

ERO RESOURCES

Environmental Analysis of Shanahan Ridge
OSMP Studies 410

Study 
ERO Resources Corporation

PC

ENVIRONMENTAL Analysis of Shanahan Ridge and Adjoining Open Space Lands and Evaluation of Trailhead Alternatives



Prepared For:

City of Boulder
Real Estate/Open Space Department

Prepared By:

ERO Resources Corporation

In Association With:

Shalkey Walker Associates, Inc.
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June 1992

MEMO

TO: Luther Green

FROM: Environmental Review Team

DATE: June 26, 1992

RE: Responses to OSD staff comments not incorporated into
Final Shanahan Ridge Open Space Report

p. 16, ¶ 3 Does this document really address plant associations?

The report does not use the concept of plant associations in discussing the vegetation within the project area. Vegetation types are used to describe existing plant communities following the habitat type classification system previously developed for the Boulder Wildlife Habitat Database. However, the state, through the Colorado Natural Areas Program, has compiled a listing (though somewhat dated) of plant associations of special concern. The CNAP inventory listed, and our survey confirmed, the occurrence of the big bluestem-Indian grass association within the study area and we thought it should be mentioned as a sensitive site feature. It has been retained in the final report.

p. 7, ¶ 3 Did the soils mapping in this area map the wetlands appropriately?

SCS soils mapping was fairly accurate in indicating the location and approximate configuration of the large wetland units in the southeastern portion of the study area. The report's Vegetation Maps should be used for the most accurate location of wetland areas.

ENVIRONMENTAL ANALYSIS OF
SHANAHAN RIDGE AND
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EVALUATION OF TRAILHEAD ALTERNATIVES

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Soils and Erosion Hazard (Southern Section)
Existing Recreation Resources (Northern Section)
Existing Recreation Resources (Southern Section)
Vegetation (4 sheets: NW, SW, NE, SE)

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INTRODUCTION

The City of Boulder Open Space Department (OSD) has requested an environmental analysis of the Shanahan Ridge and adjoining open space lands. The OSD needs the following information relative to the natural resources of the area:

- Effects of current recreation use on the environmental resources of the area;
- Identification of natural resources in the area that are potentially sensitive to visitor use;
- Determination of the likely effects of increased visitor use on these resources;
- Recommended methods for monitoring impacts;
- Recommendations for mitigating current or potential future impacts;
- An analysis of the potential effects of four identified trailhead alternatives.

OBJECTIVES

This analysis is based on the goal of maintaining the environmental integrity of the site by maintaining, restoring, and improving the site's natural resources and mitigating adverse impacts to those resources due to existing as well as future facility siting, past and future visitor use or other past disturbances. We recognize that the purposes and goals of the OSD are many and varied, and that competing goals and uses can conflict. This report is not an attempt to balance competing or conflicting goals and uses but focuses upon the conservation and management of natural areas on open space lands.

This report addresses:

- sensitive plant communities and/or wildlife habitat;
- flora and/or fauna of special concern;
- aquatic and wetland resources;
- general aesthetics.

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The overall goal of this analysis is to provide the OSD with natural resource information and recommendations that will assist them in responding to their short-term needs and long-term management plans. To meet this overall goal we identified the following objectives:

- Create a baseline map of the site that shows: 1) vegetation/habitat types; 2) soil erosion hazard areas; and 3) existing trails.
- Collect and present information that builds on existing OSD programs and capabilities.
- Identify areas that are sensitive to visitor use.
- Identify adverse impacts to the site by historical and current use.
- Determine potential adverse impacts to natural resources from projected developments and use.
- Develop recommendations for management, monitoring and mitigation measures.
- Develop a field research design to determine the effects of trail use on wildlife observability.

The most immediate OSD need is to evaluate each of the four proposed trailhead alternatives and to provide recommendations from a perspective of maintaining the integrity of the environmental resources of Shanahan Ridge and surrounding open space area.

SITE DESCRIPTION

The study area includes approximately 1,500 acres designated as City of Boulder Open Space. The study area is generally bordered by a power transmission corridor to the west, Bear Canyon to the north, the Shanahan Ridge subdivision to the north and east, and South Boulder Creek to the south and east (Figure 1).

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Figure 1. General site location and study area.

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The study area is dominated by 5 major landscape features:

1. Bear Canyon and its lush narrow riparian corridor.
2. Fern Canyon and its narrow shaded riparian corridor.
3. The ponderosa pine savannas that grade into woodlands in the northern portion of the study area.
4. The broad tallgrass prairie in the southeastern portion of the study area that merges with the ponderosa pine savanna to the north.
5. The South Boulder Creek floodplain and its riparian forest that forms the southeast boundary of the study area.

Existing Recreation Facilities and Use

Recreational facilities in the study area include only trails and trailheads. Four designated OSD trails traverse the site, including the North and South Forks of Shanahan, Big Bluestem and South Boulder Creek trails. The site is also bordered on the north by Bear Canyon trail, and on the extreme southeast by the Mesa trail, both also designated OSD trails. In addition to designated trails, there are a large number of social trails on the site, particularly where the study area abuts residential development. These social trails are mapped on the accompanying graphics (Existing Recreation Resources Map, under separate cover). There are two designated trailheads that access the site directly: the Open Space Operations Center (OSOC), and the Shanahan Ridge trailheads. Access can also be gained via South Mesa trailhead and at 14 unauthorized, but well used, locations from the Shanahan Ridge residential area.

Most trails on the site, designated and social, are relatively unimproved, except for most of the North Fork Shanahan, some of the South Fork Shanahan, and about the eastern half of the Big Bluestem trails. These trails are essentially mineral surface maintenance roads. Nearly all of the other trails (designated or otherwise) are unsurfaced, with a few

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spot drainage and erosion improvements. The condition of the surfaced trails is good to excellent. Most of the unsurfaced trails are currently in reasonable condition, but signs of increasing use and localized erosion would suggest that maintenance of these trails will become increasingly difficult in the future.

Off street parking is available only at the OSOC trailhead, where a well appointed off street lot is located. Parking is occurring in numerous other locations in the Shanahan Ridge residential area, mostly along residential streets. This residential street parking is apparently legal in most locations.

Agriculture

According to Boulder Open Space ownership and land use records, the easternmost and most of the southern part of the study area (in Sections 17, 19, and 20) is fenced and currently leased and utilized for livestock grazing. These are typically 20-year leases (with expiration in 1998) and cattle are rotated between properties within the study area over a six to ten month period each year. During the field visit in May, about 50 head were observed on the Dover-Blacker property, and about 40 head on the THP parcel (all in the SE $\frac{1}{4}$ of Section 17). Other than the usual curiosity of livestock with humans, there have been no reports of negative incidents between cattle and people. Livestock trails predominant along fence lines have resulted in degradation of some drainageways and potential wetland areas in Section 20.

PROPOSED DEVELOPMENTS

Four trailhead alternatives have been considered by OSD and a citizens' committee to allow better access to the Shanahan Ridge open space area, alleviate parking and traffic problems, private property trespass, and resource degradation (Figure 1). The proposed trailheads were evaluated primarily for their potential effects to natural resources and

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open space integrity, and secondarily for their effects on recreation and areas outside of the study area. Many of the impacts to natural resources observed in the study area are directly or indirectly the result of recreation use and future impacts will be influenced by changes in recreation use (e.g., facilities, activities, levels of use, and location).

METHODS

Information on existing vegetation and wildlife and the effects of recreation use on the site's natural resources were generated primarily from site visits in April and May 1992 and the professional experience and expertise of the principal investigators. Information on soil erosion hazards and species of special concern were primarily based on existing references and previous studies.

Vegetation

Vegetation types were mapped on 1" = 200' blue-line copies of October 1991 aerial photography. Vegetation types were based upon the habitat type classification (map unit names and abbreviations) used in the recently developed Boulder Wildlife Habitat Database (City of Boulder, draft document, September 1990). These vegetation types were used in this study with limited modification to provide continuity with an ongoing Boulder program.

Information on plant species of special concern was based on descriptive and map data provided by the Colorado Natural Areas Program (CNAP). Additionally, personal communications with Janet Coles (CNAP) and Tamara Naumann (OSD) were used to identify the potential for occurrences of plant species of special concern in the study area.

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Wildlife

The evaluation of wildlife habitats was based on four site visits that were conducted in late April and early May 1992. The emphasis of the field work was directed toward identifying important habitats, assessing the potential impacts to wildlife or wildlife habitats associated with each of the four proposed trailhead alternatives, and obtaining a list of species for the area.

Recreation and Visual Resources

The study area was visited on three separate occasions in late April 1992. Aerial photography was used to map social trails, and all designated and social trails were walked. Observations were made on trail use and condition. Based on field observations, discussions with OSD personnel, intra-team discussions, and past experience, recommendations have been made to help solve the near-term issue of access and long-term goal of natural resource management.

Soils

The soils evaluation was performed using existing information supplied primarily from the Soil Conservation Service (SCS). This includes the Boulder County soil survey and soil interpretation records for each soil type occurring in the study area (SCS; 1975, 1986, 1990). Field visits were conducted on May 1 and 2, 1992 to observe site characteristics and to update the soils map including potential wetland areas.

MAPPING

A project base map was prepared for the study area at a scale of 1 inch = 400 feet by photographically enlarging a standard U.S.G.S. 7.5 minute quad. Recreational features and soils were mapped as separate overlays to this map. Separate map layers will

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facilitate AutoCAD/LandCadd data entry if desired at a future date. Vegetation types have been mapped on an enlarged photographic base at a scale of 1 inch = 200 feet.

EXISTING NATURAL RESOURCES

The study area is a valuable regional resource due to its large size, linkage with other open space and mountain parks properties, and diversity of habitats. The study area provides habitat for species that typically require large areas, and the study area's location at the juncture of plains and mountains furnishes an excellent example of the diverse foothills environment. The site is dissected by Fern Canyon and bordered by Bear Canyon to the north and South Boulder Creek to the southeast, which provide diverse riparian and moist canyon habitats juxtaposed with the more arid foothills environment. The study area supports a prairie dog preserve and a tallgrass natural area. The study area is also rich in beautiful vistas of adjoining open space as well as the Boulder Valley. Numerous cultural resources, remnants of prior settlement, occur in the study area, which adds to the site's rich tapestry of resources.

Vegetation

The vegetation within the study area is diverse. Seventeen different vegetation types were mapped (Appendix A and Vegetation Map under separate cover) within the study area. The majority of the study area is mapped as either ponderosa pine savanna, tallgrass prairie, or mixed grass prairie.

Several occurrences of vegetation associations add to the uniqueness and importance of the study area as a regional resource.

1. Expansive areas of tallgrass prairie.
2. Large areas of wetlands and wet tallgrass prairie.

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3. Narrow moist canyons that support remnant elements of what is now considered eastern deciduous woodland flora.
4. A highly productive ponderosa pine forest.

All of these elements are related to moisture. The study area appears to have increased levels of moisture relative to most of the foothills region. The increased levels of moisture are most likely due to seeps, particularly in the eastern and southern portions of the study area, and leakage from the water tank. Topography, geology, and landscape position enhance the potential for groundwater discharge. It is obvious that snowmelt and precipitation from the mountains to the west is funneled through much of the site. Additionally, the lower bench, where the majority of the wetlands occur, forms a landscape where drainages tend to become diffuse, channels are often poorly defined or non-existent, and water is retained within the area.

Tallgrass prairie. Although xeric tallgrass lands occur along the foothills throughout Colorado, wet (mesic) tallgrass areas are known in Colorado only from the foothills area of Boulder and Jefferson Counties and the Republican River drainage of Kit Carson and Yuma Counties (Bunin 1985). The seeps and drainages that occur along the eastern and southern portions of the site support the wet tallgrass areas.

Some of the areas that were historically wet tallgrass areas have been colonized by arctic rush (*Juncus arcticus*), Kentucky bluegrass (*Poa pratensis*), redtop (*Agrostis alba*), and Canada thistle (*Cirsium arvense*). The combination of disturbance (primarily grazing) and moisture has favored colonization by these less desirable species. Although arctic rush is a native species, it will aggressively colonize wet overgrazed areas and, once established, compete with the native species that were historically dominant on the site, in this instance, native tallgrasses.

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The large area of tallgrass prairie (approximately 600 acres) is important for long term management considerations. The tallgrass prairie is not only a remnant of a once more extensive eastern and midwestern North American flora that once contacted the Rocky Mountains, it also developed under a regime of disturbance from fire and grazing. If these relict populations are to be maintained, the disturbance will need to be continued and a larger unit is more effectively managed for periodic disturbance.

Moist Canyons. The narrow moist shaded ravines of Fern and Bear Canyons, in addition to providing diverse moist habitats juxtaposed with the surrounding arid environments, also support at least one element of the eastern deciduous woodland flora, hazelnut (*Corylus cornuta*) and may support other species more typical of eastern flora.

Productive Ponderosa Pine. The ponderosa pine savanna and forest types in the study area have an unusually high rate of productivity. Throughout much of its range, natural regeneration of ponderosa pine is usually slow and frequently uncertain (Harrington and Kelsey 1979). Alexander (1986) determined that low fertility of most soils in the Front Range results in timber production potentials that vary from below average to very low. Most of the ponderosa pine along the Front Range became established after cutting or wildfires in the late 1800s. Only about one percent of the Front Range ponderosa pine is classified as seedling and sampling stands that originated after cutting or fire (Alexander 1986). Much of the study area with its high rate of reproduction would be considered part of this one percent. Natural reproduction success of ponderosa pine depends on an ample seed supply and adequate moisture for germination and survival, conditions that seldom coincide. Typically, ponderosa pine produces good seed crops only at intervals of 3 to 4 years, with lighter crops in some of the intervening years. Germination is very moisture dependent (Alexander 1974).

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The size and age class distribution of ponderosa pine for the study area varies from seedlings and saplings through pole timber and young to early mature trees. The study area lacks fully mature and decadent trees. The high rate of reproduction success and varied age classes presents opportunities and problems. Reproductive success helps to insure future healthy mixed aged stands of ponderosa pine, but without a controlling factor (e.g., disease, fire, or timber management) the ponderosa pine savanna will eventually become a closed canopy ponderosa pine forest that is continually building fuels, eliminating the relatively unique tallgrass understory, and will be more prone to disease.

Wetlands. Extensive wetlands in the Boulder area are typically associated with the floodplain of major drainages, irrigation, or lake margins. Large, shallow marshes associated with natural seeps and groundwater discharge areas are not common in the Boulder area but are common within the southeastern portion of the study area. These wetlands range from less than one acre to 25 acres and are dominated by arctic rush (*Juncus arcticus*), Nebraska sedge (*Carex nebraskensis*), and spikerush (*Eleocharis macrostachya*). They support shallow, seasonal marshes that are important to amphibians.

Wildlife

Overall, the wildlife value of the Shanahan Ridge study area is exceptionally high. In terms of wildlife, and wildlife habitat diversity, this site should be considered one of the best parcels of city open space. Many species of game and non-game wildlife occur on the site. Also, because it is a large area (approximately 2 square miles) and adjacent to extensive mountain park and open space to the north, south, and west, the site provides a considerable amount of protection for sensitive wildlife species: foxes, coyotes, mountain lion, black bear, raptors, and for mule deer during the spring fawning period.

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The wildlife habitats within the site boundaries are described here in terms of three major units: the ponderosa pine forest (including the associated shrubby draws, and the open parks); the Foothills grassland (including the shallow depressions of mesic vegetation on the lower, flatter areas in the eastern-most locations); and the riparian areas (particularly the large cottonwoods along South Boulder Creek, and the more densely vegetated areas of lower Bear Canyon).

The ponderosa pine forest is dense in the western section of the property, but quickly grades into a more open savanna type as it gives way to the prairie grassland. Wildlife species characteristic of the ponderosa forest include the Abert's squirrel, Western tanager, and pygmy nuthatch. Other species often seen here include the mule deer, coyote and, in recent years, even the mountain lion. Songbirds are common, especially in the more shrubby areas and along the drainages. Bear Canyon and Fern Canyon probably support the highest diversity of wildlife that occurs within this habitat. These drainage systems contain a greater variety of vegetation and microhabitats than exists throughout most of the ponderosa pine forest.

The foothills grassland occurs predominantly in the eastern portions of the site. The overlap of the ponderosa pine with the grassland creates a broad ecotone that is of considerable interest from a wildlife standpoint. This is a zone of overlap for many mountain and grassland wildlife species. Birds migrating along the foothills are frequently encountered in this overlap zone, particularly in the protected draws and in depressions containing open water. Commonly seen wildlife that have strong grassland affinities include the western meadowlark, vesper sparrow, and black-tailed prairie dog. A prairie dog preserve is established near the east end of Big Bluestem Trail (see Vegetation Map, NE sheet, under separate cover). Although amphibians and reptiles tend not to be numerous anywhere in the region, bullsnakes and western chorus frogs

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can be commonly found in lower grassland areas, particularly during the spring. Other species likely to be numerous include Woodhouse's toad, the Eastern yellow-bellied racer, and several species of garter snakes.

The cottonwood riparian woodland that occurs along South Boulder Creek is likely to contain the highest diversity of wildlife of the entire site. It is a relatively small area, however, and has been degraded by past agricultural and other human uses. A number of houses also closely border the stream. Wildlife commonly seen in the cottonwoods and associated thickets include a wide variety of songbirds, both nesting species as well as migrants. Waterfowl and other water birds use the area, although they do not occur in large numbers. Deer and other larger mammals can be found occasionally, attracted by the cover and water that is otherwise limited throughout the surrounding grassland. This area is an important wildlife movement corridor which links the forest and grassland. Cottonwood riparian areas are of considerable importance to wildlife because they provide cover, vegetational diversity, nest sites and, frequently, open water. These areas deserve to be protected from tree cutting, understory clearing, grazing, and other activities that result in habitat degradation.

Wildlife of the Shanahan Ridge Site. The species lists presented in Appendix B as Tables B-1, B-2, and B-3 include species of potential occurrence within the Shanahan Ridge study area as well as species that were identified during the four spring site visits. Species identified this past spring are marked with an asterisk. Additional species previously identified by Open Space personnel are marked with a plus sign. It should be emphasized that these lists are by no means complete. The potential species (those unmarked) represent a listing based on wildlife that are known to occur in similar habitats within the region. As such, these lists are realistic and give a good idea of the species that likely occur on the site.

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Soils

The study area is composed of eight soil map units (Table 1). Five of the units are soil consociations, two map units are miscellaneous land types, and one unit is a soil-rock outcrop complex. These are delineated on the Soils and Erosion Hazard Map (separate cover) for the study area. The map was generated from the SCS soils map and adjusted after the field visit to more accurately tie the map units to landforms, and to delineate smaller dissimilar inclusions such as wet areas.

Most of the study area is comprised of pediment slopes below the foothills. Deep gravelly terraces flank the property to the north, and a relatively narrow floodplain occurs along South Boulder Creek. Soil materials originate from alluvium derived dominantly from granite and sedimentary rocks. Surficial conditions are generally very cobbly to stony. Many seep areas on the pediments have produced wetlands.

Goldvale soils are mapped in conjunction with rock outcrop (map unit GrF). These soils are deep and clayey, but have a stony sandy loam surface. They occur on moderately to steeply sloping forested foothills, and have rapid runoff, high available water capacity, and a high risk of erosion. Kutch soils (KuD) only occur in a small area along the southeast edge of Shanahan Hill. They are moderately deep clayey soils and have rapid runoff, moderate available water capacity, and a high risk of erosion. Nederland soils (NdD) comprise the bulk of the study area. They are deep and cobbly, and have slow to medium runoff, moderate available water capacity, and a slight risk of erosion. Niwot soils (Nh) are deep, sandy, and somewhat stony soils that occur on low terraces and floodplains. They have slow runoff, low to moderate available water capacity, and a slight risk of erosion. Because of proximity to South Boulder Creek, some areas where Niwot soils occur are subject to flooding or prolonged periods of wetness. As a result,

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this soil series has been identified by the SCS as a hydric soil. Valmont soils (VaB, VcE) are not extensive in the study area. They are deep clayey to loamy soils that occur on alluvial fans and along drainageways. These soils have medium to rapid runoff, moderate available water capacity, and a moderate risk of erosion.

Table 1. Soil map unit legend.

Map Unit Symbol	Map Unit Name
Cu	Colluvial land
GrF	Goldvale-Rock outcrop complex, 9 to 55 percent slopes
KuD	Kutch clay loam, 3 to 9 percent slopes
NdD	Nederland very cobbly sandy loam, 1 to 12 percent slopes
Nh	Niwot soils, 0 to 1 percent slopes
Te	Terrace escarpments
VaB	Valmont clay loam, 1 to 3 percent slopes
VcE	Valmont cobbly clay loam, 5 to 25 percent slopes

Soils in the Colluvial Land map unit (Cu) are variable in depth and texture. This unit occurs on sloping land below mesas and hogbacks. The map unit was rated as having rapid runoff and high erosion hazard. The Terrace Escarpment (Te) map unit is somewhat steeper than Colluvial Land, and is composed mainly of shallow, stony soils. These soils have rapid runoff, low available water capacity, and severe erosion hazard.

Recreation and Visual Resources

The study area possesses a variety of terrain ranging from South Boulder Creek and its associated riparian communities to rolling grassland and steep foothills with ponderosa pine communities, all in generous quantity. Observations indicate that the wooded areas in the north and west portions of the study area seem to be more popular to visitors than

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the grasslands to the south and east. The riparian areas along South Boulder Creek also appear to receive limited visitation. The broad grasslands of the study area seem to be utilized mostly as through routes - - the trails in these areas are more likely to be utilized by equestrians and joggers, whose primary focus is the activity of getting from one place to another and secondarily observing the environment.

The views from almost every portion of this site are outstanding, and vantage points are too numerous to count. Additionally, there are numerous recognizable historic cultural sites existing on the site within the study area ranging from rock fences to old building foundations. Each of these is visually interesting and these sites tend to exist on portions of the study area that otherwise may be relatively uninteresting to many visitors due to the relatively homogenous grassland habitat.

The site is highly accessible, with designated trailheads on the south (South Mesa trailhead), the east (OSOC trailhead), and the north (Shanahan Ridge access and a multitude of undesignated access points). Only the access situation from the north is problematic.

SENSITIVE SITE FEATURES

Plant Species of Special Concern. A population of bird's-foot violets (*Viola pedafida*) occurs in the southwestern portion of the study area (see Vegetation Map, SW Sheet, under separate cover). The bird's-foot violet is considered a species of special concern by CNAP and is included on State List 3, which includes plant species that appear to be rare but for which information is lacking. The violet typically occurs along the edges and overhangs of large boulders, usually on the shaded north-facing side.

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Two species that were once considered very rare in Colorado (Weber 1976) have recently been determined locally abundant in the foothills environment of the Boulder area. Small-leafed false indigo (*Amorpha nana*) has been reported in several locations in the vicinity of the study area (Bunin 1985). Small-leafed false indigo was observed throughout the study area in open rocky habitats typically mapped as open shrub/grassland or ponderosa pine savanna. *Amorpha nana* is listed by the Boulder County Comprehensive Plan (1991) as a "plant species of special concern in Colorado," although it is no longer listed by the State (CNAP 1991). The largest population was observed in the southwest portion of the study area on a hill along the transmission corridor. Prairie dropseed (*Sporobolus heterolepsis*) is now described as locally abundant in tallgrass prairie remnants at the base of the Front Range (Weber 1990) and occurs throughout the study area in areas mapped as tallgrass prairie and mixed grass prairie, and appears to readily colonize disturbed areas.

Plant Associations of Special Concern. The big bluestem-Indian grass (*Andropogon gerardi-Sorghastrum nutans*) wet tallgrass prairie occurs within the Tallgrass Prairie Natural Area (see Vegetation Map, SE Sheet, under separate cover) and is considered a plant association of special concern in Colorado (CNAP 1991) with a rank of SA2 (generally less than 6 known occurrences or small acreage and requires management protection) and is also considered a plant association of local significance by Boulder County (1991). The wet tallgrass prairie type also occurs to a limited extent in Shanahan Ridge City Park.

Uncommonly Occurring Plant Species. Bear and Fern Canyons support populations of hazel nut (*Corylus cornuta*). Although not rare, hazelnut is limited in Colorado to cool moist shaded ravines in the foothills, and represents elements of the flora of eastern

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North America surviving from Pleistocene times when the eastern woodland flora contacted the Rocky Mountains.

Wetlands. Large wetland complexes (from less than one acre to 25 acres) occur in the southern and eastern portions of the study area (see Vegetation Map, Sheets SW, NW, and NE, under separate cover). These areas are dominated by sedges, arctic rush, spikerush, and prairie cordgrass (*Spartina pectinata*). The wetlands' importance to the study area is primarily as wildlife habitat, in particular amphibians and some birds (blue-winged teal, snipes, and killdeer). Shallow seasonal water, suitable for amphibian reproduction, is a habitat that is becoming increasingly scarce nationally and regionally, due to filling of shallow depressions, altering of hydrologic regimes that support these areas, and altered surrounding habitat that links these seasonal marshes.

Riparian Corridors. All of the riparian corridors (South Boulder Creek, Fern Canyon Creek, and Bear Canyon Creek) are in relatively good condition. Cottonwoods and other woody species are reproducing and there appears to be multiple age classes of woody vegetation. Degradation of these riparian areas are minimal at this time, but care should be taken to discourage concentrated visitor use in these areas. The riparian corridors are sensitive habitats because of use of the corridors by a wide variety of species.

Sensitive wildlife habitat features. As previously mentioned, the study area in its entirety is a high quality wildlife area. Some of the areas that are particularly sensitive have already been described, notably Bear Canyon, Fern Canyon, the moist lowland drainages in the grassland habitats, and the cottonwood riparian along South Boulder Creek. Additionally, old ponderosa pine trees and old cottonwood trees, including dead trees, should be considered sensitive microhabitat features. These old trees provide valuable wildlife nesting, perching, and denning habitat, and should be left standing unless they

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represent a significant safety hazard. Similarly, small areas of rock outcrops, stone piles, and dense thickets should be preserved as these sites provide important reproductive habitat for birds, mammals, reptiles, and amphibians.

The design of trails and other facilities should attempt to avoid these sensitive areas if at all possible. As a general rule, the best locations for trails would be in the upland ponderosa pine, and within the drier and more sparsely vegetated prairie grassland.

Soils and erosion hazard. Presented in Table 2 are soil properties and interpretations germane to the intended use of the soils. The ratings are based on restrictive soil features such as wetness, slope and surface soil texture. Flooding is not considered in the ratings; however, areas subject to flooding are limited for use depending on duration, intensity, and seasonality of flood events. Onsite assessments of these features is essential for planning.

Risk of erosion considers both the erodibility of the soil by water, and landscape features. The K factor indicates the susceptibility of unprotected soil to sheet and rill erosion by water. Estimates are based primarily on soil texture. The higher the value, the more susceptible the soil is to erosion by water. The erosion hazard for each map unit reflects the combination of surface texture, slope, and runoff. As shown on the Soils and Erosion Hazard Map (separate cover), map units GrF, KuD, Cu, and Te are particularly susceptible to erosion if disturbed. This is due primarily to steep slopes and erodible surface soils. Under natural conditions, the rock and vegetative cover has provided adequate protection from heavy rainfall events and snowmelt. As noted on the Soils and Erosion Hazard Map (separate cover), there are several areas of severe gully erosion and slumping in map unit Te.

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Table 2. Soil properties and interpretations for recreation development.

Map Unit	Risk of Erosion		Limitations for:		Hydric Soils	
	K Factor ¹	Hazard	Trails	Picnic Areas	% of Unit	Landscape Position
Cu	NR	high	moderate	moderate	--	--
GrF	.17/.20	high	severe	severe	--	--
KuD	.32/.24	high	slight	slight	2	swales
NdD	.05/.05	slight	slight	moderate	3	swales
Nh	.24/.10	slight	moderate	moderate	80	floodplains, low terraces
Te	NR	high	severe	severe	--	--
VaB	.24/.28	moderate	slight	slight	5	low terrace
VcE	.10/.28	moderate	slight	moderate	4	low terraces

¹Surface value/subsurface value; NR = not rated.

Limitations for trails and picnic areas refer to the suitability of soil factors that affect this use. A slight limitation indicates that soil properties are generally favorable. Conversely, a severe limitation means that special design, intense maintenance or costly soil reclamation, or a combination of these, is usually required. These are areas of heavy foot traffic and should require little or no cutting or filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface. Except for map units Te and GrF, which have steep slopes, all map units pose little to no restrictions for development.

The map units GrF and Te were rated as severe for trail and picnic area usage because of steep slopes, large rocks, and the high risk of erosion if disturbed. Placement of trails

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through these map units will require erosion control protection. The map unit Cu was rated moderate because of large stones, moderate slopes, and the erosion hazard. As above, care should be taken to minimize erosion if developed. Niwot soils (Nh) were rated moderate for both uses due to seasonal flooding and wetness in areas close to South Boulder Creek. In the context of natural resource conservation, however, these soils should be avoided to prevent disturbance to the riparian area. Though rated as having slight limitations for trail and picnic area uses, Kutch soils (KuD) are highly erodible. Because of their location and limited extent in the study area, these soils are not likely to be impacted. Valmont soils (VaB, VcE) are moderately erodible, and pose few problems for development other than normal erosion control practices. Nederland soils (NdD) are best suited for trail and picnic area development because of favorable slopes and low risk of erosion. These are the soils upon which the majority of the current trail network occurs. The presence of stones and boulders may impact facility placement.

Hydric soils are highlighted in Table 2 to indicate potential wetland areas. Wetland areas should be avoided for development due to both their importance as unique ecosystems and because of the limitations for development posed by wetness and flood hazard. In the Shanahan Ridge area, these areas occur in map units Nh (along South Boulder Creek) and inclusions of swales and drainageways in map units NdD, KuD, VaB, and VcE. The drainageways through the southern half of the study area should also be avoided.

IMPACTS TO NATURAL RESOURCES

The existing impacts to natural resources are related to several factors, some of which are readily correctable and others which are unlikely to be altered, at least not in the near future.

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Recreation

Unregulated visitor use has adversely affected the study area, particularly along the northeastern boundary of the study area where numerous social trails exist (see Existing Recreation Resources Map, under separate cover). Many of these trails occur on highly erosive rocky soils and are causing erosion and trail maintenance problems.

Livestock Grazing

A past history of localized excessive livestock grazing and moist areas has allowed the colonization of undesirable species (i.e., Canada thistle, Kentucky bluegrass, and redtop) to occur in much of the study area. It also appears that livestock grazing may have resulted in the increase of arctic rush in wet areas at the expense of native tallgrass species. This can best be observed along fence lines, e.g., the wetland that straddles the fence line south of the wood corral. Cattle appear to still be congregating in many of these wetlands, particularly the large wetland south of the stone corral. Concentrations of cattle in wetlands will continue to favor arctic rush, discourage native grasses and sedges and may, through continued disturbance, create suitable habitat for Canada thistle.

Erosion

Much of the site is susceptible to erosion if disturbed (Table 2). There are several areas of severe gully erosion and slumping within the study area (see Soils and Erosion Hazard Map, under separate cover). Many of the trails have been successfully treated for erosion.

Fire

In September 1987, a fire occurred in the ponderosa pine savanna in the northern portion of the study area resulting in an approximately 15 acre burn. Fires are common

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in the foothills and are part of maintaining the ecosystem. Quick "cool" surface fires are preferable to "hot" crown fires that kill mature trees.

Management

Lack of more than cursory timber management is having the following adverse impacts:

- accumulation of fuels
- closing of the forest canopy
- loss of the open park-like ponderosa pine savanna that is important to wildlife

If a timber management plan is not implemented, the study area will lose much of its present character and value.

ANALYSIS OF THE PROPOSED TRAILHEAD ALTERNATIVES AND RECOMMENDATIONS

The environmental evaluation team reviewed four trailhead alternative locations that had been previously selected by OSD in conjunction with a citizens' advisory committee (Figure 1). The review of each trailhead alternative focused primarily on potential effects to natural resources and open space integrity and secondarily on other issues (i.e., traffic, visual effect on adjoining neighborhood, and accessibility). Each alternative presented favorable and unfavorable features (Table 3). The team was able to reach consensus on a recommended trailhead alternative based on independent observations and joint discussions. No attempt was made to numerically rank or weigh the favorable and unfavorable features of each alternative; each alternative and its features were considered in the context of the study area, its surrounding environment and the long-term goal of maintaining the integrity of the site and its natural resources.

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Table 3. Summary of observations of trailhead options for Shanahan Ridge.

Trailhead Alternative	Favorable	Unfavorable
1 (Corral area)	Central location to lower trail system (Big Bluestem and So. Boulder Creek)	Interior trailhead disrupts the integrity of vehicleless open space
	Soils favorable for trails	Site is very "exposed" and desolate
	Level terrain	Duplicative of existing OSOC trailhead.
	Accessible from H-93	Active cattle grazing within the area
	Much of the corral area has already been disturbed by cattle	Site is not near the more popular wooded open space destinations
		Trailhead would not be visible from frequented public roads and use would be difficult to supervise
		Located in the midst of a relatively uniform habitat type, not much diversity
		Numerous seeps exist in the corral area that could create ground stability problems for a heavily used trailhead
		Wetlands would likely have to be filled and drainage patterns that feed wetlands disrupted
		Tallgrass Natural area and prairie dog preserve are nearby
2 (Shanahan Ridge Park)	Easy access via Greenbriar Drive	Loss of city park land
	Soils and terrain are favorable for development	Parking on or off street would be visually intrusive to neighborhood
		Facilities would be in direct line-of-sight of homes

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Trailhead Alternative	Favorable	Unfavorable
	Close proximity to popular open space destinations	Open space visitors would have to cross Greenbriar (near curve) to gain access to open space
	RTD service	Portion of park contains wetlands and good example of wet tallgrass prairie in an urban setting
		Need to build new trails to connect to existing trails
3 (S. side of Greenbriar)	Soils and terrain favorable for development, with many options available	May increase traffic on Greenbriar Drive
	Large area with easy entrance/exit possibilities	Would need to build new trails to connect to existing trail system
	Beautiful vista that allows the visitor to view numerous landscape features, which could fit well with an interpretive program	Prairie dog preserve exists about 1,000 feet southeast of site
	City park site to the north can provide visual and physical insulation for trailhead development	
	This trailhead option would help shift "out-of-neighborhood" trail access away from more populated areas of the neighborhood	
	Visible from neighborhood (but not in direct line-of-sight)	Visible from most neighborhood (but not in direct line-of-sight)
	RTD service	
4 (Hard- scrabble Drive)	Good north/northwest access to several existing trails	Very close proximity to homes
	Large area	Steep slope must be negotiated to get to trails and desired parking areas

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Trailhead Alternative	Favorable	Unfavorable
	RTD service	Very stony soils, difficult to maintain good road/trail conditions up slope (expensive trail/road prep.)
		Narrow city streets serving this area
		Major adverse impact on residences on cul-de-sac
		Trailhead too remote from main thoroughfare, difficult to supervise
		Open space user/neighbor conflicts

Trailhead Recommendations

The following is a summary of recommendations for each alternative.

Alternative 1 - Corral Area. An interior trailhead within the study area that has so much exterior public right-of-way cannot be recommended. The road to this site would seriously fragment and encroach upon an otherwise large and unintruded area.

Alternative 2 - Shanahan Ridge Park. It is unwise to usurp the utility of a neighborhood park site for an open space trailhead. The site also contains wetlands and wet tallgrass prairie.

Alternative 3 - South Side of Greenbriar Drive Across from Shanahan Ridge Park. Of the four trailhead locations, this site appears the most suitable for development of a trailhead. There are several locations in this general area where the topography is favorable for developing parking facilities visually unobtrusive to Greenbriar neighbors and convenient to trail connections. The Shanahan Ridge Park site can remain undisturbed while the park provides passive visual and physical insulation for trailhead

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development. Location of a trailhead in this area would help shift non-neighborhood trailhead use away from more the densely populated parts of the neighborhood.

Alternative 4 - Existing Trailhead at Shanahan Ridge and Hardscrabble Drive. This site has very stony soils that make it difficult to maintain good trail conditions, and steep slopes that would most likely need to be negotiated to get to trails and the desired parking area. Additionally, this site is very close to neighborhood homes creating a situation where trailhead users feel they are imposing on neighbors and neighbors are disturbed by numerous out-of-neighborhood visitors.

The team also recommends an additional trailhead north of the study area to accommodate the high use of the Bear Canyon trail. Additional site-specific study needs to be done to select a specific low impact trailhead location for this area. A preliminary review indicates that access through the Fern Canyon Creek/Bear Canyon Creek confluence area would not be recommended due to potential adverse impacts to the riparian environment associated with increased use and foot traffic. Existing access through the PSCO substation is functional but unsightly. A potential trailhead solution may exist with NCAR.

We recommend development of two new designated trailheads for the north side of the study area: Alternative 3 and a northern site to allow better access to the Bear Canyon area. Both of these potential locations need to be studied in more detail (i.e., trailhead layout options explored, and the various alternatives worked out in partnership with the neighbors). A new designated trail needs to be developed to connect these two trailhead locations, roughly parallel to the edge of the Shanahan Ridge residential boundary. This new trail can serve as a collector trail to accept the various access points out of the subdivision and can also be routed and configured to double as a fire fuel break and fire

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equipment access road. Any new trail in this area will need to overcome some relatively unfavorable terrain. But the need to connect the multitude of access points and social trails in this area, coupled with the critical need to prepare for an eventual fire emergency seems to be worth the investment. This trail should also be extended to the west-central portion of the study area from the recommended Greenbriar trailhead (Alternative 3) to connect with the existing Big Bluestem Trail. Any trail extending from the Greenbriar trailhead needs to avoid descending directly down the terrace slope, and should avoid the prairie dog preserve and wetlands directly to the south.

OBSERVATIONS, ANALYSIS AND RECOMMENDATIONS

The following is a collection of observations and recommendations on a variety of topics applicable to the study area. The wide range of topics indicates the complexity of the site and diversity of its resources.

OSD Visitor Use Studies

Open Space personnel have conducted visitor use surveys on several accesses into the study area. The following observations about trail use of the study area are based on the OSD survey (Table 4).

1. Designated trailheads receive a large proportion of the use at access points, and much of that use is from visitors out of the immediate Boulder area. Since the trailheads are designated, and published on maps, they are apparently well known and therefore have a more regional appeal. One exception to this is the Bear Canyon trail, which does not have a designated trailhead, but is probably widely known by virtue of the Canyon resource and its access to adjoining mountain parklands. These designated trailheads tend to collect more equestrian and picnicking use due to their regional appeal.
2. With Bear Canyon's non-Boulder resident figure so high and comparable to the other designated trailheads, it would seem that there should be a trailhead somewhere near the east end of the Bear Canyon trail.

Table 4. Summary of Boulder Open Space Department's Access Study.

Access Point	# of Visits	Avg. Time Spent	Origin (%)							Activity (%)						
			Boulder	Boulder County	Denver	Other County	Outside County	Tech. Mtn. Climb	Picnic	Wildlife View	Hike	Boulder-ing	Photography	Pet Exc.	Jogging	
Bear Canyon	1,469	2:27	73	8	12	4	3	3	7	14	37	3	5	11	15	
Stony Hill	127	1:20	84	7	9					12	37		4	39	8	
Cragmoor	386	1:15	91	6	3	3			1	12	39	1	2	24	20	
Hardscrabble*	1,216	1:58	89	24	3		3	3	0.8	17	39	2	2	21	18	
Greenbriar	59	0:44	95					5		18	30			35	4	
OSD Operations Center*	269	2:08	59	31	2		8			27	35			21	17	
So. Mesa Trail*	1,562	2:41	35	29	32	3	3	3	6	15	38	2	2	20	13	
Old Mesa Trail	139	2:25	44	38	14		4	4	3	11	31	10	3	14	10	

*Designated trailhead

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3. The Stony Hill, Cragmoor, Hardscrabble and Greenbriar access points (all undesignated accesses) are essentially neighborhood access points. This observation is based on the relatively low average time spent within the study area and rather high percentage of visitors from Boulder that use these access points.
4. Although the OSOC access is a designated trailhead and highly visible from SH-93, the OSOC trailhead is well-used relative to the busier trailheads. This situation may occur because the first segment (OSOC to the west end of Thomas Lane) is not a trail - but an unimproved dirt residential access road, and that from OSOC to the corral area the terrain is relatively homogenous.
5. Based on the visitor survey, the typical Shanahan Ridge Open Space visitor could be simply described as "A jogger or family type on a modest hike, looking for wildlife, with a dog in tow."

Recommendation: The OSD access study is valid for making general conclusions and seeing trends. In addition to the information OSD collected, we recommend the following information also be collected: visitor's age, occupation, visitor's mode of transportation to the access point (car, bike, walked, ran, etc), the frequency of visitation, and what facilities visitors would like to have available to them on site in addition to trails, gates and a few signs.

Control of access. The large number of undesignated social trails emanating from the bordering neighborhood were mapped. Uncontrolled and unplanned access to the study area is a legitimate problem. Interestingly, the problem is similar for residents of this area, as well as trail users coming from outside of the neighborhood. To neighbors, it is an irritation and an inconvenience to accommodate parking for open space visitors on their residential streets. Parking and traffic problems are an unwanted nuisance, and there is a lost sense of security in the neighborhood when a lot of "outsiders" are continually accessing the neighborhood. Similarly, it is also an irritation to OSD visitors to have to park on residential streets and feel like neighborhood intruders, and have concerns about their cars being towed or vandalized while on the trail, a lost sense of

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security as well. There are no trailhead conveniences on the residential streets (e.g., no restrooms, maps, or other orientation signage).

Recommendation: We suggest that neighbors and outside visitors both have equal access to the open space resource, and each should enjoy a sense of security and convenience. The large number of social trails around the Shanahan Ridge residential boundary is a direct result of the relatively large number of access points along this boundary. These social trails do not seem to be a result of hikers seeking open space destinations not accessed by the designated trails as much as they are a result of hikers finding the most direct and convenient access to designated trails from a multitude of access points. Some consolidation of the access points may alleviate this problem somewhat, but elimination of too many of them will result in others springing up at other points. The designated trails are extremely popular to this neighborhood, and neighbors will always find a convenient way to get to them, whether by designated access points and trails or their own means.

Wildfire. Fire has played a role in maintaining both the tallgrass prairie and the ponderosa pine savanna. Recent fire suppression may explain the advancing treeline in many areas (Bunin 1985). Native grasslands in North America east of the Rocky Mountains evolved under a system of grazing and periodic burning. In the absence of fire, grasslands in many localities are invaded by woody species (Anderson 1976). Weaver (1943, 1951) states that fire played an important role in structuring the ponderosa pine forest. The evolution of ponderosa pine and grasslands with fire is best described by Biswell (1973):

"Ponderosa pine-grasslands are dependent on frequent surface fires for their health and stability and on the other hand, frequent surface fires are dependent on the plant communities that produce the fuels that carry fire, each being dependent on the other."

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Fire is part of the Shanahan Ridge environment. It has occurred recently and with frequency in the past. It will occur again. The highly successful reproduction of ponderosa pine and lack of fire or other controlling agent is allowing fuels to build. As fuels build, the next fire will be more severe (most likely not a surface fire). Crown fires will greatly set back the ponderosa pine savanna, could be difficult to control, and endanger adjoining properties. Surface fires will help maintain a healthier system.

Recommendation: Develop a forest management and wildfire plan that addresses reduction of forest fuels. Protect the adjoining subdivision from fire through use of a fire break/fire access road. Experiment with controlled burns in the southern and eastern portions of the study area. Educate the public, through interpretive programs, as to the vital role fire plays in the foothills ecosystem.

Trail Development and Maintenance. Most of the designated trails are in good shape, but one segment on the South Fork Shanahan trail, above the water tank, needs to be widened and surfaced to match the other reaches of the trail. Almost all of the social trails observed on the site, except those coming out of the Shanahan Hills residential areas via undesignated access points, seem logical routes for hiker destinations. These "logical" social trails can be designated and spot improvements made to upgrade them as necessary, but do not need to be upgraded to the same level of improvement (widened and mineral surfaced) as most of the site's designated trails, as long as the recommended collector/fire access trail is built in the near future.

Soils map unit Te should be avoided as much as possible in developing trail systems because of the difficulty in monitoring trail integrity and preventing erosion. Map units VaB and VcE were rated as moderate due to slopes and erodible subsoils. Areas with these soils are adjacent to drainageways and fairly small in relation to the entire study

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area, and should pose no particular problems for development. Most of the study area is composed of map unit NdD, which has a low erosion hazard. As indicated on the Soils and Erosion Hazard Map (separate cover), there are areas where excessive use has caused trail degradation. These areas can be easily reclaimed by grading and reconstruction with gravel roadbed material. Adjacent disturbed areas should be revegetated. Map unit Nh (along the South Boulder Creek floodplain) is also rated as low risk.

The majority of the existing trail system is on a very cobbly sandy loam soil. Except for areas with very strong or bouldery surfaces, this is a very "workable" soil. The improvements on the Shanahan trail system in the northwest look good, and should be implemented on the southern trail system. The northern and southern trail systems can be connected at a point central to the Shanahan Ridge area. A heavily used social trail that runs south from the existing BOS Shanahan Ridge trail access point traces the fence line between sections 17/20 and 18/19. The trail crosses some wet areas that will need rehabilitation and/or rerouting, but the potential exists for great views, non-strenuous hiking/jogging (i.e., little incline), and a better network of trails.

Recommendation: We suggest the following general guidelines be considered for trail development:

1. Minimize placement of facilities in riparian and shrub vegetation types.
2. Avoid placement of facilities in wetland areas and drainageways.
3. Minimize disturbances such as cut and fill on slopes greater than 12%.
4. Include erosion control measures on both trails and cut banks in areas with slopes over 8 percent.
5. Avoid widening of designated trails due to conflicts of use between hikers and equestrians, e.g., where hikers and equestrians pass on a trail. If widening or trail

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degradation occurs, implement specific remedies (e.g., trail definition or edging, intentional widening at certain spots, or creation of steps).

6. Use native plant materials for all revegetation and landscaping efforts.

Interpretive Programs. The study area has great potential for a variety of interpretive programs. We believe interpretive programs are a great way to involve the public in OSD's mission of maintaining, restoring, and improving the natural resources of open space lands. For example, the role and danger of fire within the study area are most likely poorly understood by most of the public and therefore much of the public probably opposes forest management that involves timber cutting. An interpretive program could be used to educate the public on the role of fire and what will happen without timber management (e.g., accumulation of fuels, crown fires, disease, loss of open and park-like savanna and damage to private property).

Recommendation: The following are some topics that should be considered for interpretive programs:

1. Remnants of eastern flora (e.g., tallgrass prairie, Fern and Bear Canyons).
2. The role of fire.
3. Historical/cultural resource features.
4. Early settlers and historic activities that have taken place in the study area.

Monitoring. OSD use study statistics were very useful in analyzing trail use for this project. None of these locations appeared to be critical on our site visits, with the possible exception of a segment of the Big Bluestem Trail just north of its intersection with the Mesa Trail, but these could become more problematic with increased use.

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Recommendation: We recommend that use studies be conducted periodically on this and other OSD sites, perhaps on an annual or biannual basis. The studies could include gathering some additional information, as previously discussed at the beginning of this section. We also recommend monitoring of selected trail sections crossing wet areas throughout the site. We found the use of aerial photography to be extremely useful. OSD should consider periodic (every 2 to 3 years) monitoring of their properties via review of aerial photography since OSD tracts are typically large and remote and time consuming to canvass on foot, horseback, or by vehicle. A requested field research design for monitoring the effects of trail use on songbird observability is presented in Appendix C.

Visual Conflicts. The views from almost every portion of this site are outstanding, and vantage points are too numerous to count. Views from neighboring subdivisions are equally outstanding; any future trail improvements and trailhead development must respect the views from these homes.

Recommendations: Trailheads need to be visible from public right-of-way for supervision and orientation purposes. There seems to be little potential for spoiling visual resources by any contemplated trail improvements except for the recommended development of a combination collector and fire trail near the boundary of the Shanahan Ridge residential area. This potential visual conflict of trail construction in unfavorable terrain can be mitigated utilizing dry laid rock walls to retain cut and fill slopes. Such a trail could have the visual appeal of historic CCC/WPA era construction work, legendary for its quality of visual appeal.

Maintenance of Vegetation Type Distributions. As previously discussed, rapid successful establishment by ponderosa pine, weed infestation, and livestock grazing have and are

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altering existing native plant communities. The open ponderosa pine savanna and wet tallgrass prairie are the most immediately threatened communities. Long term, the xeric tallgrass prairie may be threatened by encroaching ponderosa pine, weeds, and non-native species.

Recommendations:

1. Develop a timber management plan.
2. Maintain or expand present woodland openings.
3. Restrict cattle from wetlands where possible.
4. Monitor weed problem.
5. Experiment with weed management program (e.g., short intensive early season grazing and fire).
6. Consider expanding the Tallgrass Natural Area to the north; this will facilitate management.

South Boulder Creek. Many of the residences that border the right descending bank of South Boulder Creek have constructed various structures in and adjacent to the channel. Such structures can cause adverse effects to the channel (e.g., bank erosion and channel changes) that could adversely affect open space lands.

Recommendation: Monitor structures along South Boulder Creek for their effects on open space lands and channel integrity.

Plant Surveys. The upper portions of Fern and Bear Canyons support populations of hazelnut, a remnant of the eastern deciduous flora. Past experience along the Front Range has shown hazelnut to be a good indicator of other species that are remnants of the eastern deciduous flora.

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Recommendation: The upper portions of Fern and Bear Canyons should be searched several times during the growing season for infrequently occurring species (a good graduate student project). Species of likely occurrence include: wild sarsaparilla (*Aralia nudicaulis*) and *Cylactis (Rubus) pubescens*.

Undesirable Plant Species. Several undesirable plant species occur in the study area. The following species have the greatest potential for becoming localized problems within the study area.

Canada thistle (*Cirsium arvense*) has become well-established in the wetlands and wet tallgrass prairie. Canada thistle is difficult to control. Observations in South Dakota suggest that cattle graze Canada thistle prior to the bud stage and generally avoid it thereafter. Mowing has eliminated Canada thistle if the treatment is applied every few weeks during the growing season. This treatment generally needs to be continued for several years. Thistles should not be allowed to grow more than 6 inches high before being cut to 3 inches or less. If Canada thistle plants are allowed to grow any taller before cutting, this treatment will not be effective.

Well-timed grazing or mowing may help control Canada thistle. It is interesting that the small wet prairie at Shanahan Ridge Park is relatively free of Canada thistle; this may be due to frequent mowing.

Prickly lettuce (*Lactuca serriola*) also occurs extensively in wet areas within the study area. This annual is best controlled by reducing disturbance and maintaining a vigorous stand of desirable perennial vegetation.

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Downy brome (*Bromus tectorum*), an annual grass, was observed primarily in the disturbed poorly vegetated areas mapped as floodplain complex (see Vegetation Map, SW sheet, under separate cover). This weed is best controlled by developing a vigorous stand of desirable perennial vegetation.

Russian olive (*Elaeagnus angustifolia*). This introduced and adventive tree occurs sparingly along South Boulder Creek. Russian olive can out compete cottonwoods that cavity nesters depend upon and should be eradicated from the study area.

Crack willow (*Salix fragilis*) is an introduced tree that occurs along South Boulder Creek and appears to out compete the native peach-leaved willow (*Salix amygdaloides*).

Repercussions of this competition are unknown except the decline of a once dominant native species. Where possible, crack willow should probably be discouraged and peach-leaved willow encouraged.

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APPENDIX A: VEGETATION TYPE DESCRIPTIONS

VEGETATION TYPE DESCRIPTIONS

The classification of vegetation types (existing plant community types) follows the habitat type classification system developed for the Boulder Wildlife Habitat Database (City of Boulder, draft, 1990) with some changes. The map abbreviation follows the vegetation type name in parentheses.

Ponderosa Pine Forest (PPF) - The Ponderosa Pine Forest vegetation type occurs to a limited degree at the highest elevations found within the northern portion of the study area. The forest is characterized by a closed canopy of ponderosa pine (*Pinus ponderosa*) with little herbaceous or woody understory. Much of what is mapped as Ponderosa Pine Savanna is developing into a closed canopy of Ponderosa Pine Forest.

Ponderosa Pine Savanna (PPS) - The Ponderosa Pine Savanna type dominates the northwestern portion of the study area. This type is characterized by widely spaced ponderosa pines with an understory dominated by grasses and occasionally scattered shrubs. The grass understory varies from a dominance of tall grasses, primarily big bluestem (*Andropogon gerardii*) to dominance by short grasses, primarily blue grama (*Bouteloua gracilis*). Common understory vegetation includes: ponderosa pine saplings, mountain muhly (*Muhlenbergia montana*), Western wheatgrass (*Agropyron smithii*), little bluestem (*Schizachyrium scoparius*), Scribner's needlegrass (*Stipa scribnerii*), sideoats grama (*Bouteloua curtipendula*), cheatgrass (*Bromus tectorum*), sun sedge (*Carex heliophila*), Oregon grape (*Mahonia repens*), wild tarragon (*Artemisia dracunculus*), winged eriogonum (*Eriogonum altatum*), Spanish bayonet (*Yucca glauca*), snakeweed (*Xanthocephalum sarothrae*), and prickly pear (*Opuntia* spp.).

Skunkbush Sumac Shrubland (SSS) - The Skunkbush Sumac Shrubland occurs primarily on rocky soils in the southwestern portion of the study area. Skunkbush sumac (*Rhus trilobata*) contributes at least 25% canopy cover to areas mapped as this type. Common understory species are the same as those listed for the Ponderosa Pine Savanna type.

Open Shrubland/Mixed Grass Prairie (OSG) - This type is similar to the Skunkbush Sumac Shrubland type but much more open, and occurs primarily in the southwestern portion of the study area.

Sumac Shrubland (SUS) - This type is restricted to a small area in the southwestern portion of the study area. Sumac Shrubland is very similar to the Skunkbush Sumac Shrubland previously described; however, the dominant shrub is smooth sumac (*Rhus glabra*).

Floodplain Complex - The Floodplain Complex occurs in the southeastern portion of the study area within the historic South Boulder Creek floodplain. This area is a complicated mix of wetlands, tallgrasses, midgrasses and introduced species that vary with minor changes in topography and soils. The numerous changes in vegetation do not show well on the aerial photography, so this area was mapped as a complex.

Mixed Mountain Shrubland (MMS) - The Mixed Mountain Shrubland type occurs primarily along the north facing slope above Bear Canyon Creek. This type is characterized by a variety of shrubs including squaw currant (*Ribes cereum*), mountain mahogany (*Cercocarpus montanus*), skunkbrush sumac, chokecherry, mountain snowberry (*Symphoricarpos oreophilus*) and serviceberry (*Amelanchier alnifolia*).

Foothills Tallgrass Prairie (TGP) - This type dominates the southern portion of the study area. The majority of the area mapped as Foothills Tallgrass Prairie fits Bunin's (1985) description of xeric tall grassland. This type is dominated by big bluestem, blue grama, sideoats grama, and little bluestem. Other species commonly occurring in this type are the same as the understory species described for the Ponderosa Pine Savannas. However, these areas are being colonized by native tall and midgrass species.

Stands of mesic tower tallgrass prairie occur bordering wetlands in the eastern and southern portions of the study area. The mesic tall grassland area is dominated by big

bluestem, switchgrass (*Panicum virgatum*), Indian grass (*Sorghastrum nutans*), and prairie chordgrass (*Spartina pectinata*). Many of these areas also support Kentucky bluegrass, Canada thistle, and prickly lettuce.

Mixed Grass Prairie (MGP) - The Mixed Grass Prairie type is also referred to as mid-height grassland (Bunin, 1985). It is dominated by western wheatgrass, Kentucky bluegrass, and blue grama. In many areas the Mixed Grass Prairie type integrates with the Tallgrass Prairie type and distinctions are difficult to make. Many of the species found in the Tallgrass Prairie type also occur in the Mixed Grass type. Additionally, much of the Mixed Grass type that was historically dominated by native grasses is now dominated by Kentucky bluegrass. The combination of mid and tallgrasses and non-native species truly makes this type a Mixed Grass and not a Mid Grass type.

Bottomland Grassland (BLG) - The Bottomland Grassland type occurs along Bear Canyon creek and is dominated by smooth brome (*Bromus inermis*), Kentucky bluegrass, and orchard grass (*Dactylis glomerata*).

Riparian Forest (RPF) - The Riparian Forest type occurs along South Boulder Creek and Bear Canyon Creek and is dominated by cottonwoods (*Populus deltoides* and *P. augustifolia*) and willows (*Salix fragilis* and *S. exigua*). Other commonly occurring woody species include: chokecherry, wildplum, hawthorn (*Crataegus macracantha*), box elder (*Acer negundo*), thinleaf alder (*Alnus tenuifolia*), river birch (*Betula fontinalis*), currants (*Ribes* spp.) and poison ivy (*Toxicodendron rydbergii*). The herbaceous understory includes bluegrass, Canada wild rye (*Elymus canadensis*), smooth brome, orchard grass (*Dactylis glomerata*) and field horsetail (*Equisetum arvense*).

Riparian Shrubland (RPS) - Similar to the Riparian Forest is the Riparian Shrubland vegetation type that occurs along Fern and Bear Canyons where a narrow band of mixed shrubs border the drainages. Shrubs commonly found in this type include: chokecherry,

wild plum, hawthorn, snowberry, willow, and currant. A herbaceous understory of bluegrass, sedges, and rushes is common.

Willow Shrubland (WLS) - The Willow Shrubland occurs in small isolated areas within the South Boulder Creek floodplain and along small drainages. The thickets are typically dominated by coyote willow (*Salix exigua*).

Rush Meadows (RSM) - Rush Meadows occur in a variety of wet to moist sites within the study area, but are most commonly found in the wetlands of the eastern and southern portions of the study area. Baltic rush is the dominant species in this type.

Sedge Meadows (SDM) - Sedge Meadows occur in the wetlands of the southern and eastern portions of the study area and are frequently associated with rush meadows. Common sedges include Nebraska sedge (*Carex nebraskensis*) and clustered field sedge (*Carex praegracilis*).

Rush and Sedge Meadows (RSM/SDM) - Although these vegetation types are distinct, they often occur as a complex within wetlands in the study area. The large wetland near the eastern study area boundary is dominated by baltic rush and sedges.

Cattail Marshes (CTM) - The Cattail Marsh type occurs within the South Boulder Creek floodplain in depressions and sloughs and around the pond near the operations center.

Miscellaneous Types (IRD and IDP) - Irrigation ditches are mapped as IRD and irrigated developed pasture is mapped as IDP.

APPENDIX B: WILDLIFE

Table B-1. Birds identified and of likely occurrence on the Shanahan Ridge site.¹

Common name	Scientific name	
*Great blue heron	Ardea herodias	III, B IVB, C ²
Cattle egret	Bubulcus ibis	
+Black-crowned night-heron	Ncticorax ncticorax	IIIB, IVB
*Canada goose	Branta canadensis	
*Mallard	Anas platyrhynchos	
American gadwall	Anas strepera	
Northern pintail	Anas acuta	
Green-winged teal	Anas crecca	
Blue-winged teal	Anas discors	
Cinnamon teal	Anas cyanoptera	
Northern shoveler	Anas clypeata	IVA
+American wigeon	Anas americana	
Wood duck	Aix sponsa	IVA
Common merganser	Mergus merganser	
*Turkey vulture	Cathartes aura	IIIA
+Northern goshawk	Accipiter gentilis	
+Sharp-shinned hawk	Accipiter striatus	IIIB
+Cooper's hawk	Accipiter cooperii	IIIB
+Red-tailed hawk	Buteo jamaicensis	IIIA
Red-shouldered hawk	Buteo lineatus	
Swainson's hawk	Buteo swainsoni	IIIA, B
+Rough-legged hawk	Buteo lagopus	
Ferruginous hawk	Buteo regalis	IIIB
+Golden eagle	Aquila chrysaetos	
+Bald eagle	Haliaeetus leucocephalus	IIA, B
+Northern harrier	Circus cyaneus	IIIA, B
+Prairie falcon	Falco mexicanus	IVB
Peregrine falcon	Falco peregrinus	I IIA, B IVC V
Merlin	Falco columbarius	
+American kestrel	Falco sparverius	IIIB
Blue grouse	Dendragapus obscurus	
American coot	Fulica americana	
*Killdeer	Charadrius vociferous	
*Common snipe	Gallinago gallinago	
Spotted sandpiper	Actitis macularia	
Solitary sandpiper	Tringa solitaria	
Greater yellowlegs	Tringa melanoleuca	
Lesser yellowlegs	Tringa flavipes	
American avocet	Recurvirostra americana	
Herring gull	Larus argentatus	
Ring-billed gull	Larus delawarensis	
Franklin's gull	Larus pipixcan	
Band-tailed pigeon	Columba fasciata	
+Pigeon	Columba livia	
*Mourning dove	Zenaida macroura	
Eastern screech-owl	Otus asio	
Western screech-owl	Otus kennicottii	IIIA, B
*Great horned owl	Bubo virginianus	

Common name	Scientific name	
+Long-eared owl	Asio otus	IIIA IVB
Short-eared owl	Asio flammeus	IVB,D
Common poorwill	Phalaenoptilus nuttallii	
+Common nighthawk	Chordeiles minor	IIIA,B
Chimney swift	Chaetura pelagica	IVC
Black-chinned hummingbird	Archilochus alexandri	
Broad-tailed hummingbird	Selasphorus platycercus	
Rufous hummingbird	Selasphorus rufus	
+Belted kingfisher	Ceryle alcyon	
*Northern flicker	Colaptes auratus	
Red-bellied woodpecker	Melanerpes carolinus	
Lewis' woodpecker	Melanerpes lewis	IIIA,B
Yellow-bellied sapsucker	Sphyrapicus varius	
+Williamson's sapsucker	Sphyrapicus thyroideus	IIIA
+Hairy woodpecker	Picoides villosus	
Downy woodpecker	Picoides pubescens	
Eastern kingbird	Tyrannus tyrannus	
Western kingbird	Tyrannus verticalis	
+Eastern phoebe	Sayornis phoebe	
Say's phoebe	Sayornis saya	IIIA IVB
Willow flycatcher	Empidonax trailli	IIIA,B IVB
Least flycatcher	Empidonax minimus	
Hammond's flycatcher	Empidonax hammondii	
Dusky flycatcher	Empidonax oberholseri	
Cordilleran flycatcher	Empidonax occidentalis	
+Western wood-pewee	Contopus sordidulus	
Olive-sided flycatcher	Contopus borealis	
Horned lark	Eremophila alpestris	IIIA
*Violet-green swallow	Tachycineta thalassina	
Tree swallow	Tachycineta bicolor	
Bank swallow	Riparia riparia	IIIB IVA
Northern rough-winged swallow	Stelgidopteryx serripennis	
Barn swallow	Hirundo rustica	
+Cliff swallow	Hirundo pyrrhonota	IIIB
Gray jay	Perisoreus canadensis	
+Blue jay	Cyanocitta cristata	
*Steller's jay	Cyanocitta stelleri	
Scrub jay	Aphelocoma coerulescens	IIIB IVA
*Black-billed magpie	Pica pica	
*Common raven	Corvus corax	
*American crow	Corvus brachyrhynchos	
Pinyon jay	Gymnorhinus cyanocephalus	
*Black-capped chickadee	Parus atricapillus	
Mountain chickadee	Parus gambeli	
Bushtit	Psaltriparus minimus	IVB
*White-breasted nuthatch	Sitta carolinensis	
*Red-breasted nuthatch	Sitta canadensis	
*Pygmy nuthatch	Sitta pygmaea	IVC
Brown creeper	Certhia americana	
American dipper	Cinclus mexicanus	IVD
*House wren	Troglodytes aedon	
Winter wren	Troglodytes troglodytes	
Carolina wren	Thryothorus ludovicianus	
Marsh wren	Cistothorus palustris	
Canyon wren	Catherpes mexicanus	
Rock wren	Salpinctes obsoletus	

Common name	Scientific name	
Gray catbird	Dumetella carolinensis	
Brown thrasher	Toxostoma rufum	
+Sage thrasher	Oreoscoptes montanus	
*American robin	Turdus migratorius	
Varied thrush	Ixoreus naevius	
Wood thrush	Hylocichla mustelina	
Swainson's thrush	Catharus ustulatus	
Gray-cheeked thrush	Catharus minimus	
Veery	Catharus fuscescens	
+Western bluebird	Sialia mexicana	IIIA, B IVA
+Mountain bluebird	Sialia currucoides	IIIA, B
Townsend's solitaire	Myadestes townsendi	
Blue-gray gnatcatcher	Polioptila nigriceps	
+Golden-crowned kinglet	Regulus satrapa	IIIB
Ruby-crowned kinglet	Regulus calendula	
Water pipit	Anthus spinoletta	
Sprague's pipit	Anthus spragueii	
Bohemian waxwing	Bombycilla garrulus	
Cedar waxwing	Bombycilla cedrorum	
Northern shrike	Lanius ludovicianus	
Loggerhead shrike	Lanius ludovicianus	IIIA, B IVA
*European starling	Sturnus vulgaris	
Bell's vireo	Vireo bellii	
Yellow-throated vireo	Vireo flavifrons	
Solitary vireo	Vireo solitarius	
Red-eyed vireo	Vireo olivaceus	IVA
*Warbling vireo	Vireo gilvus	
Black-and-white warbler	Mniotilta varia	
Prothonotary warbler	Protonotaria citrea	
Swainson's warbler	Limnothlypis swainsonii	
Worm-eating warbler	Helmitheros vermivorus	
Golden-winged warbler	Vermivora chrysoptera	
Blue-winged warbler	Vermivora pinus	
Tennessee warbler	Vermivora peregrina	
Orange-crowned warbler	Vermivora celata	
Nashville warbler	Vermivora ruficapilla	
Virginia's warbler	Vermivora virginiae	
Northern parula	Parula americana	
Yellow warbler	Dendroica petechia	
Magnolia warbler	Dendroica magnolia	
Cape May warbler	Dendroica tigrina	
Black-throated blue warbler	Dendroica caerulescens	
*Yellow-rumped warbler	Dendroica coronata	
Black-throated gray warbler	Dendroica nigrescens	
Townsend's warbler	Dendroica townsendi	
Black-throated green warbler	Dendroica virens	
Blackburnian warbler	Dendroica fusca	
Chestnut-sided warbler	Dendroica pensylvanica	IVA
Bay-breasted warbler	Dendroica castanea	
Blackpoll warbler	Dendroica striata	
Prairie warbler	Dendroica discolor	
Palm warbler	Dendroica palmarum	
Northern waterthrush	Seiurus noveboracensis	
Kentucky warbler	Oporornis formosus	
MacGillivray's warbler	Oporornis tolmiei	
Common yellowthroat	Geothlypis trichas	
Yellow-breasted chat	Icteria virens	
Hooded warbler	Wilsonia citrina	

Common name	Scientific name	
Wilson's warbler	<i>Wilsonia pusilla</i>	
Canada warbler	<i>Wilsonia canadensis</i>	
American redstart	<i>Setophaga ruticilla</i>	IVA
*House sparrow	<i>Passer domesticus</i>	
*Western meadowlark	<i>Sturnella neglecta</i>	
Yellow-headed blackbird	<i>Xanthocephalus xanthocephalus</i>	
*Red-winged blackbird	<i>Agelaius phoeniceus</i>	
Orchard oriole	<i>Icterus spurius</i>	
*Northern oriole	<i>Icterus galbula</i>	
Rusty blackbird	<i>Euphagus carolinus</i>	
*Brewer's blackbird	<i>Euphagus cyanocephalus</i>	
*Common grackle	<i>Quiscalus quiscula</i>	
*Brown-headed cowbird	<i>Molothrus ater</i>	
*Western tanager	<i>Piranga ludoviciana</i>	
Scarlet tanager	<i>Piranga olivacea</i>	
Summer tanager	<i>Piranga rubra</i>	
Northern cardinal	<i>Cardinalis cardinalis</i>	
Rose-breasted grosbeak	<i>Pheucticus ludovicianus</i>	
*Black-headed grosbeak	<i>Pheucticus melanocephalus</i>	
Blue grosbeak	<i>Guiraca caerulea</i>	IVA
Indigo bunting	<i>Passerina cyanea</i>	IVA
Lazuli bunting	<i>Passerina amoena</i>	
Evening grosbeak	<i>Coccothraustes vespertinus</i>	
Purple finch	<i>Carpodacus purpureus</i>	
Cassin's finch	<i>Carpodacus cassinii</i>	
House finch	<i>Carpodacus mexicanus</i>	
Pine grosbeak	<i>Pinicola enucleator</i>	
Rosy finch	<i>Leucosticte arctoa</i>	
Common redpoll	<i>Carduelis flammea</i>	
*Pine siskin	<i>Carduelis pinus</i>	
American goldfinch	<i>Carduelis tristis</i>	
Lesser goldfinch	<i>Carduelis psaltria</i>	
Green-tailed towhee	<i>Pipilo chlorurus</i>	
*Rufous-sided towhee	<i>Pipilo erythrophthalmus</i>	
Lark bunting	<i>Calamospiza melanocorys</i>	IIIA,B
Savannah sparrow	<i>Passerculus sandwichensis</i>	IIIA,B IVA
Grasshopper sparrow	<i>Ammodramus savannarum</i>	IIIA,B IVA
Baird's sparrow	<i>Ammodramus savannarum</i>	
*Vesper sparrow	<i>Poocetes gramineus</i>	
Lark sparrow	<i>Chondestes grammacus</i>	
*Dark-eyed junco	<i>Junco hyemalis</i>	
American tree sparrow	<i>Spizella arborea</i>	
*Chipping sparrow	<i>Spizella passerina</i>	
Clay-colored sparrow	<i>Spizella pallida</i>	
*Brewer's sparrow	<i>Spizella breweri</i>	
Field sparrow	<i>Spizella pusilla</i>	
Harris' sparrow	<i>Zonotrichia querula</i>	
White-crowned sparrow	<i>Zonotrichia leucophrys</i>	
White-throated sparrow	<i>Zonotrichia albicollis</i>	
Fox sparrow	<i>Passerella iliaca</i>	IVB
Swamp sparrow	<i>Melospiza georgiana</i>	
*Song sparrow	<i>Melospiza melodia</i>	
Lapland longspur	<i>Calcarius lapponicus</i>	

¹ Asterisks indicate birds identified during spring 1992 field work; plus signs indicate previous identifications by Open Space personnel.

²Classifications: I = extirpated species; II = threatened or endangered (A = federal, B = state); III = declining (A = Boulder Co., B = national); IV = restricted habitat (A = rare breeder, B = breeder, C = CDOW designations, D = winter resident; V = Colorado Heritage listing.

Table B-2. Mammals identified and of likely occurrence on the Shanahan site.¹

Common name	Scientific name	
Masked shrew	<i>Sorex cinereus</i>	
Wandering shrew	<i>Sorex vagrans</i>	
Little brown bat	<i>Myotis lucifugus</i>	
Silver-haired bat	<i>Lasionycteris noctivagans</i>	
Big brown bat	<i>Eptesicus fuscus</i>	
Red bat	<i>Lasiurus borealis</i>	
Hoary bat	<i>Lasiurus borealis</i>	
Brazilian free-tailed bat	<i>Tadarida brasiliensis</i>	
Eastern cottontail	<i>Sylvilagus floridanus</i>	V
Mountain cottontail	<i>Sylvilagus nuttallii</i>	
Least chipmunk	<i>Eutamias minimus</i>	
Yellow-bellied marmot	<i>Marmota flaviventris</i>	
Thirteen-lined ground squirrel	<i>Spermophilus tridecemlineatus</i>	IV
+Rock squirrel	<i>Spermophilus variegatus</i>	IV
Golden-mantled ground squirrel	<i>Spermophilus lateralis</i>	
*Black-tailed prairie dog	<i>Cynomys ludovicianus</i>	
*Abert's squirrel	<i>Sciurus aberti</i>	IV
+Fox squirrel	<i>Sciurus niger</i>	
Red squirrel	<i>Tamiasciurus hudsonicus</i>	
Northern pocket gopher	<i>Thomomys talpoides</i>	
Plains pocket gopher	<i>Geomys bursarius</i>	IV,V
Hispid pocket mouse	<i>Perognathus hispidus</i>	IV,V
Western harvest mouse	<i>Reithrodontomys megalotis</i>	V
Deer mouse	<i>Peromyscus maniculatus</i>	
Rock mouse	<i>Peromyscus difficilis</i>	IV
Northern grasshopper mouse	<i>Onychomys leucogaster</i>	V
Mexican woodrat	<i>Neotoma mexicana</i>	
Bushy-tailed woodrat	<i>Neotoma cinerea</i>	
Red-backed vole	<i>Clethrionomys gapperi</i>	
Meadow vole	<i>Microtus pennsylvanicus</i>	IV
Montane vole	<i>Microtus montanus</i>	
Long-tailed vole	<i>Microtus longicaudus</i>	
Prairie vole	<i>Microtus ochrogaster</i>	
Muskrat	<i>Ondatra zibethicus</i>	IV
Porcupine	<i>Erithizon dorsatum</i>	
*Coyote	<i>Canis latrans</i>	
Red fox	<i>Vulpes vulpes</i>	
Gray fox	<i>Urocyon cinereoargenteus</i>	iv
*Raccoon	<i>Procyon lotor</i>	
+Black bear	<i>Ursus americanus</i>	
Ermine	<i>Mustela erminea</i>	
Long-tailed weasel	<i>Mustela frenata</i>	
Badger	<i>Taxidea taxus</i>	
Spotted skunk	<i>Spilogale putorius</i>	
*Striped skunk	<i>Mephitis mephitis</i>	
+Mountain lion	<i>Felis concolor</i>	
Bobcat	<i>Lynx rufus</i>	III

Common name	Scientific name
American elk	<i>Cervus elaphus</i>
*Mule deer	<i>Odocoileus hemionus</i>
+White-tailed deer	<i>Odocoileus virginianus</i>
House mouse	<i>Mus musculus</i>
Norway rat	<i>Rattus norvegicus</i>

¹Asterisks indicate mammals identified during spring 1992 field work; plus signs indicate previous identifications by Open Space personnel.

²Classifications: I = extirpated species; II = threatened or endangered (A = federal, B = state); III = declining (A = Boulder Co., B = national); IV = restricted habitat (A = rare breeder, B = breeder, C = CDOW designations, D = winter resident; V = Colorado Heritage listing.

Table B-3. Amphibians and reptiles identified and of likely occurrence on the Shanahan Ridge site.¹

Common name	Scientific name
Utah tiger salamander	<i>Ambystoma tigrinum</i>
Woodhouse's toad	<i>Bufo woodhousei</i>
*Boreal chorus frog	<i>Pseudacris triseriata</i>
Bullfrog	<i>Rana catesbeiana</i>
*Western leopard frog	<i>Rana pipiens</i>
Western painted turtle	<i>Chrysemys picta</i>
Ornate box turtle	<i>Terrapene ornata</i>
Northern prairie lizard	<i>Sceloporus undulatus</i>
Lesser earless lizard	<i>Holbrookia maculata</i>
Eastern short-horned lizard	<i>Phrynosoma douglassi</i>
Six-lined racerunner	<i>Cnemidophorus sexlineatus</i>
Wandering garter snake	<i>Thamnophis elegans</i>
Western plains garter snake	<i>Thamnophis radix</i>
Red-sided garter snake	<i>Thamnophis sirtalis</i>
Northern lined snake	<i>Tropidoclonion lineatum</i>
Eastern yellow-bellied racer	<i>Coluber constrictor</i>
Western smooth green snake	<i>Opheodrys vernalis</i>
Bullsnake	<i>Pituophis melanoleucus</i>
Western milk snake	<i>Lampropeltis triangulum</i>
Plains black-headed snake	<i>Tantilla nigriceps</i>
+Prairie rattlesnake	<i>Crotalus viridis</i>

¹ Asterisks indicate species identified during spring 1992 field work; plus signs indicate previous identifications by Open Space personnel.

APPENDIX C:

A Field Research Design to Evaluate The Effects of Trail Use on Songbird Availability

OBJECTIVE: To evaluate the effects of trail use on songbird observability. If, on the average, fewer birds are seen along sections of well-used trails than are seen in similar habitat nearby then there is evidence to support the idea that human use of trails displaces birds, and perhaps other wildlife groups.

METHODS: From 10 to 20 trail segments should be selected. These should be high-use trails. Each segment should be at least 700 meters long. These trail segments need not be within the same Open Space parcel; also, the segments need not necessarily travel through the same vegetation type. Of crucial importance, however, is that the same vegetation type (habitat conditions) exist 200 meters to one side of the trail, in either a left or right perpendicular direction.

The investigator (a skilled birder) counts all birds seen or heard within a 50-meter radius plot. The count is conducted for 4 minutes, during mornings (6-10 AM). From 5 to 10 50-meter plots should occur along each trail segment; the exact same number of plots must also occur approximately 200 meters to one side of the trail. The plots need not be permanently marked. The distance between plots should be approximately 150 meters, which can be paced (5 plots requires a 700 meter length of trail). If a second investigator is used, it would be best if he or she alternated between off-trail and on-trail counts. It would be desirable, but not necessary, that off-trail and on-trail counts be conducted at the same time. Conduct counts along each trail segment on at least three different days. The same trail segment should be used, but the centers of the previous plots need not be exactly relocated.

Sampling adequacy (ideally) should be determined by calculating the following index of precision:

$$\text{standard error} \div \text{mean} = .10$$

The data to enter for the calculation are the number of birds counted within each plot for all the on-trail plots. Use any calculator that will calculate the standard deviation, SD (the standard error = SD/\sqrt{n}). This level of precision is equivalent to 95% confidence limits that are within $\pm 20\%$ of the mean--an adequate sample for most statistical purposes. This procedure is the best way to determine when a sufficient number of samples have been taken.

The statistical test to use is the paired-sample t-test. The Null Hypothesis is "no difference between the mean number of birds seen, between on-trail and off-trail locations."

This study is an example of one of many small research projects that could be conducted on Open Space lands.