BASELINE DATA REPORT

Section 4.0

Vegetation

OCTOBER 2009

Submitted To:

New Mexico Mining and Minerals Division
&
U.S. Forest Service (Cibola National Forest)

Prepared by:

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4.0 Vegetation

NMAC §19.10.6.602 D.(13) (c)

Provide a map which delineates existing vegetation types and a description, including cover, density and productivity of the plant communities within the proposed permit area. The description of the vegetation types and plant communities may be based upon data from adjacent areas if vegetation in the permit area has been adversely impacted by previous mining operations or other disturbances. Included in this description shall be the results of an inventory conducted for any sensitive, threatened or endangered plant species within the permit area.

4.1 Introduction

A general account of the plant communities in Sections 9, 10, and 16 is given in this section. Initial vegetation surveys were performed by Permits West, Inc. (PWI) at the Roca Honda permit area from July 31 through August 8, 2006 on Sections 9, 10, and 16 and from September 11 through October 19, 2006 on Sections 9 and 10. These reports are included at the back of this section as Appendix 4-A, Vegetation Survey, Section 16 and Appendix 4-B, Vegetation Survey, Sections 9 and 10. Surveys to measure cover, density, and productivity of the plant communities within the permit area were initiated in spring 2008. The results of these surveys are contained in Appendix 4-C, Vegetation Cover, Density and Productivity Surveys, Sections 9, 10 and 16. The surveys included an inventory of sensitive, threatened, or endangered plant species. Complete lists of all the species found at the site are tabulated in these reports.

4.2 Existing Vegetation Types

The Roca Honda permit area encompasses Sections 9, 10, and 16 of T13N R8W. Figure 4-1 is a map which shows the three main vegetation classifications: juniper savanna, piñon-juniper woodland, and grassland and/or shrubland. More detailed vegetation maps are contained in Appendix 4-C. Jesus Mesa occupies approximately half of Section 9 and slopes into Section 10. The top and upper portion of the mesa is mostly open piñon-juniper woodland with some desert grassland and scattered stands and individual ponderosa pine. The perimeter of the mesa consists of sandstone ledges with areas of exposed shale, particularly to the south of the mesa. The landscape southwest, north, and southeast of the mesa is predominantly desert grassland, with a large area of wooded slopes on the southeast side between the mesa and the lower grassland. These slopes are frequently dissected by drainages that can range from a few to 40 ft deep. There are several areas of semi-stabilized sand dunes.

Within the desert grassland community, the dominant grasses are hairy and blue grama (*Bouteloua hirsute and bouteloua gracilis*), with galleta (*Pleuraphis jamesii*) common throughout and sand dropseed (*Sporobolus cryptandrus*) common in some areas. There are a few areas of little bluestem (*Schizachyrium scoparium* var. *scoparium*) on the southeast side. The ground cover is dominated by garden purslane (*Portulaca oleracea*), changing to kiss-me-quick (*Portulaca pilosa*) in the sandiest areas, with Wislizenus's threadleaf (*Schkuhria pinnata* var. *wislizeni*) frequent throughout. Dodder (*Cuscuta* sp.) appears to be growing on a large percentage of the garden purslane.

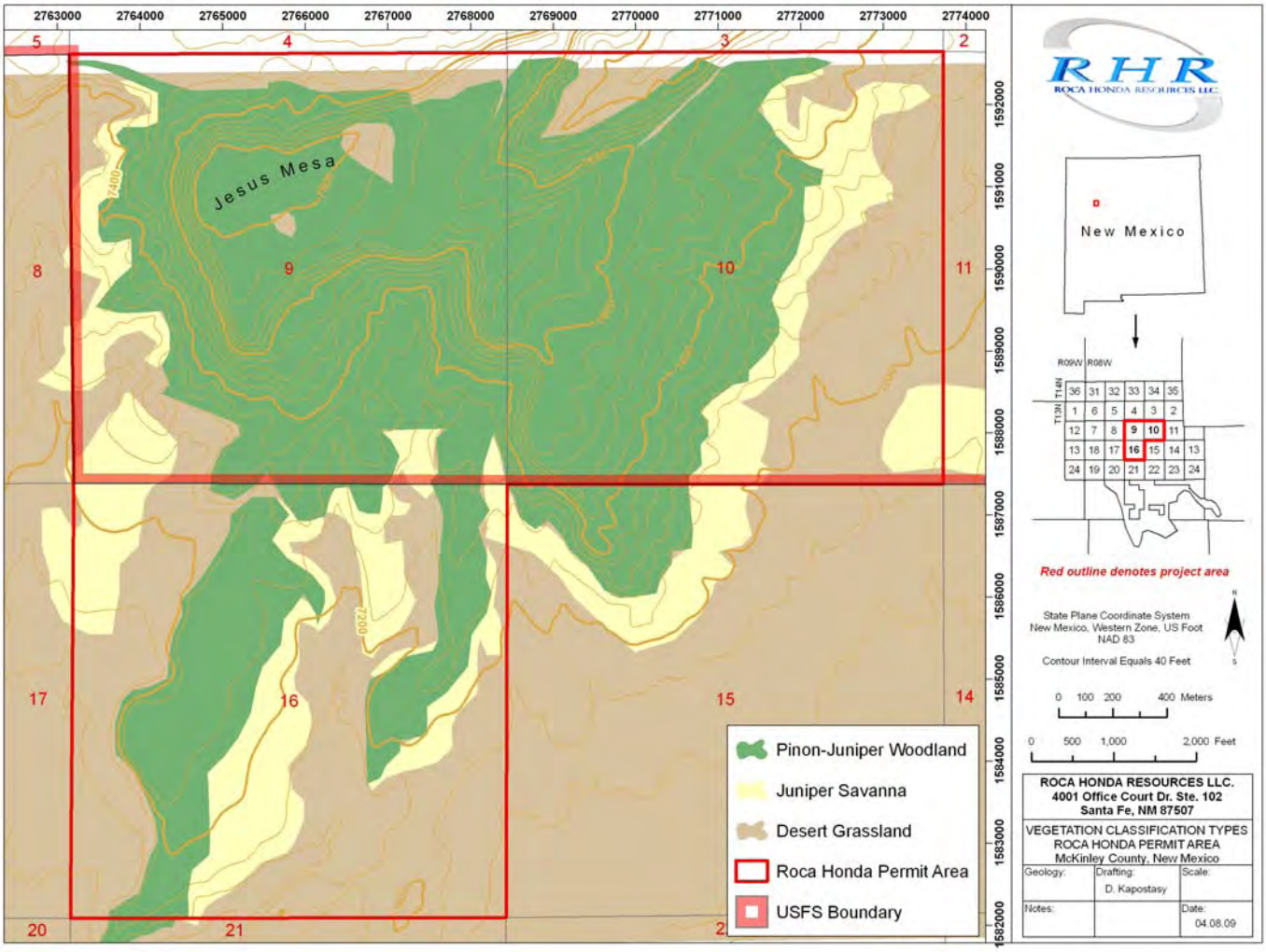

Figure 4-1. Vegetation Classification in the Roca Honda Permit Area.

Other common forbs include spiderwort (*Tradescantia occidentalis*), tufted evening-primrose (*Oenothera caespitosa*), and flixweed (*Descurainia sophia*). The southeast corner of the Roca Honda permit area has several areas dominated by Russian-thistle (*Salsola tragus*) with smotherweed (*Bassia hyssopifolia*) and American bugseed (*Corispermum americanum* var. *americanum*). There are widely scattered oneseed juniper (*Juniperus monosperma*), piñon pine (*Pinus edulis*), and four-wing saltbush (*Atriplex canescens*).

The woodland mostly consists of piñon pine and oneseed juniper. A few ponderosa pines (*Pinus ponderosa*) are on the top of Jesus Mesa and along the southeast drainages. There are some Rocky Mountain junipers (*Juniperus scopulorum*) at the head of the drainage on the north side of Jesus Mesa. Within the woodland, hairy and blue grama are often the dominant ground cover with cliffrose (*Purshia stansburiana*) and common mountain mahogany (*Cercocarpus montanus*) the most common shrubs. Common forbs include fragrant snakeroot (*Ageratina herbacea*) and thyme-leaf spurge (*Chamaesyce serpyllifolia*). Under the trees, fetid-goosefoot (*Dysphania graveolens*), Colorado four-o'clock (*Mirabilis multiflora*), and Fendler's drymary (*Drymaria glandulosa*) are very common. In the sandiest areas, field wormwood (*Artemisia campestris* var. *caudata*), flat sagebrush (*Artemisia bigelovii*), spectacle-pod (*Dimorphocarpa wislizeni*), kiss-me-quick, spiderwort, and fine-leaf woolywhite (*Hymenopappus filifolius*) are common.

The rocky slopes of Jesus Mesa support a similar plant community of scattered piñon pine and oneseed juniper with hairy and blue grama quite common. Common shrubs include flat sagebrush and cliffrose. New Mexico muhly (*Muhlenbergia pauciflora*), and both plumed and California brickellbush (*Brickellia brachyphylla* and *B. californica*, respectively) are also common. Santa Fe lipfern (*Cheilanthes feei*) and brittle bladder-fern (*Cystopteris fragilis*) are occasional at the bases of the rocks. The few shale slopes are mostly barren, but do support a few piñon pines, oneseed juniper, Colorado four-o'clock, galleta, and a four-wing saltbush. At the rocky rims of the mesa and drainages are black sagebrush (*Artemisia nova*), flat sagebrush, and common mountain mahogany.

The canyons on the southeast side of the mesa reach depths of 30 to 40 ft and support a few ponderosa pines within a piñon-juniper woodland. The most common plants include broom groundsel (*Senecio spartioides* var. *multicapitatus*), tassel-flower brickellbush (*Brickellia grandiflora*), and hairy grama.

There are several small pools of water that apparently gather along some of the drainages off Jesus Mesa. Some of these support small communities of wetland plants, indicating that they are moist much of the year. These communities include scratchgrass (*Sporobolus contractus*), mesa dropseed (*Sporobolus flexuosus*), straw-color flat-sedge (*Cyperus strigosus*), sand dropseed, rush (*Juncus* sp.), pale spikerush (*Eleocharis macrostachya*), and even cattail (*Typha domingensis*). The drainages on the west and north sides of the mesa are within sandier soils in a desert grassland. In these drainages the common plants are hairy and blue grama, rubber rabbitbrush (*Ericameria nauseosa* var. *graveolens*), and sage (*Salvia* prob. *incisa*).

There are occasional stabilized and semi-stabilized sand dunes throughout the permit area, particularly to the west, northwest, and southeast of Jesus Mesa. These areas support a variety of sand-dependent plants, including sandhill muhly (*Muhlenbergia pungens*), spectacle pod, sand sage (*Artemisia filifolia*), spiderwort, Bigelow's rubber rabbitbrush (*Ericameria nauseosa* var. *bigelovii*), kiss-me-quick, and field wormwood.

Section 16 consists of desert grassland and very open piñon-juniper woodland. The largest drainage basin begins from the base of Jesus Mesa and runs south and southwest just east of the center of Section 16. There are smaller drainages generally running southeast from the highest point in Section 16 on unnamed mesa at 7292 ft elevation (mesa 7292). On both the west and east sides of mesa 7292, drainages are found with steep slopes and cliffs up to 50 ft in height.

The area east of mesa 7292 is grazed desert grassland. The dominant grass is hairy and blue grama, with several areas of ring muhly (*Muhlenbergia torreyi*); however, much of the area is dominated by carpets of garden purslane, with other annuals in abundance. The most common of these annuals are Colorado rubberweed (*Hymenoxys richardsonii* var. *floribunda*), wild potato (*Solanum jamesii*), and both spotted and thyme-leaf spurge (*Chamaesyce maculata* and *C. serpyllifolia*, respectively). Another plant found in abundance is dodder (*Cuscuta* sp.), which is apparently parasitizing the garden purslane.

The rest of the Roca Honda permit area is very open piñon-juniper woodland with areas of desert grassland. Oneseed juniper (*Juniperus monosperma*) is much more common than piñon (*Pinus edulis*), but is usually widely scattered. There are very few understory shrubs, although flat sagebrush is common along the rims of the mesas where there is more exposed bedrock. Cliffrose is occasional along the drainages. Again, garden purslane is quite common, with kiss-me-quick replacing it in sandier areas. Colorado four o'clock is common both under the Utah junipers and in the open.

There is one seasonal cattle pond in the center of Section 16. The plants dominating this man-made pond include Mexican fireweed (*Kochia scoparia*), Russian thistle (*Salsola tragus*), and golden crownbeard (*Verbesina encelioides*), rubber rabbitbrush (*Ericameria nauseosa* var. *graveolens*), saltcedar (*Tamarix chinensis*), and foxtail barley (*Hordeum jubatum*).

4.3 Vegetation Cover, Density, and Productivity

Appendix 4-C provides a detailed description of vegetation cover and density in the permit area. The report provides detailed plant species inventory, and quantitative estimates of vegetation and ground cover, shrub and tree density and grass (herbaceous) productivity. The reviewer is referred to Appendix 4-C for a detailed discussion of vegetation cover, density and productivity.

Briefly, PWI identified eight vegetation types on the permit area;

1. Juniper Savanna
2. Piñon-Juniper Woodland
3. Drainage Bottom/Wash
4. Ponderosa Pine, Piñon-Juniper Mixed Woodland
5. Rimrock
6. Semi-Stabilized Dune
7. Disturbed Piñon-Juniper Mosaic
8. Shrub-Grassland

Each of these vegetation types were mapped and analyzed in significant detail. The productivity analysis will be ongoing for several seasons and will be reported on as data becomes available.

4.4 Sensitive, Threatened, or Endangered Species

4.4.1 Federally Listed Threatened and Endangered Plant Species

The U.S. Fish and Wildlife Service (USFWS) lists two federally threatened plant species that occur in McKinley and Cibola Counties, New Mexico. Table 4–1 lists these species with their protection status, habitat requirements, and potential to occur in the Roca Honda permit area. The federally listed species do not have appropriate habitat within the Roca Honda permit area, and no plants of these species were found during surveys.

4.4.2 State of New Mexico Listed Threatened and Endangered Plant Species

There are fifteen plant species listed by the State of New Mexico as Endangered, Threatened, or Species of Concern (SOC) that are known to occur in McKinley and Cibola Counties. Two of these species are federally listed and are addressed in Table 4–1. The remaining thirteen species are listed in Table 4–2. Two of the species have the potential to occur in the Roca Honda permit area: Naturita milkvetch (*Astragalus naturitensis*) and Laguna fame flower (*Talinum brachypodium*). These species are discussed in more detail below.

The permit area contains bedrock exposures of the Point Lookout Sandstone, Crevasse Canyon Formation (Gibson Coal and Dalton Sandstone Members), and Mulatto Tongue of the Mancos Shale. Bedrock is eroded in many places, but sandstone and shale is exposed in some places in ledges and rimrock. This environment provides limited areas of potential habitat for both Naturita milkvetch and Laguna fame flower. Two species of milkvetch were observed within the permit area, but neither matched Naturita milkvetch in habitat or vegetative characters. One species of *Phemeranthis* (formerly included in *Talinum*) was observed. However, both vegetative and floral characteristics are quite different from Laguna fame flower.

Table 4-1. USFWS Listed Endangered, Threatened, or Candidate Plants, McKinley and Cibola Counties, New Mexico

Species/Status	Habitat and Distribution	Potential to Occur in the Permit Area
Erigeron rhizomatus Zuni fleabane Threatened	Nearly barren detrital-clay hillsides with soils derived from shales of the Chinle or Baca Formations (often seleniferous), most often on north or east facing slopes in open piñon-juniper woodlands at 7,300–8,000 ft. Known from McKinley County (NMRPTC 1999 and Roth 2001c).	No appropriate habitat. There are no shales of the Chinle or Baca formations in the permit area. Most of the permit area is below the altitudinal range for this species.
Helianthus paradoxus Pecos sunflower Threatened	Saturated saline soils of desert wetlands. Usually associated with desert springs or the wetlands created from modifying desert springs, and from 3,300–6,600 ft. Known from Cibola County (NMRPTC 1999).	No appropriate habitat. There is one area with saturated soils created by damming a drainage; however, the area is not saline. The permit area is above the altitudinal range of the species.

Table 4-2. State of New Mexico Endangered, Threatened, or Species of Concern Listed Plants McKinley and Cibola Counties

Species/Status	Habitat and Distribution	Potential to Occur in the Permit Area
Astragalus chuskanus Chuska milkvetch SOC	Degraded Chuska Sandstone in openings in montane coniferous forest above 5,500 ft. Known from McKinley County (NMRPTC 1999).	No appropriate habitat. There is no Chuska Sandstone in the permit area.
Astragalus micromerius Chaco milkvetch SOC	Gypseous or limy sandstones in piñon-juniper woodland or Great Basin desert scrub from 6,600–7,300 ft. Known from McKinley County (NMRPTC 1999).	No appropriate habitat. No gypseous or limy sandstone was observed in the permit area.
Astragalus missouriensis var. *acumbens* Zuni milkvetch SOC	Gravelly clay banks and knolls, in dry alkaline soils derived from sandstone, in piñon-juniper woodland from 6,200–7,900 ft. Known from McKinley and Cibola Counties (NMRPTC 1999).	No appropriate habitat. No gravelly clay banks or knolls are present in the permit area. The soils in the permit area are not saline.
Astragalus naturitensis Naturita milkvetch SOC	Sandstone ledges and rimrock along canyons in piñon-juniper woodland from 5,000–7,000 ft. Known from McKinley County (NMRPTC 1999 and Roth 2001a).	Limited areas of potential habitat could exist along the rim and ledges of the low unnamed mesa in the permit area. No *Astragalus* matching this distinctive species was observed.
Erigeron acomanus Acoma fleabane SOC	Sandy slopes and benches beneath sandstone cliffs of the Entrada Sandstone in piñon-juniper woodland; from 6,900–7,100 ft. Known from McKinley and Cibola Counties (NMRPTC 1999 and Roth 2001b).	No appropriate habitat. There is no Entrada in the permit area.
Erigeron svinskii Sivinski's fleabane SOC	Steep barren shale slopes of the Chinle Formation in piñon-juniper woodland and Great Basin desert scrub from 6,100–7,400 ft. Known from McKinley County (NMRPTC 1999 and Roth 2001d).	No appropriate habitat. There is no Chinle Formation cropping out in the permit area.

Table 4-2. (Continued)

Species/Status	Habitat and Distribution	Potential to Occur in the Permit Area
Helianthus praetermissus Lost sunflower SOC	Perhaps wet ground based on the collection locality for the only specimen. This species is known only from the type specimen collected in 1851 on the Sitgreaves expedition at the head of the Rio Laguna (now Rio San Jose) at Ojo de la Gallina, Cibola County. This species may have been named from a depauperate specimen of *Helianthus paradoxus*.	There is wet ground in the permit area associated with a man-made cattle pond; however, the permit area is not near the only known location for the species near the Zuni Mountains.
Penstemon deaveri Mount Graham beardtongue SOC	Slopes and rocky areas from ponderosa pine forest to above timberline; from 6,500–11,280 ft. Known from Cibola County (NMRPTC 1999).	No appropriate habitat. There are no ponderosa pine forest or plant communities associated with higher elevations in the permit area.
Phacelia serrata Cinders phacelia SOC	In deep volcanic cinders, primarily associated with volcanic cones, but also in roadcuts and abandoned quarries in open, exposed, sunny locations; near ponderosa pine and piñon-juniper woodlands from 5,900–7,200 ft. Known from Cibola County (NMRPTC 1999).	No appropriate habitat. There are no areas of volcanic cinders in the permit area.
Physaria navajoensis Navajo bladderpod SOC	Windswept mesa rims of Todilto Limestone in sparse piñon-juniper woodland from 7,200–7,600 ft. Known from McKinley County (NMRPTC 1999 and Roth 2001e).	No appropriate habitat. There is no Todilto Limestone cropping out in the permit area. Most of the permit area is lower than the altitudinal range of the species.
Physaria newberryi var. *yesicola* Yeso bladderpod SOC	Nearly barren badlands of sandy gypsum and silty strata of the Yeso Formation in short grass steppe and juniper savanna; from 5,700–6,900 ft. Known from Cibola County (NMRPTC 1999).	No appropriate habitat. There is no Yeso Formation cropping out in the permit area. Most of the permit area is higher than the altitudinal range of the species.
Puccinellia parishii Parish's alkali grass Endangered	Alkaline springs, seeps, and seasonally wet areas that occur at the heads of drainages or on gentle slopes from 2,600–7,200 ft; the species requires continuously damp soils during its late winter to spring growing period. Known from McKinley and Cibola Counties (NMRPTC 1999 and Roth 2001f).	No appropriate habitat. There are no seasonally wet alkaline areas in the permit area.
Talinum brachypodium Laguna fame flower SOC	Very shallow pockets of calcareous silt to clay soils overlying limestone or travertine, or fine silty sand overlying calcareous sandstones; open piñon-juniper woodland with little understory and scattered cacti and shrubs or Chihuahuan desert scrub. Known from Cibola County (NMRPTC 1999).	Limited areas of potential habitat could exist on the low mesa in the permit area. Some of the sandy loam soil does have a high component of silt in it. No plants of this species were observed.

4.5 References

New Mexico Bureau of Geology and Mineral Resources, 2003. *Geologic Map of New Mexico*, New Mexico Bureau of Geology and Mineral Resources, scale 1:500,000.

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———, 2001b. Species account for *Erigeron acomanus*, Navajo Natural Heritage Program (http://navajofishandwildlife.org/nnhp), revised 15 February 2005.

———, 2001c. Species account for *Erigeron rhizomatus*, Navajo Natural Heritage Program (http://navajofishandwildlife.org/nnhp), revised 15 February 2005.

———, 2001d. Species account for *Erigeron svinskii*, Navajo Natural Heritage Program (http://navajofishandwildlife.org/nnhp), revised 15 February 2005.

———, 2001e. Species account for *Lesquerella navajoensis*, Navajo Natural Heritage Program (http://navajofishandwildlife.org/nnhp), revised 15 February 2005.

———, 2001f. Species account for *Puccinellia parishii*, Navajo Natural Heritage Program (http://navajofishandwildlife.org/nnhp), revised 15 February, 2005.

Wood, B., 2006a. Strathmore Minerals Corp., Roca Honda Sections 9 & 10, Botanical Report, December 26, 2006.

———, 2006b. Strathmore Minerals Corp., Roca Honda State Section, Botanical Report, October 7, 2006.

_____, 2009, Vegetation Baseline Data for Roca Honda Resources, LLC., Roca Honda Project, 2008 Field Season, On State and Federal Lands (Cibola National Forest) Sections 9, 10, and 16, T13N, R8W, McKinley County, New Mexico.

Appendix 4-A

Roca Honda Permit Area
Vegetation Survey
Section 16

PERMITS WEST, INC.
PROVIDING PERMITS for LAND USERS
37Verano Loop, Santa Fe, New Mexico 87508 (505) 466-8120

STRATHMORE MINERALS CORP.
ROCA HONDA STATE SECTION
BOTANICAL REPORT

This report discusses the potential for disturbance to endangered, threatened, and other designated sensitive flora listed by Federal and State of New Mexico agencies that may occur in the project area. The project area encompasses the 640 acres comprising all of Section 16, T. 13 N., R. 8 W., McKinley County, New Mexico. Section 16 (see next two pages) is owned by the State of New Mexico and is administered by the New Mexico State Land Office. Strathmore Minerals Corp. holds State General Mining Lease HG-0036-0001.

PROJECT DESCRIPTION

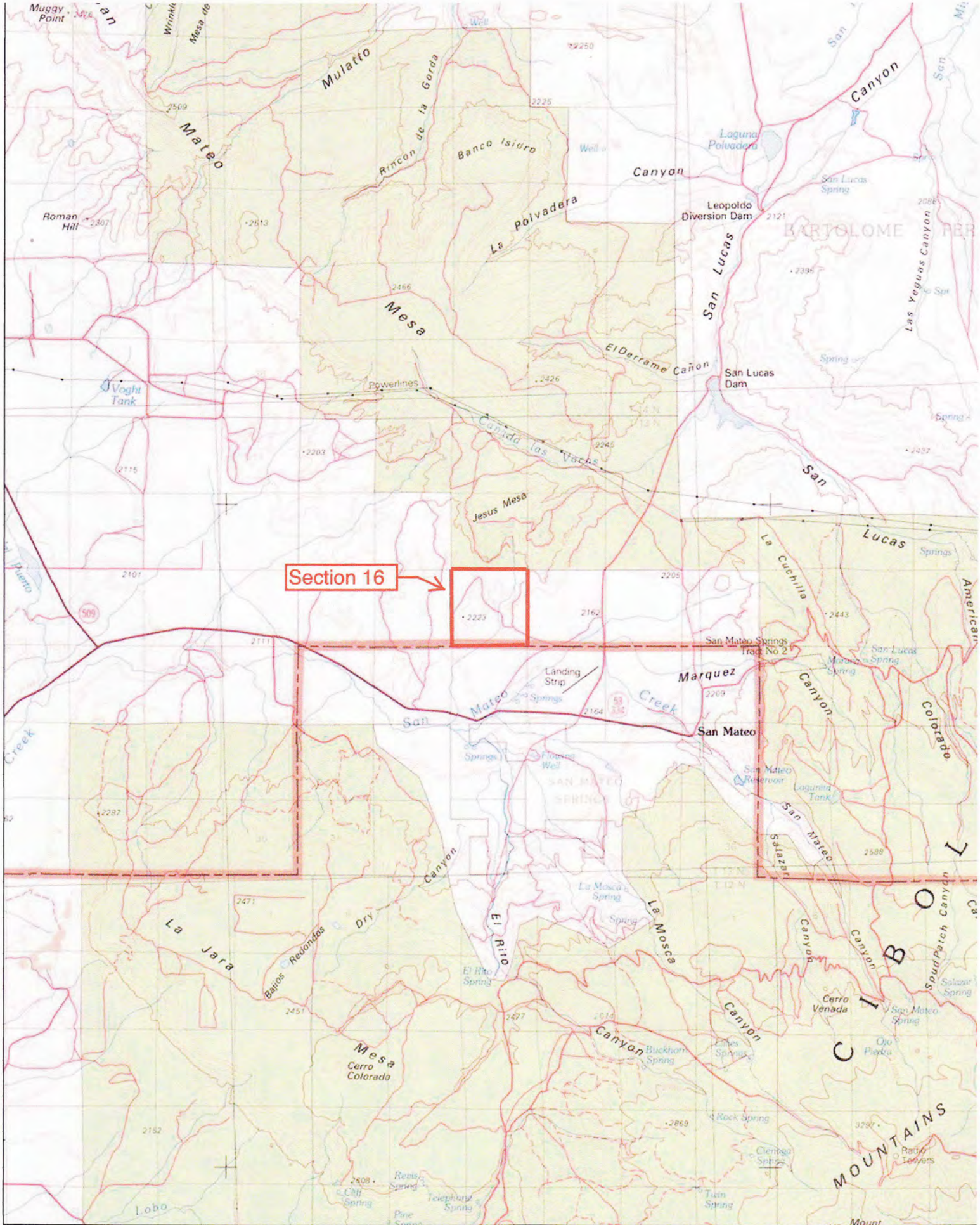
Disturbance: There are several existing dirt roads and jeep trails in the area. Parts of the project area have been test-drilled in the past. The test drill holes are sometimes marked by exposed pipes (see picture at end of report). The majority of the project area has been heavily grazed by cows, with little undisturbed land left.

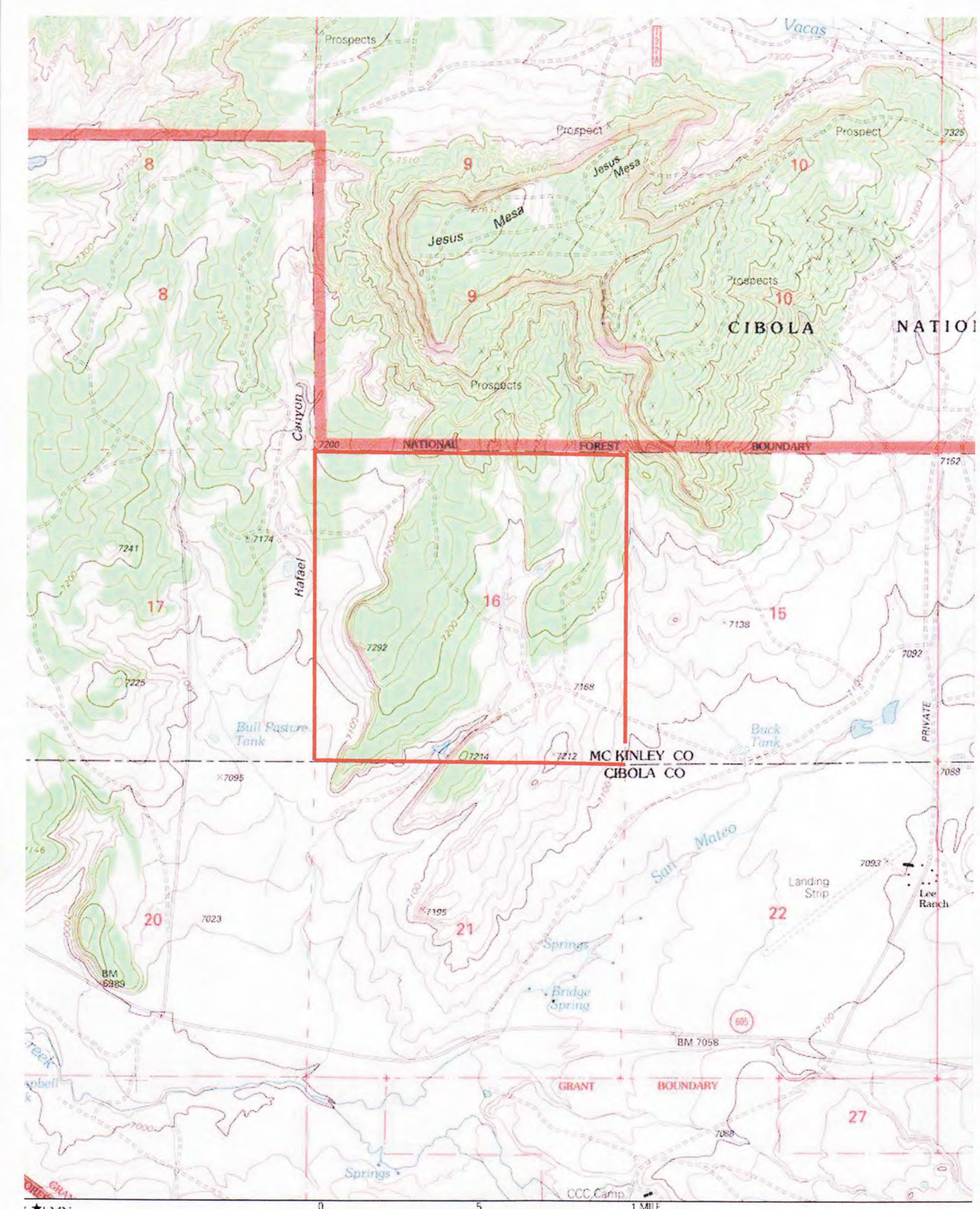
Compilation of Rare Species Data: Prior to the field work, a list was compiled of the Federal (USDI, USFWS, 2005) and State of New Mexico (NMRPTC, 1999) sensitive plant species known to occur in both McKinley County, in which the project area occurs, and Cibola County, which borders the south side of Section 16.

PROJECT AREA

Location: The proposed project is approximately 15 air miles northeast of Grants and 2 air miles northwest of San Mateo. The elevation of the section ranges from 7,070 feet to 7,300 feet. Aspect is generally to the south.

Description: Section 16 consists of heavily grazed desert grassland and very open piñon-juniper woodland (see pictures at end of report). The largest drainage (intermittent) starts from the base of Jesus Mesa and runs south and southwest just east of the center of the project area. There are several smaller drainages (all intermittent) generally running southeast from mesa 7292'. The west side of mesa 7292' and the east side of the major drainage consist of steep slopes and cliffs up to 50 feet in height.


Section 16
Muggy Point
Mulatto
Mateo
Rincon de la Gorda
Banco Isidro
La Polvadera
Canyon
Laguna Polvadera
Leopoldo Diversion Dam
Roman Hill
Mesa
San Lucas
Las Yeguas Canyon
El Derrame Cañon
San Lucas Dam
Voght Tank
Powerlines
Canada las Vacas
Jesus Mesa
La Cuchilla
Landing Strip
Marquez
San Mateo Springs Tract No 2
San Mateo
Creek
Colorado
San Mateo Reservoir
Laguna Tank
Salazar
La Mosca
El Rito
Dry Canyon
La Jara
Bajos Redondos
Cerro Venada
Spud Patch Canyon
Buckhorn Spring
Cerro Colorada
Lobo
Twin Spring
Radio Towers
MOUNTAINS
TN
MN
10½°
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 miles
0 1 2 3 4 5 km
Map created with TOPO!® ©2003 National Geographic (www.nationalgeographic.com/topo)



Map created with TOPO!® ©2003 National Geographic (www.nationalgeographic.com/topo)

Roca Honda

16-13N-8W

The area east of mesa 7292' is heavily grazed desert grassland. The dominant grass is hairy grama (*Bouteloua hirsuta*) with several areas of ring muhly (*Muhlenbergia torreyi*). However, much of the area is dominated by carpets of garden purslane (*Portulaca oleracea*) with other annuals in abundance. The most common of these annuals are Colorado rubberweed (*Hymenoxys richardsonii* var. *floribunda*), wild potato (*Solanum ja*mesii), and both spotted and thyme-leaf spurge (*Chamaesyce maculata* and *C. serpyllifolia*, respectively). Another plant in abundance is dodder (*Cuscuta* sp.), apparently parasitizing the garden purslane.

The rest of the project area is very open piñon-juniper woodland with areas of desert grassland. Utah juniper (*Juniperus osteosperma*) is much more common than piñon (*Pinus edulis*), but is usually widely scattered. There are very few understory shrubs, although flat sagebrush (*Artemisia bigelovii*) is common along the rims of the mesas where there is more exposed bedrock. Cliffrose (*Purshia stansburiana*) is occasional along the drainages. Again, garden purslane is quite common, with kiss-me-quick (*Portulaca pilosa*) replacing it in sandier areas. Colorado four o'clock (*Mirabilis multiflora*) is common both under the Utah junipers and in the open.

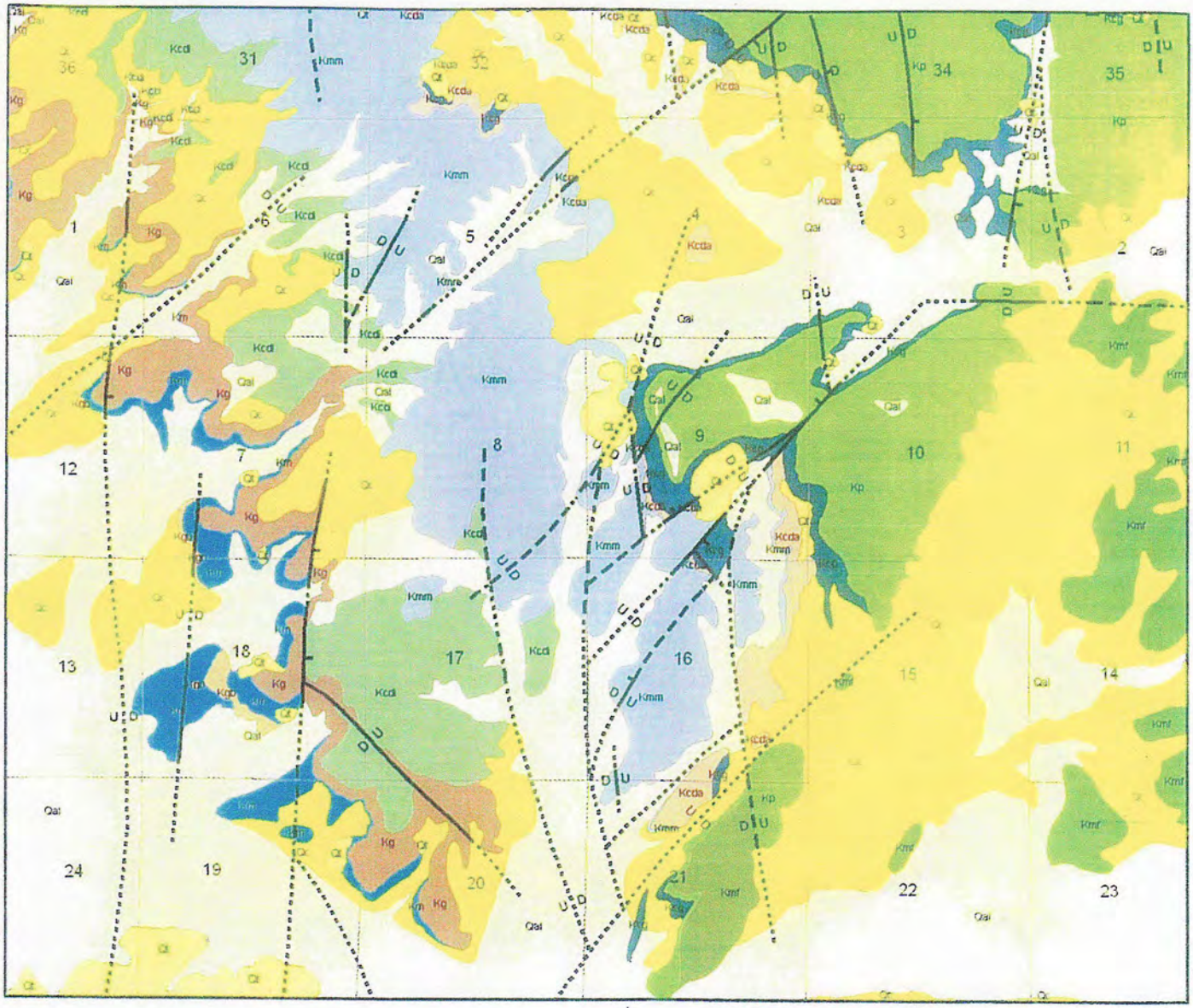
There is one cattle pond that held water at the time of the inspection. The plants dominating this man-made wetland include Mexican fireweed (*Kochia scoparia*), Russian thistle (*Salsola tragus*), and golden crownbeard (*Verbesina encelioides*), with rubber rabbitbrush (*Ericameria nauseosa* var. *graveolens*), saltcedar (*Tamarix chinensis*), and foxtail barley (*Hordeum jubatum*) also present.

About half of the project area surface is in the Mulatto Tongue of the Mancos shale. These are generally the higher areas. The lower areas are generally Quaternary alluvial or Aeolian deposits. There are also exposures of the Gibson coal member of the Crevasse Canyon Formation along the north and south lines of the section, Gallup sandstone in the east half of the section, and Point Lookout sandstone in the southeast quarter of the section. A plan view of the surface geology is on the next page.

Soils are dominated by loamy sand and sandy loam with some sandy clay loam present. A couple of areas of broad overland water flow are covered with siltier alluvial deposits. The highest portions of the section are in the Celavar-Atarque complex (soil map unit 305). Slightly lower areas of he section are Mido loamy fine sand (soil map unit 353). Even lower areas are Hagerwest-Bond fine sandy loams (soil map unit 220). Lowest areas of the section are in the Penistaja-Tintero complex (soil map unit 205). More soil information follows on pages 7 and 8.

METHODOLOGY

The project area was surveyed from July 31 through August 8, 2006, by botanists Marian Rohman and Winifred Devlin. All of the days were sunny and warm with occasional thunderstorms in the afternoons. The survey was accomplished by walking parallel transects through the area spaced at 50-75-foot intervals, depending on the habitat and terrain.

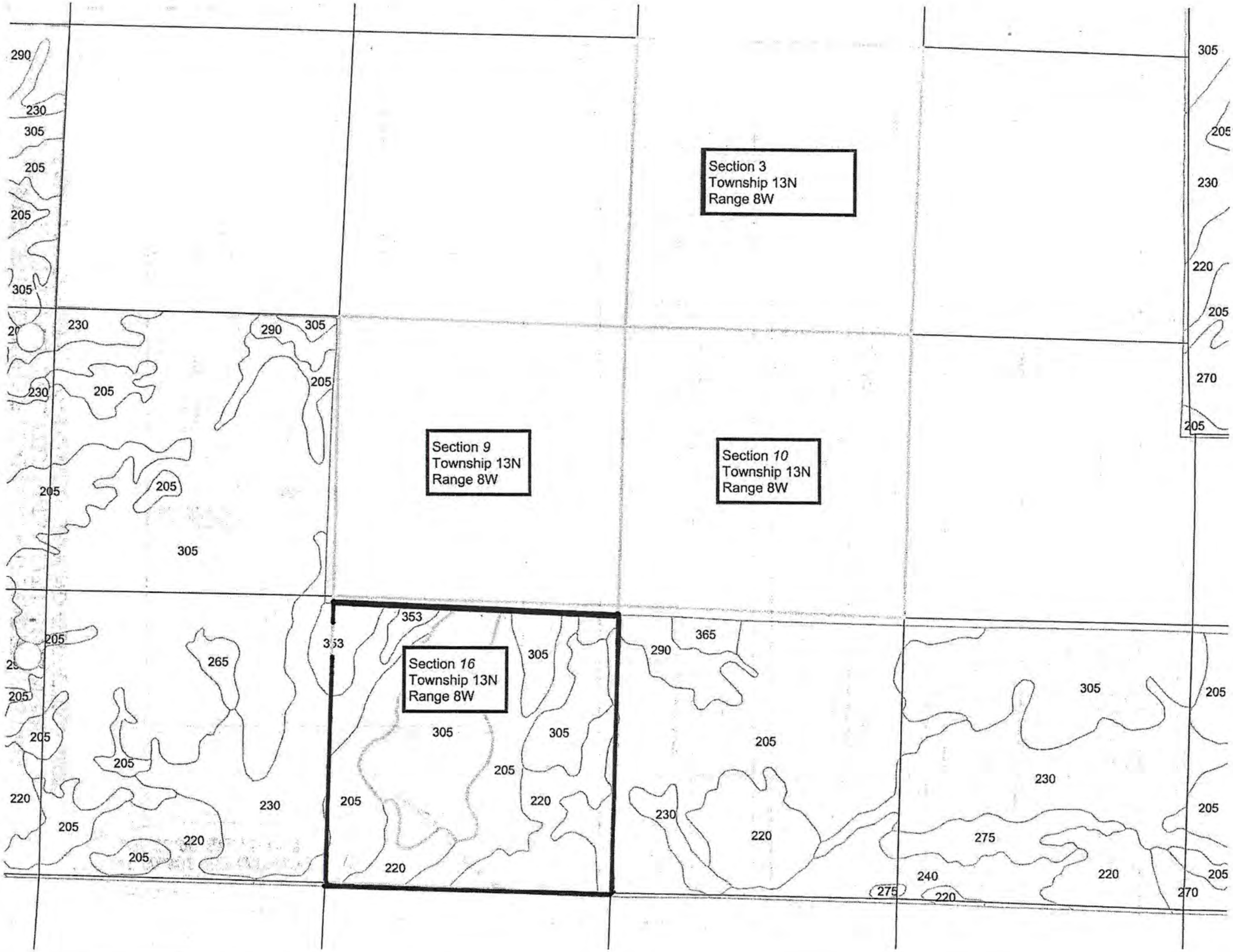


Explanation

- Qt - Talus and landslides
- Qal - Alluvial and eolian deposits
- Qc - Saprolite
- Kcda - Dalton Sandstone Member of C. C. Fm.
- Kcdi - Dilco Coal Member of C. C. Fm.
- Kg - Gallup Sandstone (main body)
- Kmf - Menefee Formation
- Kp - Point Lookout Sandstone
- Kcg - Gibson Coal Member of Crevasse Canyon Fm
- Kgb - Gallup Sandstone
- Kmm - Mancos Shale (Mulatto Tongue)
- Km - Mancos Shale (main body)

Faults

- observed
- concealed
- approximated
- dip direction


Section 3
Township 13N
Range 8W
Section 9
Township 13N
Range 8W
Section 10
Township 13N
Range 8W
Section 16
Township 13N
Range 8W

Section 16 (T13N; R08W) - Soil Survey

Map Unit Name	MUSYM	% Slopes	Elevation (ft	mean annual precip (inches)	average annual air temp (deg F)	frost free period (days)
Pentistaja-Tintero	205	1-10	6200-7100	10-13	49-53	120-140
Hagerwest-Bond	220	1-8	6500-7200	10-13	49-54	120-140
Sparank-San Mateo-Zia	230	0-3	6300-6900	10-13	49-54	120-140
Rock outcrop-Westmion-Skyvillage	290	30-80	6400-8100	10-13	49-54	120-140
Celavar-Atarque	305	1-8	6500-7500	13-14	49-53	115-135
Mido loamy fine sand	353	1-6	6300-6700	10-13	49-53	120-140

	Pentistaja	Tintero	Hagerwest	Bond	Sparank	San Mateo	Zia	Westmion	Skyvillage	Celavar	Atarque	Mido
% slope	1-5	1-10	1-5	1-8	0-3	0-3	1-3	30-50	30-40	1-8	1-8	1-6
depth to restrictive feature (in.)	none w/in 60 in	none w/in 60 in	20-40	10-20	none w/in 60 in	none w/in 60 in	none w/in 60 in	5-20	5-20	20-40	10-20	one w/in 60 in
drainage class	well	excessive	well	well	well	well	excessive	well	well	well	well	excessive
permeability	moderate	moderately rapid	moderate	moderate	very slow	moderately slow	moderately rapid	slow	moderately rapid	moderate	moderate	rapid
available water capacity	moderate	moderate	low	very low	high	high	moderate	very low	very low	low	very low	low
shrink-swell potential	low	low	low	low	high	moderate	low	high	low	low	low	low
flooding hazard	none	none	none	none	occasional	occasional	rare			none	none	none
seasonal water table min depth	> 6 ft.	> 6 ft.	> 6 ft.	> 6 ft.	> 6 ft.	> 6 ft.	> 6 ft.			> 6 ft.	> 6 ft.	> 6 ft.
runoff class	low	low	medium	high	high	medium	very low	very high	medium	low	high	negligible
Calcium carbonate max	10%	10%	10%	5%	5%	5%	5%	5%	15%	10%	3%	1%
gypsum max	none	none	none	none	none	none	none	1%	none	none	none	none
salinity	non-saline	non-saline	non-saline	non-saline	slightly saline	slightly saline	non-saline	non-saline	non-saline	non-saline	non-saline	non-saline
sodicity	non-sodic	slightly sodic	non-sodic	non-sodic	slightly sodic	slightly sodic	slightly sodic	slightly sodic	non-sodic	slightly sodic	non-sodic	non-sodic
ecological site	loamy	sandy	loamy	shallow sandstone	clayey bottomland	bottomland	sandy	foothills	sandstone	savannah	sandstone	deep sand
Conservation Tree/Shrub Group	4	3	6d	10	4cc	4	3			6d	10	5
land capability	6c	7e	6c	7s	6c	6c	6c	7e	7s	6c	7s	6c

SURVEY RESULTS

Federally Listed Threatened and Endangered Plant Species: The U.S. Fish and Wildlife Service (USFWS) lists two federally threatened plant species that occur in McKinley and Cibola Counties, New Mexico. Table 1 lists these species with their protection status, habitat requirements, and potential to occur in the project area. The Federally listed species do not have appropriate habitat within the proposed project area and no plants of these species were found.

Table 1: Plants listed by the USFWS as Endangered, Threatened, or Candidate that occur in McKinley and Cibola Counties, New Mexico.

SPECIES/STATUS	HABITAT & DISTRIBUTION	POTENTIAL TO OCCUR IN THE PROJECT AREA
Erigeron rhizomatus Zuni fleabane Threatened	Nearly barren detrital clay hillsides with soils derived from shales of the Chinle or Baca formations (often seleniferous); most often on north or east facing slopes in open piñon-juniper woodlands at 7300-8000 feet. Known from McKinley County. (NMRPTC, 1999; Roth, 2001c)	No appropriate habitat: there are no Chinle or Baca formations in the project area. Most of the project area is below the elevational for this species.
Helianthus paradoxus Pecos sunflower Threatened	Saturated saline soils of desert wetlands. Usually associated with desert springs or the wetlands created from modifying desert springs; from 3,300-6,600 ft. Known from Cibola County. (NMRPTC, 1999)	No appropriate habitat: there is one area with saturated soils created by damming a drainage, however, the area is not saline. The project area is above the elevational range of the species.

State of New Mexico Threatened and Endangered Listed Plant Species: There are fifteen plant species listed by the State of New Mexico as Endangered, Threatened, or Species of Concern that are known to occur in McKinley and Cibola Counties. Two of these species are federally listed and are addressed in Table 1. The remaining thirteen species are listed in Table 2. Two of the species have the potential to occur in the proposed project area: Naturita milkvetch (*Astragalus naturitensis*) and Laguna fameflower (*Talinum brachypodium*). These species are discussed in more detail below.

Table 2: Plants listed by the State of New Mexico as endangered, threatened, or species of concern that occur in McKinley and Cibola Counties.

SPECIES/STATUS	HABITAT	POTENTIAL TO OCCUR IN THE PROJECT AREA
Astragalus chuskanus Chuska milkvetch Species of Concern	Degraded Chuska sandstone in openings in montane coniferous forest above 5500 feet. Known from McKinley County. (NMRPTC, 1999)	No appropriate habitat: there is no Chuska sandstone in the project area.
Astragalus micromerius Chaco milkvetch Species of Concern	Gypseous or limy sandstones in piñon-juniper woodland or Great Basin desert scrub; from 6600-7300 feet. Known from McKinley County. (NMRPTC, 1999)	No appropriate habitat: the sandstone in the project area is not gypseous or limy.
Astragalus missouriensis var. *acumbens* Zuni milkvetch Species of Concern	Gravely clay banks and knolls, in dry alkaline soils derived from sandstone, in piñon-juniper woodland; from 6200-7900 feet. Known from McKinley and Cibola Counties. (NMRPTC, 1999)	No appropriate habitat: no gravely clay banks and knolls are present in the project area. The soils in the project area are not saline.
Astragalus naturitensis Naturita milkvetch Species of Concern	Sandstone ledges and rimrock along canyons in piñon-juniper woodland; from 5000-7000 feet. Known from McKinley County. (NMRPTC, 1999; Roth, 2001a)	Limited areas of potential habitat could exist along the rim and ledges of the low unnamed mesa in the project area; no *Astragalus* matching this distinctive species was observed.
Erigeron acomanus Acoma fleabane Species of Concern	Sandy slopes and benches beneath sandstone cliffs of the Entrada Sandstone Formation in piñon-juniper woodland; from 6900-7100 feet. Known from McKinley and Cibola Counties. (NMRPTC, 1999; Roth 2001b)	No appropriate habitat: there is no Entrada Sandstone Formation in the project area.
Erigeron svinskii Sivinski's fleabane Species of Concern	Steep barren Chinle shale slopes in piñon-juniper woodland and Great Basin desert scrub; from 6100-7400 feet. Known from McKinley County. (NMRPTC, 1999; Roth, 2001d)	No appropriate habitat: there is no Chinle Formation in the project area.

Helianthus praetermissus Lost sunflower Species of Concern	Perhaps wet ground based on the collection locality for the only specimen. This species is known only from the type specimen collected in 1851 on the Sitgreaves expedition at the head of the Rio Laguna (now Rio San Jose) at Ojo de la Gallina, Cibola County. This species may have been named from a depauperate specimen of *Helianthus paradoxus*.	There is wet ground in the project area associated with a man-made cattle pond; however, the project is not near the only known location for the species near the Zuni Mountains.
Penstemon deaveri Mount Graham beardtongue Species of Concern	Slopes and rocky areas from ponderosa pine forest to above timberline; from 6,500 - 11,280 feet. Known from Cibola County. (NMRPTC, 1999)	No appropriate habitat: there are no ponderosa pine forest or plant communities associated with higher elevations in the project area.
Phacelia serrata Cinders phacelia Species of Concern	In deep volcanic cinders, primarily associated with volcanic cones, but also in roadcuts and abandoned quarries in open, exposed, sunny locations; near ponderosa pine and piñon-juniper woodlands; from 5,900 - 7,200 feet. Known from Cibola County. (NMRPTC, 1999)	No appropriate habitat: there are no areas of volcanic cinders in the project area.
Physaria navajoensis Navajo bladderpod Species of Concern	Windswept mesa rims of Todilto limestone in sparse piñon-juniper woodland; from 7,200 – 7,600 feet. Known from McKinley County. (NMRPTC, 1999; Roth, 2001e)	No appropriate habitat: there is no Todilto limestone in the project area. Most of the project area is lower than the elevational range of the species.
Physaria newberryi var. *yesicola* Yeso bladderpod Species of Concern	Nearly barren badlands of sandy gypsum and silty strata of the Yeso Formation in short grass steppe and juniper savanna; from 5,700 - 6,900 feet. Known from Cibola County. (NMRPTC, 1999)	No appropriate habitat: there is no Yeso Formation in the project area. Most of the project area is higher than the elevational range of the species.

Puccinellia parishii Parish's alkali grass Endangered	Alkaline springs, seeps, and seasonally wet areas that occur at the heads of drainages or on gentle slopes; from 2600-7200 feet; the species requires continuously damp soils during its late winter to spring growing period. Known from McKinley and Cibola Counties. (NMRPTC, 1999; Roth, 2001f)	No appropriate habitat: there are no seasonally wet alkaline areas in the project area.
Talinum brachypodium Laguna fameflower Species of Concern	Very shallow pockets of calcareous silt to clay soils overlying limestone or travertine, or fine silty sand overlying calcareous sandstones; open piñon-juniper woodland with little understory and scattered cacti and shrubs or Chihuahuan desert scrub. Known from Cibola County. (NMRPTC, 1999)	Limited areas of potential habitat could exist on the low mesa in the project area. Some of the sandy loam soil does have a high component of silt in it. No plants of this species were observed.

The project area is situated on eroding bedrock of the Gallup, Gibson, Mancos, and Point Lookout Formations with occasional exposed sandstone or shale ledges and rimrock. This environment provides limited areas of potential habitat for both Naturita milkvetch and Laguna fameflower. Two species of milkvetch were observed within the project area, but neither matched Naturita milkvetch in habitat or vegetative characters. One species of *Phemeranthis* (formerly included in *Talinum*) was observed. However, both vegetative and floral characteristics are quite different from Laguna fameflower.

DISCUSSION

The proposed project will not impact any Federal or State of New Mexico listed plant species.

Signature of Author: B. Wood

Brian Wood

Date: October 7, 2006

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PLANTS IDENTIFIED IN SECTION 16, T. 13 N., R. 8 W., McKINLEY COUNTY, NM

(Scientific and common names according to Allred, 2005; identifications based on Barneby, 1989; Cronquist, 1994; Cronquist, et al, 1977; Ivey, 2003; Schneider, 2006; and Weber and Wittman, 2001.

Trees

Juniperus osteosperma	Utah juniper
Pinus edulis	Piñon pine

Shrubs and Subshrubs

Artemisia bigelovii	Flat sagebrush
Artemisia frigida	Fringed sage
Artemisia nova	Black sagebrush
Atriplex canescens	Four-wing saltbush
Cercocarpus montanus	Common mountain mahogany
Ericameria filifolia	Greene's rabbitbrush
Ericameria nauseosa var. *graveolens*	Rubber rabbitbrush
Ericameria nauseosa prob. var. *juncea*	Rubber rabbitbrush
Eriogonum microthecum var. *simpsonii*	Simpson's wild-buckwheat
Fallugia paradoxa	Apache-plume
Gutierrezia sarothrae	Broom snakeweed
Krascheninnikovia lanata	Winterfat
Lycium pallidum	Pale wolfberry
Purshia stansburiana	Cliffrose
Quercus sp.	Oak
Rhus trilobata var. *trilobata*	Skunkbush sumac
Ribes cereum	Wax currant
Tamarisk chinensis	Saltcedar
Tetradymia canescens	Spineless horsebrush
Yucca sp.	Narrow-leaved yucca
Yucca baccata	Banana yucca

Cacti

Coryphantha vivipara	Spinystar (Nipple cactus)
Cylindropuntia imbricata var. *imbriacata*	Cane cholla
Echinocereus triglochidiatus	Claret-cup cactus
Opuntia phaeacantha	Plains prickly-pear
Opuntia prob. *polyacantha*	Starvation prickly-pear

Grasses and Grass-like plants

Achnatherum hymenoides	Indian rice grass
Agrostis sp.	Bentgrass
Aristida purpurea	Purple threeawn

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Bouteloua hirsuta	Hairy grama
Cyperus poss. *squarrosus*	Awned flat-sedge
Hesperostipa comata	Needle-and-thread
Hordeum sp.	Barley
Hordeum jubatum	Foxtail barley
Munroa squarrosa	False-buffalograss
Muhlenbergia pungens	Sandhill muhly
Muhlenbergia torreyi	Ring muhly
Pleuraphis (Hilaria) jamesii	Jame's galleta
Sporobolus airoides	Alkali sacaton
Sporobolus cryptandrus	Sand dropseed

Ferns

Cheilanthes feei	Santa Fe lipfern

Forbs

Abronia fragrans	Fragrant sand-verbena
Allionia incarnata	Trailing windmills
Amaranthus poss. *palmeri*	Palmer's amaranth
Ambrosia acanthicarpa	Burr ragweed
Artemisia dracunculus	Tarragon
Artemisia ludoviciana	Wormwood
Asclepias sp.	Milkweed
Astragalus spp.	Milkvetch
Bahia dissecta	Ragged-leaf bahia
Boechera sp.	Rockcress
Brickellia brachyphylla	Plumed brickellbush
Brickellia prob. *californica*	California brickellbush
Carduus nutans	Musk thistle
Castilleja poss. *austromontana*	Rincon Indian-paintbrush
Chaetopappa ericoides	Sand aster
Chamaesaracha coronopus	Green-leaf five-eyes
Chamaesyce sp.	Spurge
Chamaesyce maculata	Spotted spurge
Chamaesyce serpyllifolia	Thyme-leaf spurge
Chenopodium album	Lambs quarter
Cirsium arvense	Canadian thistle
Cirsium prob. *neomexicanum*	New Mexico thistle
Cleome serrulata	Rocky Mountain beeplant
Commelina dianthifolia	Bird-bill dayflower
Commelina erecta var. *angustifolia*	White-mouth dayflower
Convolvulus arvensis	Field bindweed
Cryptantha cinerea	Jame's cat's-eye
Cuscuta sp.	Dodder
Dalea candida	White prairie-clover

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Descurainia prob. *obtusa*	Blunt tansy-mustard
Dieteria sp.	Spine-aster (Tansy aster)
Dimorphocarpa wislizeni	Spectacle-pod
Erigeron divergens	Spreading fleabane
Eriogonum cernuum	Nodding wild-buckwheat
Eriogonum jamesii	James' wild-buckwheat
Eriogonum palmerianum	Palmer's wild-buckwheat
Gilia longiflora	Blue trumpets
Grindelia squarrosa	Curly-cup gumweed
Helianthus petiolaris	Plains sunflower
Heterotheca villosa	Hairy goldenaster
Hymenopappus filifolius	Fine-leaf woolywhite
Hymenoxys richardsonii var. *floribunda*	Colorado rubberweed
Ipomopsis longiflora	Blue trumpets
Ipomopsis multiflora	Many-flowered skyrocket
Kallstroemia parviflora	Warty caltrop
Kochia scoparia	Mexican fire-weed
Lappula occidentalis	Spiny sheepbur
Linum (Cathartolinum) sp.	Flax
Mentzelia albicaulis	Whitestem blazingstar
Mirabilis multiflora	Colorado four-o'clock
Mirabilis oxybaphoides	Spreading four-o'clock
Oenothera caespitosa	Tufted evening-primrose
Oenothera coronopifolia	Hairy-throat evening-primrose
Oxalis violacea	Violet wood-sorrel
Peteria scoparia	Rush peteria
Phacelia integrifolia	Gypsum scorpion-weed
Phemeranthis confertiflorus	New Mexico flameflower
Phoradendron juniperinum ssp. *juniperinum*	Juniper mistletoe
Physalis poss. *pubescens* var. *integrifolia*	Husk-tomato
Physalis virginiana	Virginia ground-cherry
Portulaca oleracea	Garden purslane
Portulaca pilosa	Kiss-me-quick
Potentilla sp.	Cinquefoil
Psilostrophe tagetina	Woolly paper-flower
Salsola tragus	Russian-thistle
Salvia prob. *subincisa*	Saw-tooth sage
Sanvitalia abertia	Abert's dome
Senecio sp.	Groundsel
Solanum jamesii	Wild potato
Sphaeralcea coccinea	Scarlet globemallow
Sphaeralcea poss. *parvifolia*	Small-leaf globemallow
Stanleya pinnata var. *pinnata*	Prince's-plume
Stephanomeria sp.	Wire-lettuce
Phemeranthis confertiflorus	New Mexico flameflower

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Tiquilia hispidissima	Hairy crinklemat
Townsendia annua	Annual Townsend-daisy
Townsendia incana	Hoary Townsend-daisy (Easter daisy)
Tradescantia occidentalis	Spiderwort
Verbena macdougalii	MacDougal's vervain
Verbesina encelioides	Golden crownbeard
Zinnia grandiflora	Plains zinnia

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LOOKING NORTH TOWARD JESUS MESA FROM NORTH OF HILL 7292

LOOKING EAST FROM HILL 7212

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LOOKING SOUTH AT PLUGGED DRILL HOLE IN NENE SECTION 16

LOOKING NORTH AT STOCK POND IN CENTER OF SECTION 16

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Appendix 4-B

Roca Honda Permit Area
Vegetation Survey
Sections 9 and 10

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STRATHMORE MINERALS CORP.
ROCA HONDA SECTIONS 9 & 10
BOTANICAL REPORT

This report discusses the potential for disturbance to endangered, threatened, and other designated sensitive flora listed by Federal and State of New Mexico agencies that may occur in the project area. The 1,280 acre project area includes all of Sections 9 and 10, T. 13 N., R. 8 W., McKinley County, New Mexico. Both of the sections (see maps on the next two pages) are administered by the Cibola National Forest.

PROJECT DESCRIPTION

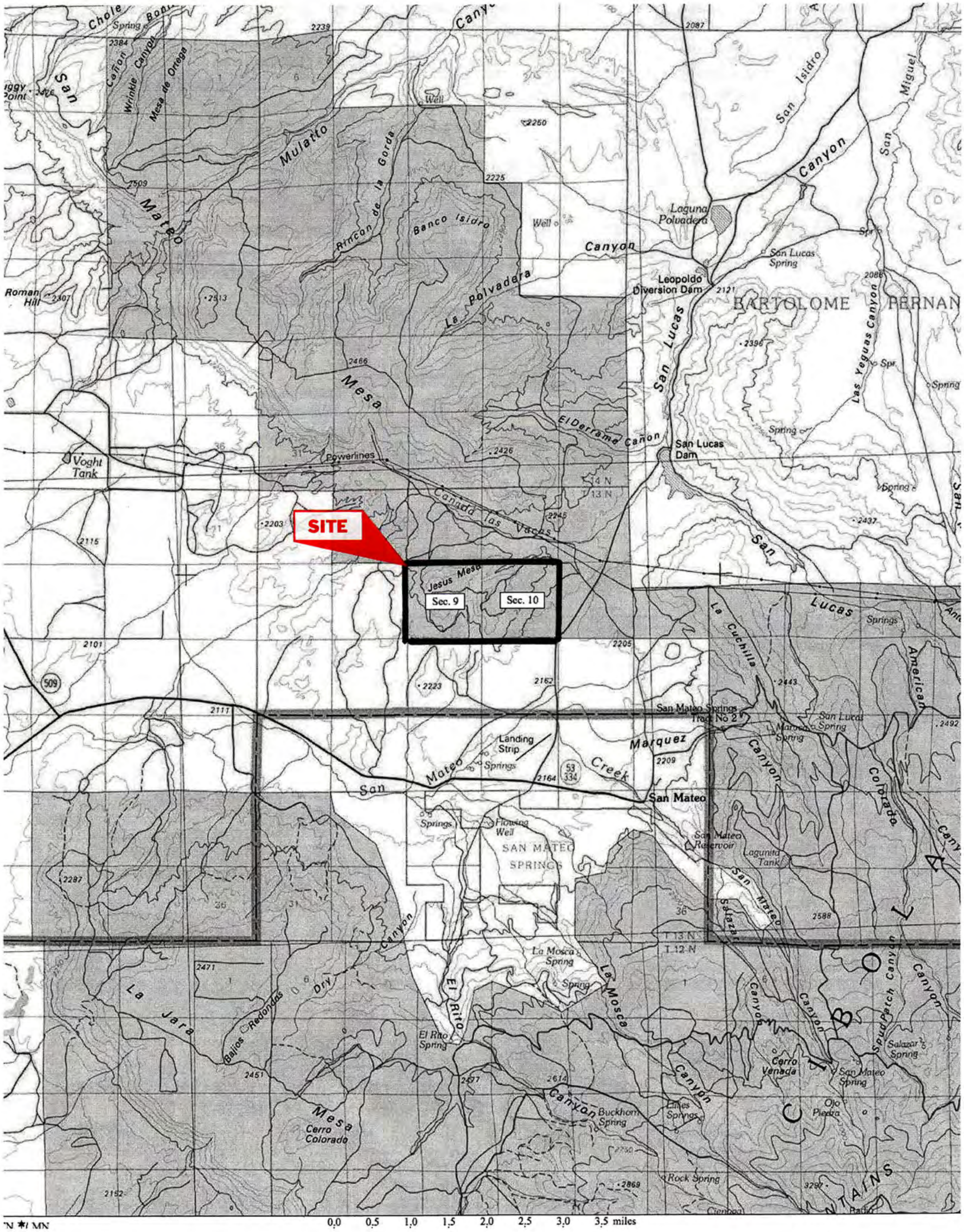
Disturbance: There are numerous existing dirt roads, jeep trails, and drill sites ("Prospects" on the map) in the area. (Not all of them are shown on the attached 1980 San Lucas Dam and 1981 San Mateo USGS topographic maps.) Much of the project area has been grazed by livestock. Forested areas have been used by firewood cutters.

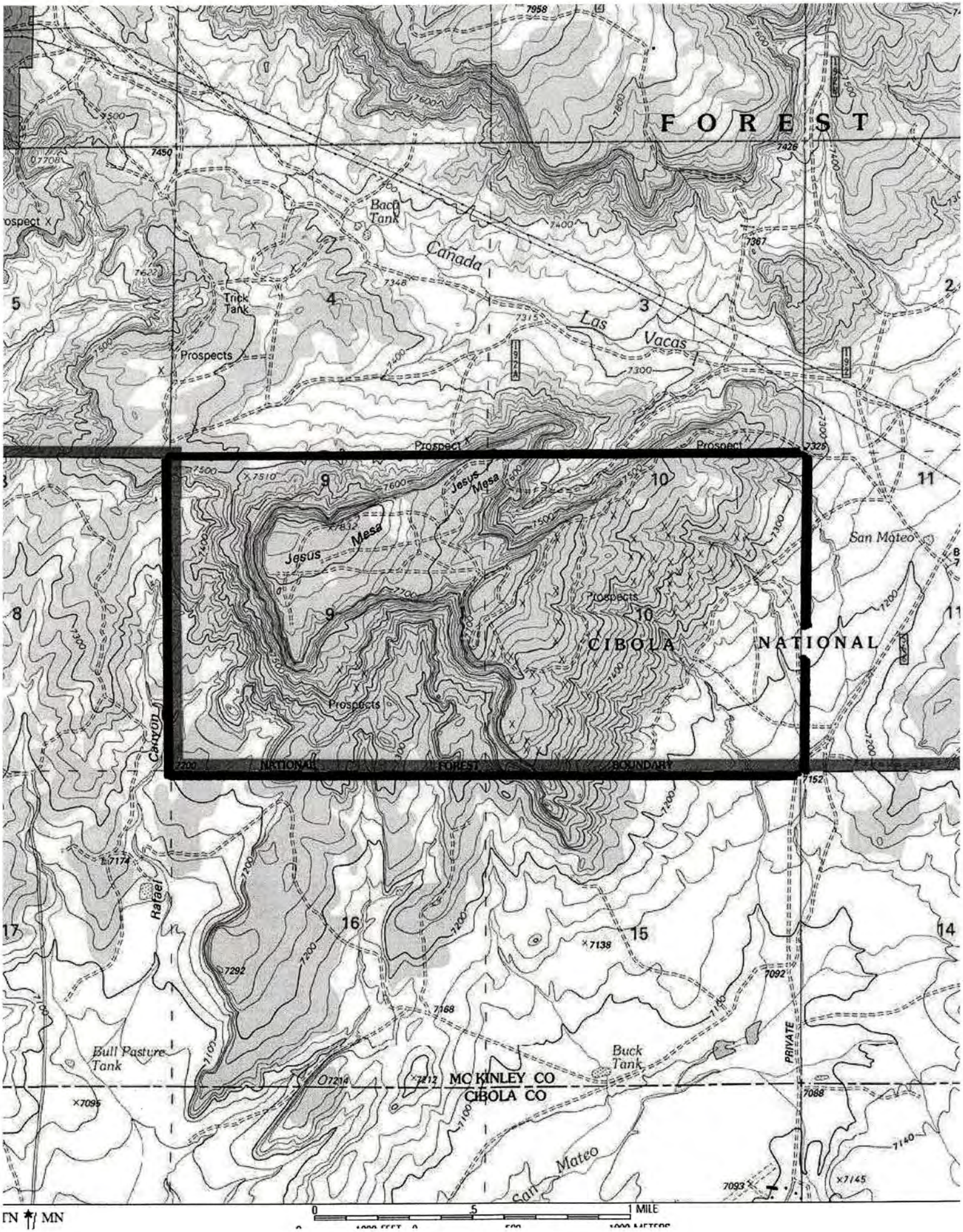
Compilation of Rare Species Data: Prior to the field work, a list was compiled of the Federal (USDI, USFWS, 2005) and State of New Mexico (NMRPTC, 1999) sensitive plant species known to occur in both McKinley County, in which the project area occurs, and Cibola County, which is a mile south.

PROJECT AREA

Location: The project area is on Jesus Mesa, which is approximately 17 air miles northeast of Grants and 3 air miles northwest of San Mateo. The elevation of the project area ranges from 7,152 feet to 7,840 feet. Aspect is generally to the south. However, Section 10 has a pronounced dip to the southeast.

Climate: San Mateo is the closest weather station and is at a comparable elevation. Average annual high at San Mateo is 61.7° F. Average annual low is 34.6° F. July is the hottest month with an average high of 83.1° F. January is the coldest month with an average low of 16.0° F. Average total precipitation is 8.66 inches. August is the wettest month with an average rainfall of 2.11 inches. Average total snowfall is 9.7 inches. December is the snowiest month with an average snowfall of 3.1 inches.


SITE
Sec. 9
Sec. 10
Jesus Mesa
Cañada las Vacas
Powerlines
Mulatto
Mesa
Mateo
San
Rincon de la Gorda
Banco Isidro
La Polvadera
Canyon
El Derrame Cañon
Laguna Polvadera
Leopoldo Diversion Dam
San Lucas
San Lucas Dam
San Lucas Spring
BARTOLOME
FERNAN
San Isidro
San Miguel
Las Vegas Canyon
Voght Tank
Roman Hill
Cañon Wrinkle Canyon
Mesa de Ortega
San Mateo Springs Tract No 2
Marquez
Creek
San Mateo
Landing Strip
Springs
Flowing Well
SAN MATEO SPRINGS
San Mateo Reservoir
Lagunita Tank
La Cuchilla
American
Colorado
Canyon
La Mosca Spring
La Mosca
El Rito
El Rito Spring
Dry Canyon
Bajios Redondos
La Jara
Mesa
Cerro Colorado
Buckhorn Spring
Lilies Springs
Rock Spring
Cerro Venada
San Mateo Spring
Ojo Piedra
Spud Patch Canyon
Salazar Spring
Salazar
CIBOLA
MOUNTAINS
T 14 N
T 13 N
T 13 N
T 12 N
509
53
334
Well
Spring
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 miles


FOREST
Canada
Las Vacas
Jesus Mesa
Prospects
CIBOLA NATIONAL
NATIONAL FOREST BOUNDARY
San Mateo
Rafael Canyon
Bull Pasture Tank
Buck Tank
MC KINLEY CO
CIBOLA CO
PRIVATE
TN MN
0 5 1 MILE

Description: Jesus Mesa occupies approximately half of Section 9 and two-thirds of Section 10. The top of the mesa is mostly open piñon-juniper woodland with some desert grassland. The perimeter of the mesa consists of sandstone ledges, with areas of exposed shale, particularly to the south of the mesa. The landscape southwest, north, and southeast of the mesa is predominantly desert grassland, with a large area of wooded slopes on the southeast side between the mesa and the lower grassland. These slopes are frequently dissected by drainages that can range from a few to 40 feet deep. There are several areas of semi-stabilized sand dunes (see picture).

Rafael Canyon is immediately west of the project area and there are several smaller drainages flowing into it from the rocky slopes of the mesa. Canada Las Vacas is north of the mesa. San Mateo Valley is to the south and east. None of the drainages are perennial.

Within the desert grassland community the dominant grass is hairy grama (*Bouteloua hirsuta*), with galleta (*Pleuraphis jamesii*) common throughout and sand dropseed (*Sporobolus cryptandrus*) common in some areas. There are a few areas of little bluestem (*Schizachyrium scoparium* var. *scoparium*) on the southeast side. The ground cover is dominated by garden purslane (*Portulaca oleracea*), changing to kiss-me-quick (*Portulaca pilosa*) in the sandiest areas, with Wislizenus's threadleaf (*Schkuhria pinnata* var. *wislizeni*) frequent throughout. Dodder (*Cuscuta* sp.) appears to be parasitizing a large percentage of the garden purslane. Other common forbs include spiderwort (*Tradescantia occidentalis*), tufted evening-primrose (*Oenothera caespitosa*), and flixweed (*Descurainia sophia*). The southeast corner of the project area has several areas dominated by Russian-thistle (*Salsola tragus*) with smotherweed (*Bassia hyssopifolia*) and American bugseed (*Corispermum americanum* var. *americanum*). There are widely scattered Utah juniper (*Juniperus osteosperma*), piñon pine (*Pinus edulis*), and four-wing saltbush (*Atriplex canescens*).

The woodland mostly consists of piñon pine and Utah juniper. A few ponderosa pines (*Pinus ponderosa*) are on the top of Jesus Mesa (see picture) and along the southeast drainages. There are some Rocky Mountain juniper (*Juniperus scopulorum*) at the head of the drainage on the north side of Jesus Mesa. Within the woodland, hairy grama is often the dominant ground cover with cliffrose (*Purshia stansburiana*) and common mountain mahogany (*Cercocarpus montanus*) the most common shrubs. Common forbs include fragrant snakeroot (*Ageratina herbacea*) and thyme-leaf spurge (*Chamaesyce serpyllifolia*). Under the trees, fetid-goosefoot (*Dysphania graveolens*), Colorado four-o'clock (*Mirabilis multiflora*), and Fendler's drymary (*Drymaria glandulosa*) are very common. In the sandiest areas, field wormwood (*Artemisia campestris* var. *caudata*), flat sagebrush (*Artemisia bigelovii*), spectacle-pod (*Dimorphocarpa wislizeni*), kiss-me-quick, spiderwort, and fine-leaf woolywhite (*Hymenopappus filifolius*) are common.

The rocky slopes of Jesus Mesa support a similar plant community of scattered piñon pine and Utah juniper with hairy grama quite common. Common shrubs include flat sagebrush and cliffrose. New Mexico muhly (*Muhlenbergia pauciflora*), and both plumed and California brickellbush (*Brickellia brachyphylla* and *californica*, respectively) are also common. Santa Fe lipfern (*Cheilanthes feei*) and brittle bladder-fern (*Cystopteris fragilis*) are occasional at the bases of the rocks. The few

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shale slopes are mostly barren, but do support a few piñon pine, Utah juniper, Colorado four-o'clock, galleta, and a four-wing saltbush. At the rocky rims of the mesa and drainages are black sagebrush (*Artemisia nova*), flat sagebrush, and common mountain mahogany.

The canyons on the southeast side reach depths of thirty to forty feet and support a few ponderosa pines within a piñon-juniper woodland. The most common plants include broom groundsel (*Senecio spartioides* var. *multicapitatus*), tassel-flower brickellbush (*Brickellia grandiflora*), and hairy grama.

There are several pools along the drainages, many of which support small communities of wetland plants, indicating that they are moist much of the year. The plants within these communities include scratchgrass (*Sporobolus contractus*), mesa dropseed (*Sporobolus flexuosus*), straw-color flat-sedge (*Cyperus strigosus*), sand dropseed, rush (*Juncus* sp.), pale spikerush (*Eleocharis macrostachya*), and even cattail (*Typha* prob. *domingensis*). The drainages on the west and north sides are within sandier soils within a desert grassland. In these drainages the common plants are hairy grama, rubber rabbitbrush (*Ericameria nauseosa* var. *graveolens*), and sage (*Salvia* prob. *incisa*)

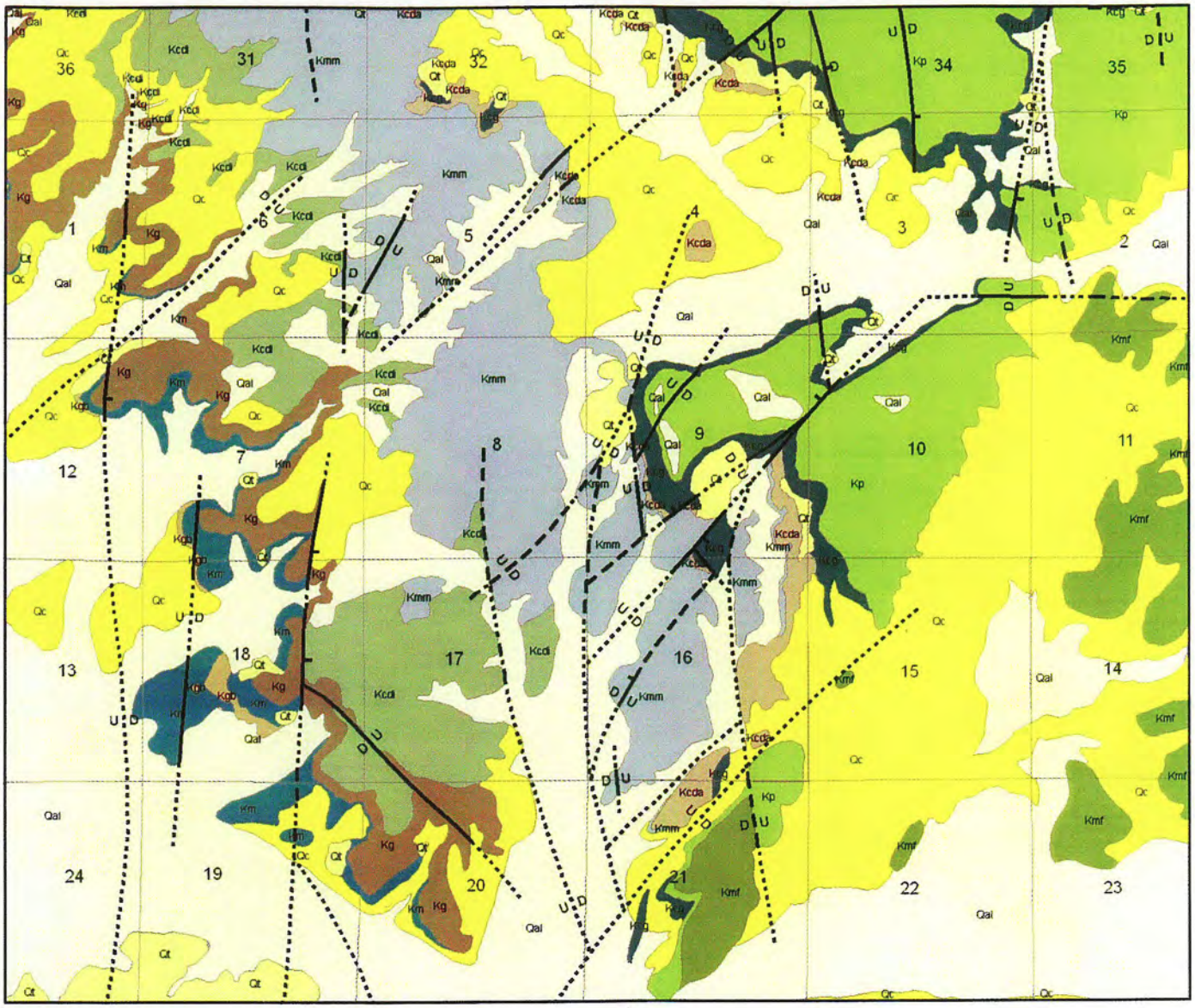
There are occasional stabilized and semi-stabilized sand dunes throughout the project area, particularly to the west, northwest, and southeast of the mesa. These areas support a variety of sand dependent plants, including sandhill muhly (*Muhlenbergia pungens*), spectacle pod, sand sage (*Artemisia filifolia*), spiderwort, Bigelow's rubber rabbitbrush (*Ericameria nauseosa* var. *bigelovii*), kiss-me-quick, and field wormwood.

The highest portion of the project, and the most common surface formation in the project area, is the Point Lookout sandstone. The gray black Gibson coal member of the Crevasse Canyon Formation is below the Point Lookout. Dalton sandstone is below the Gibson coal and is exposed in Section 9. Mancos shale Mulatto Tongue is below the Dalton sandstone and also found in Section 9. A plan view of the surface geology is on the next page.

The southeast-most third of the project area consists primarily of soils derived from the decomposing sandstone. Most of the exposed bedrock is sandstone with infrequent areas of shale, particularly to the south of the mesa. Soils derived from all of these formations are present, but are dominated by loamy sand and sandy loam with some sandy clay loam present. Sand dunes are found on the highest parts of the mesa.

METHODOLOGY

The project area was surveyed from July 31 through August 8, 2006 and from September 11 through October 19, 2006, by botanists Marian Rohman and Winifred Devlin. There were occasional afternoon thunderstorms during the first phase. Most of the days were sunny and warm with a few partly cloudy and windy days during the second phase. The survey was accomplished by walking parallel transects spaced at 50-75-foot intervals, depending on the habitat and terrain.



Explanation

- Qt - Talus and landslides
- Qal - Alluvial and eolian deposits
- Qc - Saprolite
- Kcda - Dalton Sandstone Member of C. C. Fm.
- Kcdi - Dilco Coal Member of C. C. Fm.
- Kg - Gallup Sandstone (main body)
- Kmf - Menefee Formation
- Kp - Point Lookout Sandstone
- Kcg - Gibson Coal Member of Crevasse Canyon Fm.
- Kgb - Gallup Sandstone
- Kmm - Mancos Shale (Mulatto Tongue)
- Km - Mancos Shale (main body)

Faults

- observed
- concealed
- approximated
- dip direction

SURVEY RESULTS

Federally Listed Threatened and Endangered Plant Species: The U.S. Fish and Wildlife Service (USFWS) lists two federally threatened plant species that occur in McKinley and Cibola Counties, New Mexico. Table 1 lists these species with their protection status, habitat requirements, and potential to occur in the project area. The Federally listed species do not have appropriate habitat within the proposed project area and no plants of these species were found.

Table 1: Plants listed by the USFWS as Endangered, Threatened, or Candidate that occur in McKinley and Cibola Counties, New Mexico.

SPECIES/STATUS	HABITAT & DISTRIBUTION	POTENTIAL TO OCCUR IN THE PROJECT AREA
Erigeron rhizomatus Zuni fleabane Threatened	Nearly barren detrital clay hillsides with soils derived from shales of the Chinle or Baca formations (often seleniferous); most often on north or east facing slopes in open piñon-juniper woodlands at 7300-8000 feet. Known from McKinley County. (NMRPTC, 1999; Roth, 2001c)	No appropriate habitat: there are no Chinle or Baca formations in the project area. Most of the project area is below the elevational for this species.
Helianthus paradoxus Pecos sunflower Threatened	Saturated saline soils of desert wetlands. Usually associated with desert springs or the wetlands created from modifying desert springs; from 3,300-6,600 ft. Known from Cibola County. (NMRPTC, 1999)	No appropriate habitat: there are no springs in the project area. The project area is over 500' above the elevational range of the species.

State of New Mexico Threatened and Endangered Listed Plant Species: There are fifteen plant species listed by the State of New Mexico as Endangered, Threatened, or Species of Concern that are known to occur in McKinley and Cibola Counties. Two of these species are federally listed and are addressed in Table 1. The remaining thirteen species are listed in Table 2. None of the fifteen species were found.

Table 2: Plants listed by the State of New Mexico as endangered, threatened, or species of concern that occur in McKinley and Cibola Counties.

SPECIES/STATUS	HABITAT	POTENTIAL TO OCCUR IN THE PROJECT AREA
Astragalus chuskanus Chuska milkvetch Species of Concern	Degraded Chuska sandstone in openings in montane coniferous forest above 5500 feet. Known from McKinley County. (NMRPTC, 1999)	No appropriate habitat: there is no Chuska sandstone in the project area and no montane coniferous forest.
Astragalus micromerius Chaco milkvetch Species of Concern	Gypseous or limy sandstones in piñon-juniper woodland or Great Basin desert scrub; from 6600-7300 feet. Known from McKinley County. (NMRPTC, 1999)	No appropriate habitat: the sandstone in the project area is not gypseous or limy.
Astragalus missouriensis var. *acumbens* Zuni milkvetch Species of Concern	Gravely clay banks and knolls, in dry alkaline soils derived from sandstone, in piñon-juniper woodland; from 6200-7900 feet. Known from McKinley and Cibola Counties. (NMRPTC, 1999)	No appropriate habitat: no gravely clay banks and knolls are present in the project area. However, the soils in the project area are not saline.
Astragalus naturitensis Naturita milkvetch Species of Concern	Sandstone ledges and rimrock along canyons in piñon-juniper woodland; from 5000-7000 feet. Known from McKinley County. (NMRPTC, 1999; Roth, 2001a)	No appropriate habitat: there are sandstone ledges and rimrock around the periphery of Jesus Mesa and along the drainages in the southeast portion of the project area. However, the elevation in these areas ranges from 7300 to 7800 feet, ≥300' above the elevational range of the species..
Erigeron acomanus Acoma fleabane Species of Concern	Sandy slopes and benches below Entrada sandstone cliffs in piñon-juniper woodland; from 6900-7100 feet. Known from McKinley and Cibola Counties. (NMRPTC, 1999; Roth 2001b)	No appropriate habitat: there is no Entrada Sandstone Formation in the project area.

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Erigeron svinskii Sivinski's fleabane Species of Concern	Steep barren shale slopes of the Chinle Formation in piñon-juniper woodland and Great Basin desert scrub; from 6100-7400 feet. Known from McKinley County. (NMRPTC, 1999; Roth, 2001d)	No appropriate habitat: there is no Chinle Formation in the project area.
Helianthus praetermissus Lost sunflower Species of Concern	Perhaps wet ground based on the collection locality for the only specimen. This species is known only from the type specimen collected in 1851 on the Sitgreaves expedition at the head of the Rio Laguna (now Rio San Jose) at Ojo de la Gallina, Cibola County. This species may have been named from a depauperate specimen of *Helianthus paradoxus*.	There is wet ground in the project area associated with small ephemeral pools along drainages; however, the project is not near the only known location for the species near the Zuni Mountains.
Penstemon deaveri Mount Graham beardtongue Species of Concern	Slopes and rocky areas from ponderosa pine forest to above timberline; from 6,500-11,280 ft. Known from Cibola County. (NMRPTC, 1999)	No appropriate habitat: there are a few ponderosa pine trees and no alpine areas in the project area.
Phacelia serrata Cinders phacelia Species of Concern	In deep volcanic cinders, primarily associated with volcanic cones, but also in roadcuts and cinder quarries in open, exposed, sunny locations; near ponderosa pine and piñon-juniper woodlands; from 5,900-7,200 ft. Known from Cibola County. (NMRPTC, 1999)	No appropriate habitat: there are no areas of volcanic cinders in the project area.

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Physaria navajoensis Navajo bladderpod Species of Concern	Windswept mesa rims of Todilto limestone in sparse piñon-juniper woodland; from 7200-7600 feet. Known from McKinley County. (NMRPTC, 1999; Roth, 2001e)	No appropriate habitat: there is no Todilto limestone in the project area.
Physaria newberryi var. *yesicola* Yeso bladderpod Species of Concern	Nearly barren badlands of sandy gypsum and silty strata of the Yeso Formation in short grass steppe and juniper savanna; from 5,700-6,900 ft. Known from Cibola County. (NMRPTC, 1999)	No appropriate habitat: there is no Yeso Formation in the project area. All of the project area is ≥200' higher than the elevational range of the species.
Puccinellia parishii Parish's alkali grass Endangered	Alkaline springs, seeps, and seasonally wet areas that occur at the heads of drainages or on gentle slopes; from 2600-7200 feet; the species requires continuously damp soils during its late winter to spring growing period. Known from McKinley and Cibola Counties. (NMRPTC, 1999; Roth, 2001f)	No appropriate habitat: there are no seasonally wet alkaline areas in the project area. Most of the project area is above the elevation range of the species.
Talinum brachypodium Laguna fameflower Species of Concern	Very shallow pockets of calcareous silt to clay soils overlying limestone or travertine, or fine silty sand overlying calcareous sandstones; open piñon-juniper woodland with little understory and scattered cacti and shrubs or Chihuahuan desert scrub. Known from Cibola County. (NMRPTC, 1999)	No appropriate habitat: there are limited areas of fine silty sand. However, the sandstone in the area is not notably calcareous.

The project area is situated on bedrock of the Crevasse Canyon, Mancos, and Point Lookout Formations. This combination of geology, hydrology, habitat types, soils, aspect, and elevation does not provide potential habitat for the sensitive plant species considered threatened, endangered, or species of concern in McKinley and Cibola Counties.

DISCUSSION

The proposed project will not impact any Federal or State of New Mexico listed plant species.

Signature of Author: _____ **Date: December 26, 2006**

Brian Wood

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PLANTS IDENTIFIED IN SECTIONS 9 & 10, T. 13 N., R. 8 W.
McKINLEY COUNTY, NM

The following scientific and common names are according to Allred, 2005; Cronquist, 1994; Cronquist, et al, 1977; Crohquist, et al, 1984; Flora of North America Editorial Committee, eds. 1993+; Hitchock and Chase, 1951: Ivey, 2003; Martin and Hutchins, 2001a and 2001b; and Weber and Wittman, 2001.

Trees

Juniperus osteosperma	Utah juniper
Juniperus scopulorum	Rocky Mountain juniper
Pinus edulis	Piñon pine
Pinus ponderosa	Ponderosa pine
Populus deltoides	Cottonwood

Shrubs and Subshrubs

Artemisia bigelovii	Flat sagebrush
Artemisia filifolia	Sand sage
Artemisia frigida	Fringed sage
Artemisia nova	Black sagebrush
Atriplex canescens	Four-wing saltbush
Brickellia brachyphylla	Plumed brickellbush
Brickellia californica	California brickellbush
Brickellia grandiflora	Tassel-flower brickellbush
Cercocarpus montanus	Common mountain mahogany
Ericameria filifolia	Greene's rabbitbrush
Ericameria nauseosa var. *graveolens*	Rubber rabbitbrush
Ericameria nauseosa var. *bigelovii*	Bigelow's rubber rabbitbrush
Eriogonum corymbosum	Crispy wild-buckwheat
Eriogonum leptophyllum	Slender-leaf widl-buckwheat
Eriogonum microthecum var. *simpsonii*	Simpson's wild-buckwheat
Eriogonum umbellatum	Sulphur-weed
Fallugia paradoxa	Apache-plume
Gutierrezia sarothrae	Broom snakeweed
Krascheninnikovia lanata	Winterfat
Lycium pallidum	Pale wolfberry
Nolina microcarpa	Beargrass
Purshia stansburiana	Cliffrose
Quercus sp.	Oak
Quercus gambelii	Gambel's oak
Rhus trilobata var. *trilobata*	Skunkbush sumac
Ribes cereum	Wax currant

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Yucca sp.	Narrow-leaved yucca
Yucca baccata	Banana yucca

Cacti

Coryphantha vivipara	Spinystar (Nipple cactus)
Cylindropuntia imbricata var. *imbriacata*	Cane cholla
Echinocereus triglochidiatus	Claret-cup cactus
Opuntia phaeacantha	Plains prickly-pear
Opuntia prob. *polyacantha*	Starvation prickly-pear

Grasses and Grass-like plants

Achnatherum hymenoides	Indian rice grass
Aristida adscensionis	Six-weeks threeawn
Aristida divaricata	Poverty threeawn
Aristida purpurea var. *longiseta*	Red threeawn
Aristida purpurea prob. var. *purpurea*	Purple threeawn
Blepharoneuron tricholepis	Pine dropseed
Bothriochloa prob. *springfieldii*	Springfield's bluestem
Bouteloua barbata	Six-weeks grama
Bouteloua curtipendula	Side-oats grama
Bouteloua eriopoda	Black grama
Bouteloua hirsuta	Hairy grama
Chloris virgata	Showy windmillgrass
Cyperus strigosus	Straw-color flat-sedge
Eleocharis macrostachya	Pale spikerush
Elymus elymoides	Bottlebursh squirreltail
Elymus smithii	Western wheatgrass
Hordeum sp.	Barley
Juncus sp.	Rush
Lycurus setosus	Bristly wolftail
Monroa squarrosa	False-buffalograss
Muhlenbergia sp.	Muhly
Muhlenbergia asperifolia	Scratchgrass
Muhlenbergia minutissima	Least muhly
Muhlenbergia pauciflora	New Mexico muhly
Muhlenbergia pungens	Sandhill muhly
Muhlenbergia torreyi	Ring muhly
Pleuraphis jamesii	Galleta
Schedonnardus paniculatus	Tumblegrass
Schizachyrium scoparium var. *scoparium*	Little bluestem
Sporobolus sp.	Dropseed
Sporobolus airoides	Alkali sacaton

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Sporobolus contractus	Spike dropseed
Sporobolus cryptandrus	Sand dropseed
Sporobolus flexuosus	Mesa dropseed
Typha prob. *domingensis*	Cattail, probably southern

Ferns

Cheilanthes feei	Santa Fe lipfern
Cystopteris fragilis	Brittle bladder-fern

Forbs

Abronia fragrans	Fragrant sand-verbena
Ageratina herbacea	Fragrant snakeroot
Allionia incarnata	Trailing windmills
Amaranthus hybridus	Smooth amaranth
Amaranthus palmeri	Palmer's amaranth
Ambrosia acanthicarpa	Burr ragweed
Ambrosia artemisiifolia var. *elatior*	Annual ragweed
Artemisia campestris var. *caudata*	Field wormwood
Artemisia carruthii	Carruth's sagebrush
Artemisia dracunculus	Tarragon
Artemisia ludoviciana	Wormwood
Asclepias sp.	Milkweed
Astragalus spp.	Milkvetch
Astragalus kentrophyta	Spiny milkvetch
Bahia dissecta	Ragged-leaf bahia
Bassia hyssopifolia	Smotherweed
Castilleja poss. *austromontana*	Rincon Indian-paintbrush
Chaetopappa ericoides	Sand aster
Chamaesaracha coronopus	Green-leaf five-eyes
Chamaesyce maculata	Spotted spurge
Chamaesyce revoluta	Curl-leaf
Chamaesyce serpyllifolia	Thyme-leaf spurge
Chenopodium album	Lambs quarter
Chenopodium fremontii	Fremont's goosefoot
Chenopodium leptophyllum	Narrowleaf goosefoot
Cirsium poss. *neomexicanum*	New Mexico thistle
Cleome serrulata	Rocky Mountain beeplant
Commelina dianthifolia	Bird-bill dayflower
Conyza canadensis	Horseweed
Corispermum americanum var. *americanum*	American bugseed
Cryptantha cinerea var. *jamesii*	Jame's cat's-eye
Cryptantha fendleri	Fendler's cat's-eye

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Cuscuta sp.	Dodder
Dalea sp.	Prairie-clover
Dalea candida	White prairie-clover
Descurainia obtusa	Blunt tansy-mustard
Descurainia sophia	Flixweed
Dieteria bigelovii var. *bigelovii*	Bigelow's spine-aster
Dimorphocarpa wislizeni	Spectacle-pod
Draba cuneifolia var. *cuneifolia*	Wedgeleaf Whitlow-grass
Drymaria glandulosa	Fendler's drymary
Drymaria leptophylla	Canyon drymary
Drymaria molluginea	Slimleaf drymary
Dysphania graveolens	Fetid-goosefoot
Dyssodia papposa	Fetid-marigold
Erigeron sp.	Fleabane
Erigeron pulcherrimus	Basin fleabane
Eriogonum sp.	Wild-buckwheat
Eriogonum alatum	Winged wild-buckwheat
Eriogonum cernuum	Nodding wild-buckwheat
Eriogonum jamesii	James' wild-buckwheat
Eriogonum ovalifolium	Cushion wild-buckwheat
Euphorbia sp.	Spurge
Geranium richardsonii	Richardson's geranium
Grindelia squarrosa	Curly-cup gumweed
Hedeoma drummondii	Drummond's false-pennyroyal
Helianthus petiolaris	Plains sunflower
Heterotheca villosa	Hairy golden aster
Hymenopappus filifolius	Fine-leaf woolywhite
Hymenoxys richardsonii var. *floribunda*	Colorado rubberweed
Ipomopsis aggregata	Skyrocket
Ipomopsis longiflora	Blue trumpets
Ipomopsis multiflora	Many-flowered skyrocket
Kallstroemia parviflora	Warty caltrop
Kochia scoparia	Mexican fire-weed
Laennecia schiedeana	Pineland woolwort
Linum lewisii	Prairie flax
Linum puberulum	Plains flax
Machaeranthera tanacetifolia	Tahoka daisy
Mentzelia multiflora	Adonis blazing star
Mirabilis linearis	Ribbon four-o'clock
Mirabilis multiflora	Colorado four-o'clock
Mirabilis oxybaphoides	Spreading four-o'clock
Monarda pectinata	Plains beebalm

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Nama hispidum	Purple roll-leaf
Oenothera albicaulis	White-stem evening-primrose
Oenothera caespitosa	Tufted evening-primrose
Oenothera coronopifolia	Hairy-throat evening-primrose
Orobanche ludoviciana subsp. *multiflora*	Louisiana broom-rape
Oxalis violacea	Violet wood-sorrel
Pectis angustifolia	Lemon weed
Peteria scoparia	Rush peteria
Phacelia integrifolia	Gypsum scorpion-weed
Phemeranthis confertiflorus	New Mexico flame flower
Physalis sp.	Ground-cherry
Physalis virginiana	Virginia ground-cherry
Physaria rectipes	Straight bladder pod
Portulaca oleracea	Garden purslane
Portulaca pilosa	Kiss-me-quick
Pseudognaphalium canescens	Wright's rabbit-tobacco
Psilostrophe tagetina	Woolly paper-flower
Psoralidium lanceolatum	Wild scurf-pea
Salsola tragus	Russian-thistle
Salvia prob. *subincisa*	Sage, probably saw-tooth
Sanvitalia abertia	Abert's dome
Schoenocrambe linearifolia	Slim-leaf plains-mustard
Schkuhria pinnata var. *wislizeni*	Wislizenus's threadleaf
Sedum lanceolatum	Rosewort
Senecio spartioides var. *multicapitatus*	Broom groundsel
Silene laciniata var. *greggii*	Cardinal catchfly
Sisymbrium altissimum	Tall hedge-mustard (Jim Hill mustard)
Solanum jamesii	Wild potato
Solanum triflorum	Cut-leaf nightshade
Solidago wrightii var. *adenophora*	Wright's goldenrod
Sphaeralcea sp.	Globemallow
Sphaeralcea poss. *angustifolia*	Copper globemallow
Sphaeralcea coccinea	Scarlet globemallow
Stanleya pinnata var. *pinnata*	Prince's-plume
Stenotus armerioides	Mock goldenweed
Taraxacum officinale	Common dandelion
Thelypodium wrightii	Wright's thelypody
Townsendia annua	Annual Townsend-daisy
Townsendia incana	Hoary Townsend-daisy (Easter daisy)
Tradescantia occidentalis	Spiderwort
Verbesina encelioides	Golden crownbeard
Wyethia scabra	Badland mule's-ears

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Xanthisma grindelioides	Ray-less sleep-daisy (Rayless tansy aster)
Xanthisma spinulosum var. *spinulosum*	Lacy sleep-daisy (Lacy tansy aster)
Zinnia grandiflora	Plains zinnia

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LOOKING NORTHWEST FROM NESE SEC. 9

LOOKING NORTHEAST AT PONDEROSA PINES NEAR CENTER SEC. 9

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LOOKING NORTHWEST FROM NENW SEC. 9

LOOKING NORTH AT SAND DUNE IN NWSW SEC. 9

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LOOKING NORTHEAST FROM NWSE SEC. 10

LOOKING EAST TOWARD LA CUCHILLA MESA FROM NESW SEC. 10

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LOOKING NORTHEAST FROM SWNW SEC. 10

LOOKING SOUTH TOWARD MOUNT TAYLOR FROM NWSW SEC. 10

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Appendix 4-C

Roca Honda Permit Area
Vegetation Cover, Density, and Productivity Surveys
Sections 9, 10, and 16

VEGETATION BASELINE DATA FOR ROCA HONDA RESOURCES, LLC. ROCA HONDA PROJECT 2008 FIELD SEASON

ON STATE AND FEDERAL LANDS (CIBOLA NATIONAL FOREST) SECTIONS 9, 10, AND 16, T. 13N, R. 8 W. McKINLEY COUNTY, NEW MEXICO

PREPARED BY
PERMITS WEST, INC.
SANTA FE, NM
30 SEPTEMBER 2009

Contents

1.0 Vegetation

1.1 Vegetation Data Overview

1.1.1 Background

The general vegetation types encountered at the site have been described previously and a list of plant species observed in mid-summer at the project site was prepared (Wood 2006a, 2006b).

For the evaluation phase, detailed descriptions were needed. This includes quantitative measurements of cover, density, and productivity of the various plant communities. A vegetation map was also needed. Starting in March 2008, additional data needs in the vegetation characteristics of the Roca Honda site were thoroughly assessed and a study plan was prepared that contained the elements listed in Table 1 below.

Table 1. Roca Honda Data Needs (2008).

Data Need	Need Fulfilled by the Following
Vegetation map	A vegetation map will be prepared using a combination of aerial photographs, topographic maps and field surveys. The field assessments will involve surveying transect lines to collect quantitative measurements of vegetation cover.
Vegetation productivity measurements	Exclosures will be established and plant samples will be collected and weighed after the growing season to determine productivity of the herbaceous cover.
A complete plant species inventory	A partial plant species inventory has been made. Additional surveys for spring- and fall-flowering species will take place in March, April, May, June, August and September, 2008.
Assessment of the potential impacts of high water volume discharge in an unnamed tributary of San Mateo Creek	A survey of the vegetation in the drainage running from Section 16 to Section 21 and the unnamed tributary of the San Mateo Wash will be made during the spring, summer, and fall of 2008. The potential impacts of the high volume of water on the vegetation can then be evaluated.

1.1.2 Status of 2008 objectives

The data collected during 2008 are summarized in Table 2 below. Data analysis is summarized in Table 3 below.

Table 2. Data collected at Roca Honda (2008).

Number/form of data collection	Data collected	Object of data collection
106 transect lines	Biotic and abiotic cover along each transect line	Determine vegetation type, quantitative cover and productivity
11 transect lines	Biotic and abiotic cover and topology of transect lines across San Mateo arroyo	Determine profile and cover along the arroyo and potential impact after high volume water flow.
117 transect lines	Number of shrubs within 50 meters^2 (164 feet^2) band	Determine shrub density
117 transect lines	Number and size of trees within 50 meters^2 (164 feet^2) band	Determine tree density and contribute to woody productivity calculations
351 squares on 117 transects	Individual species and their cover within 100 meters^2 (328 feet^2) square at 3 predetermined points on transect line	Determine species diversity (species inventory)
48 exclosures	Grass, forb, and shrub dry weights	Productivity
90 trees	Height and circumference of 30 trees of each species	Determine woody productivity (to be determined in conjunction with aerial photographs)
2 relevés	Biotic and abiotic cover and species list	Determine cover and vegetation type

Table 3. Data entered and analyzed at Roca Honda (2008).

Number/form of data collection	Data analyzed	Result of data collection
53 transects	Biotic and abiotic cover along each transect line	Cover and productivity
24 transects	Number of shrubs and within 50 meters^2 (164 feet^2) band	Shrub density
24 transects (72 squares)	Species within 100 meters^2 (328 feet^2) square at 3 points on transect lines	Species diversity
48 exclosures	Grass weights	Grass (herbaceous) productivity

Vegetation types and grass productivity of the site have been described in this report and a vegetation map has been prepared. The sites from which data have been used generally reflect the numerical designation of their locations in the field. That is, data from transect 1 was entered first, data from transect 2 entered next, etc. Data to describe ground cover at the project site were entered for transect lines 1 through 52. Data for transect line 105 was also entered. Conclusions that contribute to identifying species diversity and shrub density are based on data from transects 1 through 24. Data for grass productivity from all 48 exclosures were entered and analyzed.

1.2 Data Collection

Prior to the fieldwork, a list of the Federal (US Fish and Wildlife Service 2007), State of New Mexico (NMRPTC 2008), and USDA Forest Service plant species of concern (Bosch, 2008) that are known to occur within McKinley and Cibola Counties, New Mexico was compiled. In addition, U.S. Department of Agriculture (USDA) Forest Service designated Management Indicator Species (MIS) were also considered. No plant MIS are reported for the Cibola National Forest (deGruyter 2005). The sensitive species and Species of Special Concern that are most likely to occur at the project site are tabulated in Table 4 on page 6.

Table 4. Plants listed by the State of New Mexico as endangered, threatened, or species of concern occurring in McKinley and Cibola Counties.

Species/Status	Habitat	Potential to occur in the project area
Astragalus chuskanus Chuska milkvetch Species of Concern	Degraded Chuska sandstone in openings in montane coniferous forest above 5500 feet. Known from McKinley County. (NMRPTC, 1999)	No appropriate habitat; there is no Chuska sandstone in the project area.
Astragalus micromerius Chaco milkvetch Species of Concern	Gypseous or limy sandstones in piñon-juniper woodland or Great Basin desert scrub; from 6,600-7,300 feet. Known from McKinley County. (NMRPTC, 1999)	No appropriate habitat; the sandstone in the project area is not gypseous or limy.
Astragalus missouriensis var. *acumbens* Zuni milkvetch Species of Concern	Gravely clay banks and knolls, in dry alkaline soils derived from sandstone, in piñon-juniper woodland; from 6200-7900 feet. Known from McKinley and Cibola Counties. (NMRPTC, 1999)	Minimal appropriate habitat; no gravely clay banks and knolls are present in the project area.
Astragalus naturitensis Naturita milkvetch Species of Concern	Sandstone ledges and rimrock along canyons in piñon-juniper woodland; from 5000-7000 feet. Known from McKinley County. (NMRPTC, 1999; Roth, 2001a)	Limited areas of potential habitat exist along the rim and ledges of the low unnamed mesa in the project area; no *Astragalus* matching this distinctive species was observed.
Erigeron acomanus Acoma fleabane Species of Concern	Sandy slopes and benches beneath sandstone cliffs of the Entrada Sandstone Formation in piñon-juniper woodland; from 6900-7100 feet. Known from McKinley and Cibola Counties. (NMRPTC, 1999; Roth 2001b)	No appropriate habitat; there is no Entrada Sandstone Formation in the project area.
Erigeron svinskii Sivinski's fleabane Species of Concern	Steep barren shale slopes of the Chinle Formation in piñon-juniper woodland and Great Basin desert scrub; from 6100-7400 feet. Known from McKinley County. (NMRPTC, 1999; Roth, 2001d)	No appropriate habitat; there is no Chinle Formation in the project area.
Helianthus praetermissus Lost sunflower Species of Concern	Possibly wet ground, based on the collection locality for the only specimen. This species is known only from the type specimen collected in 1851 on the Sitgreaves expedition at the head of the Rio Laguna (now Rio San Jose) at Ojo de la Gallina, Cibola County. This species may have been named from a depauperate specimen of *Helianthus paradoxus*.	There is wet ground in the project area associated with a man-made cattle pond; however, the project is not near the only known location for the species near the Zuni Mountains.
Penstemon deaveri Mount Graham beardtongue Species of Concern	Slopes and rocky areas from ponderosa pine forest to above timberline; from 6,500-11,280 ft. Known from Cibola County. (NMRPTC, 1999)	No appropriate habitat; there are no ponderosa pine forest or plant communities associated with high elevations in the project area.
Phacelia serrata Cinders phacelia Species of Concern	In deep volcanic cinders, primarily associated with volcanic cones, but also in roadcuts and abandoned quarries in open, exposed, sunny locations; near ponderosa pine and piñon-juniper woodlands; from 5,900-7,200 ft. Known from Cibola County. (NMRPTC, 1999)	No appropriate habitat; there are no areas of volcanic cinders in the project area.
Physaria navajoensis Navajo bladderpod Species of Concern	Windswept mesa rims of Todilto limestone in sparse piñon-juniper woodland; from 7,200-7,600 ft (NMRPTC, 1999; Roth, 2001e)	No appropriate habitat; there is no Todilto limestone in the project area.
Physaria newberryi var. *yesicola* Yeso bladderpod Species of Concern	Nearly barren badlands of sandy gypsum and silty strata of the Yeso Formation in short grass steppe and juniper savanna; from 5,700-6,900 ft. Known from Cibola County. (NMRPTC, 1999)	No appropriate habitat: there is no Yeso Formation in the project area. Most of the project area is higher than the elevational range of the species.
Puccinellia parishii Parish's alkali grass Endangered	Alkaline springs, seeps, and seasonally wet areas that occur at the heads of drainages or on gentle slopes; from 2,600-7,200 feet; the species requires continuously damp soils during its late winter to spring growing period. Known from McKinley and Cibola Counties. (NMRPTC, 1999; Roth, 2001f)	Very little appropriate habitat. The survey conducted at an appropriate time of year failed to find any individuals or habitat typical of other known sites.
Talinum brachypodium Laguna fameflower Species of Concern	Very shallow pockets of calcareous silt to clay soils overlying limestone or travertine, or fine silty sand overlying calcareous sandstones; open piñon-juniper woodland with little understory and scattered cacti and shrubs or Chihuahuan desert scrub. Known from Cibola County. (NMRPTC, 1999)	Limited areas of potential habitat could exist on the low mesa in the project area. Some of the sandy loam soil does have a high component of silt in it. No plants of this species were observed during surveys conducted at an appropriate time of year.

1.2.1 Data collection periods

Six trips were made during 2008 to survey for plant species and gather information with which to prepare a vegetation map. The dates and activities during each trip are reported in Table 3 on page 4. Surveys were planned in order to capture both short-lived annuals and perennials for the plant species inventory. Surveys in April and June were appropriate to observe and identify the two sensitive species most likely to occur at the project site. Inventory surveys *per se* were not carried out in July and August in 2008 since surveys for plant species in the project site had already been made at that time in 2006. In 2006, the survey periods were from July 31 through August 8 and from September 11 through October 19 within Sections 9 and 10 (Wood 2006a) and July 31 through August 8 within Section 16 (Wood 2006b).

Transect lines were surveyed for cover in June 2008. Herbaceous productivity measurements were initiated in March 2008 by erecting exclosures, and sampling occurred in late September/early October 2008. Originally the time period, April through August, was selected since it is the typical growing season of *Bouteloua* sp. (hairy and blue grama grass), which are the dominant grasses at the project site. *Bouteloua* species are warm-season, short-lived, perennial short grasses and biomass production of hairy grama grass positively correlates with precipitation during the growing season (Zlatnik 1999). Therefore, a relatively long period (5 months) between setting up the exclosures and harvest was selected to ensure the greatest likelihood that precipitation will occur during the potential growing period. Harvesting the exclosure plots was in fact postponed until late September since there was little precipitation by August.

1.2.2 Materials and Methods

1.2.2.1 Surveys for plant species and vegetation mapping

The project site was methodically surveyed several times throughout the growing season. Particular attention was made to find sensitive species, selenium-indicator species, and noxious non-native species. Certain areas were particularly targeted at different times of the year in order to have the best chance of finding sensitive and/or rare species. The lead botanist was always accompanied by one or two additional botanist/ecologists who walked 20 meters to 50 meters (22 yards to 54 yards) parallel paths so that the whole area was carefully covered. Notes were associated with GPS coordinates in order to document the vegetation types that occurred throughout the project site.

1.2.2.2 Cover and density measurements

Data collection for vegetation cover estimates was conducted in June, July and September 2008, as listed in Table 5 below. Vegetation cover was measured using the point intercept method along a 50 meter (164 foot) transect line (Elzinga et al., 2001). The cover that intercepted the line at 1m intervals along the 50 meter (164 foot) transect line was measured using an optical device, as seen in Figure 1. Using this method, the total cover was calculated as the percentage of interceptions ("hits"), relative to the total number of points sampled (for example, see "Rangeland Monitoring in Western Uplands" on ForestandRange.org website at: http://www.forestandrange.org/modules/vegmonitor/mod9/mod9-14.shtml). The cover of individual plant species was estimated by recording the plant species name when intercepted by a point.

Table 5. Vegetation survey dates in 2008.

Date	**Activity**
March 22-March 31	Inventory and sensitive species survey
April 21-26	Inventory and sensitive species survey
May 20-27	Inventory and sensitive species survey
June 20-30	Inventory and quantitative data for vegetation type characterization. Sensitive species survey
July 15-17	Quantitative data for arroyo characterization
September 30-Oct 5	Quantitative data collection for productivity measurements

Figure 1. Use of an optical laser device to measure cover.

During the survey, bare ground was defined as soil alone. Gravel and coarse sand were particles up to 7.6 centimeters (3 inches), rocks are particles greater than 7.6 centimeters (3 inches). Litter was dead

plant material directly covering the ground, dead perennial vegetative bases, or animal scat, including cow dung. If a small stem or piece of litter was not considered large enough to intercept a raindrop, the "hit" was the ground covering, or lack of covering, below it. Dead annual forbs were considered as litter cover when unattached to the roots and potentially wind blown. A dead annual forb that was attached to its root and recognizable to species was recorded as that species. Species were recorded when the sampling point fell on any part of the vegetation. When the canopy of multiple species overlapped, canopy overhung bare ground, litter, or gravel/coarse sand, all the cover-types were recorded.

Transect line percent-cover results are reported as the arithmetic mean, the standard deviation of the mean, the mode[1], and median of the species cover class. All of these values are useful in visualizing the frequency (commonness/rareness) with which the species occurs as well as how much canopy they contribute to cover. For example, the mean value may be a large number while the mode is zero. Therefore, one can conclude that the species is abundant in only some areas and it is not commonly encountered throughout the site.

The point intercept method is objective and fairly rapid. Floyd and Anderson (1987) found that the point intercept method achieved the same level of precision as the line-intercept method while taking one third of the time (Elzinga et al., 2001). In some cases this method can tend to overestimate cover (Korb et al., 2003). On the other hand, an important disadvantage of the method is that species with low cover values are often not effectively sampled because points so rarely intersect them (Korb et al., 2003). The latter problem was mitigated by making visual estimates of relative abundance of each species in 10 meter (33 foot) squares (100 meters^2 or 328 feet^2 area) at 0 meters (0 feet), 25 meters (82 feet), and 50 meters (164 feet), along the transect lines when describing each community, as demonstrated in Figure 2 below.

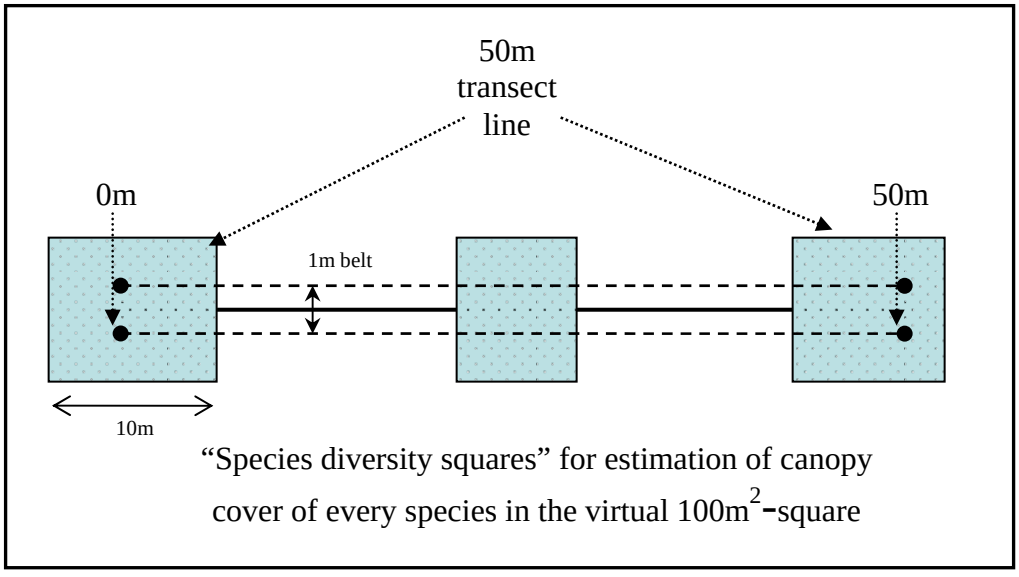

Figure 2. Transect design (not to scale).

All species that were in this 10 meter (33 foot) wide square were recorded and their cover estimated. In the field, cover over these squares was estimated to within a numeric class that represented a range, as

[1] Mode = the most frequently occurring value in a frequency distribution
Median = the middle value of the given numbers n in their ascending order

detailed in Table 6 below. These cover sampling squares are termed “species diversity squares” in subsequent Tables in this report.

Table 6. Cover classes per species per transect line.

Percent cover	Class
<1	1
1 to 5	2
5.1-15	3
15.1-25	4
25.1-50	5
50.1-75	6
75.1-95	7
>95	8

Shrubs and trees were counted within 1 meter (39 inches) of the 50 meter (164 feet) transect lines (belt transects) that were used to estimate ground cover. All trees were counted and their heights measured (using a clinometer) within 10 meter (33 foot) each side of the transect line. The data was recorded by species so that tree, full shrub (woody species), and sub-shrub (suffrutescent species) density values could be calculated for each community type. These measurements can also be used in conjunction with the aerial photographs to estimate site tree density.

UTM coordinates of each end of the transect lines were recorded. In the project area the ends were also marked with whiskers and wooden stakes pounded into the ground so that the whiskers were at the level of the soil surface. In the Wildlife Reference Area, the beginning (0 meters or 0 feet) of the transect line was also marked by a plastic-capped rebar.

1.2.2.3 Productivity measurements

There are various methods available to obtain a measure of plant productivity; for example, Leaf Area Index (LAI), measures of above ground biomass, and remote sensing imaging technologies have all been used to measure productivity (Breckenridge et al., 1995, Hunt et al., 2003). The current standard for an accurate measurement of herbaceous plant productivity is to measure above ground biomass by clipping, weighing, oven drying, and re-weighing vegetation that has been growing in an area (exclosure) that has been protected from grazing. This is the method used for the 2008 growing season.

Herbaceous productivity measurements were only made in vegetation types having a significant amount of herbaceous cover; shrub-grassland, juniper savanna and low elevation piñon juniper woodland. Exclosures (1 meter x 1 meter, or 39 inches x 39 inches) were erected in representative areas throughout the project area. These exclosures can be seen in Figure 3a on page 12.

Pictures i-vi demonstrate as follows:

(i). A completed exclosure and the template frame.

(ii) The 1 meter x 1 meter (39 inch x 39 inch) frame in the foreground was used as the template for erecting the four support rebars (one at each corner)

(iii). A narrow trench was dug so the sides of the exclosure were buried

(iv) and then the trench completely filled in with the soil that was removed so that erosion would be avoided

(v). Completed exclosures with "lids" secured by baling wire

(vi). An additional image of a completed exclosure.

i)

ii)

iii)

iv)

v).

vi).

Figure 3a.

Locations of exclosures throughout the project area are shown in Figure 3b on page 14. At the time when the exclosures were being erected, the project site area also included the southern third of Section 11 and the southwest quarter of the southwest quarter of Section 12. The number of exclosures erected took into account a potential loss of three exclosures due to environmental or ungulate disturbance. No exclosures were completely lost, although there was evidence of rodent activity in Exclosure 8.

The exclosures were erected during March 28-March 31 2008. The photographs in Figure 3a (i-vi) on page 12 illustrate the design. Exclosures were not erected in shaded areas. The sides were buried several inches (less than 5 centimeters) to deter burrowing animals. Tops were secured to prevent cattle from grazing inside. During September 30 to October 5 the plant material within the exclosures was harvested. A 40 centimeter x 40 centimeter (16 inch x 16 inch) sampling square made from half-inch (approximately 1 centimeter) pvc pipe was placed in the center of each exclosure. Only the vegetation within the square was harvested. This was to obtain vegetation that was undisturbed and buffered by vegetation between the edge of the square and edge of the exclosure. Therefore "edge-effects" on the samples were minimized. All plant material within the designated sample area was clipped to within less than an inch of the ground. Plant material was divided into grasses, shrubs, forbs, and vagrant lichen and stored in separate bags.
The weather was very dry during this period and samples were collected after 9.00am. All samples were placed in zip-lock plastic bags, and double bagged with as much air removed as practical. Extra debris (e.g., dirt, rocks, and pellets) were removed. All samples were cooled below the condensation temperature by placing them in an ice chest with ice packs. Samples were stored in a refrigerator or an ice chest packed with fresh ice daily for less than a week. They were then transferred to a deep freeze in a laboratory at the University of Wyoming prior to processing.

1.2.2.4 Sampling locations

The distribution of vegetation types were estimated from the USGS topographical quad maps and observations made on the ground made during the plant inventory surveys.

Ninety eight transects were distributed throughout the project site but were more numerous in those areas that were indicated to be potentially impacted by the mining activities. A grid was placed over a topographic map of the project site and the grids numbered. The sample (exclosure and transect line) locations were determined by initially randomly locating points within each quad map with some restrictions: In some cases specific vegetation types for analysis were targeted and the point was discarded if it was found to fall outside of the type targeted. For example, if the potential location of a transect line or exclosure destined to describe a vegetation type fell on an obvious historic drill hole, the point was discarded and the next location coordinates picked by random number generator was used. Another restriction was that the grid systems were set up so that transects would be distributed approximately evenly throughout the site. A further restriction in an exclosure's placement was that they were only located in vegetation types with appreciable grass cover. For example, no exclosures were placed on bedrock. One or more transect lines were surveyed at each exclosure site. Transect line locations are shown in Figure 3b on page 14.

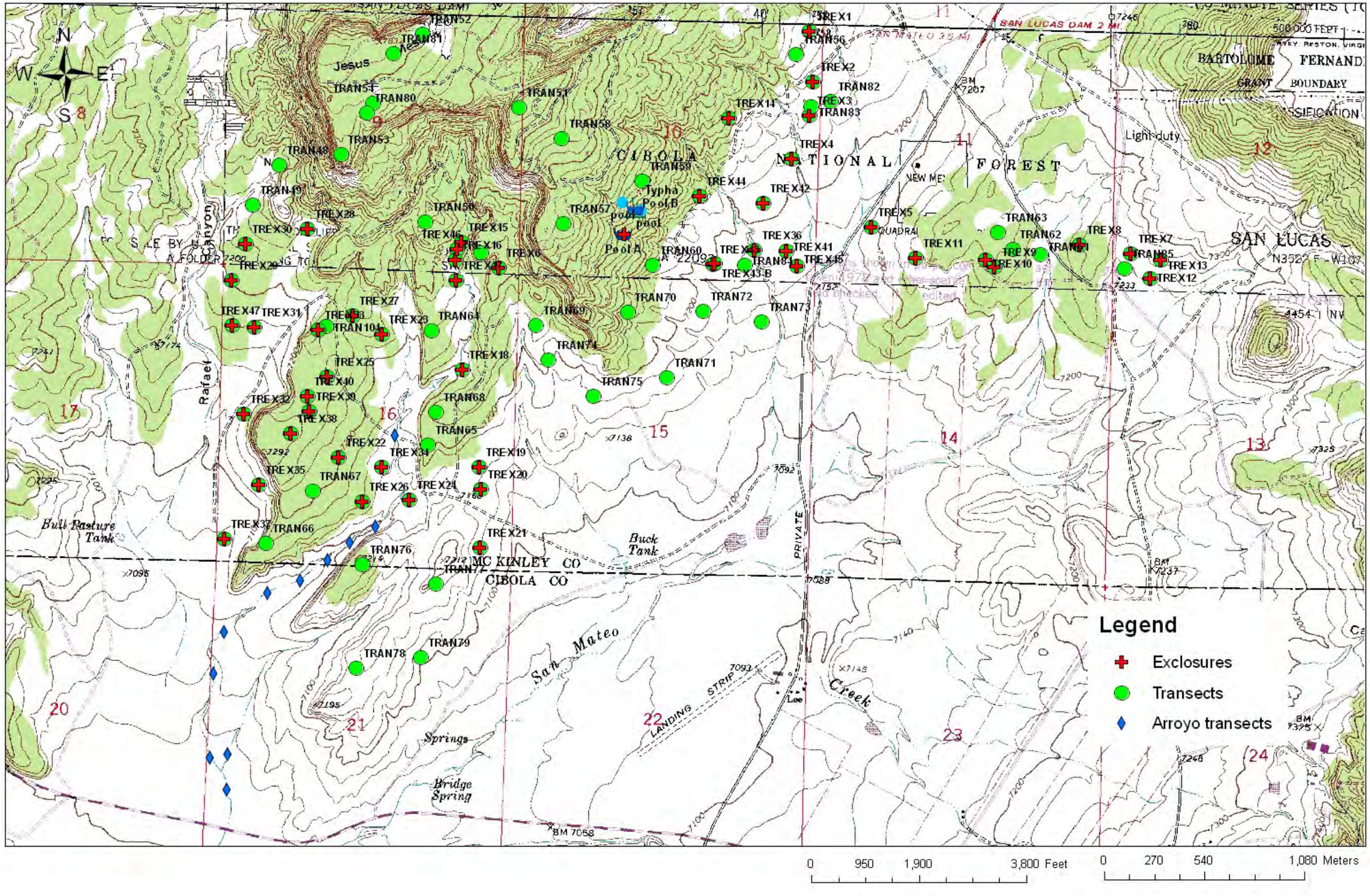

Figure 3b. Locations of exclosures and transects at Roca Honda (2008).

In the field, the transect line was objectively orientated with respect to compass directions. The orientation was according to a list of numbers, between 0 to 360, which was generated using a computerized random number generator (Microsoft Office Excel software – Professional 2003 edition) and each number on the list used sequentially to orient each transect. A compass was then used to orient the corresponding transect line in the field. Transects were surveyed by two teams of people, 3 people per team.

Ninety eight (98) transects were surveyed throughout the project site to characterize the vegetation types. Forty seven (47) transect lines were within 5 meters (16 feet) of an exclosure. Eleven (11) of the 98 transect lines were located across the tributary to San Mateo Creek in Sections 16 and 21. The topography along these transects was also measured in addition to cover. The remaining transect lines were distributed thus: 20 transects in Section 10; 14 in Section 9; 31 in Section 16; 8 in Section 11; 4 in Section 12; 7 in Section 15; 3 in Section 21. Data was collected for site characterization at each pool area in Section 10 using a relevé method.

The relevé method utilizes a delimited plot of vegetation that has fairly homogenous structural and compositional features. Using the relevé method a list of the plants and information on species cover, substrate and other abiotic features in the plot is collected. It is considered a semi-quantitative method since it relies on ocular estimates of plant cover rather than on counts of the "hits" of a particular species along a transect line or on precise measurements of biomass by weighing techniques. This subjective plot placement is particularly useful in describing native vegetation in fragmented landscapes.

An additional 19 transect lines were surveyed in the designated Wildlife Reference Area in T. 14 N., R. 8 W., Sections 26, 27, 28 and 34. A map of these 19 transects is in Figure 3c below. In total, a total 117 transect lines and two relevés were surveyed, as listed in Table 2 on page 4.

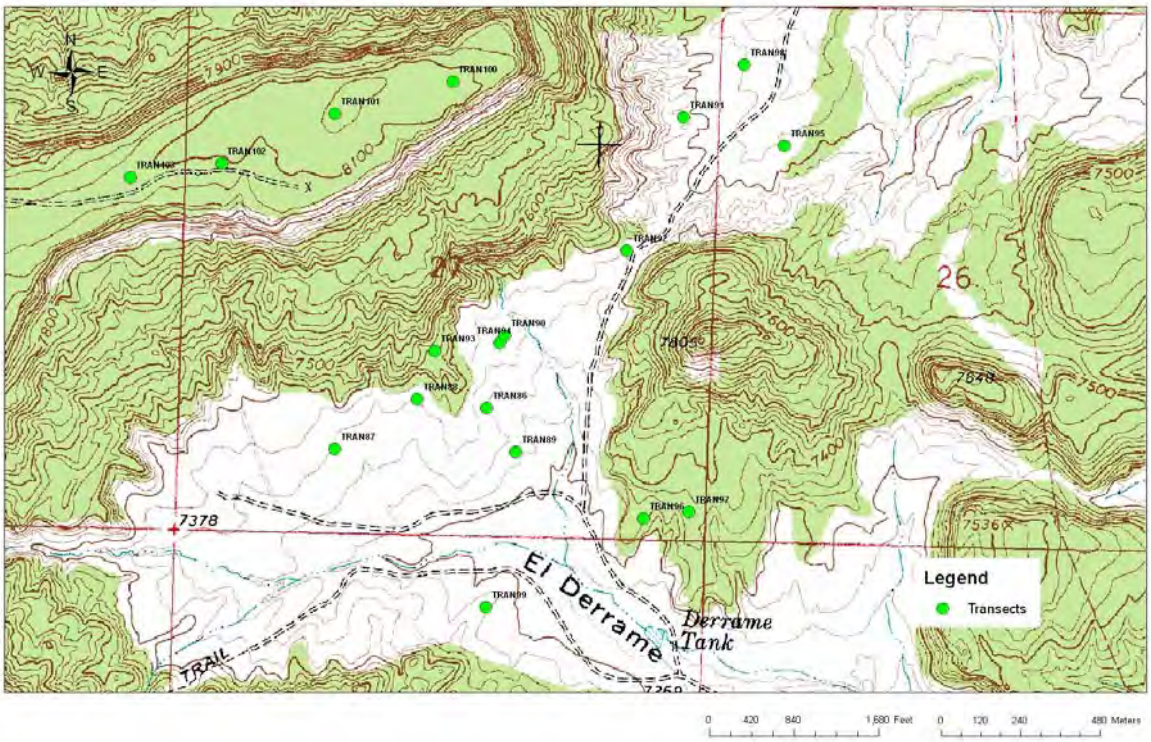

Figure 3c. Map of transects in Wildlife Reference Area at Roca Honda (2008).

1.2.3 Vegetation Map

The objective of the vegetation mapping effort is to document the state of pre-mining vegetation. In conjunction with surveys on the ground, aerial photographs were used to delineate the vegetation types within the project area. The aerial images were taken by a low flying aircraft on July 17, 2008. The photos were taken using standard color infrared (CIR) photography methods at a resolution of 1 pixel to 6 inches (15 centimeters). The images were ortho-rectified having Transverse Mercator (UTM) projection and NAD83 datum.

The vegetation map in Figure 4 on page 17 was created in ArcGIS 9.3 (ESRI, Redlands, California). The smallest mapping unit for vegetation type was generally 1 hectare (2.47 acres). However, when a feature was ecologically significant it was added as a point feature to the vegetation map. For example, areas with surface water (e.g., springs, seeps, or ponds) were surveyed and mapped in detail because of the importance of aquatic/wetland features to the ecological functioning of the landscape. Additional features of biological/ecological interest included stands of invasive saltcedar, particularly large trees, the two cottonwoods at the site, and areas of well-developed microbiotic crusts.

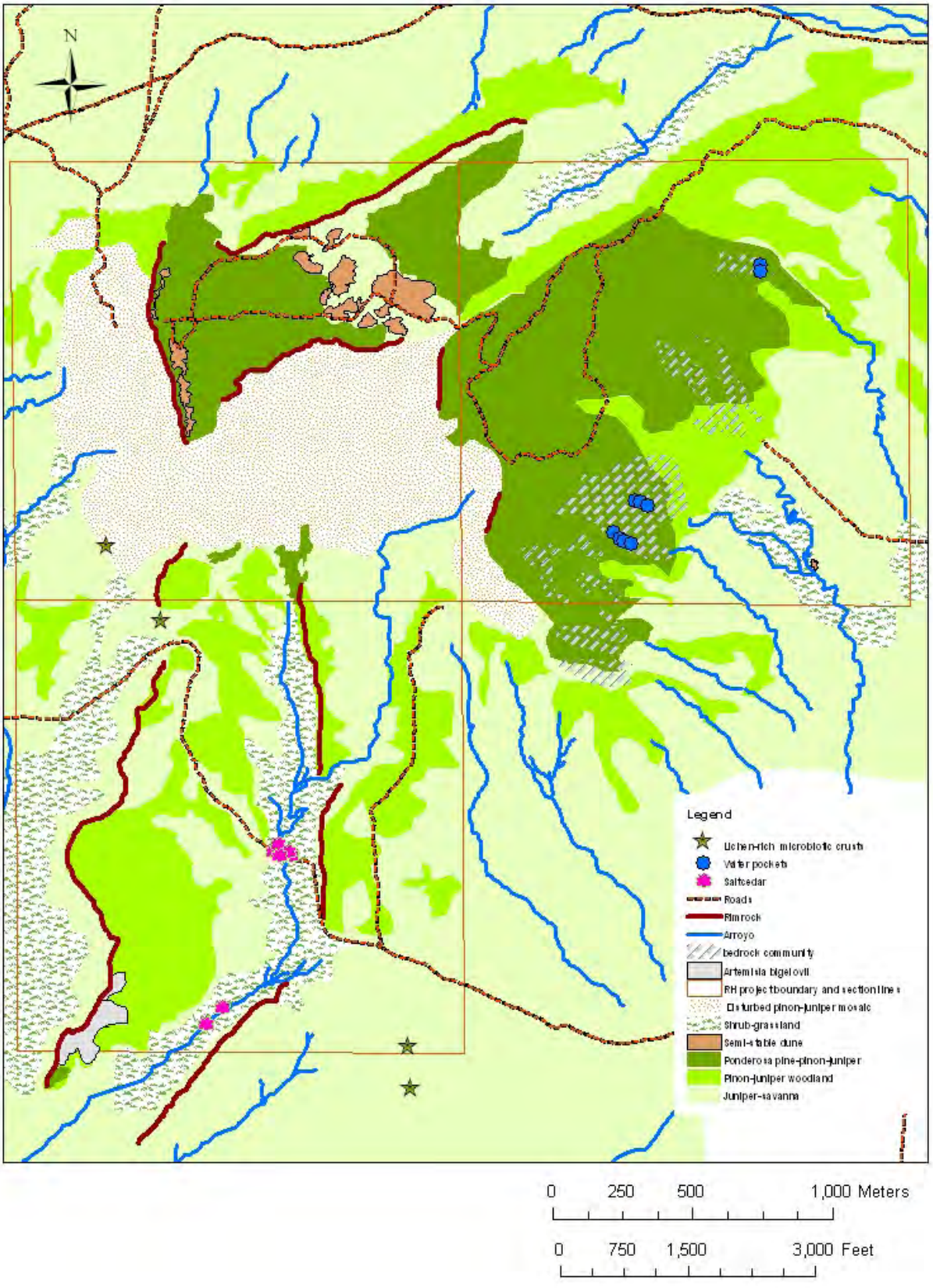

Figure 4. Roca Honda Vegetation Map.

1.3 Vegetation Results

1.3.1 Plant Species Inventory

1.3.1.1 Plant Species Compilation

The number of species observed at the site indicates that there is a good amount of species diversity. In 2008, the vegetation cover was less dense and the number of plant species observed was fewer than in 2006 (Rohman and Devlin personal communication 2008). The most likely reason is because 2008 was considerably drier than previous years and the area appeared to be suffering through a significant drought. In several cases the dried remains of many of the species noted in 2006 could be clearly identified in 2008. For example, the desiccated parts of *Mirabilis multiflora* (Colorado four-o'clock) were abundant but there were relatively few living individuals.

Some areas had obviously been impacted by intense grazing pressure, but it is notable that there were relatively few non-native weed species. In general the native cover appeared to be healthy and recruitment was evident amongst tree, shrub, and forb species.

Tables 6a-6f on pages 18-23, list the species identified during the 2008 field season. Plant species names used are those accepted by ITIS. Where the names accepted by ITIS and the Flora of North America differ, the name accepted by the latter is placed in parentheses. For example, ITIS accepts *Chenopodium graveolens* but in the current Flora of North America, *Dysphania* is accepted due to an expanded circumscription that includes all "glandular" taxa previously treated in *Chenopodium* subg. *Ambrosia* (Clements and Mosyakin 2003, ITIS[2] 2009).

Table 6a. Trees.

Life form – Species	Section	Common name	Status/Comment
Trees			
Juniperus monosperma	All	One-seed juniper	
Juniperus scopulorum	9&10	Rocky Mountain juniper	
Pinus edulis	All	Piñon pine	
Pinus ponderosa	9&10	Ponderosa pine	
Populus deltoids	9&10	Cottonwood	

[2] Integrated Taxonomic Information System

Table 6b. Shrubs and sub-shrubs.

Shrubs and Subshrubs	**Section**	**Common name**	**Status/Comment**
Artemisia bigelovii	All	Flat sagebrush	
Artemisia filifolia	9&10	Sand sage	
Artemisia frigid	All	Fringed sage	
Artemisia nova	All	Black sagebrush	
Atriplex canescens	All	Four-wing saltbush	
Brickellia brachyphylla	9&10	Plumed brickellbush	
Brickellia californica	9&10	California brickellbush	
Brickellia grandiflora	9&10	Tassel-flower brickellbush	
Cercocarpus montanus	All	Mountain mahogany	
Chrysothamnus greenei	All	Greene's rabbitbrush	
Ericameria nauseosa	All	Rubber rabbitbrush	
Ericameria nauseosa var. bigelovii	9&10	Bigelow's rubber rabbitbrush	
Ericameria nauseosa var. graveolens	All	Rubber rabbitbrush	
Eriogonum corymbosum	9&10	Crispy wild-buckwheat	
Eriogonum leptophyllum	9&10	Slender-leaf wild-buckwheat	
Eriogonum microthecum var. *simpsonii*	All	Simpson's wild-buckwheat	
Eriogonum umbellatum	9&10	Sulphur-weed	
Fallugia paradoxa	All	Apache-plume	
Gutierrezia sarothrae	All	Broom snakeweed	
Krascheninnikovia lanata	All	Winterfat	
Lycium pallidum	All	Pale wolfberry	
Nolina microcarpa	10	Beargrass	
Purshia stansburiana	All	Cliffrose	
Philadelphus microphyllus	10	mockorange	
Quercus gambelii	9&10	Gambel's oak	
Quercus grisea	9&10	Gray oak	
Quercus xpauciloba	9&10	Wavyleaf oak	
Quercus sp.	16	Oak	
Rhus trilobata var. trilobata	All	Skunkbush sumac	
Ribes cereum	9&10	Wax currant	
Tamarix chinensis	16	Saltcedar	Invasive. Class C weed (NM)
Tetradymia canescens	16	Spineless horsebrush	
Yucca baccata	All	Banana yucca	
Yucca sp.	All	Narrow-leaved yucca	

Table 6c. Cacti.

Cacti	**Section**	**Common name**	**Status/Comment**
Escobaria vivipara	All	Spinystar (Nipple cactus)	
Cylindropuntia imbricata var. imbricata	All	Cane cholla	
Echinocereus fendleri	10	Pinkflower hedgehog cactus	
Echinocereus triglochidiatus	All	Claret-cup cactus	
Opuntia phaeacantha	All	Plains prickly-pear	
Opuntia polyacantha	All	Starvation prickly-pear	

Table 6d. Ferns.

Ferns	Section	Common name	Status/Comment
Cheilanthes feei	All	Santa Fe lipfern	
Cystopteris fragilis	9&10	Brittle bladder-fern	

Table 6e. Forbs.

Forbs	Section	Common name	Status/Comment
Abronia fragrans	All	Fragrant sand-verbena	
Ageratina herbacea	9&10	Fragrant snakeroot	
Allionia incarnate	All	Trailing windmills	
Allium sp.	All		
Amaranthus palmeri	9&10	Palmer's amaranth	
Amaranthus hybridus	9&10	Smooth amaranth	
Amaranthus palmeri	16	Palmer's amaranth	Not conclusively identified to species.
Ambrosia acanthicarpa	All	Burr ragweed	
Ambrosia artemisiifolia var. *elatior*	9&10	Annual ragweed	
Artemisia campestris var. caudata	9&10	Field wormwood	
Artemisia campestris var. *scouleriana (Artemisia campestris* ssp. *pacifica)*	9&10	Pacific wormwood	
Artemisia carruthii	9&10	Carruth's sagebrush	
Artemisia dracunculus	All	Tarragon	
Artemisia ludoviciana	All	Wormwood	
Asclepias sp.	16	Milkweed	
Ascleplias macrosperma	All		
Astragalus kentrophyta	9&10	Spiny milkvetch	
Astragalus spp.	All	Milkvetch	
Bahia dissecta	All	Ragged-leaf bahia	
Bassia hyssopifolia	9&10	Smotherweed	Introduced
Kochia scoparia	All	Mexican fire-weed	
Boechera sp.	16	Rockcress	
Brickellia brachyphylla	16	Plumed brickellbush	
Brickellia californica	16	California brickellbush	
Carduus nutans	16	Musk thistle	Invasive-class B weed (NM)
Castilleja spp.	All	Indian-paintbrush	
Chaetopappa ericoides	All	Sand aster	
Chamaesaracha coronopus	All	Green-leaf five-eyes	
Chamaesyce fendleri	All	Fendler's sandmat	
Chamaesyce maculate	All	Spotted spurge	
Chamaesyce revolute	9&10	Curl-leaf	
Chamaesyce serpyllifolia	All	Thyme-leaf spurge	
Chamaesyce sp.	16	Spurge	
Chenopodium album	All	Lambs quarter	
Chenopodium fremontii	9&10	Fremont’s goosefoot	
Chenopodium graveolens (Dysphania graveolens)	9&10	Fetid-goosefoot	
Chenopodium leptophyllum	9&10	Narrowleaf goosefoot	
Cirsium arvense	16	Canadian thistle	Invasive-class A weed (NM)
Cirsium neomexicanum	All	New Mexico thistle	Not conclusively identified to species.
Cleome serrulata	All	Rocky Mountain beeplant	
Commelina dianthifolia	All	Bird-bill dayflower	

Commelina erecta var. angustifolia	16	White-mouth dayflower	
Convolvulus arvensis	16	Field bindweed	Invasive-class C weed (NM)
Conyza Canadensis	9&10	Horseweed	
Corispermum americanum var. americanum	9&10	American bugseed	
Cryptantha cinerea	16	James' cryptantha	
Cryptantha cinerea var. jamesii	9&10	James' cryptantha	
Cryptantha crassisepala	All	Thicksepal cryptantha	
Cryptantha fendleri	9&10	Sanddune cryptantha	
Cuscuta sp.	All	Dodder	
Dalea candida	All	White prairie-clover	
Dalea sp.	9&10	Prairie-clover	
Descurainia obtuse	All	Blunt tansy-mustard	
Descurainia Sophia	9&10	Flixweed	Introduced
Dieteria bigelovii var. bigelovii	9&10	Bigelow's spine-aster	
Dieteria sp.	16	Spine-aster (Tansy aster)	
Dimorphocarpa wislizeni	All	Spectacle-pod	
Draba cuneifolia var. cuneifolia	9&10	Wedgeleaf Whitlow-grass	
Drymaria glandulosa	9&10	Fendler's drymary	
Drymaria leptophylla	9&10	Canyon drymary	
Drymaria molluginea	9&10	Slimleaf drymary	
Dyssodia papposa	9&10	Fetid-marigold	
Erigeron divergens	16	Spreading fleabane	
Erigeron pulcherrimus	9&10	Basin fleabane	
Erigeron sp.	9&10	Fleabane	
Eriogonum alatum	9&10	Winged wild-buckwheat	
Eriogonum cernuum	All	Nodding wild-buckwheat	
Eriogonum jamesii	All	James' wild-buckwheat	
Eriogonum ovalifolium	9&10	Cushion wild-buckwheat	
Eriogonum palmerianum	16	Palmer's wild-buckwheat	
Eriogonum rotundifolium	All	Roundleaf buckwheat	
Eriogonum sp.	9&10	Wild-buckwheat	
Euphorbia sp.	9&10	Spurge	
Geranium richardsonii	9&10	Richardson's geranium	
Gilia longiflora	16	Blue trumpets	
Gnaphalium palustre	10	western marsh cudweed	
Grindelia squarrosa	All	Curly-cup gumweed	
Hedeoma drummondii	9&10	Drummond's false-pennyroyal	
Helianthus petiolaris	All	Plains sunflower	
Heterotheca villosa	All	Hairy goldenaster	
Hymenopappus filifolius	All	Fine-leaf woolywhite	
Hymenoxys richardsonii var. *floribunda*	All	Colorado rubberweed	
Ipomopsis aggregate	9&10	Skyrocket	
Ipomopsis longiflora	All	Blue trumpets	
Ipomopsis multiflora	All	Many-flowered skyrocket	
Kallstroemia parviflora	All	Warty caltrop	
Laënnecia schiedeana	9&10	Pineland woolwort	
Lappula occidentalis	16	Spiny sheepbur	
Lesquerella sp.	All	Bladderpod	
Linum (Cathartolinum) sp.	16	Flax	

Linum lewisii	9&10	Prairie flax	
Linum puberulum	9&10	Plains flax	
Machaeranthera grindelioides (Xanthisma grindelioides)	9&10	Rayless tansy aster	Likely accumulates selenium
Machaeranthera tanacetifolia	9&10	tanseyleaf tansyaster	Likely accumulates selenium
Machaeranthera pinnatifida (Xanthisma spinulosus)(Haplopappus spinulosus)	9&10	Lacy tansy aster	Likely accumulates selenium
Marrubium vulgare	10	Horehound	Non-native
Mentzelia albicaulis	16	Whitestem blazingstar	
Mentzelia multiflora	9&10	Adonis blazing star	
Mirabilis linearis	9&10	Ribbon four-o'clock	
Mirabilis multiflora	All	Colorado four-o'clock	
Mirabilis oxybaphoides	All	Spreading four-o'clock	
Monarda pectinata	9&10	Plains beebalm	
Nama hispidum	9&10	Purple roll-leaf	
Oenothera albicaulis	9&10	White-stem evening-primrose	
Oenothera caespitosa	All	Tufted evening-primrose	
Oenothera coronopifolia	All	Hairy-throat evening-primrose	
Oenothera pallid	All		
Orobanche ludoviciana subsp. multiflora	9&10	Louisiana broom-rape	
Oxalis violacea	All	Violet wood-sorrel	
Packera multilobata	All		
Pectis angustifolia	9&10	Lemon weed	
Penstemon barbatus	All	beardlip penstemon	
Peteria scoparia	All	Rush peteria	
Phacelia integrifolia	All	Gypsum scorpion-weed	
Talinum confertifolium (Phemeranthus confertiflorus[a]*) (Phemeranthus parviflorus)*	All	New Mexico flame flower	
Phoradendron juniperinum ssp. Juniperinum	16	Juniper mistletoe	
Physalis pubescens var. integrifolia	16	Husk-tomato	Not conclusively identified to species
Physalis sp.	9&10	Ground-cherry	
Physalis virginiana	All	Virginia ground-cherry	
Physaria rectipes	9&10	Straight bladder pod	
Plantago patagonica	All	Woolly plantain	
Portulaca oleracea	All	Garden purslane	
Portulaca pilosa	All	Kiss-me-quick	
Potentilla sp.	16	Cinquefoil	
Pseudognaphalium canescens	9&10	Wright's rabbit-tobacco	
Psilostrophe tagetina	All	Woolly paper-flower	
Psoralidium lanceolatum	9&10	Wild scurf-pea	
Salsola tragus	All	Russian-thistle	Introduced
Salvia prob. Subincisa	All	Sage, probably saw-tooth	
Sanvitalia abertii	All	Abert's dome	
Schkuhria pinnata var. wislizeni	9&10	Wislizenus's threadleaf	
Schoenocrambe linearifolia	9&10	Slim-leaf plains-mustard	
Sedum lanceolatum	9&10	Rosewort	
Senecio sp.	16	Groundsel	
Senecio spartioides var. *multicapitatus*	9&10	Broom groundsel	

Silene laciniata var. *greggii*	9&10	Cardinal catchfly	
Sisymbrium altissimum	9&10	Tall tumblemustard	Introduced
Solanum jamesii	All	Wild potato	
Solanum triflorum	9&10	Cut-leaf nightshade	
Solidago wrightii var. *adenophora*	9&10	Wright's goldenrod	
Sphaeralcea coccinea	All	Scarlet globemallow	
Sphaeralcea parvifolia	16	Small-leaf globemallow	
Sphaeralcea angustifolia	9&10	Copper globemallow	Not conclusively identified to species
Sphaeralcea sp.	9&10	Globemallow	
Stanleya pinnata var. *pinnata*	All	Prince's-plume	Selenium indicator and accumulator[b]
Stenotus armerioides	9&10	Mock goldenweed	
Stephanomeria sp.	16	Wire-lettuce	
Taraxacum officinale	9&10	Common dandelion	
Tetraneuris ivesiana	All	Ives' fournerved daisy	
Thelesperma megapotamicum	All	Hopi tea greenthread	
Thelypodium wrightii	9&10	Wright's thelypody	
Tiquilia hispidissima	16	Hairy crinklemat	
Townsendia annua	All	Annual Townsend-daisy	
Townsendia incana	All	Hoary Townsend-daisy (Easter daisy)	
Tradescantia occidentalis	All	Spiderwort	
Verbena macdougalii	16	MacDougal's vervain	
Verbesina encelioides	All	Golden crownbeard	
Wyethia scabra	9&10	Badland mule's-ears	
Zinnia grandiflora	All	Plains zinnia	

Table 6f. Non-vascular species.

Non-vascular species	Section	Common name	Status/Comment
Marchantia polymorpha [liverwort]	All		Not conclusively identified to species
Xanthoparmelia chlorochroa [lichen]	All		Not conclusively identified to species
Nostoc commune [cyanobacteria]	All		Not conclusively identified to species
Microcoleus vaginatus [cyanobacteria]	All		Not conclusively identified to species

a. According to USDA PLANTS database. FNA subscribes to these species being in synonomy. ITIS recognizes *Talinum confertifolium* and *Talinum parviflorum* as distinct species and has not endorsed the genus "*Phemeranthus*"

1.3.1.2 Plant Species of Special Concern

No sensitive plant species were observed during the surveys in 2008. This is consistent with the previous surveys. The combination of geology, hydrology, habitat types, soils, aspect, and elevation in Sections 9 and 10 does not provide potential habitat for the sensitive plant species considered threatened, endangered, or species of concern that are likely to occur in McKinley and Cibola Counties (Wood 2006a). There are limited areas of potential habitat for two species of concern, *Astragalus naturitensis* (Naturita milkvetch) and *Talinum brachypodium* (Laguna flameflower) within the project area in Section 16 (Wood 2006b). *Astragalus naturitensis* grows on sandstone ledges and rimrock along canyons in piñon-juniper woodland from 5,000-7,000 feet. Therefore rim rock areas were targeted for this species. *Talinum brachypodium* grows in shallow pockets of calcareous silt to clay soils overlying sandstones in open piñon-juniper woodland with little understory and scattered cacti and shrubs. Only one species of *Talinum, T. confertifolium*, was found and that in Section 10 under PJ woodland. *Talinum confertifolium* is clearly and easily distinguishable from *T. brachypodium*.

Typically, plant species are most definitively identified if they are in flower and/or in fruit. The plant inventory survey in early May was the most appropriate time to make a search for *Astragalus naturitensis* (flowers late April to May) and in late June for *Talinum brachypodium* (flowers June to August).

1.3.1.3 Selenium Accumulators

Selenium accumulators were identified for range management purposes. Knowledge of existing selenium-accumulators may be important in evaluating future restoration efforts (Wyoming DEQ Land Quality Division. 1997).

Plant species known to accumulate selenium that occur within the project site were identified in Tables 6a-6f on page 18-23. Only *Stanleya piñata* (prince's plum) is an indicator plant for selenium rich soils. Some *Machaeranthera* (tansy aster) and *Astragalus* (milkvetch) species are selenium accumulators when they grow in selenium-rich soils. However, *A. kentrophyta* (spiny milkvetch) has not been reported to be an accumulator. *Krascheninnikovia lanata* (winterfat) and *Atriplex canescens* (four-wing saltbush) will accumulate selenium if growing on selenium rich soils but neither is recognized as selenium indicator species.

1.3.1.4 Invasive Non-native Species

The only noxious weeds observed in 2008 were field bind weed (*Convolvulus arvense*) and saltcedar (*Tamarix* species). Saltcedar trees were few at the site. These non-native species are both considered to be a Class C noxious weed by the state of New Mexico (DuBois 1999). "Class C weeds are species that are widespread in the state. Management decisions for these species should be determined at the local level based on feasibility to control and level of infestation" (DuBois 1999).

In 2006, two additional species of noxious weeds were observed; Canada thistle (*Cirsium arvense*) and musk thistle (*Carduus nutans*). Both these species were observed in drainage areas in Section 16. Canada thistle is considered a Class A noxious weed while Musk thistle is considered a Class B noxious weed by the state of New Mexico (DuBois 1999). "Class A weeds are species that currently are not present in New Mexico or have limited distribution; preventing new infestations of these species and eradicating existing infestations is the highest priority" and "Class B weeds are species that are limited to portions of the state. In areas that are not infested, these species should be treated as Class A weeds. In areas with severe infestations, management plans should be designed to contain the infestation and stop any further spread" (DuBois 1999).

1.3.2 Vegetation Types and Mapping Units at the project site

1.3.2.1 Vegetation Map

Aerial photographs of the Roca Honda project site were taken in 2008. In conjunction with field observations, these photographs were used to delineate the vegetation communities within the project area. The vegetation map shown in Figure 4 on page 17 shows the distribution and extent of the vegetation types observed at the site. Shapefiles for the permit boundary line, fences, and contour lines were provided by Roca Honda Resources, LLC. These have been used for the maps developed in vegetation descriptions.

Historic drill holes were numerous throughout the site. There was no "typical" vegetation type in these areas but they all tended to have been (re)colonized to various extents by *Juniper monosperma, Pinus edulis, Ericameria nauseosa, Gutierrezia sarothrae, Aristida purpurea* (three-awn), *Grindelia squarrosa,* and *Senecio multicapitatus*. It appeared that the more recent areas tended to have fewer shrubs than older sites. Tree species were between 15 centimeters (6 inches) to approximately 1.5 meters (5 feet) high. Grass cover was generally low. *Schizachyrium scoparium* var. *scoparium* (little bluestem) was particularly common and abundant at historic drill hole locations and on the trails linking them in Section 10. The abundance of *Schizachyrium scoparium* at these sites and its absence from undisturbed areas suggested that seeds of this species were planted in these areas sometime over the past few decades. A large area in Section 9 has been marked on the vegetation map (Figure 4 on page 17) as "disturbed PJ woodland." Although clearly disturbed with scant understory in many places, the vegetation consisted mostly of native species.

"Pinon juniper woodland" delineated in Sections 9, 10, and 16 differs from "Disturbed Pinon juniper (PJ) woodland" delineated in Section 9 and the south west corner of Section 10 by the type and extent of disturbance observed. Large tracts of land in "Disturbed PJ woodland" had been exposed to heavy machinery and extensive digging that resulted in steep downcuts and old roads/tracks crossing the area. Plant species diversity was richer in the "Pinon juniper woodland" as compared to the "Disturbed PJ woodland." In general, land in Section 9 was less forested, more grassy, and the substrate more sandy and less rocky than in the areas covered by PJ in Sections 10 and 16.

1.3.2.2 Descriptions of Vegetation Cover and Mapping Units

The vegetation type descriptions and maps in this report carefully document the vegetation types encountered and provide a solid basis for appreciating the pre-mining vegetation within the Roca Honda project site.

The vegetation communities at the Roca Honda site have a complex structure. Superficially, the vegetation at the Roca Honda project site is consistent with the grama-galleta steppe and juniper-pinon woodland mosaic described by Bailey (1978). At higher physiognomic hierachial levels all vegetation types at the site can be classified as juniper savanna, pinon juniper woodland, ponderosa pine-pinon-juniper mixed woodland or shrub-grassland. Within these broad vegetation types there were numerous and highly variable patches of plant species that are locally unique, which can be described at a floristic level; for example, pinon-juniper woodland with an understory of *Artemisia bigelovii*.

There are also abundant and diverse non-vascular species, especially lichens, on the project site. The most common lichen that contributed significantly to the carbon balance in some areas was a *Xanthparmelia* species, probably *X. chlorochroa*. This species was identified from gross morphological characteristics only and no microscopic or chemical analyses were made. This lichen is a relatively large and easily identified species and its biomass was included when measuring productivity at the site.

A variety of lichen species were observed growing on the soil (terricolous), rocks (saxicolous) and trees (corticolous). Well-developed microbiotic crusts are distributed throughout the project site. Within these crusts, terrestrial lichen species included those of the genera *Collema, Psora,* and *Dermatocarpon*. Other non vascular plants that contributed to the microbiotic cover included species of two cyanobacteria; *Microcoleus,* likely *M. vaginatus,* and *Nostoc,* likely *N. communis*. It appeared that the latter was less abundant and widespread than *Microcoleus* which formed relatively dense patches in some areas. Cyanobacteria provide nitrogen as well as carbon to the soil. Other than for the

vagrant lichen *X. chlorochroa* which was obvious and easily harvestable, no attempts were made to consider the productivity of microbiotic crust.

The areas occupied by the various vegetation types within the project site are summarized in Table 7 below. Each vegetation type is described in more detail starting on page 30. The "vegetation type" concept used in this report may be likened to USDA Forest Service "ecological types" (USDA Forest Service 1991).

Table 7. Vegetation type and acreage at Roca Honda (2008).

Vegetation type and mapping units	**Permit Area (777 hectares, or 1,920 acres; 3 Sections)**		
	Total hectares	**Total acres**	**Percent of project site area**
Juniper savanna	275	679.54	35%
Piñon-juniper woodland	152	375.60	20%
a. *Artemisia bigelovii*	3	7.41	(0.4)[1] %
b. Bedrock plant community	3.4	8.40	(0.4) %
Ponderosa pine-piñon-juniper woodland	151	373.13	19%
a. Bedrock plant community	16.5	40.77	(2) %
i. Perennial pool sites	0.1	0.25	--
Semi-stabilized dunes	7	17.30	1%
Disturbed piñon-juniper mosaic	116	286.64	15%
Shrub-grassland	75	185.33	10%
a. Standing water (ephemeral pond)	0.3	0.74	(0.4) %

[1] Figures in parentheses are included in the parent vegetation type

Quantitative measures of cover obtained through transect line survey are tabulated in each section. Results are presented for the following categories: Percent cover for each plant species grouped according to life form (tree, shrub and subshrub, grass, forb, succulent and microbiotic); percent litter; percent rock; percent gravel; percent bare ground. These parameters all help in estimating the potential to provide wildlife habitat and forage for livestock grazing.

The cover of bare ground, litter and grass on each transect line is diagrammatically represented as bar charts on the map in Figure 5 on page 27. The green bar indicates the percent cover of grass on each transect. Production measurements are graphically portrayed in Figure 6 on page 28 using stacked bar charts. Green grass is represented by the turquoise color, brown or dried grass by the orange color and *Xanthoparmelia chlorochroa* by lilac. The height of the bars indicates the relative contribution of the three materials to the total biomass harvested within the 40 x 40 centimeters (16 inches x 16 inches) sampling square within each exclosure.

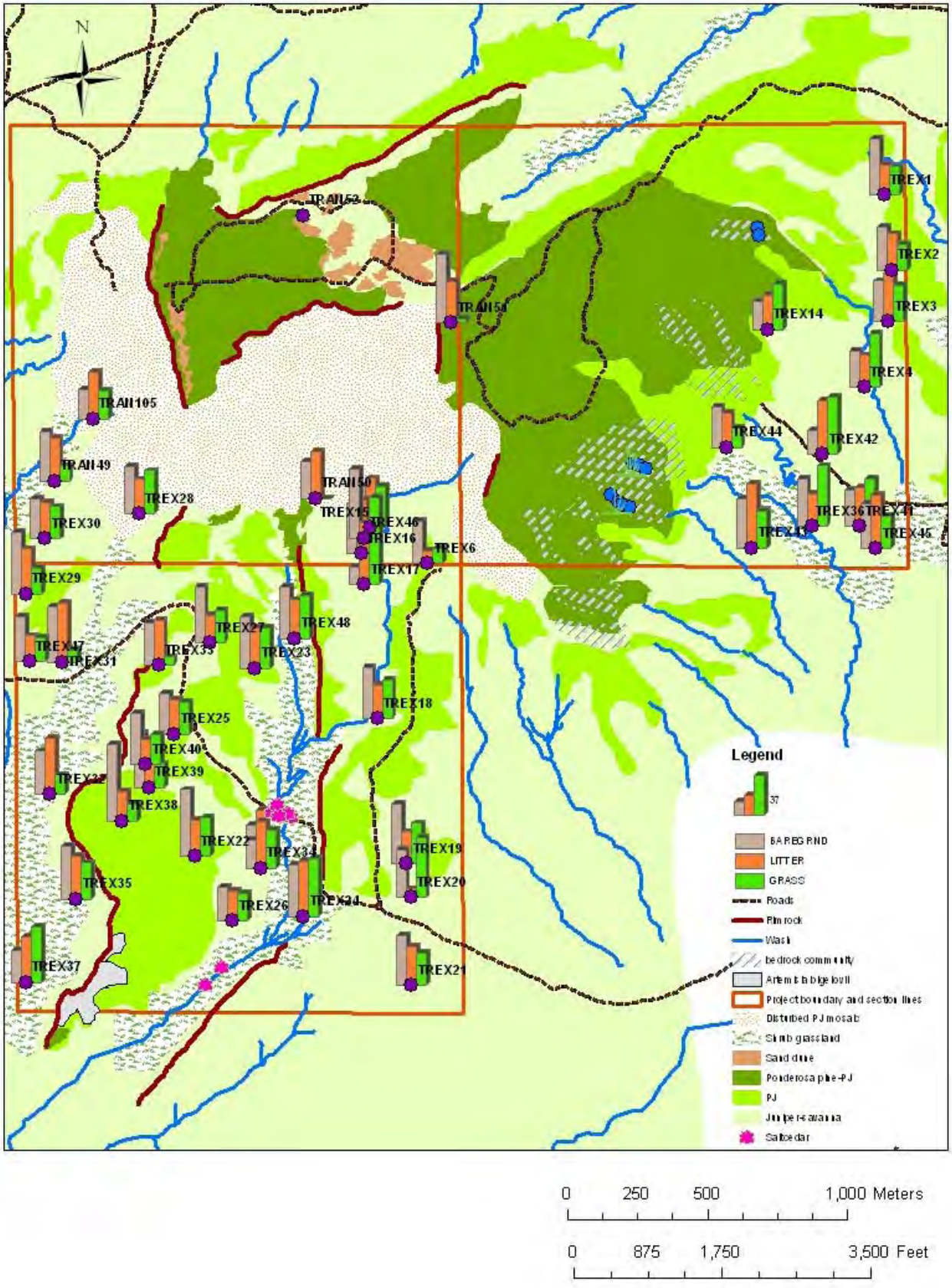

Figure 5. Percent cover of grass, bare ground, and litter on each transect location.

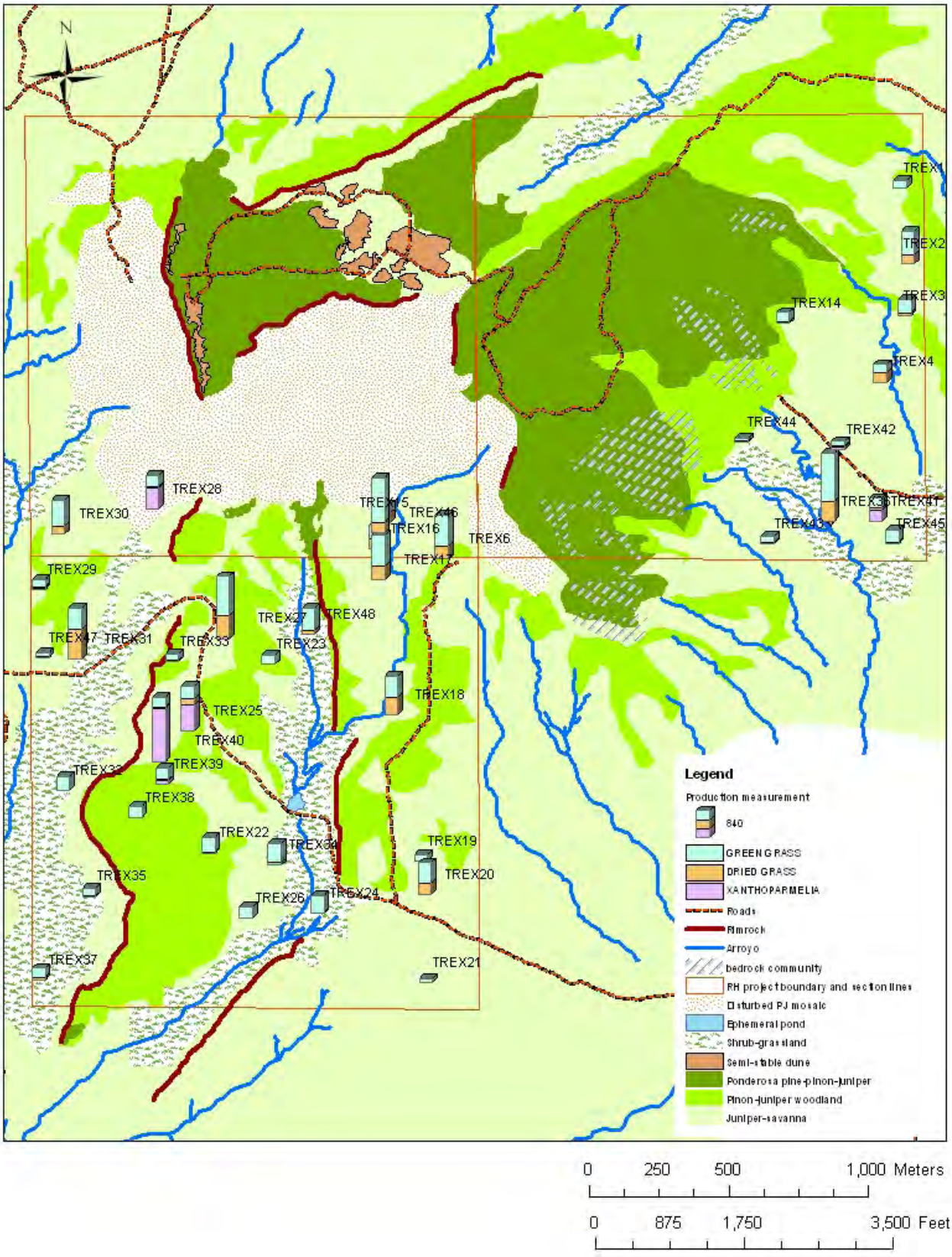

Figure 6. Measured biomass (kg/ha) at Roca Honda (2008).

The estimated areas that are occupied by each of the vegetation types within the project site are listed in Table 8 below. The areas of the vegetation types potentially affected by mining are estimated from the map provided in Section 6.0 (Topsoil) of the Sampling and Analysis Plan. Total area (in hectares) of each vegetation type potentially affected by mining and associated activities and the percent of each vegetation type potentially affected by mining and associated activities is reported in Table 8 below. Table 9 on page 30, provides a breakdown of location by section number and number of transect lines for each vegetation type

Table 8. The total number of hectares (ha) of each vegetation at Roca Honda.

Project Site area	**Vegetation Type**						
	1. Piñon juniper woodland	**2. Juniper savanna**	**3. Shrub-grassland**	**4. Pools and standing water**	**5. Disturbed Pinon-Juniper mosaic**	**6. Semi-stabilized dunes**	**7. Ponderosa pine-pinon-juniper woodland**
Total (all Sections)	152 hectares 376 acres	275 hectares 680 acres	75 hectares 185 acres	0.31 hectares 1 acre	116 hectares 287 acres	7 hectares 17 acres	151 hectares 373 acres
Area potentially affected by mining (restricted to Sec 16 and 10)	14 hectares 35 acres	50 hectares 124 acres	11 hectares 27 acres	0	2 hectares 5 acres	0	2 hectares 5 acres
% area potentially impacted by mine (restricted to Sec 16 and 10)	10	50	11	0	2	0	1 hectare 2 acres
Sec. 16	77 hectares 190 acres	124 hectares	58 hectares 143 acres	0.3 hectares 1 acre	0	0	<0.1 hectares <0.3 acres
Sec. 16 area potentially affected by mining	14 hectares 35 acres	24 hectares 44 acres	9 hectares 22 acres	0	N/A	N/A	0
Sec. 16 % area potentially impacted by mining	18	19	16	0	N/A	N/A	0
Sec. 10	53 hectares 131 acres	81 hectares 200 acres	13 hectares 32 acres	0.01 hectares 0.03 acres	7 hectares 17 acres	0.1 hectares 0.3 acres	105 hectares 256 acres
Sec. 10 potentially impacted by mining	1hectares 2 acres	24 hectares 59 acres	2 hectares 5 acres	0	0	0	2 hectares 5 acres
Sec. 10 % area potentially impacted by mining	2	29	16	0	0	0	2
Sec. 9	22 hectares 54 acres	71 hectares 175 acres	4 hectares 10 acres	0	109 hectares 269 acres	7 hectares 17 acres	46 hectares 114 acres
Sec. 9 potentially impacted by mining	0	2 hectares 5 acres	0	N/A	2 hectares 5 acres	0	0
Sec. 9 % area potentially impacted by mining	0	3	0	N/A	2	0	0

Table 9. The location (section number) and number of transect lines for each vegetation type.

	Number of transects							
		Section						
Vegetation type	**Total**	**9**	**10**	**16**	**11**	**12**	**15**	**21**
Juniper savanna	24	3	8	10	2	0	1	---
Piñon juniper woodland	24	2	3	13	4	0	1	1
Shrub-grassland	16	1	---	9	---	4	---	---
Ponderosa pine-piñon-juniper	9	3	4	---	---	---	1	---
Disturbed piñon-juniper mosaic	3	3	0	0	0	0	0	0
Semi-stabilized dunes	3	2	1	0	0	0	0	0
Across major tributary to San Mateo Creek	9	0	0	4	0	0	0	7
*Either juniper-savanna or pinon-juniper woodland	3	0	0	0	0	0	3	0
*Either juniper-savanna or shrub-grassland	3	0	0	0	0	0	0	3
*Either juniper-savanna or pinon-juniper woodland or shrub-grassland	2	0	0	0	1	0	1	0

1. Juniper savanna vegetation type.

This is the most ubiquitous vegetation type at lower elevations and intergrades with other vegetation types without sharp boundaries. A savanna is defined a grassland dotted with trees or as a matrix of trees and grasses in a wet-dry climate where most precipitation falls during a single time period. In savannas the grasses are usually mixed with herbs and shrubs while the trees are scattered individually or in small clumps. As in this case, savannas can be a transitional zone occurring between woodland regions and grassland regions.

The juniper savanna vegetation type at the Roca Honda project site consists of *Juniperus monosperma* (one-seeded juniper) dispersed in intermittently grazed grasslands dominated by C4 (warm season) perennial grasses, mostly *Bouteloua gracilis* (blue grama grass) but also with substantial patchy cover by *Pleuraphis jamesii* (galleta grass), *Muhlenbergia torreyi* (ring muhly), and *Bouteloua hirsuta* (hairy grama grass). *Pinus edulis* (piñon) individuals are sporadically present at this vegetation type where it interfaces with piñon-juniper woodland woodland.

Shrubs were thinly dispersed throughout the juniper savanna, becoming more common at the interface with what was best categorized as shrub-grassland. Individuals and small and large stands of shrubs were dispersed throughout the grasses in this vegetation type. *Atriplex canescens* (four-wing saltbush) was common throughout the project site. *Artemisia filifolia* was common in Section 10. Small stands of *Lycium pallidum* were in areas with sandy soils and were noticed to be often associated with small mammal burrows. The percent cover of the various species is listed in Tables 10 and 11 on pages 31-32. Table 12 on page 31 provides shrub density by species in juniper savanna vegetation type.

Table 10. Percent cover in juniper savanna.

Cover or Species	**Percent cover**			
	Mean	**Std dev**	**Median**	**Mode**
Bare ground	39.0	11.2	38	38
Gravel	2.4	7.2	0	0
Rock	0.8	2.4	0	0
Litter	36.2	13.7	34	50
Microbiotic cust	4.0	8.0	0	0
Xanthoparmelia chlorochroa (lichen)	0.9	2.3	0	0
Grasses				
Aristida purpurea	0.1	0.4	0	0
Bouteloua spp. (predominantly *B. gracilis*)	32.9	14.3	32	22
Hesperostipa comate	0.5	1.1	0	0
Pleuraphis jamesii	3.4	5.8	0	0
Muhlenbergia torreyi	1.0	2.7	0	0
Sporobolus cryptandrus	0.9	1.7	0	0
Trees				
Juniperus monosperma	0.5	1.8	0	0
Pinus edulis	0.1	0.4	0	0
Shrubs and succulents				
Artemisia filifolia	0.3	1.0	0	0
Atriplex canescens	1.0	1.9	0	0
Cercocarpus montanus	0.0	0.0	0	0
Chrysothamnus greenei	0.1	0.4	0	0
Gutierrezia sarothrae	2.7	4.0	2	0
Opuntia spp.	0.1	0.4	0	0
Forbs				
Eriogonum cernuum	0.1	0.4	0	0
Cryptantha jamesii	0.1	0.4	0	0
Cryptantha crassisepala	0.1	0.4	0	0
Dimorphocarpa wislizeni	0.3	0.7	0	0
Hymenopappus filifolius	0.1	0.4	0	0
Chaetopappa ericoides	0.2	0.6	0	0
Plantago patagonica	0.1	0.4	0	0
Salsola tragus	0.1	0.4	0	0
Senecio spartioides var. *multicapitatus*	0.1	0.4	0	0

Table 11. Cover of individual species.

Life Form/Species	Cover estimate (%)	Life Form/Species	Cover estimate (%)
Trees		**Forb**	
Juniperus monosperma	<1	*Dimorphocarpa wislizeni*	<1
Pinus edulis	<1	*Chaetopappa ericoides*	<1
Shrubs		*Salsola tragus*	<1
Gutierrezia sarothrae	1-5%	*Hymenopappus filifolius*	<1
Atriplex canescens	1-5%	*Senecio spartioides* var.	<1
Ericameria nauseosa var. *bigelovii*	<1	*Cryptantha crassisepala*	<1
Chrysothamnus greenei	<1	*Sphaeralcea coccinea*	<1
Artemisia bigelovii	<1	*Ipomopsis longiflora*	<1
Artemisia filifolia	<1	*Boechera fendleri*	<1
Lycium pallidum	<<1	*Eriogonum cernuum*	<1
Succulents		*Machaeranthera pinnatifida*	<1
Opuntia species	<1	*Tradescantia occidentalis*	<1
Cylindropuntia imbricata	<1	*Plantago patagonica*	<1
Grasses		*Psilostrophe tagetina*	<1
Bouteloua sp.	25-50%	*Descurainia* sp.	<<1
Pleuraphis jamesii	1-5%	*Hymenoxys richardsonii* var.	<<1
Muhlenbergia torreyi	<1	*Ipomopsis multiflora*	<<1
Aristida purpurea	<1	*Abronia fragrans*	<<1
Hesperostipa comate	<1	*Cryptantha crassisepala*	<<1
Sporobolus cryptandrus	<1	*Oenothera pallida*	<<1
Achnatherum hymenoides	<1	*Dieteria* sp. (*Machaeranthera*	<<1
Elymus elymoides ssp. *Elymoides*	<<1	*Artemisia campestris* var.	<<1
Agropyron sp.	<<1	*Heterotheca villosa*	<<1
Microbiotic species		*Phacelia sp.*	<<1
Microbiotic crust	<1		
Xanthoparmelia chlorochroa	<1		

Gutierrezia sarothrae (snakeweed) was very common and was the most abundant shrub or subshrub at the project site as listed above in Table 11. In many areas there were abundant small-sized individuals of less than 6 cm (2 inches) high and taking up less than 4 cm^2 (1.6 $inches^2$). Depending on the location there may be none of these small plants while in other areas they comprised as many as 76% of those shrubs counted. This high level of *G. sarothrae* recruitment may indicate high grazing pressure. The most common forb in 2008 appeared to be *Senecio spartioides* var. *multicapitatus* (broom groundsel). *Dimorphocarpa wislizeni* (spectacle-pod), *Hymenopappus filifolius* (fine-leaf woollywhite), *Chaetopappa ericoides* (sand aster), *Chamaesyce maculata* spotted spurge) and *C. serpyllifolia* (thyme-leaf spurge) were also common forbs that were quite abundant in some areas. *Chenopodium graveolens* (fetid-goosefoot) was frequent under the tree canopies.

Table 12. Shrub density in juniper savanna vegetation type.

Shrub and tree species	Estimated number per hectare
Juniper monosperma	236
Pinus edulis	127
Gutierrezia sarothrae	10,182
Artemisia bigelovii	73
Artemisia filifolia	91
Ericameria nauseosa	364
Atriplex canescens	691
Lycium pallidum	36
Chrysothamnus greenei	145
Opuntia spp.	127

2. Piñon juniper woodland vegetation type.

The *Pinus edulis* (piñon) and *Juniperus monosperma* (juniper) trees form open to very open stands, with their crowns not usually touching. Piñon-juniper (PJ) woodland vegetation type is common along the ridges and at lower elevations on southeasterly facing slopes. The forb and grass layer is often sparse. Understory plants tend to be widely spaced with stands of shrubs in the gaps within the tree canopy. In some areas, microbiotic crusts composed of various species of cyanobacteria, lichen, and moss (all discernable with the naked eye) cover the soil surface in this vegetation type.

Frequent understory shrub species include *Atriplex canescens, Chrysothamnus greenei,* and *Gutierrezia sarothrae*. *Cercocarpus montanus, Purshia stansburiana, Fallugia paradoxa* and *Yucca* species were less common. *Opuntia* species (pricklypear) and *Echinocereus triglochidiatus* (kingcup or claret cup cactus) individuals were common succulent species. A few *Echinocereus fendleri* individuals were encountered in this vegetation type in Section 10. The most common grasses were *Bouteloua* species, *Achnatherum hymenoides* and *Elymus elymoides*. *Lycurus setosus* and *Schizachyrium scoparium* were common in this vegetation type in Section 10. The percent cover is listed in Tables 13 and 14 on pages 34-35 and the shrub densities are described in Table 15 on page 36.

Table 13. Percent cover in the piñon juniper woodland vegetation type.

Cover/Species	**Percent cover**			
	Mean	**Std dev**	**Median**	**Mode**
Bare ground	47.0	15.5	48	48
Gravel	1.8	3.1	0	0
Rock	1.2	3.0	0	0
Litter	32.5	5.1	32	28
Microbiotic crust	3.2	3.5	2	0
Moss	0.2	0.6	0	0
Xanthoparmelia chlorochroa	4.0	6.1	0	0
Grasses				
Aristida purpurea	0.5	0.9	0	0
Bouteloua spp.	26.7	12.0	27	26
Pleuraphis jamesii	0.8	1.8	0	0
Muhlenbergia torreyi	0.3	0.8	0	0
Sporobolus cryptandrus	0.8	1.3	0	0
Trees				
Juniperus monosperma	4.2	5.4	3	0
Pinus edulis	3.3	9.3	0	0
Shrubs				
Artemisia bigelovii	0.3	1.2	0	0
Atriplex canescens	0.3	1.2	0	0
Chrysothamnus greenei	0.3	0.8	0	0
Gutierrezia sarothrae	0.8	1.3	0	0
Forbs				
Chaetopappa ericoides	0.2	0.6	0	0

Table 14. Cover of individual species in juniper woodland vegetation type.

Species	Estimate cover
Tree	
Juniperus monosperma	1-5%
Pinus edulis	1-5%
Shrub and succulents	
Gutierrezia sarothrae	1-5%
Atriplex canescens	<1
Ericameria nauseosa var. *bigelovii*	<1
Lycium pallidum	<1
Chrysothamnus greenei	<<1
Opuntia spp.	<1
Cylindropuntia imbricata	<1
Echinocereus fendleri	<<1
Grasses	
Bouteloua sp.	25-50%
Sporobolus cryptandrus	<1
Aristida purpurea	<1
Pleuraphis jamesii	<1
Muhlenbergia torreyi	<1
Muhlenbergia porteri	<<1
Forb	
Chaetopappa ericoides	<1
Tradescantia occidentalis	<1
Dimorphocarpa wislizeni	<1
Salsola tragus	<1
Boechera fendleri	<1
Sphaeralcea coccinea	<1
Machaeranthera pinnatifida	<1
Hymenopappus filifolius	<<1
Ipomopsis longiflora	<<1
Mirabilis multiflora	<<1
Cryptantha crassisepala	<<1
Descurainia sp.	<<1
Gilia longiflora	<<1
Ipomopsis longiflora	<<1
Phacelia sp.	<<1
Astragalus sp.	<<1
Chamaesyce fendleri	<<1
Heterotheca villosa	<<1
Hymenoxys richardsonii	<<1
Mirabilis sp.	<<1
Microbiotic	
Microbiotic crust	1-5
Xanthoparmelia chlorochroa	1-5
Moss	<<0.1

Table 15. Shrub density in piñon juniper woodland vegetation type.

Shrub and tree species	**Estimated number of individuals per hectare**
Juniper monosperma	767
Pinus edulis	400
Gutierrezia sarothrae	8,000
Ericameria nauseosa	267
Atriplex canescens	633
Lycium pallidum	100
Chrysothamnus greenei	433
Opuntia spp.	133

The PJ vegetation type can be further divided at the floristic level to a PJ-*Artemisia bigelovii* association and by substrate as PJ woodland on bedrock.

a. Artemisia bigelovii

Artemisia bigelovii shrub was dominant in areas with fairly widely spaced (20-30 meters or 65-100 feet) piñon-juniper on a sandy clay soil with patches of exposed bedrock. Few other vascular plants grew in this association. Microbiotic crusts with high proportions of cyanobacteria covered the soil with little herbaceous understory. In addition to the area in Section 16 that is delineated in Figure 4 on page 17, small patches of less than an acre (0.4 hectares) were distributed under widely spaced piñon-juniper canopy at lower elevations on the south easterly facing slopes in Section 10.

b. Bedrock

PJ woodland frequently grew in areas with high amounts of rock and/or bedrock where the vegetation was concentrated within gaps in the rocks. This was especially true in Section 10, where bedrock with deep drainage channels extended over large areas. *Quercus gambelii, Quercus grisea, Quercus undulatus, Rhus trilobata* var. *trilobata, Ribes cereum,* and *Yucca baccata w*ere common shrubs in these areas. Patches of *Geranium richardsonii* (wild geranium) were common in the drainages in the bedrock. One large *Marrubium vulgare* (horehound) individual was observed in this area. This is an introduced species. However, the observation is notable because this large individual was the only one observed within the whole project site and its presence lends support to the perception that the bedrock formation provides unique habitat conditions for several different species. See the descriptions under "ponderosa pine-piñon-juniper woodland" for more details.

3. Drainage bottom/arroyo.

In general, plant species found in the drainages reflect the surrounding vegetation. The arroyo bottoms are generally either sandy or rocky. Both substrates obviously influence the extent of vegetation cover.

Atriplex canescens and *Ericameria nauseosa* are common shrubs in the drainage bottoms. *Salsola tragus, Kochia scoparia, Mentzelia multiflora* (blazingstar) and *Verbena macdougalii* (MacDougal's vervain) are common forbs that can be abundant in patches. *Pascopyrum smithii* (western wheat grass) and *Muhlenbergia porter*i were the most common grasses in the drainages.

4. Ponderosa pine-piñon-juniper mixed woodland vegetation type

Ponderosa pine-piñon -juniper mixed woodland is found at higher elevations on the mesa top and south easterly facing slopes in Sections 9 and 10. The trees (*Pinus ponderosa, Pinus edulis, Juniperus monosperma*) tend to form open stands, with crowns not usually touching. This vegetation type is distinctive from the PJ woodland since there are frequent solitary and small stands of ponderosa pine. The ponderosa pines form an additional and higher canopy layer to the pinon and juniper, which may be significant for wildlife habitat. Although it is unconventional to use the term woodland, rather than forest, when describing vegetation types that include ponderosa pine, it is used here to reflect the generally open canopy cover. Forests are differentiated from woodlands by the extent of canopy coverage. In a forest, the branches and foliage of separate trees typically meet or interlock, although there can be gaps of varying sizes within an area referred to as forest. However the tree dispersion pattern in Sections 9 and 10 is more appropriately regarded as woodland since the trees are spaced further apart so that there is a more continuously open canopy, which allows more sunlight to penetrate to the ground between them.

Dominant understory species include *Cercocarpus montanus, Purshia stansburiana, Quercus gambelii, Artemisia bigelovii, Quercus grisea, Quercus undulatus, Rhus trilobata var. trilobata, Ribes cereum* and *Yucca baccata*. Thickets of *Quercus gambelii* (Gambel oak) and *Quercus* x*pauciloba* (wavyleaf oak) are common. There are some *Juniperus scopulorum* (Rocky Mountain juniper) at the head of the drainage on the north side of Jesus Mesa (Wood 2006a). *Cheilanthes feei* (Santa Fe lipfern) and *Cystopteris fragilis* (brittle bladder-fern) are occasional in the nooks between rooks. Stands of little bluestem (*Schizachyrium scoparium var. scoparium*) were common on slopes in Section 10 (north diagonal half portion of Section 10). Data from a transect line located in this vegetation type is listed in Table 16 below.

Table 16. Sample percent cover on Transect 51 in ponderosa pine vegetation type.

Cover/Species (Transect 51)	**Percent cover**
Bare ground	34
Gravel	40
Rock	10
Litter	28
Downed wood	16
Microbiotic crust	4
Pinus edulis	12
Artemisia bigelovii	2
Gutierrezia sarothrae	2

Within this community there was bedrock formation that extends across both PJ woodland and ponderosa pine- piñon-juniper woodland vegetation types (see map in Figure 4 on page 17). See also the brief discussion under “b. Bedrock” on page 38 in the PJ woodland vegetation type.

a. Bedrock

Ostensibly the bedrock in Sections 10 and 15 is covered by either a ponderosa pine-piñon-juniper woodland (higher elevations) or pinon-juniper woodland (lower elevations) with a sparse understory of mainly shrubs. This area has been delineated on the vegetation map in Figure 4 on page 17 because it provided unique habitats and certain plant species were restricted to the drainages in the bedrock under the ponderosa pine- piñon-juniper woodland cover as shown. Species restricted to the drainages included *Typha domingensis, Juncus tenuis, Nolina greenei* (woodland beargrass), *Philadelphus microphyllus, Brickellia grandiflora, Solidago wrightii,* and *Marchantia polymorpha* (liverwort).

Initially the *Nolina* species was identified as *N. texana* but on further examination it was determined to be *N. greenei*. *Nolina greenei* was resurrected for the plants of *Nolina* that occur in central New Mexico. They are similar to *N. texana* with respect to the inflorescence contained within the leaves, persistent elongated bracts, and seeds that burst the ovary wall and remain attached. They differ primarily in their broader, slightly serrulate leaves (although some leaves may be entire), copper-colored seeds, and an open woodland-grassland habitat. *Marchantia polymorpha, a liverwort,* is most often found on moist or wet mineral soils and is known to tolerate and accumulate heavy metals (Mathews 1993).

Several seasonal catchment pools were intermittently distributed up at least two of these deep drainages.

b. Water pockets

Water pockets are cavity-like seasonal pools eroded in sandstone by runoff from steep slopes. The drainages in the bedrock formation in the southwest quarter of Section 10 contained several water pockets. Two were within 50 meters (164 feet) of each other in the same drainage. The lower one was surrounded by bedrock and had no vascular plants associated with it. The algae that grew in the water were not identified. The other two water pockets were primarily in bedrock but some soil had accumulated in them, which supported a variety of vascular plants. *Typha domingensis* (southern cattail), an obligate[3] wetland species (US Fish and Wildlife Service 1988, 1993), was a dominant species at both these water pockets. A few individual *Typha* plants extended up and down the drainage from these sites. *Juncus tenuis* (FACW-) was also present at these water pockets and extended in discrete patches both up and down the drainages from the water pockets. Other species at these sites included *Poa fendleriana* and *Descurainia obtusa.* Cheatgrass (*Bromus tectorum*) also grew near the water pockets. *Cyperus strigosus* (straw-color flat-sedge; FACW) and *Eleocharis macrostachya* (pale spikerush; OBL), were observed in this area in 2006. The leaves of these species may well have been in the drainages in 2008 but it was likely too dry for any vigorous flowering stands to develop. In this case they may have been obscured by the stands of *Juncus* and other grasses that also included *Sporobolus contractus* (scratchgrass) and *Sporobolus flexuosus* (mesa dropseed).

5. Rimrock vegetation type

Rimrock is an outcrop of a horizontal layer of resistant rock at the edge of a plateau or mesa, generally forming a cliff or ledge (Bates and Jackson 1984). This is not strictly a vegetation type since the

[3] OBL Obligate Wetland species occur almost always (estimated probability 99%) under natural conditions in wetlands. FACW Facultative Wetland species usually occur in wetlands (estimated probability 67%-99%), but are occasionally found in non-wetlands. FACW+ species are even more likely in wetlands than FACW species but can not be classed as totally obligate since some exceptions occur.

vegetation was part of either PJ woodland or ponderosa pine-piñon-juniper woodland as seen on the map in Figure 4 on page 17. However the rimrock areas were delineated on the vegetation map because they can provide unique habitat for some plant species. For example, *Astragalus naturitensis* (Naturita milkvetch) grows only on sandstone ledges and rimrock.

6. Semi-stabilized dune vegetation type

Areas of semi-stabilized dunes have been marked on the vegetation map, (see Figure 4 on page 17). *Muhlenbergia pungens* (sandhill Muhly) is a distinctive member of this vegetation type. It was also restricted to this vegetation type. The most common shrub was *Ericameria nauseosa.* In Section 9 on the mesa top, thickets of *Quercus gambelii* (Gambel oak) were common in this vegetation type. The cover on the transect lines surveyed in this vegetation type is described in Tables 17 and 18 on pages 40-41. Table 17 is an example of cover measured using the point-intercept method along 50 meter (164 feet) transect lines (6 transect lines in this vegetation type). Table 18 is an example of using visual estimation of cover over a 100 meter^2 (328 foot^2) area at 0 meters (0 feet), 25 meters (82 feet), and 50 meters (164 feet) along the transect line (see text for protocol) within the semi-stabilized dune vegetation type (6 species diversity squares in this vegetation type). Shrub densities are estimated from a 50 meters^2 or 164 feet^2 (50 meter x 1 meter, or 164 feet x 3.3 feet) band transect (average of 2 transects in this vegetation type), and are reported in Table 19 on page 41.

Table 17. Percent cover in the semi-stabilized dune vegetation type.

	Percent cover			
Cover/Species	**Mean**	**Std dev**	**Median**	**Mode**
Bare ground	49.7	11.3	45	40
Gravel	0.7	1.0	0	0
Rock	0.3	0.8	0	0
Litter	28.0	12.1	32	n/c[a]
Microbiotic crust	8.0	15.8	1	0
Grasses				
Achnatherum hymenoides	1.0	1.7	0	0
Aristida purpurea	0.0	0.0	0	0
Bouteloua spp.	13.7	11.6	11	n/c[a]
Elymus elymoides	0.0	0.0	0	0
Hesperostipa comata	0.3	0.8	0	0
Pleuraphis jamesii	0.0	0.0	0	0
Muhlenbergia pungens	9.3	13.3	6	6
Muhlenbergia torreyi	0.0	0.0	0	0
Sporobolus cryptandrus	0.7	1.0	0	0
Trees				
Juniperus monosperma	3.3	7.2	0	0
Pinus edulis	2.3	3.7	0	0
Shrubs and succulents				
Artemisia filifolia	1.3	3.3	0	0
Atriplex canescens	1.0	1.1	1	2
Cercocarpus montanus	0.3	0.8	0	0
Ericameria nauseosa	2.0	3.3	0	0
Gutierrezia sarothrae	1.0	1.7	0	0
Lycium pallidum	0.3	0.8	0	0
Opuntia spp.	0.3	0.8	0	0
Forbs				
Hymenopappus filifolius	1.3	1.6	1	0

a. Could not be calculated; each value unique.

Table 18. Cover of individual species.

Species	Percent cover	Species	Percent cover
Juniperus monosperma	1-5%	**Forbs**	
Pinus edulis	<1	*Dimorphocarpa wislizeni*	<1
Shrubs		*Hymenopappus filifolius*	<1
Gutierrezia sarothrae	1-5%	*Senecio spartioides* var. *multicapitatus*	<1
Artemisia bigelovii	<1	*Artemisia* sp.	<1
Atriplex canescens	<1	*Cryptantha crassisepala*	<1
Chrysothamnus greenei	<1	*Ipomopsis multiflora*	<1
Ericameria nauseosa var. *bigelovii*	<1	*Salsola tragus*	<1
Cercocarpus montanus	<1	*Boechera* sp.	<1
Purshia stansburiana	<1	*Descurainia* sp.	<1
Yucca sp.	<1	*Eriogonum alatum*	<1
Grasses		*Eriogonum jamesii*	<1
Bouteloua sp.	5.1-15%	*Heterotheca villosa*	<1
Muhlenbergia pungens	1-5%	*Chaetopappa ericoides*	<1
Achnatherum hymenoides	<1	*Linum puberulum*	<1
Hesperostipa comate	<1	*Machaeranthera* sp.	<1
Aristida purpurea	<1	*Eriogonum cernuum*	<1
Sporobolus cryptandrus	<1	*Phacelia* sp.	<1
Pleuraphis jamesii	<1	*Chamaesyce fendleri*	<1
Elymus elymoides ssp. *Elymoides*	<1	*Ipomopsis longiflora*	<1
Microbiotic		*Mentzelia* sp.	<1
Microbiotic crust	1-5	*Orobanche ludoviciana* subsp. *multiflora*	<1
Xanthoparmelia chlorochroa	<1	*Sphaeralcea coccinea*	<<1

Table 19. Shrub density in the semi-stabilized dune vegetation type.

Shrub and tree species	Estimated number of individuals per hectare
Juniper monosperma	1,100
Pinus edulis	500
Gutierrezia sarothrae	12,000
Ericameria nauseosa	200
Atriplex canescens	200
Artemisia bigelovii	100
Yucca sp. (narrow leaved)	200
Chrysothamnus greenei	500

On the mesa top in the northeast quarter of Section 9 the sandy areas were dominated by *Artemisia campestris* (field sagewort). The taxonomic treatments of the subspecies of *A. campestris* are various because this species is morphologically variable and prone to introgression. The subspecies in Section 9 was identified as *A. campestris* ssp. *pacifica* using the Flora of North America (Shultz 2006).

7. Disturbed Piñon-juniper mosaic vegetation type

Much of the cliff sides and lower west and southwest facing slopes in Section 9 contain historic drill hole locations from exploration within the last 40 years, although there are small areas of relict undisturbed vegetation. Varying amounts of (re)colonization has occurred over much of the disturbed area and there is a mosaic of native shrubs, grasses and forbs amongst widely spaced piñon and juniper trees. Little microbiotic crust occurs in this area. In addition to the species measured on the two transects lines surveyed for quantitative data in this vegetation type, other species that were particularly common in the area included: *Ericameria nauseosa, Chrysothamnus greenei, Bouteloua curtipendula,* and *Kochia scoparia*. The cover, recorded in Table 20 below, was measured using the point-intercept method along 50 meter (164 foot) transect lines.

Table 20. Percent cover in the disturbed piñon-juniper mosaic vegetation type.

Cover/Species	**Percent cover**		
	TX28	**TN105**	**Average**
Bare ground	44	48	46
Gravel	2	4	3
Rock	2	0	1
Litter	32	36	34
Xanthoparmelia chlorochroa	2	2	2
Grasses			
Bouteloua spp.	28	22	25
Elymus elymoides	2	0	1
Pleuraphis jamesii	10	18	14
Shrubs			
Artemisia bigelovii	2	0	1
Gutierrezia sarothrae	6	2	4
Krascheninnikovia lanata	4	2	3
Forbs			
Salsola tragus	2	0	1

8. Shrub-grassland vegetation type

Vegetation types initially classified as grasslands at the project site have been revised (Wood 2006a, Wood2006b). Because there are numerous large stands of shrubs and also many isolated individuals within the grassland matrix, this vegetation type is described as shrub-grassland and has been delineated as such in the vegetation map in Figure 4 on page 17. This vegetation type is typically found in a drainage area and on either side of arroyos where it intergrades with juniper savanna and PJ woodland within the project site.

The grass stands can be subdivided into two main types according to composition: *Bouteloua gracilis* (blue grama), with *Pleuraphis jamesii* (galleta), and *Sporobolus cryptandrus* (sand dropseed) (Wood 2006a); and *Bouteloua gracilis* with *Muhlenbergia torreyi* (ring muhly) (Wood 2006b). Relatively small areas where *Bouteloua hirsuta* (hairy grama) was a dominant grass were also observed. *Achnatherum hymenoides* (Indian ricegrass) and *Elymus elymoides* (squirreltail) were common, but never abundant in any area throughout this vegetation type. The percent cover is described in Tables 21 and 22 on pages 43-44. The cover listed in Table 21 was measured using the point-intercept method

along 50 meter (164 feet) transect lines (12 transect lines in this vegetation type). Table 22 on page 44, lists results of using ocular estimation of cover over 100 meter^2 (328 foot^2) area at 0 meters (0 feet), 25 meters (82 feet), and 50 meters (164 feet) along the transect line (see text for protocol) within the shrub-grassland vegetation type (15 species-diversity squares in this vegetation type).

Table 21. Percent cover in the shrub-grassland vegetation type.

Cover/Species	**Percent cover**			
	Mean	**Std dev**	**Median**	**Mode**
Bare ground	38.8	10	40	40
Gravel	1.2	2	0	0
Rock	0.0	0	0	0
Litter	47.3	6	49	52
Grasses				
Bouteloua gracilis	29.3	15	34	34
Elymus elymoides	0.2	1	0	0
Pleuraphis jamesii	1.2	2	0	0
Muhlenbergia torreyi	1.5	4	0	0
Sporobolus cryptandrus	0.2	1	0	0
Shrubs				
Atriplex canescens	1.5	5	0	0
Cercocarpus montanus	0.0	0	0	0
Chrysothamnus greenei	0.2	1	0	0
Ericameria nauseosus	0.8	2	0	0
Gutierrezia sarothrae	6.3	7	4	0
Krascheninnikovia lanata	0.5	1	0	0
Lycium pallidum	0.2	1	0	0
Forbs				
Cryptantha crassisepala	1.2	3	0	0
Salsola tragus	0.2	1	0	0
Microbiotic crust	0.3	1	0	0

Table 22. Cover of individual species.

Species	**Percent (%) cover**
Trees	
Juniperus monosperma	<<1
Pinus edulis	<<1
Shrubs and succulents	
Gutierrezia sarothrae	5.1-15
Atriplex canescens	1-5
Ericameria nauseosa var. *bigelovii*	<1
Krascheninnikovia lanata	<<1
Chrysothamnus greenei	<<1
Cylindropuntia imbricata	<1
Opuntia spp.	<1
Escobaria vivipara	<<1
Grasses	
Bouteloua sp.	15.1-25
Muhlenbergia torreyi	1-5
Elymus elymoides ssp. *elymoides*	1-5
Sporobolus cryptandrus	<1
Pleuraphis jamesii	<1
Sporobolus airoides	<<1
Unidentified grass	<<1
Agropyron sp.	<<1
Sporobolus contractus	<<1
Forbs	
Salsola tragus	<1
Sphaeralcea coccinea	<1
Chaetopappa ericoides	<1
Hymenopappus filifolius	<1
Townsendia sp.	<1
Cryptantha crassisepala	<1
Eriogonum rotundifolium	<1
Lappula occidentalis	<1
Senecio spartioides var. *multicapitatus*	<<1
Plantago patagonica	<<1
Annual *Atriplex* sp.	<<1
Descurainia sp.	<<1
Dimorphocarpa wislizeni	<<1
Erigeron sp.	<<1
Sphaeralcea parviflora	<<1
Sphaealcea sp.	<<1
Microbiotic	
Microbiotic crust	<1
Xanthoparmelia chlorochroa	<<1

The species and size of the shrub stands vary considerably. The most common shrub species included A*triplex canescens* (four-wing saltbush), *Ericameria nauseosa* (rabbitbrush), *Krascheninnikovia lanata* (winterfat), and *Lycium pallidum* (wolfberry). *Fallugia paradoxa* (Apache plume) was infrequent. *Artemisia filifolia* (sand sagebrush) was both common and abundant in parts of Section 10 but not elsewhere within the project site. *Cylindropuntia imbricata* (cholla cactus) individuals were infrequent within the project site. The data in Table 23 below has been presented separating the number of shrubs per hectare by location estimated from a 50 meters^2 or 164 feet^2 (50 meter x 1 meter, or 164 feet x 3.3 feet) band transect.

Table 23. Shrub density in the shrub-grassland vegetation type.

Shrub and tree species	**Number of individuals per hectare**
	Average of 2 transects in the project site
Juniper monosperma	0
Pinus edulis	0
Gutierrezia sarothrae	38,400
Krascheninnikovia lanata	100
Ericameria nauseosa	0
Atriplex canescens	5,600
Opuntia spp.	300
Cylindropuntia imbricata	0

a. Standing water (ephemeral pond)

An ephemeral stock pond in the central part of Section 16 is identified on the vegetation map in Figure 4 on page 17. This man-made cattle pond accumulates water from the drainages that lead into it. Nine saltcedar (*Tamarix chinensis*) trees are growing around the pond. Other plants dominating this man-made wetland include *Kochia scoparia* (Mexican fireweed), *Salsola tragus* (Russian thistle), and *Verbesina encelioides* (golden crownbeard). *Ericameria nauseosa* var. *graveolens* (Rubber rabbitbrush) and *Hordeum jubatum* (foxtail barley) are also present.

1.3.2.3 Productivity Measurements

Biomass measurements of grass and the vagrant lichen, *Xanthoparmelia chlorochroa,* have been analyzed and the results are described in this report. When the plant material was harvested from the exclosures an estimate of the percent cover inside the sampling square (40 cm x 40 cm or 16 in x 16 in) was made. These estimates were compared to the percent cover measured along the transect line as shown in Table 24 on page 46. In general there was more cover inside the exclosures than outside suggesting that grazing has an impact on the production even during a drought year. In some cases the difference was negligible (e.g. Exclosure 1 in PJ woodland, Table 24) whereas in others it was highly significant (e.g. Exclosure 5 in shrub-grassland, Table 24). The extent and pattern of the differences between measurements inside and outside the exclosures suggest that they are related to grazing pressure intensities. For example, the differences tended to be larger in shrub-grassland than in PJ woodland (see Table 24). It is reasonable to assume that cattle are more likely to congregate and spend

longer periods of time in more moist shrub-grassland in the valleys than on the slopes in PJ woodland where there is less herbaceous material.

Table 24. Percent grass and Xanthoparmelia chlorochroa cover.

Vegetation type	Exclosure number	Percent cover			Vegetation type	Exclosure number	Percent cover	
		Exclosure Estimate[1]	On transect				Exclosure Estimate[1]	On transect
PJ woodland	1	32	26		Jun savanna[2]	3	43	34
PJ woodland	8	70	50		Jun savanna	4	62	50
PJ woodland	8	65	50		Jun savanna	9	70	34
PJ woodland	10	85	58		Jun savanna	11	48	52
PJ woodland	21	35	30		Jun savanna	14	48	42
PJ woodland	22	40	36		Jun savanna	15	55	38
PJ woodland	23	48	38		Jun savanna	16	72	28
PJ woodland	25	56	30		Jun savanna	17	83	74
PJ woodland	33	35	8		Jun savanna	18	68	36
PJ woodland	38	60	16		Jun savanna	19	48	38
PJ woodland	39	70	22		Jun savanna	20	70	56
PJ woodland	40	55	28		Jun savanna	26	50	26
PJ woodland	44	35	18		Jun savanna	27	35	30
PJ woodland	28	70	40		Jun savanna	29	45	24
					Jun savanna	30	60	30
Shrub-grassland	5	92	44		Jun savanna	41	63	44
Shrub-grassland	24	75	54		Jun savanna	42	35	54
Shrub-grassland	31	95	12		Jun savanna	43	30	36
Shrub-grassland	32	60	18		Jun savanna	43B	---	34
Shrub-grassland	34	64	4		Jun savanna	45	47	30
Shrub-grassland	34B[4]	----	36		Jun savanna	47	28	22
Shrub-grassland	35	45	34		Jun savanna	2	70	24
Shrub-grassland	37	75	52					
Shrub-grassland	48	35	35		Dune[3]	6	62	14
Sec. 12-shrub-g[5]	7	55	26		Dune	36	90	56
Sec. 12-shrub-g[5]	12	80	48		Dune	46	95	38
Sec. 12-shrub-g[5]	13	60	34					

[1] Estimated within the 40 cm x 40 cm square within the exclosure.
[2] Juniper savanna
[3] Semi-stabilized dunes
[4] "B" indicates a second transect was surveyed in the vicinity of this exclosure.
[5] Shrub-grassland vegetation type in Section 12.

Material from the central sample area of the exclosure was divided according to whether it was grass, forb, vagrant lichen or shrub. The grass tissue was further subdivided at harvest into green grass and brown grass. The various samples were placed in separate bags and dried and weighed separately. It is apparent that the green grass represented the herbaceous (grass) production in the current year but some of the brown grass may have also been current year production since it was such a dry year. In general there was very little brown tissue as can be seen as the difference between "total grass" weight and "green grass" weight. Estimated vegetation biomass is listed in Table 25 on page 47. Units have been given in kg/ha and lbs/acre for ease of comparison with published reports in the literature.

Table 25. Vegetation biomass at Roca Honda.

Vegetation type	#	Sample	Measured g/sampling square (1,600centimeters^2 or 52.5 inches^2)	kg/ha		lbs/acre
			Mean	Mean	Std dev	Mean
PJ woodland	13	Green (current year) grass	4.1	289	118	257
PJ woodland		Total grass	4.8	333	147	271
PJ woodland		*Xanthoparmelia* (lichen)	5.6	348	570	310
PJ woodland		Total	10.4	681	604	606
Juniper savanna	21	Green (current year) grass	7.7	481	326	429
Juniper savanna		Total grass	11.2	698	518	621
Juniper savanna		*Xanthoparmelia* (lichen)	0.4	23	74	20
Juniper savanna		Total	11.5	721	497	642
Semi-stabilized dunes	3	Green (current year) grass	21.04	1315	285	1171
Semi-stabilized dunes		Total grass	28.3	1770	384	1576
Shrub-grassland	8	Green (current year) grass	7.6	478	177	425
Shrub-grassland		Total grass	10.5	653	429	582
Shrub-grassland, sec. 12	3	Green (current year) grass	7.0	437	102	389
Shrub-grassland, sec. 12		Total grass	9.0	565	110	503

[a]. # = Number of exclosures

The productivity at the site is described in Table 25 above. Range managers consider grass production to be most important since it provides forage for domestic animals. However, when considering the ground cover biomass, lichens contribute significantly to carbon and nitrogen cycling and aid in preventing soil erosion. Terricolous lichen biomass measurements are typically very difficult and can be confounded by adhering soil. However, at the project site, the macro vagrant lichen, *Xanthoparmelia*, was common and in many areas was abundant, especially in Section 16. Where it occurred within the exclosures, *Xanthoparmelia* was collected and weighed after drying. No significant amount of soil adhered to the lichen and it could be handled just like vascular plant tissue.

In PJ woodland *Xanthoparmelia chlorochroa* was only present in 5 of the 13 exclosures but was particularly dense in the areas where it occurred since it comprised half of the weight of the vegetation that covered the ground surface (5.6 grams or 0.2 ounces of a total of 10.4 grams or 0.4 ounces; see Table 25 above). When considering only the five transects on which *Xanthoparmelia* occurred, the mean weight per sampling square was 14.5 grams/1,600 centimeters^2 or 0.5 ounces/52.5 inches^2. However, its weight represents the accumulation of mass over several years. Growth rates in lichens are not well documented. *Xanthoparmelia* species apparently grow more rapidly than other lichen species but most research has been conducted on saxicolous species when they grow in all directions at just over 2 mm per year (Benedict 2008). *Xanthoparmelia* was less abundant in juniper savanna and essentially absent from the other vegetation types.

Bouteloua species, *Pleuraphis jamesii* and *Muhlenbergia torreyi*, in various proportions, comprised the grass samples in all the exclosures except for those in the semi-stabilized dune vegetation type.

Muhlenbergia pungens was the grass species in the samples in the semi-stabilized dune vegetation type.

Herbaceous forage production ranged from a mean of 333 kilograms/hectare (297 pounds/acre) in PJ woodland to 1,770 kilograms/hectare (1,579 pounds/acre) in the semi-stabilized dunes. The juniper savanna and shrub-grassland vegetation types at this project site have many similarities to a short grass steppe vegetation type in Colorado and a *Bouteloua-Aristida* shortgrass prairie in northern Mexico. Average forage production over a 51 year period was reported to be 750 kilograms/hectare (669 pounds/acre) on an ungrazed short-grass steppe site in north-central Colorado where *Bouteloua gracilis* was the dominant grass species (Milchunas et al. 1994). Herbaceous (*Bouteloua hirsuta* and *Aristida* spp.) production was 600 kilograms/hectare (535 pounds/acre) on a native shortgrass prairie community in northern Mexico (Corronado and Romo 2001). These values are comparable to the mean production value of 698 kilograms/hectare (623 pounds/acre) estimated within the juniper savanna and 658 kilograms/hectare (pounds/acre) in the shrub-grassland at this project site.

1.4 Field Data Collection Forms

The "Plant Community Form" in Table 26 on pages 49 includes general vegetation composition, the dominant plant species, characteristic topography, soil types, average slope, aspect, and interspersion with, or relationship to, other community types. The "Transect Data Collection Form" in Table 27 on page 50 captures data from the point-intercept method. Both these forms were used at the project site to uniformly record field data by all field technicians, then collected and collated for data entry and analysis.

Table 26. Plant Community Form.

Map Site #	UTM Northing	UTM Easting	Date
Surveyor name(s)			
Community type:			
Erosion:			
Disturbance:			
Topography:			
Average slope(s):	%	%	
Soil types:			
Aspect:			
Interspersion with or relationship to other community types:			
General vegetation composition:			

Square Plot 1

To determine relative abundance (dominance):					
Plant species	%	Plant species	%	Plant species	%
..					
..					
..					
..					
..					
..					
..					
..					

Map Site #	UTM Northing	UTM Easting	Date

Square Plot 2

To determine relative abundance (dominance):					
Plant species	%	Plant species	%	Plant species	%
..					

Square Plot 3

To determine relative abundance (dominance):					
Plant species	%	Plant species	%	Plant species	%
..					

Trees and Shrubs

Tree species	Number in 20-m × 50-m belt
Shrub, sub-shrub, succulent species	**Number in 1-m × 50-m belt**

Table 27. Transect Data Collection Form.

Site #:		**Date:**	**Surveyors**	
Site location:				
Community:				
Notes:				
Transect orientation:				
Transect coordinates:	**Northing:**	**Easting:**	**Northing:**	**Easting:**

Cover/Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Bare ground																																																		
Rock																																																		
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