine-loamy, mixed, mesic Ustic Torriorthents. Over time, these soils will develop stronger structure and more distinct horizonation.

One of the pits, Soil Pit 2, was anomalous in that it contained a loamy, cambic B horizon that overlaid a clayey, densic (USDA 2010) C horizon. It is unknown how a horizon exhibiting structural development came to overlay a horizon presumably compacted by heavy equipment, unless (1) the extremely hard and extremely firm consistence of the C horizon are natural characteristics of the original soil subsurface, or (2) the backfilled soil materials were handled in such a way that some of the original structure was retained. This soil is classified as a loamy, mixed, mesic Ustic Haplocambid and has the following characteristics:

- **Ak:** 0–4 inches; dark yellowish brown (10YR 3/4 moist) loam; weak, coarse angular blocky structure breaking to weak, coarse granular structure; soft, very friable; slightly effervescent, disseminated; moderately alkaline (pH 8.4); abrupt boundary.

- **Bwk:** 4–10 inches; brown (10YR 4/3 moist) loam; moderate, coarse angular blocky structure; slightly hard, friable; strongly effervescent, disseminated; strongly alkaline (pH 8.8); abrupt boundary.
- **Ckd:** 10–14+ inches; dark yellowish brown (10YR 4/4 moist) silty clay or clay; massive breaking to strong coarse angular blocky structure; extremely hard, extremely firm; strongly effervescent, disseminated; strongly alkaline (pH 9.0).

Vegetation cover in Unit 2 was estimated to be between 10 and 20 percent across most of the unit. Within the evaporation pond fence, which serves as a small "grazing exclosure" because livestock do not have access to vegetation within the pond's security fence, cover is up to 30 percent. Forty plant species were found in Unit 2 (Table 3), one-third of which are weedy (four species are also noxious). Aside from plant foliar cover, major differences in vegetation between the grazed and ungrazed portions of the site are not yet obvious. Some species are more abundant in one area than the other; for example, desert madwort and rubber rabbitbrush are more common in the grazed portions of Unit 2, and redstem stork's bill and yellow salsify are more abundant within the fence. Some variation in species richness can be attributed to the much greater acreage of the grazed area, and other variations may be attributed to short-term impacts from grazing (for example, livestock prefer yellow salsify over desert madwort). If grazing continues at the site over time, the fenced exclosure will help assess longer-term impacts. Photos 5, 6, 7, and 8 show vegetation within this unit. Photo 8 provides a visual comparison of grazed and ungrazed areas. Table 3 summarizes the plant cover in Unit 2.

Table 3. Plant Species Within Unit 2, Revegetated Area, Moderately Deep Soils

Scientific Name	Common Name	Relative Cover Category			
		Sample A	Sample B	Inside Evap. Pond Fence (July)	Inside Evap. Pond Fence (June)
Achnatherum hymenoides	Indian ricegrass				Trace
Agropyron cristatum	Crested wheatgrass			Trace	
Alyssum desertorum	Desert madwort	Dominant	Dominant	Trace	Secondary
Artemisia campestris	Field sagewort				Trace
Artemisia tridentata	Big sagebrush	Trace	Trace		
Asclepias subverticillata	Horsetail milkweed	Trace			
Astragalus sp.	Milkvetch		Trace		
Atriplex canescens	Fourwing saltbush		Trace		
Bassia scoparia	Burningbush (kochia)		Trace		
Berteroa incana	Hoary alyssum				Trace
Bromus tectorum	Cheatgrass	Trace	Dominant	Dominant	Dominant
Chenopodium berlandieri	Pitseed goosefoot	Trace		Trace	
Convolvulus arvensis	Field bindweed		Trace		
Descurainia sophia	Herb sophia	Trace	Trace	Trace	Trace
Elymus trachycaulus	Slender wheatgrass	Trace		Trace	
Eremopyrum triticeum	Annual wheatgrass	Trace			
Ericameria nauseosa	Rubber rabbitbrush	Secondary	Dominant	Trace	Trace

Table 3 (continued). Plant Species Within Unit 2, Revegetated Area, Moderately Deep Soils

Scientific Name	Common Name	Relative Cover Category			
		Sample A	Sample B	Inside Evap. Pond Fence (July)	Inside Evap. Pond Fence (June)
Erodium cicutarium	Redstem stork's bill	Trace	Trace	Dominant	Dominant
Gutierrezia sarothrae	Broom snakeweed	Trace	Trace		
Juniperus osteosperma	Utah juniper	Trace			
Lactuca serriola	Prickly lettuce	Trace	Trace		
Lepidium perfoliatum	Clasping pepperweed			Trace	Trace
Macharanthera canescens	Hoary tansyaster			Trace	
Malacothrix sp.	Desert dandelion				Trace
Melilotus officinalis	Sweetclover	Trace	Trace		
Opuntia polyacantha	Plains pricklypear	Trace	Trace		
Pascopyrum smithii	Western wheatgrass	Trace	Dominant	Dominant	Dominant
Pinus edulis	Twoneedle pinyon	Trace			
Pleuraphis jamesii	James' galleta	Trace			
Poa secunda	Sandberg bluegrass		Trace	Trace	
Pseudoroegneria spicata	Bluebunch wheatgrass	Trace		Secondary	Trace
Salsola tragus	Prickly russian thistle	Trace		Trace	Trace
Sarcobatus vermiculatus	Greasewood		Trace		
Sisymbrium altissimum	Tall tumblemustard	Trace	Trace	Trace	Trace
Sphaeralcea coccinea	Scarlet globemallow	Trace	Trace	Secondary	Trace
Sporobolus airoides	Alkali sacaton				Trace
Sporobolus cryptandrus	Sand dropseed	Secondary			
Thinopyrum intermedium	Intermediate wheatgrass	Trace			
Tragopogon dubius	Yellow salsify	Trace		Dominant	Dominant
Verbascum thapsus	Common mullein	Trace			
Species Richness	**40**	**26**	**20**	**17**	**16**

Unit 3, Native Shrub Area: This unit, encompassing about 5 acres on the disposal site, is characterized by 3–15 percent slopes and the presence of native shrub and grass plant species, as it was relatively undisturbed by remedial action activities. Soils are formed in residuum or colluvium from the Wasatch Formation and are moderately deep or deep (unknown) over highly weathered bedrock. A typical soil profile (Soil Pit 3, Figure 1) is classified as a fine-loamy, mixed, mesic Ustic Haplocambid and has the following horizons and characteristics:

- **Ak:** 0–4 inches; dark yellowish brown (10YR 4/4 moist) silt loam; weak, medium angular blocky structure; soft, very friable; strongly effervescent, disseminated; moderately alkaline (pH 8.2–8.4); abrupt boundary.
- **Bwk:** 4–11 inches; dark yellowish brown (10YR 4/4 moist) loam; moderate, coarse angular blocky structure; slightly hard, friable; strongly effervescent, disseminated; moderately to strongly alkaline (pH 8.4–8.6); gradual boundary.

- **Ck:** 11–18+ inches; dark yellowish brown (10YR 4/4 moist) loam; weak, medium and coarse prismatic structure; hard, friable; strongly effervescent, disseminated; strongly alkaline (pH 8.6).

The dominant plant species in this unit are big sagebrush and Indian ricegrass, which are both desirable natives. Of the 19 species found in this area, only 2 are weedy (but both are noxious). Total foliar cover was estimated at 10 to 30 percent. Although desirable native grasses are present, species composition indicates that overgrazing may have occurred at the site in the past. This is apparent because plants generally avoided by livestock, such as plains pricklypear, greasewood, broom snakeweed, and big sagebrush, are abundant. Table 4 summarizes the plant cover in Unit 3, and Photos 9 and 10 show vegetation in two portions of Unit 3.

Table 4. Plant Species Within Unit 3, Native Shrub Area

Scientific Name	Common Name	Relative Cover Category
Achnatherum hymenoides	Indian ricegrass	Dominant
Agropyron cristatum	Crested wheatgrass	Trace
Alyssum desertorum	Desert madwort	Secondary
Artemisia tridentata	Big sagebrush	Dominant
Atriplex canescens	Fourwing saltbush	Trace
Atriplex confertifolia	Shadscale saltbush	Trace
Bromus tectorum	Cheatgrass	Trace
Erodium cicutarium	Redstem stork's bill	Trace
Gutierrezia sarothrae	Broom snakeweed	Secondary
Juniperus osteosperma	Utah juniper	Trace
Lepidium perfoliatum	Clasping pepperweed	Trace
Opuntia polyacantha	Plains pricklypear	Secondary
Pinus edulis	Twoneedle pinyon	Trace
Pleuraphis jamesii	James' galleta	Secondary
Poa secunda	Sandberg bluegrass	Trace
Pseudoroegneria spicata	Bluebunch wheatgrass	Trace
Sarcobatus vermiculatus	Greasewood	Secondary
Sphaeralcea coccinea	Scarlet globemallow	Trace
Xanthisma grindelioides	Gumweed aster	Trace
Species Richness		**19**

Unit 4, Native Pinyon/Juniper, Steep Slopes: Unit 4 is composed of steep (30–45 percent), actively eroding hill slopes that were undisturbed by remedial action activities. Weathered outcrops of the Wasatch Formation are visible in this unit. It encompasses about 22 acres on the Rifle disposal site. Soils typically are very shallow (<10 inches deep) over highly weathered bedrock and are classified as loamy-skeletal, mixed, mesic Ustic Torrirothents, or possibly as Ustic Haplocalcids, depending upon the calcium carbonate content in the soil (which was not analyzed). The observed Soil Pit 5 (Figure 1) had the following characteristics:

- **Ak:** 0–5 inches; olive brown (2.5Y 4/4 moist) extremely gravelly coarse sandy loam; single grain structure; loose dry and wet consistence; violently effervescent, disseminated; strongly alkaline (pH 8.8).

- **Crk:** 5–8+ inches; highly weathered, extremely stony bedrock; violently effervescent, disseminated.

The current, active erosional processes within Unit 4 areas do not, and are not expected to, affect the integrity of the disposal cell.

This unit is forested; twoneedle pinyon is the dominant species and there are lesser numbers of Utah juniper. A variety of species make up the undergrowth. Total foliar cover is estimated to be about 10 percent. Of the 14 plant species observed in this area, none are weedy. Table 5 summarizes plant cover in Unit 4, and Photo 11 shows representative soils and vegetation.

Table 5. Plant Species Within Unit 4, Native Pinyon/Juniper, Steep Slopes

Scientific Name	Common Name	Relative Cover Category
Achnatherum hymenoides	Indian ricegrass	Trace
Artemisia tridentata	Big sagebrush	Trace
Atriplex confertifolia	Shadscale saltbush	Trace
Cercocarpus montanus	Alderleaf mountain mahogany	Trace
Eriogonum lonchophyllum	Spearleaf buckwheat	Trace
Gutierrezia sarothrae	Broom snakeweed	Trace
Heterotheca villosa	Hairy false goldenaster	Trace
Juniperus osteosperma	Utah juniper	Secondary
Opuntia polyacantha	Plains pricklypear	Trace
Pinus edulis	Twoneedle pinyon	Dominant
Pleuraphis jamesii	James' galleta	Trace
Sarcobatus vermiculatus	Greasewood	Trace
Senecio sp.	Groundsel	Trace
Tetradymia canescens	Spineless horsebrush	Trace
Zuckia brandegeei	Siltbush	Trace
Species Richness		**14**

Unit 5, Native Pinyon/Juniper, Moderately Steep Slopes: Unit 5 areas also are forested but have more moderate (5–25 percent) slopes than Unit 4. Like Unit 4, this area was undisturbed by remedial activities. Unit 5 comprises about 34 acres on the disposal site. Soils within the unit are formed in residuum and colluvium derived from the underlying Wasatch Formation and form a complex of soil types. One type, found in relatively stable areas, is classified as a fine, mixed, mesic Ustic Haplargid. The other type, found in less stable areas, is classified as either a fine-loamy, mixed, mesic Ustic Torriorthent or Ustic Haplocalcid, depending upon the calcium carbonate content in the soil (which was not analyzed). Following are descriptions of the two types:

- Ustic Haplargid (Soil Pit 9, Figure 1)
  - **Ak:** 0–3 inches; brown (7.5YR 4/4 moist) silty clay loam; weak, coarse angular blocky structure; soft, very friable; slightly effervescent, disseminated; strongly alkaline (pH 8.8).

— **Btk:** 3–10+ inches; brown (7.5YR 5/4 moist) silty clay; very hard, extremely firm; strongly effervescent, disseminated; very strongly alkaline (pH 9.2–9.4).

- Ustic Torriorthent or Ustic Haplocalcid (Soil Pit 6, Figure 1)
  - — **Ak1:** 0–3 inches; dark brown (10YR 3/3 moist) gravelly loam; weak, coarse granular structure breaking to single grain; loose dry and moist consistence; violently effervescent, disseminated; strongly alkaline (pH 8.6); abrupt boundary.
  - — **Ak2:** 3–7 inches; dark brown (10YR 3/3 moist) gravelly loam; weak, coarse subangular blocky structure; slightly hard, friable; violently effervescent, disseminated; strongly alkaline (pH 8.6); abrupt boundary.
  - — **Ck:** 7–18+ inches; brown (7.5YR 4/4 moist) gravelly loam or clay loam; weak, coarse subangular blocky structure; slightly hard, friable; violently effervescent, disseminated; strongly alkaline (pH 8.7).

Foliar cover within Unit 5 ranges from 20 to 50 percent and is co-dominated by twoneedle pinyon and Utah juniper. The understory includes native shrubs, grass, and cacti. Cryptobiotic soils—associations of lichens, fungi, and other soil microbes that characterize undisturbed arid environments—are relatively abundant in this area. Of the 16 plant species in Unit 5, 1 is a noxious weed. Table 6 summarizes plant cover, Photo 12 is a representative photo of the area, and Photo 13 is a kingcup (claret cup) cactus growing in this unit. Kingcup cacti are generally indicators of undisturbed, native plant communities.

Table 6. Plant Species Within Unit 5, Native Pinyon/Juniper, Moderately Steep Slopes

Scientific Name	Common Name	Relative Cover Category	
		Sample A	Sample B
Achnatherum hymenoides	Indian ricegrass	Trace	Trace
Alyssum desertorum	Desert madwort		Trace
Artemisia tridentata	Big sagebrush	Secondary	Trace
Atriplex confertifolia	Shadscale saltbush		Trace
Bromus tectorum	Cheatgrass	Trace	Trace
Cercocarpus montanus	Alderleaf mountain mahogany		Trace
Cryptantha sp.	Cryptantha		Trace
Echinocereus triglochiadiatus	Kingcup (claret cup) cactus	Trace	Trace
Ericameria nauseosa	Rubber rabbitbrush	Trace	
Gutierrezia sarothrae	Broom snakeweed	Trace	Trace
Juniperus osteosperma	Utah juniper	Secondary	Dominant
Opuntia polyacantha	Plains pricklypear	Secondary	Secondary
Phlox andicola	Prairie phlox	Trace	Trace
Pinus edulis	Twoneedle pinyon	Dominant	Dominant
Pleuraphis jamesii	James' galleta	Dominant	
Sarcobatus vermiculatus	Greasewood	Trace	
Species Richness	**16**	**12**	**14**

Unit 6, Catchment Area: Unit 6 consists of a 2-acre man-made catchment area located immediately north of the disposal cell (Photo 14). It is a swale-like feature that captures surface runoff before it reaches the cell and redirects it to an offsite drainage. Soil characteristics are similar to those observed in Soil Pit 5 in Unit 4. Even though slopes are moderately steep (10 to 30 percent), the area is vegetated and stable.

Vegetation in the catchment area differs from other parts of the site, and some species were only found in this area. The current plant community is early successional. Because soils are similar to Unit 4, the plant community may eventually develop into forest, similar to Unit 4. Nineteen species were identified within this unit, four of which were weedy (none noxious). The total foliar cover was 10 to 15 percent. The dominant shrub was rubber rabbitbrush, and spiny hopsage was secondary. The sparse understory was dominated by non-weedy grasses and forbs. Table 7 summarizes vegetation in this area.

Table 7. Plant Species Within Unit 6, Catchment Area

Scientific Name	Common Name	Relative Cover Category
Achnatherum hymenoides	Indian ricegrass	Secondary
Alyssum desertorum	Desert madwort	Trace
Astragalus sp.	Milkvetch	Secondary
Cirsium ochrocentrum	Yellowspine thistle	Trace
Elymus trachycaulus	Slender wheatgrass	Trace
Ericameria nauseosa	Rubber rabbitbrush	Dominant
Grayia spinosa	Spiny hopsage	Secondary
Gutierrezia sarothrae	Broom snakeweed	Trace
Hordeum jubatum	Foxtail barley	Trace
Machaeranthera canescens	Hoary tansyaster	Trace
Malacothrix sp.	Desert dandelion	Trace
Melilotus officinalis	Sweetclover	Trace
Opuntia polyacantha	Plains pricklypear	Trace
Pascopyrum smithii	Western wheatgrass	Trace
Penstemon sp.	Penstemon	Trace
Rhus trilobata	Skunkbush sumac	Trace
Salsola tragus	Prickly russian thistle	Trace
Sisymbrium altissimum	Tall tumblemustard	Trace
Xanthisma grindelioides	Gumweed aster	Trace
Species Richness		**19**

Unit 7, Rock Riprap: This unit encompasses the riprapped disposal cell cover and rock apron south of the cell, where riprap was laid to prevent existing arroyos from headcutting into the cell. The total area of the unit is about 95 acres. The cell cover can be seen in the background of Photos 7, 8, and 10. No soil sample was collected in this unit.

DOE completed disposal cell construction in 1996. Although the cell cover was not originally designed to support vegetation, a few plants have become established in windblown sediments

within the rock interstices. Vegetation was very sparse (less than 1 percent total foliar cover). Eleven species were identified, six of which were weeds (two noxious). Four small twoneedle pinyon saplings were growing on the cell top, and four saltcedar shrubs were growing in the rock-covered drainage along the southeast side of the site. The saltcedar shrubs were treated with herbicide during the baseline characterization (see Section 3.3, Noxious Weeds). Substantial vegetation has established along the edges of the riprap where the soil is presumably more moist than in the surrounding areas. Table 8 summarizes the plant cover in Unit 7.

Table 8. Plant Species Within Unit 7, Rock Riprap

Scientific Name	Common Name	Relative Cover Category	
		Cell Edge and Top	Cell Top (annual inspection)
Bromus inermis	Smooth brome	Trace	Trace
Convolvulus arvensis	Field bindweed		Trace
Ericameria nauseosa	Rubber rabbitbrush	Trace	
Hordeum jubatum	Foxtail barley	Trace	Trace
Lactuca serriola	Prickly lettuce	Trace	Trace
Melilotus officinalis	Sweetclover	Trace	
Pascopyrum smithii	Western wheatgrass	Trace	
Pinus edulis	Twoneedle pinyon	Trace	Trace
Sisymbrium altissimum	Tall tumblemustard	Trace	
Sphaeralcea coccinea	Scarlet globemallow	Trace	
Tamarix ramosissima	Saltcedar (tamarisk)	Trace	Trace
Species Richness	**11**	**10**	**6**

Unit 8, Drainage Channel and Banks: To the east and downslope of the disposal cell is a south-flowing drainage that is ephemeral in the northern portion and intermittent in the southern portion. Runoff water from the disposal cell surface and one small seep compose the primary sources of stream flow in the intermittent portion. At the time of the August 1 soil and vegetation characterization, the intermittent portion of the streambed was moist or wet in places but did not exhibit surface flows. No soil samples were collected in this unit.

Twenty-seven plant species were identified in Unit 8, 37 percent of which were weedy (3 of these were noxious). Shrubs, mainly big sagebrush and rubber rabbitbrush, dominated the banks of the channel, and common mullein was secondary throughout the unit. Vegetation cover is summarized in Table 9, and Photo 15 shows the banks and channel.

Table 9. Plant Species Within Unit 8, Drainage Channel and Banks

Scientific Name	Common Name	Relative Cover Category	
		Sample A	Sample B (annual inspection)
Agrostis stolonifera	Creeping bentgrass	Trace	
Amaranthus retroflexus	Redroot amaranth	Trace	
Apocynum sp.	Dogbane	Trace	
Artemisia tridentata	Big sagebrush		Dominant
Astragalus sp.	Milkvetch		Trace
Calochortus nuttallii	Sego lily		Trace
Cercocarpus montanus	Alderleaf mountain mahogany	Trace	Trace
Chenopodium berlandieri	Pitseed goosefoot	Trace	
Cirsium ochrocentrum	Yellowspine thistle	Trace	
Convolvulus arvensis	Field bindweed		Trace
Cryptantha sp.	Cryptantha		Trace
Ericameria nauseosa	Rubber rabbitbrush	Secondary	Dominant
Ipomopsis aggregata	Scarlet gilia	Trace	Trace
Juniperus osteosperma	Utah juniper		Trace
Lactuca serriola	Prickly lettuce	Trace	
Malacothrix sp.	Desert dandelion	Trace	
Melilotus officinalis	Sweetclover	Trace	Trace
Penstemon sp.	Penstemon		Trace
Pinus edulis	Twoneedle pinyon		Trace
Pleuraphis jamesii	James' galleta		Trace
Senecio sp.	Groundsel		Trace
Sonchus asper	Spiny sowthistle	Trace	
Tamarix ramosissima	Saltcedar (tamarisk)	Trace	
Thlaspi arvense	Field pennycress		Trace
Verbascum Thapsus	Common mullein	Secondary	
Xanthium strumarium	Rough cocklebur	Trace	
Yucca sp.	Yucca	Trace	Trace
Species Richness	**27**	**16**	**16**

3.2 Soil Erosion

Stoller scientists documented several areas of active erosion (Figure 1) on the Rifle disposal site, all of which have been documented in the past (DOE 2013). The most impressive erosion feature on the site is the large gully that transmits runoff from the Unit 6, Catchment Area, to the offsite drainage west of the disposal site. Significant erosion occurred in this gully during a major rain event in 2005. Repairs were made to the lower section of the Catchment Area, and rocks were placed into the upper part of the eroded gully. Photo 16 shows some of the rock riprap that was placed in the gully. Given the erosive nature of the soil and the underlying Wasatch Formation materials in Unit 4, through which the gully transects, it is a matter of time before runoff water

forms new channels adjacent to the riprap and widens the gully. Eventually, additional riprap will need to be placed in the gully to maintain the integrity of the Catchment Area. This eroding feature does not threaten the integrity of the disposal cell itself.

Minor erosion, anticipated during the design of the cell, is evident in the channel at the outlet below the toe ditch (in the southeast corner of the cell). Bedrock is exposed in this area, and rock riprap previously placed in the outlet to stabilize the erosion continues to drop into the eroded area, making the channel self-armoring. These erosional processes do not affect the integrity of the disposal cell.

Even more-minor erosion, on the sides of the disposal cell in the form of rills, was previously identified and noted again during the baseline characterization (Figure 1). None of these features currently affect the integrity of the disposal cell.

Three arroyos are present in Unit 3, Native Shrub Area, south of the disposal cell and below the rock apron. As the arroyos have migrated into the apron, the rock has self-armored the arroyos and effectively stabilized them from further erosion.

The processes of wind erosion and sediment deposition may affect the disposal cell over the long term. Windblown sediments from the region have been, and will continue to be, deposited into rock interstices on the cell cover, providing a seed bed for plant germination and a medium for continued growth. In a few areas, an early-seral plant community is developing (see Section 3.1, Unit 7 description). The roots from some plant species could eventually penetrate cover materials and negatively affect the percolation or gas exchange properties of the cell cover. For this reason, the LTSP currently requires DOE to remove deep-rooted species from the cell if they are determined to be a threat to the integrity of the cover. However, research is now indicating that perhaps roots could improve the performance of the cover by increasing evapotranspiration rates (Waugh et al. 2009). As research progresses on the effects of vegetation on disposal cells, the LTSP may be revised to modify vegetation management requirements.

3.3 Noxious Weeds

Two state-listed Class B noxious weed species—bull thistle and saltcedar—and three Class C noxious weed species—downy brome, field bindweed, and common mullein—were identified at the disposal site (see Figure 1 for locations). Class B species are required by state law to be controlled in accordance with the county noxious weed plan, and Class C species must be prevented from spreading. In Garfield County, bull thistle must be suppressed and saltcedar must be contained. All infestations of bull thistle and saltcedar were treated with appropriate herbicides at the time of the baseline characterization. Noxious weed populations at the site will continue to be mapped and treated in compliance with the Federal Noxious Weed Act (Title 7 *United States Code* Section 2814) and the Colorado Noxious Weed Act (Title 35 *Colorado Revised Statutes* Articles 5.5-101–5.5-119).

4.0 Recommendations

It is recommended that DOE continue to monitor vegetation conditions and livestock trespassing incidents on the disposal site during annual inspections. If needed, communications with the BLM grazing permittee may need to be resumed to prevent future rangeland degradation.

As required by the LTSP, DOE will continue to monitor the erosional features on and near the disposal site (see Section 3.2, Soil Erosion). Erosional repairs will be made as needed.

The control of noxious weeds on the site will be a minor but continual maintenance issue. It is recommended that noxious weeds be spot-treated with herbicide annually until they are eradicated. Afterward, site ecologists should conduct periodic monitoring to ensure that new populations of noxious weeds are treated effectively. None of the current infestations are widespread and should easily be eradicated after several years. During at least one of the site visits, noxious weed conditions on surrounding lands should be inventoried in a general fashion to determine if DOE needs to engage adjacent landowners in weed-control activities.

Section 4.0 of the LTSP requires DOE to remove deep-rooted species on the cell if they are determined to be a threat to the integrity of the cover. To date, only deep-rooted saltcedar saplings have been treated, as they are considered a noxious weed. The other deep-rooted saplings present on the cell, four small twoneedle pinyon trees, have not been treated, as they are not yet considered a threat. DOE's ongoing research (DOE 2014) concerning the effects of vegetation on traditional UMTRCA disposal cell covers could change the way vegetation is controlled in the future.

5.0 References

10 CFR 40.27. U.S. Nuclear Regulatory Commission, "General License for Custody and Long-Term Care of Residual Radioactive Material Disposal Sites," *Code of Federal Regulations*.

35 CRS 5.5-101–5.5-119. Agriculture, "Colorado Noxious Weed Act," *Colorado Revised Statutes*.

7 USC 2814. Noxious Weeds, "Management of undesirable plants on Federal lands," *United States Code*.

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Appendix A

Photographs

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Photo 1. View southeast of Unit 1, Revegetated Area, Very Shallow Soils

Photo 2. View north-northwest of Rifle disposal site area before construction was begun

Photo 3. View north of Rifle disposal site during construction in 1992

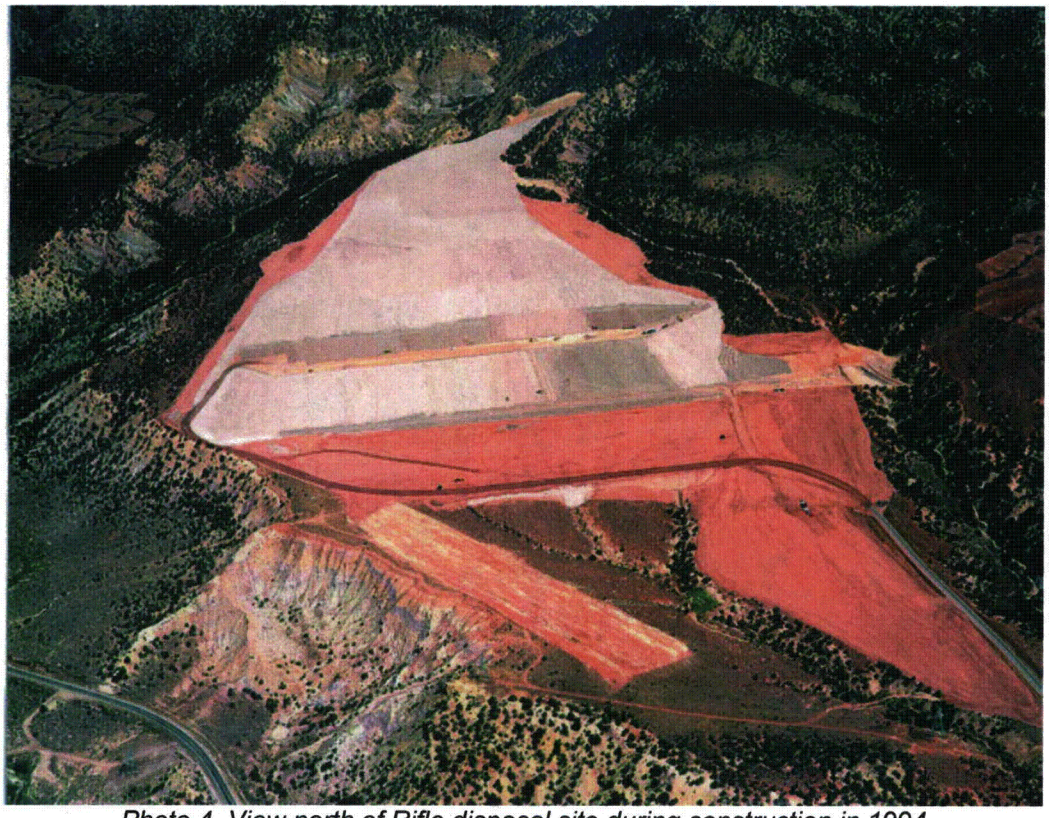

Photo 4. View north of Rifle disposal site during construction in 1994

Photo 5. View west of Unit 2, Revegetated Area, Moderately Deep Soils; note the evaporation pond exclosure in the right mid-ground

Photo 6. Close-up of vegetation on grazed flats in Unit 2, Revegetated Area, Moderately Deep Soils (south of the disposal cell)

Photo 7. View northwest of plant cover within the fenced evaporation pond area in Unit 2, Revegetated Area, Moderately Deep Soils (south of the disposal cell)

Photo 8. View northwest of the fence-line contrast in plant cover between grazed and ungrazed vegetation within Unit 2, Revegetated Area, Moderately Deep Soils

Photo 9. View southeast of Unit 3, Native Shrub Area

Photo 10. View north-northwest of Unit 3, Native Shrub Area

Photo 11. View southwest of Unit 4, Native Pinyon/Juniper, Steep Slopes; note the extremely gravelly soil surface

Photo 12. View northeast of Unit 5, Native Pinyon/Juniper, Moderately Steep Slopes

Photo 13. Kingcup (claret cup) cactus in Unit 5, Native Pinyon/Juniper, Moderately Steep Slopes

Photo 14. View northeast of Unit 6, Catchment Area

Photo 15. View of south of Unit 8, Drainage Channel and Banks
(photo from the annual inspection in June 2013)

Photo 16. View downslope of the actively eroding gully within Unit 4 transmitting runoff from the Catchment Area (Unit 6) to the offsite natural drainage way

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