FOREST STEWARDSHIP PLAN

FOR

KEN-CARYL RANCH
OPEN SPACE

PREPARED FOR:
KEN-CARYL RANCH MASTER ASSOCIATION
7676 S. CONTINENTAL DIVIDE ROAD
LITTLETON, CO 80127

PREPARED BY:
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GOLDEN, COLORADO 80401
303-279-9757

APRIL 2006
FOREST STEWARDSHIP PLAN
FOR
KEN-CARYL RANCH
OPEN SPACE

JEFFERSON COUNTY, COLORADO
WITHIN SECTIONS 25, 26, 27, 35, & 36,
TOWNSHIP 5 SOUTH, RANGE 70 WEST;
AND SECTIONS 1, 2 & 12 OF
TOWNSHIP 6 SOUTH, RANGE 70 WEST
2500 ACRES

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MARCH 2006
This management plan has been prepared at the request of the Ken-Caryl Ranch Master Association (KCRMA) to guide their forest management activities, which they will voluntarily apply on Ken-Caryl Ranch Open Space property. This plan has been developed using the Colorado State Forest Service standards for Forest Stewardship Plans.

This plan will guide the KCRMA in their forest management activities for the next ten years. However, if there is a major change in forest condition, management priorities, or ownership boundaries prior to 2016, this plan may be amended to accommodate those changes. The Colorado State Forest Service should be consulted prior to making major changes in the management plan or its implementation.

___________________________________    ________________________
KCRMA Representative    Date

___________________________________    ________________________
CSFS District Forester    Date
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1.0 INTRODUCTION

This Forest Management Plan has been prepared by a professional forester at the request of the Ken-Caryl Ranch Master Association to guide them in implementing forest management activities on this property.

This plan discusses the current condition and desired future condition of forest resources on the 2500 acres of Open Space on the west side of Ken-Caryl Ranch. The plan also outlines the goals of the landowner and recommends management activities that integrate these goals with accepted forest management practices. This plan represents a ten-year land management strategy that includes completing specific activities on an annual basis. An annual work plan is provided to assist the landowners in planning forest management activities.

This plan is intended to be a working document that can and should be modified to accommodate unforeseen events that may alter the property’s landscape. Events such as wildfires and floods would undoubtedly affect the management of this property and subsequently change the scope of this plan.
2.0 GOALS & OBJECTIVES

Forest management goals are statements that express the Ken-Caryl Ranch Master Association’s desired future state of their property. The landowner’s management goals for this property are to:

- Reduce the threat of catastrophic wildfire;
- Maintain and improve wildlife habitat;
- Improve overall forest health;
- Maintain aesthetic and recreation resources;
- Enhance and protect water quality;
- Prevent soil erosion; and
- Integrate all management activities.

Forest management objectives represent activities that Ken-Caryl Ranch needs to implement in order to achieve their goals. Objectives will establish the framework for creating measurable and planned results that correspond to preestablished forest management goals. The Ken-Caryl Master Association’s objectives for this property are:

- Thin stands for improvement of forest health and vigor, as well as to reduce risk of catastrophic wildfire;
- Treat and prevent insect and disease outbreaks;
- Create fuelbreaks to reduce the risk of catastrophic wildfire;
- Encourage Ken-Caryl Ranch resident awareness of the importance of forest management;
- Work cooperatively with adjacent landowners to manage their land in a similar manner, in order to increase the effectiveness of treatments done on Ken-Caryl Ranch property; and
- Achieve objectives in a cost-effective and timely manner.
3.0 GENERAL DISCUSSION

3.1 LOCATION

Ken-Caryl Ranch is a residential development located in Jefferson County, Colorado, approximately one mile west of the Denver Metro area. Within the boundaries of Ken-Caryl Ranch are over 4,800 acres of Open Space, 2500 acres of which will be the subject of this plan.

The Open Space property discussed in this plan is located within Sections 25, 26, 27, 35, and 36 of Township 5 South, Range 70 West, and Sections 1, 2 and 12 of Township 6 South, Range 70 West. (See Maps, pages 8 & 9). The approximate UTM coordinates of the site are Zone 13S, 484350N, 4379700E. The elevation of this property varies between 6200 feet and 7855 feet.

The access to the Open Space property can be reached by driving west on Highway 285 from Denver. From the intersection of C-470 and Highway 285, go south on C-470 for 4.5 miles. Exit at Ken-Caryl Avenue and turn right (west) at the bottom of the ramp. Proceed for 0.2 miles, and bear right onto Valley Parkway. Drive 1.0 miles, and bear left onto Valley Parkway. After 0.1 miles, turn right onto Mountain Laurel drive, and another right onto Manor House Road. Before reaching the parking lot for the Manor House Restaurant, turn right onto a dirt road. This road is the only vehicular access to the Open Space.

3.2 GENERAL DESCRIPTION

The Ken-Caryl Ranch Open Space that is the subject of this plan lies to the west of the residential development. The easternmost portion of the Open Space is at the edge of a valley and is composed of grassland on flat-to-moderate slopes. The western side of the property is considered part of the foothills of the Front Range, and the terrain is steeper and more rugged. Vegetation on the western three-fourths of the property is classified as a lower montane woodland, with drought-resistant, shrubby vegetation on the south sides of hills and heavy timber on the north sides of hills. A number of drainages run from the top of the Open Space property to the east and into the valley.

Looking west across the Open Space (as viewed from the access road).
3.3 HISTORICAL LAND USE

Ken-Caryl Ranch has a rich history, which has been well-documented by the Ken-Caryl Ranch Historical Society. Archaeological sites within the Ranch have yielded prehistoric and Woodland Indian artifacts. A site found in the area, thought to have been used as a shelter for indigenous peoples, has been dated to 565 B.C. Nearly 250 sites of archaeological significance have been found.

Ken-Caryl Ranch was historically a part of a 10,000-acre ranch, first purchased and settled by Major Robert Boyles Bradford in 1859. The ranch changed hands several times until 1971, when it was purchased by the Johns-Manville Corporation, who bought it with the intent of locating its corporate headquarters there as well as setting aside home sites. The first residences were constructed soon thereafter.

Little John’s Chimney (pictured, at left) was recently preserved. It is the only historically significant site in the area for which this plan is written. Forest management activities will enhance the aesthetic nature of the site as well as protect it from future degradation, such as that caused by a wildfire.

3.4 CLIMATE

The elevation of this property varies between 6875 feet and 7942 feet. No specific climate data is available for this property. However, meteorological data is available for Evergreen, CO, located approximately 7 miles to the northwest. The Evergreen weather station is the closest weather station most similar in topography and elevation (7040 feet) to this property, so one may assume that the meteorological data will also be similar. In fact, data from the Evergreen weather station was used in the 1972 analysis of the ecology of the western portion of Ken-Caryl Ranch.

The estimated climactic data for this property is:

- Average Annual Maximum Temperature (°F): 60.7
- Average Annual Minimum Temperature (°F): 26.9
- Average Annual Precipitation (in.): 18.88
- Average Total Snowfall (in.): 84.8

(Source: Western Regional Climate Center, 2003)
3.5 IMPACTS ON NEIGHBORS

Stewardship of this property according to this management plan should not adversely affect any neighbors. In fact, management of this property will benefit the surrounding properties by implementing prescriptions to mitigate insect and disease outbreaks, as well as the threat of wildfire. Furthermore, the neighboring residential developments of Willow Springs and West Ranch have open space that is adjacent to that of Ken-Caryl. Both properties are also under forest management plans, and the opportunity for collaborative, cross-boundary efforts is abundant. This opportunity will be discussed in more detail in Section 6.0, Land Management Recommendations.

3.6 SOCIAL, ECONOMIC AND MARKET CONDITIONS

Society is increasingly accepting of forest management activities. Recent fires in the area (such as the Buffalo Creek, Hi Meadow, and Hayman fires) have lead to a heightened awareness about the destructive capacity of wildfires. This has led to an increased understanding among the general public regarding the role of fire in forested ecosystems and the effects of fire suppression during the last 100 years. Additionally, recent insect outbreaks (such as that of the mountain pine beetle) have helped to increase awareness of the need for forest management.

The market for timber products is currently limited along the Front Range of Colorado. Competition from foreign markets, reductions in regional harvest levels, and lower-quality products have negatively impacted many sawmills. However, limited markets do exist for some sawlog, post and pole, and furniture material. Air quality restrictions on wood burning have also affected the market for firewood in the Denver metropolitan area. However, current high energy costs have led to a greater interest in and higher prices for fuelwood. Additionally, there is some market for Christmas trees, sapling transplants, and Douglas-fir boughs.

Economic conditions have resulted in a shift in the way that management decisions are made. Because the market for timber products is limited, management prescriptions designed to use the value of forest products removed as a way to pay for management activities (or even to generate revenue) are in many cases inappropriate. However, because of increased public understanding of the need active for management, recent years have seen increased public and private spending on projects where little or no product is produced (i.e. mastication projects). This has encouraged the development of a body of contractors capable of doing such work. Accordingly, management practices which result in little or no forest products removed (and will require such a group of contractors to perform the work) may be designed.
By implementing this stewardship plan, the landowners will be promoting forest stewardship. This will enable the land to be passed onto future generations in a healthy condition. This plan will serve as an example to other landowners of how to reduce the risk of wildfire and increase the health of the forest, while at the same time preserving the integrity and beauty of the land.
4.0 RESOURCE INVENTORY

4.1 FOREST RESOURCES

The open space property consists of four distinct types of trees and a grassland (see Map, following page). The types are classified as Douglas-fir, ponderosa pine, Gambel oak, and aspen. As this plan focuses on the management of the forested portion of the property, the grassland was not fully inventoried.

These stands were inventoried by Ken-Caryl Ranch Park Rangers and Colorado State Forest Service personnel between 2001 and 2005. A variable plot sample was used in to inventory the Douglas-fir and ponderosa pine stands, using a basal area factor (BAF) of 20. Regeneration within the stands was measured using a 1/100th acre fixed plot, as was the Gambel oak stand. Because of the small size of the aspen stand, individual aspen trees were randomly sampled to obtain data. A total of 34 sample points were established. Two computer software programs were used to process the data from the timber inventory: Forest Vegetation Simulator and RMCRUZ5. The full timber inventory output tables are located in Appendix A, and a short narrative of the attributes of each stand is included in this section. Some of the terms used in this section will be unfamiliar to the reader; please consult the Glossary in Section 8.0 for definitions.

4.1.1 DOUGLAS-FIR

This stand type is 338 acres in size and is located primarily on north-facing slopes. Within the open space, there are 10 separate (non-contiguous) stands of Douglas-fir, but they will be collectively referred to as "the stand." The slope averages 25%, but varies from 10 to 50%. The dominant species in the stand is Douglas-fir (Pseudotsuga menziesii), but ponderosa pine (Pinus ponderosa) also occurs with regularity throughout the stand. Density of the trees and their crowns is variable, ranging from 25 to 65% crown closure and averaging 230 trees per acre. The basal area in the stand is 113 ft²/acre.

The trees in the stand are mostly healthy, but as they continue to grow, competition will increase and the stands will become denser and grow less vigorously. Trees in this stand average 9.5" diameter at breast height (DBH) and 45" tall. The average age of the stand is 67. Trees in the Douglas-fir stand have an average growth rate of 0.5" in diameter every ten years, and increase in height 0.75" annually.
Due to the variable crown closure in the stand, the abundance of understory vegetation is also variable. For the most part, tree regeneration (seedlings and saplings) is limited. Douglas-fir seedlings are found along the edges of the stand and in small openings where there are no overstory trees. Likewise, the greatest amount and variability of other understory vegetation is found where sunlight reaches the ground, i.e. along the edges of the stand and in small openings. Major shrub species in the Douglas-fir stand include Oregon grape (Mahonia repens), common juniper (Juniperus communis), ninebark (Physocarpus monogynus), cliff jamesia (Jamesia americana), buffaloberry (Sheperdia canadensis), and woods rose (Rosa woodsii). Herbaceous species in the understory include sun sedge (Carex heliophila), smooth brome (Bromopsis inemis), mountain muhly (Muhlenbergia montana), heartleaf arnica (Arnica cordifolia). The remainder of the forest floor is composed of litter, moss, and small rock outcroppings.

Douglas-fir stands tend to be cool, moist, and densely treed. Douglas-fir trees reach maturity at 200 years old, and regularly attain diameters of 15 to 20 inches, although in this area they may grow as large as 30 inches. Seed crops are produced every one to three years and are dispersed by wind. Douglas-fir is a shade-tolerant species, which means that growth (and regeneration) can occur successfully even under a thick, closed canopy. Mixed conifer stands can be successfully managed (with techniques such as thinning) up to 360 years of age.

4.1.2 PONDEROSA PINE

This stand type is 126 acres in size and is located in the northwestern portion of the property. Slopes vary between 10 and 50%, and average 30%. The stand is mostly located along ridgetops and in a small basin, and has east, south, and west aspects. The dominant species is ponderosa pine, with scattered Douglas-fir and Rocky Mountain juniper (Juniperus scopulorum) throughout the stand. Many portions of the stand also have a Gambel oak (Quercus gambelii) understory. Much of the stand consists of moderately-spaced, open-grown ponderosa, although in some areas (especially in the area known as Beacon Hill) the trees grow much more densely and form a nearly closed canopy. The condition of the stand is good; few recent-dead trees were observed and growth is vigorous. This stand has an average of 184 trees per acre, which have an average diameter of 9.4” and a height of 36 feet. The basal area is 89 ft² per acre, and the trees are 65 years old, growing ¾” in diameter every 10 years.

The understory vegetation is mostly grass, and the major species are smooth brome, mountain muhly, Kentucky bluegrass (Poa pratensis), little bluestem (Schizachyrium scoparium), and mountain timothy (Phleum pratense). Mountain mahogany (Cercocarpus montanus) and kinnickinnik (Arctostaphylos uva-ursi) are common shrubs. Forbs found in the ponderosa pine stand include yarrow (Achillea millefolia), fringed sagewort (Artemisia frigida), prairie sagewort
(Artemisia ludoviciana), yellow salsify (Tragopagon dubius), and hairy goldenaster (Heterotheca villosa). Exposed rock, bare mineral soil, and litterfall make up the remainder of the ground cover.

Ponderosa reach maturity around 160 years old. They can live 500 years or more on the Colorado Front Range, attaining diameters of over 40 inches. Ponderosa pine stands can be successfully managed (with techniques such as thinning) at any age, but respond best (in terms of growth) before 200 years of age. Removing small-diameter trees (such as Gambel oak and Douglas-fir) from the understory will increase the health of the old-growth ponderosa, as well as encourage their longevity. For example, thinning around a medium-sized 100-year old ponderosa can yield a dramatic increase in growth and vigor, and the tree may eventually attain a large diameter and height. Thinning around a medium-sized 250-year old ponderosa will increase health, but it will not become a much larger tree over time as the younger ponderosa would.

A portion of this stand (on Beacon Hill) was thinned several years ago. Cores taken from the trees have shown an increase in growth rates since the thinning occurred; however, for optimal results, it should be thinned to a lower residual density. This will be discussed in greater detail in Section 5.0, Land Management Recommendations.

4.1.3 ASPEN

The aspen stand, at 5 acres, is small yet significant. Aspen stands are rare at this elevation and in this portion of the Front Range, and so it bears some discussion despite its small size. This stand is in the northeastern portion of the property, in a small drainage just west of the saddle. The slope is gentle (15%) and faces west.

The aspen, on average, are between 3 and 5" DBH, 35' tall, and are between 20 and 40 years old. There are approximately eight hundred trees per acre. For the most part, the aspen are healthy, although some of the more mature individuals (>40 years old) have begun to decline, as evidenced by heart rot. The younger aspen remain vigorous and show good annual growth.

Understory vegetation is grassy, with smooth brome dominating. Other common herbaceous species include elk sedge, timothy, yarrow, geranium (Geranium caestitosum), and
goldenbanner (*Thermopsis divaricarpa*). Shrub species include common juniper, kinnickinnik, wild rose, and serviceberry (*Amelanchier alnifolia*). The ground remains fairly moist throughout the year and the soil is deep and fertile, and so it is almost entirely vegetated. Areas not covered by living plants are covered in litter and dead vegetation.

Aspen stands are usually fairly short-lived, although it depends on the availability of moisture. While this stand is moist (relative to the rest of the property), it is not moist enough to produce a long-lived stand of large trees. As the aspen trees reach maturity at about 40 years of age, they begin to decline. As they die, they will be replaced by new aspen shoots. Conifers (such as Douglas-fir and blue spruce) are beginning to encroach into this stand; as they do, they will begin to compete with and crowd out the aspen. It is important to remove these conifers in order to allow the stand to continue to reproduce and exist.

### 4.1.4 GAMBEL OAK

The Gambel oak stand is by far the largest vegetative type in the Open Space, covering 1162 acres. It is found on a variety of slopes and aspects throughout the Open Space, and forms a nearly continuous canopy from north to south. Grassland and Douglas-fir stands create the breaks in the Gambel oak stand, and occur when the slopes are either too dry or do not receive enough sunlight to support Gambel oak (respectively). Occasional ponderosa pine and Rocky Mountain juniper are found in the stand.

Gambel oak is a multi-stemmed, shrublike species of tree. In this stand, the stems average 1.8 DRC (diameter at root collar) and 60 feet tall. The average age is 17. There is great variability within the stand; individuals grow larger in drainages where more water and deeper soil is available, and much smaller on hot, rocky hillsides. The largest specimen is 12.3 DRC, 20 feet tall, and at least 60 years old. The smaller specimens (which are much more common) were a fraction of an inch at DRC and a foot tall.

The oak forms a continuous canopy throughout the stand. The ground is covered by grass, forbs, and fallen leaves, with occasional rock outcroppings. Common species include yarrow, rosy pussytoes (*Antennaria rosea*), golden aster, bluegrass, smooth brome, sun sedge, mountain muhly, bluestem, chokecherry (*Prunus virginiana*), and woods rose.

Gambel oak typically grow on sites which are too dry and hot to support timber species. They grow in unbroken thickets and can cover many, many acres. Gambel oak usually reproduce by
suckering roots spread out laterally from the existing tree, and will create new individuals when they break the surface of the soil. The oak are considered "early successional" species, which means that they are one of the first species to re-colonize a site after a catastrophic event such as fire. This is visible on Ken-Caryl Ranch where the oak has colonized the areas burned by the 1978 Murphy Gulch Fire.

Oak are susceptible to dieback, which occurs when the leaves and buds at the tips of branches die from a hard frost or a root problem. A late-season frost in spring of 2003 caused dieback in many of the Gambel oak stands in this part of the Front Range, although it appears this stand has since recovered. Gambel oak stands can live for over 100 years, but rarely do individuals grow large.

4.1.5 GRASSLAND

The remaining 867 acres of Open Space is classified as grassland. It occurs in areas which are unable to support tree species due to poor soils and little available water. As the focus of this management plan is Ken-Caryl's forest resources, a resource inventory and narrative were not developed for the grassland.

4.2 INSECTS AND DISEASES

There are few agents causing issues of major concern within the stands of Ken-Caryl Ranch Open Space. Several insects and diseases are causing occasional damage and mortality to trees within the stands, and these will be addressed in the following section. Populations of these insects should be monitored on an annual basis in order to assess whether or not they are becoming a major threat. How to monitor and manage these problems will be discussed in detail in Section 6.0, Land Management Recommendations.

4.2.1 MOUNTAIN PINE BEETLE

During the field survey, evidence was found of endemic populations of mountain pine beetle (Dendroctonus ponderosae). This means that the mountain pine beetle (MPB) has been killing a few trees per year for many years, but is not at epidemic levels. Adult beetles, which are black and about a quarter-inch long, lay a distinctive gallery of eggs in the wood tissue right underneath the bark. The beetles lay eggs in the fall, and the larvae develop over the winter and emerge as adults in mid-summer. Adult beetles also transmit bluestain fungi into the tree, and the combination of larval feeding under the bark and the growth of the fungus rapidly kills the tree.

The presence of MPB is identified by four factors: popcorn-shaped masses of pinkish-white sap on the boles of the tree (called pitch-outs; see Photo, above), boring
dust (which looks like a fine sawdust) at the base of the tree and in cracks in the bark, a change in the color of foliage from green to red in the spring, and a blue stain in the wood (caused by fungus introduced by the beetles).

During drought years, such as 2002, populations of MPB may increase to epidemic levels and cause the mortality of groups of ponderosa. The closest area of high MPB populations is within two miles, to the west near Highway 285. Should an exceedingly dry year occur, it is distinctly possible that populations of MPB both on and off the Open Space property will increase to epidemic levels.

The treatment for mountain pine beetle is to cut down the tree and treat the wood, either chemically or by solar treatments. This must be done by June at the latest, in order to kill the larvae before they emerge as adults in late July and August. More specific information on the treatment of MPB is found in Appendix D.

### 4.2.2 DOUGLAS-FIR BEETLE

The Douglas-fir beetle (*Dendroctonus psuedotsugae*), like the mountain pine beetle, has been causing sporadic mortality at endemic levels for years. The beetle is closely associated with Douglas-fir trees immediately adjacent to the boundary of the 1978 Murphy Gulch Fire. Like most bark beetles, the Douglas-fir beetle is attracted to trees that have been under stress, and later will attack adjacent [healthy] trees. In this case, the fire likely killed part of the root systems of the trees at its edge, which did not kill the trees outright but caused them to be stressed. This encouraged attack by the Douglas-fir beetle. Once the trees stressed by fire had been killed by the beetle, the populations moved on to the nearby trees. That process has continued for decades, causing the mortality of several trees per year.

The Douglas-fir beetle is an insect similar in size, color and behavior to the mountain pine beetle. The two are distinguished by the species of trees they attack, as well as the pattern of the egg galleries they create. While the Douglas-fir beetle does not usually create pitch tubes, it is easily identified by a proliferation of fine, red-orange boring dust in the cracks of the bark and around the base of the tree, and by the crown turning bright red in a matter of months.

Treatment and prevention of the Douglas-fir beetle is similar to that of the mountain pine beetle—cutting and treating the wood, and preventative spraying.
4.2.3 WESTERN SPRUCE BUDWORM

The western spruce budworm (*Choristoneura occidentalis*) is becoming a serious concern in the area. Damage is most extensive in the Deer Creek Canyon area, but the epidemic seems to be moving northward. Lightly affected trees were found in late 2005 on Ken-Caryl Open Space, and severely damaged trees were found on the adjacent West Ranch.

The spruce budworm is a moth larva. It is brownish in color and grows to around an inch long. The larvae feed on foliage, cones, and buds of Douglas-fir during the spring. The spruce budworm will infest a tree or forest stand for several years, repeatedly defoliating much of the crown, and eventually weakening the tree so much that it dies. During its weakened state, the Douglas-fir is also much more susceptible to bark beetle infestation and mortality. While the larvae are able to defoliate and kill a tree within just one season, the more common scenario is repeated partial defoliation and a slow decline in health until mortality occurs.

Spruce budworm epidemics in Colorado are cyclical in nature, and occur every few decades. The infestation can then last for years. During the large spruce budworm epidemic on the Front Range in the 1970s, a great amount of mortality across the Front Range (which is still easily visible throughout the Highway 285 and I-70 corridors) was caused by the combination of spruce budworm and Douglas-fir beetle, and a similar situation may occur again.

On the Open Space property, budworm has infested approximately 1% of the Douglas-fir trees in the extreme northwestern corner, as well as 5% of trees in the Douglas-fir stand closest to the aspen stand. This low degree of infestation does not demand immediate treatment. However, it must be stressed that the epidemic has greatly expanded in the last year, and so the percentage of affected trees at Ken-Caryl may greatly increase next year. Monitoring the level of spruce budworm infestation is crucial to continued forest health.

There are few cost-effective controls for the larvae; in fact, a hard, late spring frost can be the most effective control. Aerial spraying using parasitic bacteria (*Bacillingus thuringensis*, or BT) has been moderately effective at control, but for it to be cost effective, a
large area must be sprayed. High-value trees, such as those near trails, may be individually sprayed with chemical or microbial insecticides. Forest thinning will increase the health and vigor of the Douglas-fir, and make them less susceptible to mortality by the spruce budworm (but will not reduce the incidence of infestation). The stand may also be underplanted with non-host species; spruce budworm will not attack lodgepole or ponderosa pine.

### 4.2.4 ASPEN DECLINE

The older trees within the aspen stand are beginning to decline. A natural ecological process called "succession" is occurring. Aspen, a somewhat short-lived species, are one of the first species to colonize a site after a disturbance such as a fire. Aspen stands begin to decline as the individual trees age and as conifers grow up underneath them. This process is identified by poor growth and the presence of decay in the older aspen trees.

"Heart rot" is a decay of the inner wood of aspen, caused by a fungus called *Phellinus tremulae*. It is characterized by hoof-shaped fruiting bodies, or "conks," which emerge from the bark of the tree trunk. While this fungus generally doesn’t kill the tree outright, it weakens the structure of the tree (by making it hollow) and it is therefore likely to fall.

Various cankers caused by fungi, such as Cytospora and sooty-bark, are also causing the decline of trees in the mature aspen stands. These fungi attack the outer parts of the stems of trees, including the outer and inner bark. The fungus kills the bark and tissues that transport water and nutrients, grows bigger every year, and eventually kills the tree by girdling it. Canker fungi are often introduced to the tree when animal damage (such as antler rub) occurs.

There is no viable control treatment for the decline of individual trees. It should be viewed as a natural part of the forest cycle. However, some management can be done to ensure the entire stand does not decline. For example, small conifers can be removed, and declining aspen can be cut to encourage new shoots to come up. Management techniques will be discussed in more detail in Section 6.0.

Please note: Since the *Phellinus* stem decay is known to weaken trees, care should be taken when working or recreating near aspen with the visible conks. If possible, infected trees should be cut if there is a chance they may fall onto humans, vehicles, structures, or roads.

Information concerning the identification and control of mountain pine beetle, Douglas-fir beetle, and western spruce budworm is included in Appendix D.
4.3 RIPARIAN FEATURES

There is only one small riparian area within the forested section of this property. It is located just to the southwest of the aspen stand. This area is denoted as riparian because of the presence of water and/or wet soils during much of the year. Riparian vegetation is also found in the area, such as alder (*Alnus incana*), blue spruce (*Picea pungens*), aspen, and sedges. This seep was at one time utilized by settlers (as evidenced by concrete structures), and seems to currently be used by wildlife, most notably as an elk wallow.

Riparian areas are fragile, and often support the greatest diversity of species on the landscape. Therefore, it is important to perform work in these areas with care. Heavy management work is not recommended in the riparian area itself. When managing the aspen and Douglas-fir stands that lie on either side of the riparian area, care must be taken to not run through the riparian area with heavy machinery, or drag slash or wood products through it. The displacement of ground cover (such as litter and vegetation) should be limited in and around the riparian area.

While there are other riparian areas in the drainages of this Open Space, they occur in the grassland and are therefore not part of this management area. Any management activity which occurs in the forested stands of the Open Space will be sufficiently far from the riparian areas so as not to impact them.

For a map of the riparian area, please refer to Section 7.0, Figures.

4.4 SOILS

The Natural Resource Conservation Service (NRCS, Price and Amen 1980) describes eighteen soil types occurring on this property. A map and a brief description of each soil are contained in Appendix B.

The large number of different soil types is a reflection of the varied topography of the Open Space. For the most part, water permeates quickly through the soils, keeping them fairly dry in nature. Other than the deep, fine soils associated with aspen stand and part of the grassland, the soils tend to be somewhat coarse and rocky. Erosion is a moderate hazard across much of the property.

Forest management activities can negatively impact the soils when heavy equipment is used, which tends to remove the vegetative cover and scarify the soil, thus making erosion from water a good possibility. To avoid this, the number of skid trails created for thinning should be
minimized, and as much ground cover (low-growing plants, small vegetative debris) should be left in place as possible. If the ground cover is disturbed, skid trails should be reseeded to minimize erosion.

4.5 WILDLIFE

Ken-Caryl Ranch has a diverse landscape and diverse plant communities, and therefore hosts an excellent variety of wildlife. During the field survey, evidence of elk, deer, red-tailed hawk, black bear, Merriam’s turkey, coyote, fox, pine squirrel, rabbit, deer mouse, black-capped chickadee, downy woodpecker, raven, and various songbirds were seen. Other species that have been seen on the property includes mountain lion, grouse, and various snakes. An inventory of birds was performed in the lower-elevation shrublands between 1997 and 1999. A summary of the study is attached to this document in Appendix C.

Forest management activities will maintain and improve most wildlife habitats. Thinning opens up the canopy of the forest, which allows more sunlight to pass through on to the ground and enables more understory vegetation to grow. That vegetation provides browse, forage, and habitat. Hiding cover for large animals will still be amply available in the neighboring [untreated] forest stands, and some slash piles may be left to provide habitat for small animals. While forest management activities (such as cutting trees or chipping slash) may cause a temporary disturbance to the fauna, the only lasting effect will be a healthier forest.

4.6 THREATENED & ENDANGERED SPECIES

No threatened and endangered species are known to utilize this property, according to the Natural Diversity Information Source website. A rare species, Bell’s twinpod (Physaria bellii), is known to inhabit shale rock outcroppings in Ken-Caryl Open Space. While the twinpod is not a federally protected species, it is prudent to exercise great care when working near it. Fortunately, forest management work will not be performed near any shale rock outcroppings, and so the possibility of harming this species is minimal.
4.7 UNIQUE RECREATIONAL QUALITIES

Excellent views of Mount Evans, the Front Range, and the Denver metropolitan area can be found in the management area. Numerous recreational trails cross the property, and are used for hiking, trail running, biking, and horseback riding. Several designated campsites and picnic areas are also within the management area.

Forest management activities will impact recreational activities in the short-term. Cutting and removing trees will create noise, dust, and a visual impact. Care must be taken to limit the access of Ken-Caryl Ranch residents during management activities, especially for their own safety. If cut trees and slash are properly removed in areas of high public visibility, the visual impact of management will abate quickly. Furthermore, thinning the trees will open up the forest canopy, allowing for better vistas and increased growth of attractive understory species, like grasses and flowers.

4.8 INVASIVE AND NOXIOUS WEEDS

Noxious weeds are found primarily along the trails, and only rarely in the general forest. Weed populations identified include Canada thistle (*Cirsium avense*), musk thistle (*Carduus nutans*), cheatgrass (*Bromus tectorum*), Russian knapweed (*Centaurea repens*), leafy spurge (*Euphorbia esula*), yellow toadflax (*Linaria vulgaris*) and mullein (*Verbascum thapsus*). In 2005, a contractor for Ken-Caryl Ranch created a detailed weed management plan, which will be supplemented annually with a work plan created by KCR staff. Because the weed management plan is in place, it is unnecessary to address the particulars of managing those weeds in this document.

Control and prevention of the establishment of noxious weeds is especially important when conducting forest management activities. Such activities, especially if machinery is involved, can remove the litter layer covering the mineral soil. This scarification allows noxious weeds to seed into the area and become established. Also, thinning operations open up the forest canopy, allowing more sunlight onto the forest floor. While this encourages native vegetation to flourish, it can also encourage noxious weeds to flourish. Although there are few weeds in the interior of the forested stands, their seeds may be laying dormant on the forest floor, and so the potential for populations to grow in the interior exists.

Four control measures are necessary to prevent the establishment and spread of noxious weeds in the stands. First, equipment and personnel working in the stands should be cleaned of seeds and plant material from noxious weeds before entering the stands. Second, the stands must be monitored for new populations of weeds. Third, if weeds are found in the stands, they should be...
removed by chemical treatment or hand-pulling. Fourth, any areas where the soil cover was removed should be reseeded with a native mix, in the hopes that those plants would be able to out-compete noxious weeds for establishment.

It is estimated that 10% of the 1300 native species in Colorado have already been replaced by noxious weeds. For the continued health of the forest and proper ecosystem function, these weeds must be controlled. Literature on identifying and treating these four noxious weeds is found in Appendix D, Supplementary Information. For more information on Canada thistle and other noxious and invasive weeds, access the Colorado Weed Management Association’s website at: http://www.cwma.org.

Smooth brome, a non-native grass, is also a species of concern. While it is not considered invasive, it does have negative impacts on ecosystem health. After the 1978 Murphy Gulch Fire, much of the burned area on Ken-Caryl Ranch was reseeded with smooth brome to prevent erosion and provide forage. In many areas, the establishment of smooth brome was so successful that it prevented the re-establishment of native herbaceous species.

Smooth brome grows in a dense mat, with extensive root systems. This prevents other species from coming up through it, and creates a “biological desert.” While the lack of diversity in the grasslands is a negative attribute in and of itself, it also reduces the diversity and number of wildlife species that are unable to utilize brome for habitat. Smooth brome is a “decreaser,” meaning that the more it is disturbed (i.e. by grazing, mowing, or wildfire), the less it grows back. The vegetation that is native to the grasslands, such as sideoats grama, are “increasers,” so that with increasing disturbance, they increase in coverage. Obviously, grazing would not be in keeping with Ken-Caryl’s management philosophy, so mowing and prescribed fire are the best options for removing the smooth brome and restoring the appropriate ecological function of the grasslands. This management activity will be discussed in greater detail in Section 6.0, Land Management Recommendations.

4.9 KNOWN ARCHEOLOGICAL SITES

No archaeological sites are known to be within the management area. Little John’s Chimney, a historical site (pictured on page 11) is within the management area, but will be protected from damage from management work. Management activities in the aspen stand near the chimney will be conducted manually (cutting down small conifers with chainsaws) and the risk of damage to the chimney is very low. Furthermore, the site is enclosed by a buck-and-rail fence, which will serve to protect it by providing a boundary for management activities.
5.0 WILDFIRE HAZARD

Wildfire is a natural part of the forest ecosystem. Before European settlers began suppressing them, wildfires would burn periodically through the forest. For example, a wildfire would occur in the low-density ponderosa every decade or so; once every few decades in the medium-density ponderosa; and every 50-200 years or more in the mixed conifer and lodgepole stands. Before settlement, litter, woody materials, and vegetation (grass, shrubs, and trees) were reduced by natural, low-intensity surface fires, so large fires occurred less frequently as there was less fuel for them to burn. One of the reasons we thin the forest, or conduct "wildfire mitigation," is to mimic the natural effects of fire without the risks. Wildfire mitigation reduces the fuel loading, and thus reduces the potential of severe, extreme wildfire behavior. The large wildfires of recent years, such as the 2002 Hayman Fire, were so severe and large because a century of fire suppression had created an unnatural amount of fuel loading. In fact, the 1978 Murphy Gulch Fire, which burned part of the Open Space, was considered one of the first significant fires in the Front Range wildland-urban interface.

Please refer to the Wildfire Hazard Map on the following page. This map was developed using fuel types and slope, which combine to give a prediction of how severe the wildfire hazard could be. Generally speaking, wet areas or grassy areas contribute the least to the wildfire hazard of an area, and densely stocked areas of timber or brush would contribute the most. Another contributing factor is the continuity of fuels, both in the horizontal and vertical axes. For example, grassy meadows have continuous horizontal fuel loading, and therefore a fire can spread very quickly. But, since there is nothing above the grass (like trees), fire does not spread vertically. Because of this, it is often easier to control. By contrast, a stand of ponderosa with grass and Gambel oak underneath is much more hazardous. The grasses carry the fire horizontally, and the shrubs carry the fire vertically and into the crowns of trees, making the fire much more difficult to control and creating a much more severe wildfire hazard.

Another method of classifying fuels and identifying potential fire severity is through using fuel models. Fuel models describe fuel loading, which, when combined with slope, wind, and humidity, can be used to develop fire hazard information. The fuel conditions on this property are best described using the U.S. Forest Service publication, Standard Fire Behavior Fuel Models.

The grasslands are classified as Fuel Model GR4. If a wildfire were to occur here, it would move rapidly though the grasses. Grass fires can burn quite hot, but exhaust their fuel source.
quickly and are rapidly extinguished. Assuming a moderate wind speed (i.e. 10 mph) and moderate humidity (i.e. 30%), the fire could travel 1.8 miles in an hour, with flame lengths of 10 feet.

The low-density ponderosa with a grassy (not shrubby) understory and the aspen stand type are classified as Fuel Model TU1. Fires in this type spread primarily through the fine herbaceous fuels (grass and litter) on the ground. Occasionally, they may encounter downed wood from the ponderosa, or small coniferous seedlings and saplings, which will create a higher-intensity fire that may produce firebrands. Assuming a moderate wind speed and moderate humidity, the fire could travel 330 feet in an hour, with flame lengths of 2 feet. Given a high wind speed and very low humidity, fire in these stands is predicted to reach a maximum spread of a quarter-mile per hour, with flame lengths up to 4.5 feet.

Fuel Model SH5 represents the Gambel oak stand — the vegetation is composed of a continuous layer of shrubs, and the litter layer is also thick and continuous. Fires will easily carry through this flammable layer of vegetation with moderate wind speeds. Under moderate conditions, fire in this stand could travel 1.25 miles in an hour, with flame lengths of 20 feet. Under severe fire weather conditions, fire could travel 2.5 miles per hour and have flame lengths of over 25 feet. Obviously, fires in most conditions in this stand would be highly destructive, dangerous, and difficult to control.

Fuel Model SH5 is representative of open ponderosa with a heavy Gambel oak or mountain mahogany layer in the understory. Fires here will carry through the shrub and grass layer, and cause individual trees to torch. Because most of this stand type is on steeper slopes (35-50%), fires would travel especially quickly. Under moderate conditions on these slopes, fires can travel up to 3 miles per hour and produce flame lengths of 25 feet.

The Douglas-fir stand can be described by Fuel Model TL1. In this model, fuel loading is low. There is little downed woody debris, few dead trees, and a compact litter layer. Under moderate conditions, fires would spread 120 feet per hour and have flame lengths of less than a foot. Fires would carry in the litter layer and be unlikely to get into the crowns of trees. Evidence of such fire behavior can be found at the edge of the Murphy Gulch fire on a steep, north-facing slope in the Douglas-fir stand. The fire blackened the bases of the trees and consumed much of the debris on the ground, but the intensity of the fire was enough to cause mortality.

The inflammability of a site depends on four factors: 1) the amount of ground fuels, 2) the ease of ignition, 3) the dryness of the fuels, and 4) slope. Fuel models are useful in describing the first factor, but cannot take into account factors such as variable weather conditions, slope,
and other geographic features. These fuel models should be used as a tool to help land managers identify which sites are a priority to treat, based on the potential intensity (given the rate of spread and flame length) of a fire. The Wildfire Hazard Map on page 28 takes into account the fourth factor, slope, and can be used to better predict priority treatment areas. Ease of ignition and fuel moisture are highly variable and cannot be predicted.

Fires will spread fastest in the fuel models with a grassy understory layer, but would burn most intensely (when one combines rate of spread and flame length) in the open ponderosa with a shrubby understory. A fire in the Gambel oak type would be a close second in terms of intensity and rate of spread. Fires in the mixed-conifer and aspen types present a moderate hazard, but if certain weather conditions develop a fire could be more severe and dangerous. Due to the density of trees and continuity of the litter layer beneath them, in the right conditions a fire in these fuel models could move quickly, burn hot, and kill the live trees.

Several factors in the area can act as ignition sources. Dry lightning storms are common in the summer, and could either ignite a fire on the property or in the area. As Ken-Caryl Ranch lies within the wildland-urban interface, there are many humans living, working, and recreating in the area. A spark caused by construction work, a carelessly tossed cigarette butt, or an escaped campfire are some of the many ways that humans could cause ignition of a wildfire.

The Murphy Gulch fire and the grasslands that cross the property help to serve as natural fuelbreaks. In parts of these areas, fuel loading is lower than that of the surrounding area in areas of mixed conifer that burned (see above), the regrowth is sparse and mostly grassy. While some areas of Gambel oak are dense and well-established, others are comprised of 2tall oak interspersed with grass. If a wildfire were to occur, it would slow down and become less intense as it crossed the old fire and the grasslands. This would provide an opportunity to control the fire in a safer and more efficient manner. The burned area and grasslands, due to their locations, would help to slow the spread of a fire from the south and north. The remaining threats to control would be a fire that came from the west or north, as fuels are heavy and nearly continuous between Highway 285 and the Ken-Caryl boundary. Additionally, the prevailing wind in the area comes from the west. Because of those factors, fuelbreaks are planned on the western and northern boundaries.

Thinning, fuelbreaks, fire road access, and other forms of wildfire mitigation are critical to human life, forest health, aesthetics, and the continued valuation and liveability of the property. Wildfire mitigation is discussed in more detail in Section 6.0, Land Management Recommendations.
6.0 LAND MANAGEMENT RECOMMENDATIONS

All of the management activities recommended for Ken-Caryl Ranch will take place in the northwestern portion of the Open Space. Four major management activities are proposed: thinning the ponderosa stand, thinning the Douglas-fir stand, restoring the aspen stand, and creating fuelbreaks. Minor management activities include monitoring and treating for insects and diseases, controlling noxious weeds, and collaborating with neighboring landowners to conduct cross-boundary management work. This plan should be implemented within the next ten years, and revised as necessary in 2016.

The main goal in conducting forest management activities is to reduce the threat of catastrophic wildfire. In doing so, many other benefits will be reaped. Forest health will be improved, wildlife habitat will be maintained and expanded, and aesthetics will be maintained and improved. By reducing the risk of stand-destroying events such as wildfire or insect epidemics, Ken-Caryl will also reduce the risk of soil erosion and water quality degradation. Furthermore, recreation resources and property values will remain intact in the long term.

The management activities are focused on areas with good accessibility, so that people and/or equipment may get into the areas without undue difficulty. Basing the management units off of the existing roads and trails system reduces the need to create new trails to access the areas. Furthermore, establishing fuelbreaks off of roads and trails makes them much more efficient and usable. Conducting management activities in the other forested portions of the Open Space property [to the south] were not recommended in this management plan because the difficulty of accessibility makes management work less feasible than the areas to the north. When this plan is revised in 2016 or work is complete in the units recommended in the 2006 plan, this issue may be revisited.

Some of the terms in this section may be unfamiliar to the reader. Please consult the glossary in Section 8.0 for definitions. A Map of the management areas is located on Page 33.

6.1 THINNING

Thinning the forested stands on this property will achieve multiple objectives, as stated above. By reducing the density of the forest, competition for water, light, and nutrients between the remaining trees will be reduced. Because of that, they are under less stress, will grow faster, and will be less susceptible to damage and mortality by insects and diseases. Therefore, forest health and vigor will be increased. Healthy, vigorous trees also tend to live longer, so thinning will not only protect existing old growth, but also encourage the creation of more areas of old growth trees. A reduction in tree density will also decrease the fuel loading in the forest. Should a wildfire occur, it may burn slower and cooler, and may not have as severe an effect as it would in an unthinned forest. Reducing tree density will also create better wildlife habitat, as it creates a more open environment for large ungulates and birds to travel, allows more light onto the forest floor which increases the amount of palatable vegetation, and creates a more diverse stand structure which is useful for feeding, hiding, and breeding for a wide variety of species.
Forest thinning has several components. First, the most healthy and vigorous trees should remain, and the small, unhealthy trees should be cut. Often, the most health and vigorous trees are the “dominants” that is, the largest trees in the stand. Dominant trees have that characteristic because of the microsite on which they grow (i.e. better water and nutrient availability), genetic superiority, or the fact that they are the older trees in the stand and were able to establish themselves before the other trees. Many smaller trees are often “suppressed” meaning that competition with other trees has not only slowed their growth over time, but their future potential for becoming a vigorous tree is permanently reduced. Such suppressed trees are more likely to be stressed, and therefore susceptible to damage and mortality by insects, diseases, and environmental factors like drought.

For both the ponderosa pine and the mixed conifer thinning, it is important to again stress that the most “vigorous” trees should remain— the largest, healthiest trees, with full crowns and little or no visible insect or disease damage. Vigorous trees are likely to survive for many more years, and will provide a good (genetically sound) seed source for the future forest. “Understory” trees, or those trees which grow underneath the crowns of larger trees, should be removed. Understory trees present a wildfire hazard because they can act as ladders which can carry the fire from the ground into the tops of trees. They are also slow-growing, and even with thinning they will probably never grow into a large tree. Trees that have obvious insect, disease, or animal damage should be removed. Those kinds of trees may have evidence of bark beetle activity, mistletoe, antler rub, or dead tops. Finally, trees with poor crowns are also good candidates for removal. If the length of the crown is small in relation to the total length of the tree (such as a crown 10’ in length on a tree that is 45’ tall), they are unproductive and the tree should be removed.

Some (but not all) standing and fallen dead trees should be removed. Dead wood can contribute significantly to fuel loading, and therefore greatly increases the hazard of a severe wildfire. However, retaining several dead trees per acre is good for wildlife purposes— birds utilize the tops of standing dead trees (called snags), and rodents, amphibians, and small mammals utilize downed woody debris as habitat. If possible, three standing and five dead trees over 8” in diameter should remain in place, as wildlife favor larger material as habitat. The remainder of the woody debris should be removed from the stand for wildfire hazard reduction purposes, as time and resources allow.

### 6.1.1 THINNING IN PONDEROSA PINE

The areas recommended for thinning in ponderosa pine are 18.5 acres total, and are broken up into two units. One unit is on the southwest flank of Tincup, and the other is on Beacon Hill. A portion of the Beacon Hill unit was thinned previously, but the density of trees should be further reduced. The particular goal of this thinning is to increase spacing between the ponderosa and remove ladder fuels (Gambel oak, Douglas-fir, and smaller ponderosa pine), thus reducing wildfire hazard and increasing forest health.

1 The length of time it takes for a suppressed tree to become “permanently suppressed” varies by species, but it generally occurs between 70 and 100 years of age.
The stand currently averages 184 trees per acre and a basal area of 89 ft²/acre. However, this figure is an average between the denser parts of the stand (such as on Tincup and Beacon Hill) and the more open parts of the stand. While recommendations for what the residual stand should look like are usually quantified through trees per acre and basal area, that would not be accurate for this stand because of its variability. Rather, the thinning work should be conducted on a basis of tree spacing and the health and vigor of individual trees. Ponderosa grow best when spaced 15-25 feet apart between trunks, and when at least two sides of the crown receive sunlight. As there are few insect and disease problems in the stand, the “leave” trees may be prioritized by relative location and relative crown health. The following are guidelines for thinning the ponderosa stand:

- Remove trees that are growing directly underneath the crowns of larger trees, including small ponderosa pine, Douglas-fir, and Gambel oak.
- Remove trees that have a crown ratio less than 20%.
- Remove trees that appear to be in declining health. Indicators of declining health are:
  - Severe mistletoe infection
  - Dead top
  - Discolored foliage
- Remove trees that are leaning severely, or have a severe crook.
- Space trees in the medium-density ponderosa pine type to 15 to 25 feet apart between boles.

The spacing recommendation is in place because it will allow the trees to optimize their access to light, nutrients, and water. By reducing competition between trees, they will grow faster, larger, live longer, and be less susceptible to insect and disease infestations. However, the spacing recommendation is not ironclad. Leaving small groups of thicker trees will retain wildlife habitat (such as hiding cover for deer and elk) and prevent the stand from looking like a plantation. Similarly, in some areas the trees may be thinned to an even wider density, which will create more diversity in the stand structure.

It is also possible to create vertical diversity in the stand. While for the most part it will be the smaller trees that are removed, some should be maintained as part of the “future forest.” For example, mountain pine beetle favor infesting larger trees, and if an epidemic occurred, the smaller ones would be very valuable because they would not be attacked by the beetle. So, while the guidelines listed above are considered ideal for meeting our main goals of wildfire hazard reduction and forest health improvement, it is still important to retain diversity within the stand to achieve the other goals of wildlife habitat and aesthetics. To quantify this idea, 90% of the management area should be thinned to the standards on the bulleted list, and 10% should be thinned to retain diversity.
6.1.2 THINNING IN DOUGLAS-FIR

The Douglas-fir stand is starting to become overly dense. This density reduces the vigor of individual trees, making them more susceptible to outbreaks of insects and diseases, like Douglas-fir beetle. For the most part, the Douglas-fir stand is even-aged; most of the trees are of similar age, height, and diameter. Ladder fuels are not as great of a concern here as they are in the ponderosa stands—the high crown closure and attendant lack of sunlight prevents regeneration of new trees. A few areas (such as that pictured below) have some fallen dead trees, but not enough to appreciably increase fuel loading. The management goal in this stand is to reduce the density of trees, enabling them to grow faster and be more resistant to insect and disease outbreaks. Thinning will separate the crowns and allow more sunlight onto the forest floor, which will encourage the growth of herbaceous vegetation and thus improve wildlife habitat.

Generally speaking, trees in this stand should be removed so that the remaining trees are spaced 10-15 feet apart between trunks. The following are guidelines for thinning the Douglas-fir stand:

- Remove trees that appear to be in declining health. Indicators of declining health are:
  - Dead top
  - Antler rub over more than 50% of the trunk circumference
  - Discolored foliage
- Remove trees that are leaning severely, or have a severe crook.
- Remove seedlings, saplings, and shrubs over 2 feet tall that are growing directly underneath larger, healthy trees.
- Remove trees with a crown ratio of less than 15%.
- Space trees in the mixed conifer forest type 10 to 15 feet apart between trunks.

As the Douglas-fir stand is much less variable in terms of density than the ponderosa pine stand, we can rely on basal area and trees per acre to help achieve management goals. Currently, there are 230 trees per acre, with a basal area of 113 ft²/acre. The thinning should remove roughly one-third of the trees, so the stand will have a residual density of 151 trees per acre and a basal area of 80 ft². This basal area is low enough that the stand will become more vigorous and healthy, but crown closure will remain high enough that it will be difficult for new tree seedlings and shrubs to become established or compete with the remaining overstory trees.

As with the ponderosa thinning, it is a good idea to create structural diversity within the stand. Trees should be thinned so that a
few clumps of trees remain intact for hiding cover and visual variability. The smallest trees must
not always be removed, as they will be the future forest and some of them should be left to grow.
However, this type of management should be limited to 5% of the stand or less. The reason for
this is because spruce budworm (which will be elaborated on in Section 6.5) thrives in stands
with a multi-storied structure. If such vertical diversity of structure is limited to a small portion
of the stand, it will still reap benefits for wildlife and aesthetics, but not change the character of
the entire stand in a manner that would predispose it to a spruce budworm infestation.

6.2 FUELBREAKS

Two fuelbreaks are planned for the Open Space property. Fuelbreaks are an important line of
defense against a wildfire. Their primary function is to break up the continuity of fuels in a
forest and provide an area where the fire will slow down and be more easily controlled. The two
fuelbreaks are strategically located for several reasons. When protecting the property from
wildfire, we must look at the direction of spread. Should it come from the south, the old Murphy
Gulch Fire burned area and the natural grasslands that run east-west break up the continuity of
fuels and will act as a natural firebreak. Fires in this area very rarely come from the east. So,
our remaining concern is a fire that comes from the west and north, and that’s why the fuelbreaks
are located where they are. Second, the fuelbreaks are located in areas that are rapidly accessible
by firefighting personnel and equipment. This is an important aspect of fuelbreak siting for
them to work, they have to be defensible. They will reduce the intensity of a fire to the point that
it can be safely fought, but are not able to stop the fire by themselves.

A very important key to fuelbreaks is that one must make a commitment to maintaining them.
Thinning trees in the fuelbreak area often allows the ground to receive more sunlight and
precipitation, which causes an increase in the quantity of vegetation. This new vegetation
increases the fuel loading in general, and also creates ladder fuels. So, if the fuelbreak is not
maintained, the fire hazard will be greater than before it was created. Following the fuelbreak
maintenance schedule is crucial to its success.

The two fuelbreaks are designed to work in tandem with the thinning units. Together, they will
reduce the chance of a catastrophic wildfire, and provide for a safe anchor from which
firefighting operations may be conducted.

6.2.1 GAMBEL OAK FUELBREAK

One fuelbreak will utilize Manor House Trail as its anchor. The predominant vegetation to be
modified is the Gambel oak that grows thickly along the road. This will not only break up the
continuity of fuels, but it will also protect the road, allowing firefighters to travel safely along it
in the event of a wildfire. According to the Colorado State Forest Service’s guidelines, fuels
should be modified 210 below the road and 110 above it. All Gambel oak within 30 of the
downhill side of the road should be removed, and all oak within 150 of the uphill side should be
removed. Beyond those boundaries feet, the oak should be partially removed, and cut into a
mosaic pattern. Ponderosa pine and Douglas-fir occur sporadically through the Gambel oak
stand. Oak should be cut within 10 of the edge of the crowns of conifers this will reduce
wildfire hazard, and help the conifers to grow better.
The western 0.7 miles of this fuelbreak is vegetated with heavy Gambel oak, and will require a good deal of management work. The eastern 0.2 miles has Gambel oak, but it grows in a much less continuous fashion. Less intensive management work will be necessary to achieve the desired treatment levels.

Gambel oak grow in "clones," where an individual tree has many stems that branch underground. This clonal tendency is visible in aerial photos, where Gambel oak thickets take on a circular shape. When creating the fuelbreak (beyond the 15- and 30-foot total exclusion zones), personnel should work with the clones. The outer stems of the oak should be cut, so that clones have corridors between them at least 10' in width. Cutting the outer stems, but not the entire clone, will help to prevent resprouting and will still break up the continuity of fuels. Resprouting will be the greatest obstacle to maintenance of this fuelbreak, and will be addressed in more detail below.

Ken-Caryl has several options for removing the oak. First, it could be manually felled with chainsaws, and the debris hauled to the road and disposed of. However, that would be very labor-intensive and time-consuming. If extensive resprouting occurs, it may have to be re-cut within three years. A masticating machine, such as a Hydroax, is the least labor-intensive but could be costly. Because of the steep slopes along Manor House Trail, the machine may only be able to work in the total-exclusion zone along the road, and a crew would have to manually fell the oak beyond that boundary.

Using goats to consume sprouts and prune trees is an environmentally-friendly option that has been proven to be very effective, but the use of manual felling may still be necessary to meet objectives. A third option is the use of chemicals to kill live trees and abate resprouting. A number of chemicals and methods of use are available. For example:

- The oak could be cut and the stumps immediately sprayed with Round-Up to prevent resprouting. May impact dicots in the area if runoff occurs.
- Pronone Power Pellets (a selective herbicide) can be distributed on the surface of the fuelbreak over two seasons, causing mortality of oak and juniper by the end of the second year.
- Arsenal can be sprayed on the live foliage of a few individuals per clone. The herbicide will get into the oak's root system and kill the entire clone, permanently.

Obviously, use of herbicides still involves manual felling. Although the oak will die, they will still need to be cut for aesthetic purposes. A combination of any of these methods will be effective, such as goats followed by manual felling to clean up, or mastication followed by...
treatment of new sprouts with Round-up in three years. Information on all these methods is included in Appendix D.

6.2.2 MIXED CONIFER FUELBREAK

The second fuelbreak is located on the top of Tincup, and is anchored to the old bulldozer lines from the Murphy Gulch Fire. It is also anchored to fuelbreaks that will be created on Willow Springs property. In this management unit, a portion of it is in ponderosa pine and another is in Douglas-fir. The management recommendations are the same for both stand types.

The guidelines for creating this fuelbreak are as follows:

- The fuelbreak should extend 250 feet to the west and north of the dozer line.
- Separate crowns of trees by at least 10 feet, needle-tip to needle-tip.
- The largest, healthiest trees are preferred for "leave trees."
- Branches on remaining trees should be pruned to between 6 and 10 feet, but not more than 1/3 the height of the tree.
- Ladder fuels should be removed, including brush and regeneration.
- Dead trees and downed woody debris should be removed.

Again, proper construction of the fuelbreak, as outlined above, and committing to its maintenance are crucial. At least every five years, an assessment should be made as to whether or not the fuelbreak needs maintenance. Some signs that it needs maintenance are:

- Regeneration is reaching such a height that it begins to act as a ladder fuel (generally, over 6 feet tall).
- Shrubs and Gambel oak have grown back and are several feet high
- An insect or disease outbreak, or an abiotic event such as a windstorm, has killed numerous trees in the fuelbreak.

Because an important aspect of a functioning fuelbreak is being able to access it with firefighting personnel and equipment, Ken-Caryl managers should explore the possibility of keeping the old dozer line open. While the steepness of the slope may prevent 4-wheel drive vehicles from being able to drive on it, it should be kept clear of debris and stumps so that handline or a new dozer line could be easily constructed in the event of a wildfire.
6.3 ASPEN RESTORATION

The aspen stand is a unique and aesthetic resource on the Open Space property, and efforts should be made to ensure the stand’s continued health and existence. Conifers and Gambel oak are encroaching on the aspen stand, regeneration of the aspen has slowed, and some of the older trees are beginning to decline.

In order to maintain the stand’s function, the encroaching species should be removed. Any Gambel oak, blue spruce, or other conifer greater than 2\(\text{ft}\) tall should be cut and removed. The aspen that show signs of decline (presence of conks on bole, many dead branches in crown) should also be cut. Doing so will serve two purposes: first, it will reduce the hazard of rotten trees accidentally falling on recreationists. Second, cutting the trees will cause a hormonal signal to be sent to the roots of the aspen clone, signaling the need for regeneration. The roots will then send up new sprouts, and the aspen stand will continue living.

6.4 SLASH TREATMENT & WOOD UTILIZATION

Slash treatment on the Ken-Caryl Open Space property presents a problem. Unless a masticating machine is used (which will chip all slash and live trees in place), the thinning projects will be conducted manually. While most of the thinning units are near trails, they are still far enough from roads that hauling the slash away is a difficult undertaking. Piling and burning is a good option, but is limited by factors such as local fire department restrictions and Jefferson County air quality permits. The effects of such limitations could mean things like piles would have to be extinguished by 4pm, and they would have to be accessible by a fire engine. So, where possible, slash should be brought to an area where it could either be chipped, hauled away, or burned near a road. Where pulling slash out of the units would be too far to be feasible, and where it would not present a problem with aesthetics (like along trails) it should be lopped and scattered. Some piles (three to four per acre) may be left in place to create wildlife habitat.

If Ken-Caryl can get access to ATVs or a small tracked machine with a chipper that runs via a Power Take-Off (PTO), that would be ideal. ATVs can be modified to have a large basket on the back that can hold slash, or they could pull a small trailer that slash could be loaded on to. A tracked machine with a chipper would also be useful, as it could operate on steeper slopes, and slash would only have to be handled once. Proper slash treatment is important for wildfire mitigation, especially in the fuelbreaks. The depth and compactness of slash (i.e. lopped-and-scattered slash vs. chips) can influence fuel loading, and thus wildfire hazard. Furthermore, the type and amount of slash left in the units can have a negative impact on aesthetics, which would be in contradiction with management goals.
ATVs and/or a tractor would also be helpful for removing logs from the units. The trees cut could have many uses, such as buck-and-rail fences, benches, and firewood. Removing logs by hand is time-consuming and difficult, so it would be best if there were a mechanized process of getting the wood out.

6.5 MONITOR AND TREAT FOR INSECTS AND DISEASES

Ken-Caryl Ranch staff should monitor and treat for insects and diseases on a yearly basis. At the current time only minimal insect and disease damage exists within the Open Space. However, given the dense forest conditions and cyclical nature of many insects/diseases, the potential for insect and disease outbreaks always exists.

During the forest inventory, minor western spruce budworm damage was noted in the very northwestern corner of the Open Space. Given the dense, multi-storied nature of this area, the potential exists for a significant outbreak. This area should be monitored in coming years to determine if treatment is warranted. Treatment would likely consist of an aerial application of a naturally occurring insecticide (like *Bacillus thuringiensis*). Additionally, because insect outbreaks occur across ownership boundaries, communication should be maintained with adjacent landowners as to the extent and level of damage. Doing so will result in more effective and cost efficient treatment, if warranted.

As Ken-Caryl has had problems with mountain pine beetle and Douglas-fir beetle in the past, these populations should be monitored. Most of them have historically occurred on or near Beacon Hill, and along the edges of the Murphy Gulch Fire.

The long-term (and most effective) strategy towards insect and disease management is the creation of healthy, vigorous stands of trees which are resilient to insect and disease outbreaks. To this end, actions such as the thinning prescribed in the previous section will work to create such healthy and vigorous stands. Beyond this general strategy, continual monitoring should be done for new and previously undetected insect and disease issues. Once identified, a determination can be made as to the appropriateness of treatment activities.

6.6 CONTROL NOXIOUS AND NON-NATIVE WEEDS

Noxious and invasive weeds present a great threat to biodiversity and the ecological function of Ken-Caryl Open Space. Noxious weeds should be controlled according to the 2005 Noxious Weed Management plan, and the property should be surveyed annually to monitor the extent of current populations and location of new ones.
Smooth brome is an incredibly prevalent non-native species on the Open Space. Its prevalence creates problems for diversity, and an effort should be made to restore the native grassland. Many of the grassy areas occupied by smooth brome are on steep, rocky slopes, and management activity is not feasible. However, it is possible to manage brome in the upper meadow (near the aspen stand).

The meadow should be mowed in mid- to late-May, after the brome has put up its seedhead spike but before it has produced mature seed. Immediately after mowing, the meadow should be reseeded with a native grass and forb mix preferably one which includes mountain muhly, little bluestem, sun sedge, timothy, sageworts, and various wildflowers, the major native species that should be found in the meadow. This process may need to be repeated for several years, or until the smooth brome has mostly been replaced by native species. The meadow should be monitored in the future, in order to ensure that the brome has not returned in a large population. Similar results can be done through prescribed fire, although such an activity is more involved and would require more planning than can be done in this document.

If Ken-Caryl Ranch managers would like to further explore prescribed fire opportunities, they may create a burn plan at a later date.

6.7 ACCESS AND CROSS-BOUNDARY MANAGEMENT

The management units described in this plan are the best, most efficient options for meeting Ken-Caryl’s management goals. The units also dovetail with those planned on adjacent West Ranch and Willow Springs. Such cross-boundary management is very effective, and provides the opportunity for collaboration between the Master Associations. If possible, these management activities can be coordinated so that resources can be shared (such as thinning contractors, mastication machines, chippers, etc.). Sharing resources will reduce the longevity of disturbance, such as noise pollution and dust, and could also reduce the cost per acre.

Part of the process of cross-boundary management may also entail shared access. For example, it would be very beneficial if Willow Springs could use Manor House Trail to access and construct the fuelbreak on their southern boundary. Ken-Caryl would receive the benefit of the Willow Springs fuelbreak, because it would reduce the wildfire hazard on their own property. Creating such agreements to cooperate is, of course, up to the property managers.

A Map of forest management projects prescribed for adjacent properties (which provide opportunities for cross-boundary management) is included in Section 7.0, Figures.
8.0 GLOSSARY

**Abiotic:** Damage such as snowbreak, windthrow, or drought injury; not caused by a living agent.

**Aspect:** The compass direction toward which a slope faces.

**Basal Area:** The cross-sectional area of a single stem, including the bark, measured at breast height (4.5 feet).

**Basal Area Factor:** A designation of the type of prism used to determine basal area. Also, the numerical factor used to calculate basal area per acre.

**Blowdown (also “windthrow”):** Uprooting by the wind. Also refers to a tree or trees so uprooted.

**Bole:** The trunk of a tree.

**Canopy (crown) closure:** The progressive reduction of space between crowns as they spread laterally, increasing canopy cover.

**Crown:** The live branches and foliage of a tree.

**Crown Ratio:** The ratio of the [vertical] length of crown to the total length of the tree.

**Defensible Space:** An area around a structure where fuels and vegetation are treated, cleared or reduced to slow the spread of wildfire towards the structure.

**Density (of trees):** A measurement of how numerous trees are in a given area, such as trees per acre.

**Density-Dependent Mortality:** Trees which die as a result of other (usually larger) trees being able to out-compete them for light, water, and nutrients.

**Diameter at Breast Height (DBH):** The diameter of the bole of a tree at 4 ½ feet above the ground.

**Doghair:** An extraordinarily dense area of trees. A term often given to lodgepole pine, where the trees may number in the thousands per acre.

**Forb:** Herbaceous, non-woody vegetation.

**Flagging:** Individual branches whose foliage has been killed. So called because foliage often turns bright orange when dying, which appears like a flag amidst the green foliage.

**Forest Floor:** The ground underneath the trees in a forest, which includes the organic soil.
horizon (decomposing organic material), fallen pine needles and leaves, herbaceous vegetation (usually less than 20 high), rock outcroppings, and more.

Fuel Loading: The oven-dry weight of fuel per unit area. Generally used to describe the amount and live and dead vegetative material that would contribute to the heat/intensity of a wildfire.

Fuel Model: A classification given to each type of fuel, based on a wildfire's expected behavior under certain conditions in that fuel type.

Fuel Type: A classification on forest fuels in relation to wildfire hazard, based on the density of live and dead trees, shrubs, herbaceous vegetation, and the composition of the forest floor (thickness and continuity of pine needles, dead grasses, etc.)

Fuelbreak: A strategically located strip of land, depending on fuel and terrain, in which fuel density is reduced, thus improving fire control opportunities. The stand is thinned and remaining trees are pruned to remove ladder fuels. An open, park-like appearance is established.

Intermittent Stream: A small waterway which flows periodically in the form of a stream, generally after heavy rains or during spring snowmelt.

Ladder Fuels: Vegetative materials with vertical continuity that allows fire to burn from the ground level up to the branches and crowns of trees.

Leave Tree: A tree which is not cut during forest management activities.

Litter: The surface layer of a forest floor that is not in an advanced stage of decomposition, usually consisting of freshly fallen leaves, needles, twigs, stems, bark, and fruits.

Multi-Storied Stand: A stand which has trees with a wide variety of heights.

Noxious Weed: A plant specified by law as being especially undesirable, troublesome, and difficult to control.

Overstory: That portion of the trees in a forest forming the uppermost canopy layer.

Perennial Stream: A stream which flows at all times of the year.

Pitch-out: A pocket of sap, seen on the outside of the tree, that is indicative of past or current pine beetle infestation.

Riparian Area: Wet area with characteristic vegetation adjacent to a body of water.

Sapling: A young tree with a DBH greater than one inch but less than five inches.
Seedling: A young tree, from the time of germination to the sapling stage, having a DBH equal or less than one inch.

Shade-Tolerant: a tree which can grow underneath the canopy of other trees. Does not require full sunlight to thrive.

Shade-Intolerant: a tree which requires sunlight on at least two sides to germinate and thrive.

Skid Trail: a road on which cut logs are hauled out of the forest.

Snag: A standing, generally unmerchantable dead tree from which the leaves and most of the branches have fallen

Stagnant: A tree which, due to poor growing conditions, is growing very slowly.

Stand: A contiguous group of trees sufficiently uniform in age-class distribution, composition, and structure, and growing on a site of sufficiently uniform quality, to be a distinguishable unit.

Stressed Tree: A tree whose growth and vigor has been adversely affected by environmental conditions such as drought, competition, insects/diseases, etc.

Suckering: a method of regeneration wherein roots of an existing tree (such as Gambel oak or aspen) can break the surface of the soil and create new individuals

Thinning: A cultural treatment made to reduce stand density of trees primarily to improve growth, enhance forest health, or recover potential mortality

Understory: Herbaceous vegetation (such as grasses and forbs) and woody vegetation (such as shrubs and small trees) which occupy the forest floor under a canopy of larger trees.

Vigor: A description of how fast the tree is able to uptake soil and nutrients, which (if it has good vigor) will lead the tree to grow faster, live longer, and be more resistant to damaging agents like bark beetles.

Woody Debris: Fallen material from trees that is located on the forest floor, such as dead branches, twigs, and dead trees themselves.
9.0 BIBLIOGRAPHY


APPENDIX B: SOIL DESCRIPTIONS

The following is a brief description of each soil type and any special management considerations:

- **Soil Type 3: Allens Park Variant-Ratake-Rock outcrop complex, 30 to 50% slopes.**
  This soil complex is found on north-facing mountain side slopes and summits that are vegetated by ponderosa pine, Douglas-fir, mountain mahogany, grasses, and forbs. The soil, which is gravelly-loamy, was formed by weathering of metamorphic and igneous rocks and is moderately deep and well-drained. Rooting depth is 20-40". The surface of the soil is typically covered by an inch-thick mat of partly decomposed needles, leaves, and twigs. Permeability of the soil is moderate, and available water capacity is low. Runoff is rapid and erosion is a severe hazard. Due to the erosion hazard, it is especially important to maintain ground cover during forest management activities. Access roads and trails should be constructed with care—attention to grade and the use of culverts will help to prevent erosion.

- **Soil Type 37: Earcree gravelly sandy loam, 9 to 15% slopes.**
  These soils are found on mountain toe slopes, drainages, and alluvial fans. It is deep and well drained, with moderate permeability, moderate water capacity, and moderate speed of runoff. Erosion is a severe hazard. The native vegetation on this soil is Douglas-fir, aspen, and lodgepole, with an understory of shrubs and grasses. The ground cover is typically a 2" thick mat of fallen pine needles and leaves. Due to the erosion hazard, it is especially important to maintain ground cover, as well as construct roads with culverts (instead of creating fords across the drainages).

- **Soil type 55: Grimstone-Hiwan-Rock outcrop complex, 30 to 50% slopes.**
  This complex is on north-facing mountain side slopes and ridges. Grimstone soil makes up 35 percent of this complex, Peeler soil makes up 30 percent, and Rock outcrop makes up 20 percent. The Grimstone soil is moderately deep and well drained. Permeability of the Grimstone soil is moderate. Runoff is rapid, and water erosion is a severe hazard. The Hiwan soil is shallow and well drained, the permeability is rapid, and the available water capacity is low. Runoff is rapid, and water erosion is a severe hazard. Rock outcrop consists of exposures of igneous and metamorphic bedrock, talus, and large boulders. Runoff is rapid, but water erosion is only a slight hazard on most rock surfaces. The native vegetation on this soil includes Douglas-fir, lodgepole pine, kinnikinnick, common juniper, forbs, and grasses.

- **Soil type 56: Grimstone-Peeler-Rock outcrop complex, 15 to 30% slopes.**
  This complex is on north-facing mountain side slopes. Grimstone soil makes up 40 percent of this complex, Peeler soil makes up 25 percent, and rock outcrop makes up 20 percent. The Grimstone soil is moderately deep and well drained. Permeability of the Grimstone soil is moderate. Runoff is rapid, and water erosion is a severe hazard. The Peeler soil is deep and well drained, the permeability is moderate, and the available water capacity is high. Runoff is rapid, and water erosion is a severe hazard. Rock outcrop consists of exposures of igneous and metamorphic bedrock, talus, and large boulders.
Runoff is rapid, but water erosion is only a slight hazard on most rock surfaces. These soils are in the Douglas-fir/Lodgepole Pine woodland group.

- **Soil type 57: Grimstone-Peeler-Rock outcrop complex, 30 to 50% slopes.**
  This complex is on north-facing mountain side slopes. Grimstone soil makes up 40 percent of this complex, Peeler soil makes up 25 percent, and rock outcrop makes up 20 percent. The Grimstone soil is moderately deep and well drained. Permeability of the Grimstone soil is moderate. Runoff is rapid, and water erosion is a severe hazard. The Peeler soil is deep and well drained, the permeability is moderate, and the available water capacity is high. Runoff is rapid, and water erosion is a severe hazard. Rock outcrop consists of exposures of igneous and metamorphic bedrock, talus, and large boulders. Runoff is rapid, but water erosion is only a slight hazard on most rock surfaces. These soils are in the Douglas-fir/Lodgepole Pine woodland.

- **Soil type 58: Hargreave sandy loam, 3 to 9% slopes.**
  This deep and well-drained soil is found on hill slopes. It is a reddish, loamy material derived from sedimentary rocks. This native vegetation on this soil is western wheatgrass, blue grama, and Sandberg bluegrass. Rooting depth is 20 to 40", permeability is moderate, and water capacity is moderate. Runoff is slow, and erosion from wind and water is moderate. This soil supports rangeland that is useful for wildlife.

- **Soil type 59: Hargreave-Bernal sandy loams, 9 to 15% slopes.**
  This soil is very similar to Hargreave sandy loam. The inclusion of the coarser Bernal soil causes this soil to have a lower water capacity and increased permeability. Vegetation and other characteristics are the same as soil type 58.

- **Soil type 72: Lavate-Bernal-Rock outcrop complex, 15-30% slopes.**
  This soil is found on hill slopes. Like the Hargreave soils, it is reddish in color and derived from sandstone. Permeability is rapid and available water capacity is low. It is shallow and well-drained, and rooting depth is 8 to 20 inches. Runoff is rapid, and water erosion is a severe hazard. Native vegetation is similar to that of the Hargreave soils. Maintenance of vegetative cover is crucial for the prevention of erosion.

- **Soil type 78: Legault-Tolvar-Rock outcrop complex, 50 to 70% slopes.**
  This complex is found on side slopes and ridges, and is composed of 35 percent Legault soil, 30 percent Tolvar soil, and 20 percent rock outcrop. The Legault soil is shallow, well drained, and rapidly permeable. The Tolvar soil is deep, well drained, and moderately permeable. The water capacity for both soils is low. Rock outcrop consists of exposures of igneous and metamorphic bedrock, talus, and large boulders. Runoff is rapid. Water erosion is a slight hazard on most rock surfaces, but it is a severe hazard on Legault and Tolvar soils. The native vegetation on this soil includes Douglas-fir, lodgepole pine, kinnikinnick, common juniper, forbs, and grasses.

- **Soil type 85: Lininger-Ratake complex, 15 to 30% slopes.**
  These soils are found on mountain side slopes, ridges, and stable summits. Lininger soil makes up 45 percent of this complex and Ratake soil makes up 40 percent. The Lininger
soil is deep and moderately permeable. The Ratake soil is shallow and moderately permeable. Both soils are well-drained, have low water capacities, and have medium to rapid runoff. The potential for erosion is severe. The native vegetation on this soil is ponderosa pine and various grasses.

- **Soil type 87: Lininger-Trag sandy loams, 9 to 20% slopes.**
  These soils are on stable summits, mountain toe slopes, and side slopes. Lininger soil makes up 50 percent of this complex and Trag makes up 35 percent. The Lininger soil is moderately deep and well-drained, moderately permeable, and the available water capacity is low. Trag soil is deep and well drained, and the available water capacity is high. Runoff in the complex is moderate to rapid, and the possibility of erosion is severe. The native vegetation is grass with scattered ponderosa pine.

- **Soil type 122: Ratake-Cathedral very stony sandy loams, 25 to 60 percent slopes.**
  These soils are on mountain side slopes and ridges that have an east, west, or south aspect. Ratake soil makes up 50 percent of the complex and Cathedral makes up 35 percent. Both soils are shallow and well-drained. The Ratake soil is moderately permeable and has a low available water capacity. The Cathedral soil is rapidly permeable and has a low water capacity. This complex has the potential for severe water erosion. The native vegetation is Gambel oak, scattered ponderosa pine, and various grasses. Plant cover is often difficult to establish and maintain because of the shallowness to rock and low water capacity.

- **Soil type 123: Ratake-Cathedral-Rock outcrop complex, 25 to 60% slopes.**
  These soils are on mountain side slopes and ridges that have an east, west, or south aspect. Ratake soil makes up 35 percent of the complex, Cathedral makes up 30 percent, and rock outcrop makes up 20 percent. Both soils are shallow and well-drained. The Ratake soil is moderately permeable and has a low available water capacity. The Cathedral soil is rapidly permeable and has a low water capacity. Rock outcrop consists of exposures of igneous and metamorphic bedrock, talus, and large boulders. Runoff is rapid, and water erosion is a slight hazard on most rock surfaces. This complex has the potential for severe water erosion. The native vegetation is Gambel oak, scattered ponderosa pine and Rocky Mountain juniper, and various grasses. Plant cover is often difficult to establish and maintain because of the slope, shallowness to rock and low water capacity.

- **Soil type 124: Ratake-Cathedral-Rock outcrop complex, 25 to 60% north slopes.**
  These soils are differentiated from type 123 because they occur on north-facing mountain side slopes and ridges. Their composition and characteristics are identical to the above soil. Vegetation is similar, although it lacks the Gambel oak component. Again, plant cover is often difficult to establish and maintain because of the slope, shallowness to rock and low water capacity.

- **Soil type 125: Ratake-Lininger stony sandy loams, 30 to 60% slopes.**
  These soils are on mountain side slopes and ridges that face east, south, or west. Ratake makes up 55 percent of this map unit and Lininger makes up 30 percent. The Ratake soil
is shallow and well drained, with moderate permeability and low water capacity. The Lininger soil is deep and well-drained, also with moderate permeability and low water capacity. Both have rapid runoff and the potential for severe water erosion. The native vegetation is grass with scattered ponderosa pine.

- **Soil type 138: Rock outcrop, igneous and metamorphic, 15 to 100% slope.**
  Rock outcrop consists of exposures of igneous and metamorphic bedrock, talus, and large boulders. Runoff is rapid, and water erosion is a slight hazard on most rock surfaces.

- **Soil type 152: Trag sandy loam, 3 to 9% slopes.**
  This soil is found on fans, toe slopes, and drainageways. It is deep and well drained, moderately permeable, and has a high water capacity. Runoff is slow, and water erosion is only a slight hazard. The native vegetation is grass. If disturbed, the grass may take some time to come back due to the short growing season.

- **Soil type 153: Trag sandy loam, 9 to 25% slopes.**
  This soil is found on fans, toe slopes, and drainageways. It is deep and well drained, moderately permeable, and has a high water capacity. Runoff is medium to rapid, and water erosion is a moderate to severe hazard. The native vegetation is grass. If disturbed, the grass may take some time to come back due to the short growing season and slope.
APPENDIX C: PLANTS AND WILDLIFE NATIVE TO KEN-CARYL RANCH
APPENDIX D: SUPPLEMENTARY INFORMATION

Fact Sheets and Brochures in this Appendix:

1. Noxious Weeds Descriptions and Treatments
   a. Canada Thistle
   b. Musk Thistle
   c. Russian Knapweed
   d. Leafy Spurge
   e. Cheatgrass
   f. Common Mullein
   g. Yellow Toadflax

2. Insects and Diseases
   a. Mountain Pine Beetle
   b. Mountain Pine Beetle Q & A
   c. Preventative Spraying for Mountain Pine Beetle
   d. Solar Treatment of Mountain Pine Beetles
   e. Diesel Fuel Treatment of Mountain Pine Beetles
   f. Douglas-Fir Beetle
   g. Western Spruce Budworm

3. Forest Thinning
   a. Landowner Guide to Thinning
   b. Creating Fuelbreaks for Forested Subdivisions
   c. Best Management Practices for Colorado

4. Gambel Oak Mitigation
   a. Herbicide options and applications
   b. Pronone Article
   c. Arsenal Advertisement
   d. Round-Up memo
   e. Using Goats for Fire Mitigation
   f. Misc. Goat publications