APPENDIX 3-1

ALTON SAGE-GROUSE HABITAT ASSESSMENT AND MITIGATION PLAN

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Alton, Utah Ecological Site Description

The town of Alton Utah (-112.474° longitude, 37.462° latitude), the Alton Amphitheater, and Sink Valley are located between the Pink Cliffs to the west and the Paunsaugunt plateau to the east (Figure 1). The town and surrounding valley occur within a larger watershed basin confined by steep side-slopes to shallow foothills. The soils in this area are high in clay content.

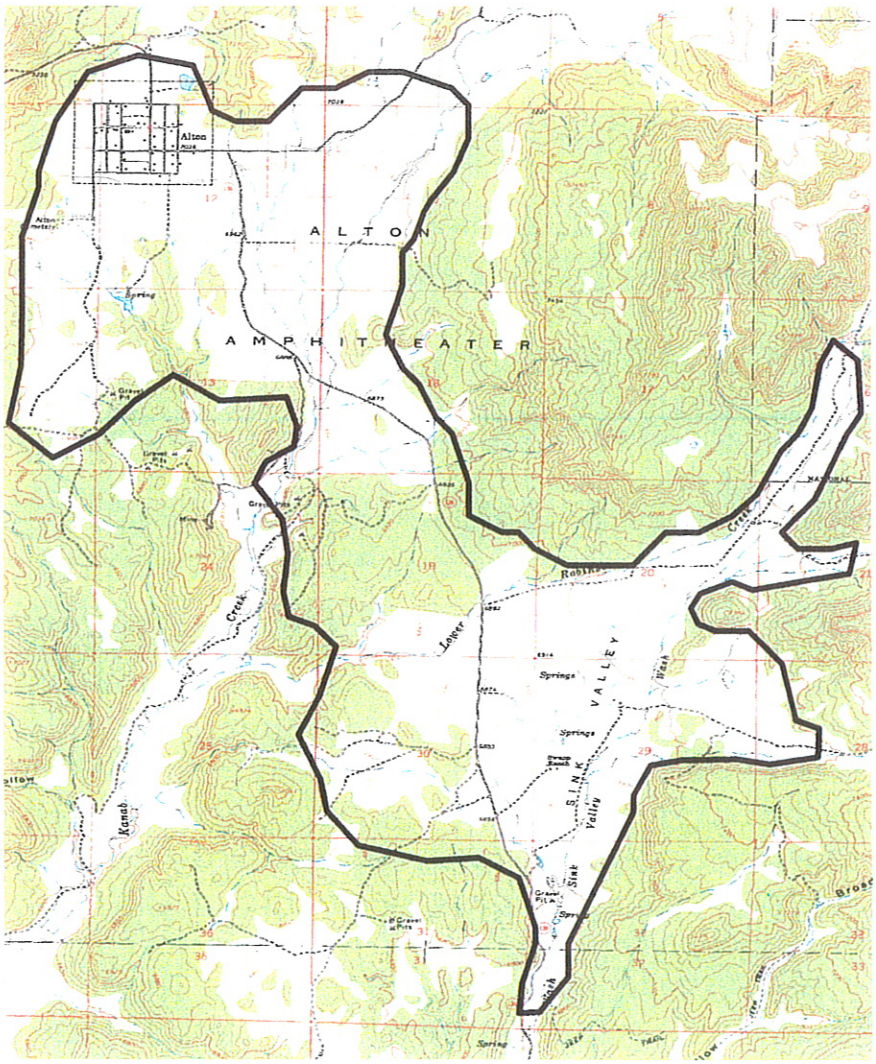

Figure 1. 7.5 minute topographic map of the Alton region. The black line delineates the zone where mining activity and mitigation will be concentrated.

Four predominant plant associations occur within the immediate Alton region (Figure 2). Plant associations are the pinyon – juniper dominated woodland area, the sagebrush dominated community, the valley floor grassland region, and irrigated croplands.

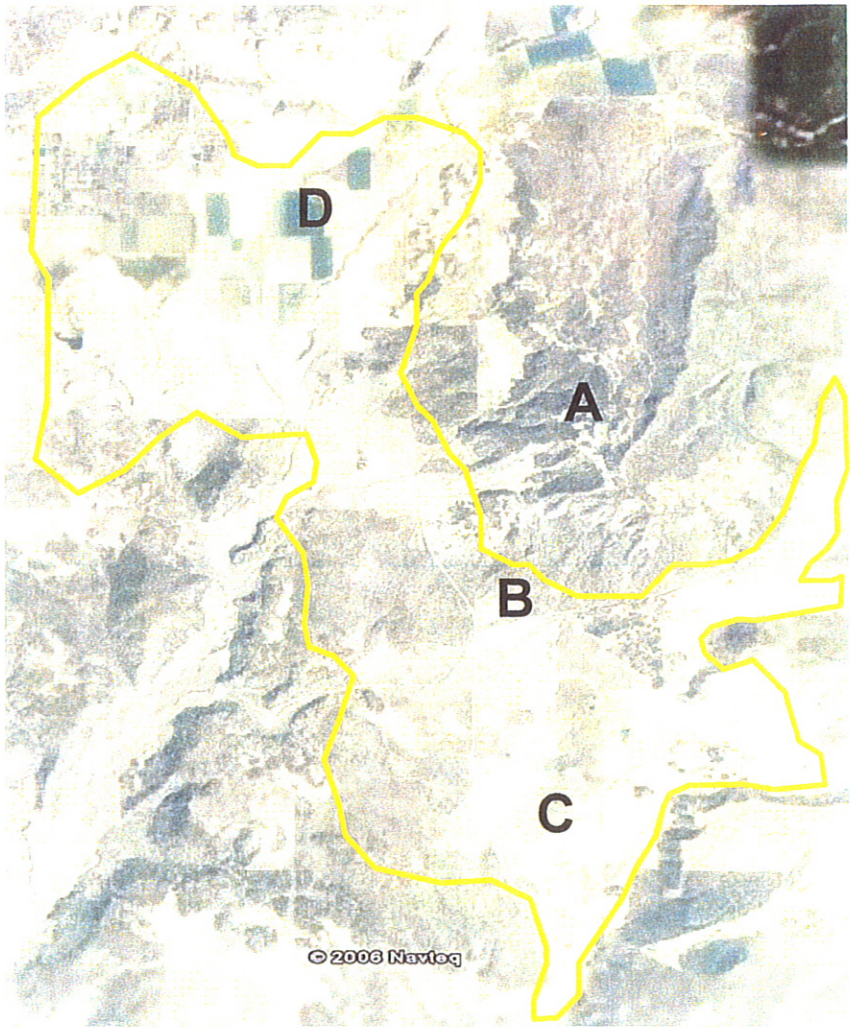

Figure 2. Satellite image of the Alton region (Google-earth 2006). The yellow line delineates the zone of mining activity and mitigation. Vegetation associations include A) Pinyon-juniper dominated woodlands, B) Sagebrush Communities, C) Valley-floor grasslands, and D) Irrigated cropland.

Pinyon-Juniper Dominated Woodlands

Utah juniper (*Juniperus osteosperma*) and pinyon pine (*Pinus edulis*) dominated plant communities (PJ) occur widely throughout the Alton area, ranging from the

open valley floor to steep mountain slopes (Figure 3). Several shrub species that occur within these communities include big sagebrush (*Artemisia tridentata* var. *tridentata* and var. *vaseyana*), black sagebrush (*Artemisia nova*), and antelope bitterbrush (*Purshia tridentata*). Predominant grass species occurring in this region are bluebunch wheatgrass (*Agropyron spicatum*), Idaho fescue (*Festuca idahoensis*), and needlegrass (*Stipa* species). There are a variety of forb species that can be found exhibiting a wide range in density and cover. Common forb species in these woodlands include tailcup lupine (*Lupinus caudatus*) and western yarrow (*Achillea millefolia*).

Figure 3. Juniper and pinyon dominated plant communities located throughout the Alton basin.

Juniper-dominated plant communities, which are transitional between lower elevation arable lands and higher elevation coniferous forests, serve an important ecological role providing seasonal areas for livestock grazing and wildlife habitat such as critical big game winter range (Roundy and Vernon 1999). Prior to European settlement, juniper and pinyon woodlands were primarily confined to shallow rocky soil slopes underlain by fractured bedrock (Miller and Wigand 1994, Miller and Rose 1995). Before this woodland encroachment occured, plant communities were dominated by short and tall sagebrush species, grasslands, riparian zones, and quaking aspen parklands (Burkhardt and Tisdale 1969, Miller et al. 2000, Bates et al. 1999).

Today, juniper and pinyon encroached ecosystems that occur throughout the Intermountain West have increased 10 fold from 1.5 million hectares to 15 million hectares (Miller et al. 2001). This expansion of PJ woodlands has increased as a result of fire suppression (e.g. reduced fire frequency), climate change, heavy grazing, or any combination of these factors (Eddleman 1983). As a result, juniper has moved into more productive, deeper, and well-drained soils from where they historically had been excluded (Burkhardt and Tisdale 1969, Miller and Rose 1995, West et al. 1978). Within the Alton area, most trees have expanded into the foothills and valley bottoms within the past century. This is noted by the relatively young age class of most trees within the area (100-150 years old).

Juniper and pinyon, which are deep-rooted tree species, have the ability to extract water from a wide range of soil depths. Extending deep into groundwater reserves, these trees have been found to directly impact aquifer recharge. They have high transpiration rates, especially during the active growing season. Reports indicate that during peak growth rates, juniper trees will transpire between 30-40 gallons of water each day. Juniper and pinyon can intercept a significant proportion of the precipitation prior to reaching the soil surface. In Texas, for example, evapotranspiration by juniper accounted for 80-95% of the water loss from rangelands (Thurow and Taylor 1995), and in Oregon, western juniper intercepted up to 74% of the precipitation during any given storm event (Eddleman 1983).

Juniper trees are very competitive with other plant species for limited resources, in particular water. The rapid uptake of water by juniper and pinyon trees reduces the availability of water to shallower rooted plant species. In fully occupied juniper woodlands, shrub mortality is initially evident, followed by a decline in grass and forb density and cover (Figure 4). As a result, the intercanopy area will often experience a severe decrease in plant structure and diversity. This in turn exposes bare soil to raindrop impacts, accelerated erosion rates, decreasing infiltrations rates, and high sediment movement and deposition in runoff. Once fully occupied, fuel loads in juniper woodlands (i.e. shrubs, grasses, and other low-growing

vegetation) become limiting, preventing naturally occurring fire from spreading. This in turn can result in long periods without natural disturbance.

Figure 4. Juniper and pinyon dominated plant communities located 50m west of the country road between Alton and Sink Valley.

Sagebrush Communities

Sagebrush dominated plant communities occur along the foothills and intermittently throughout the valley bottom in the Alton area (Figure 5). These sites are dominated by moderate to tall growing shrub species. Similar to juniper encroached areas, dominant species include big sagebrush (*Artemisia tridentata* var. *tridentata* and var. *vaseyana*), black sagebrush (*Artemisia nova*), and antelope bitterbrush (*Purshia tridentata*). Similarly, common grasses and forbs include bluebunch wheatgrass (*Agropyron spicatum*), Idaho fescue (*Festuca idahoensis*), and bottlebrush squirreltail (*Sitanion hystrix*).

Sagebrush dominated stands in the Alton area are limited in size and extent. Most sites that would have once sustained characteristic sagebrush dominated communities have been encroached by juniper. Under natural fire regiimes, sagebrush dominated communities have characteristic fire-return-intervals of approximately 30-37 years (Heyerdahl et al. In Press). Following fire, perennial grasslands establish rapidly until over time sagebrush plants establish and develop

to maturity. With an ignition source along with a buildup of fuels, fire will soon reoccur destroying plants and returning the system to an earlier seral community. With fire suppression in addition to rapid and far-reaching juniper dispersal, the fire-return-interval for many of these systems has increased to 75-150 years. As a result, juniper woodlands have expanded and sagebrush communities have decreased within this area since the 1990's.

Intact sagebrush stands provide important habitat for a variety of sagebrush obligate and sagebrush facultative bird and mammal species. Sage sparrow (*Oreoscoptes montanus*), sage thrasher (*Amphispiza belli*), and Brewers sparrow (*Spizells breweri*) are sagebrush dependant passerine species found throughout the sagebrush grassland biome. Pygmy rabbit (*Brachylagus idahoensis)* and greater sage-grouse are species dependant of contiguous stands of sagebrush communities for providing adequate habitat.

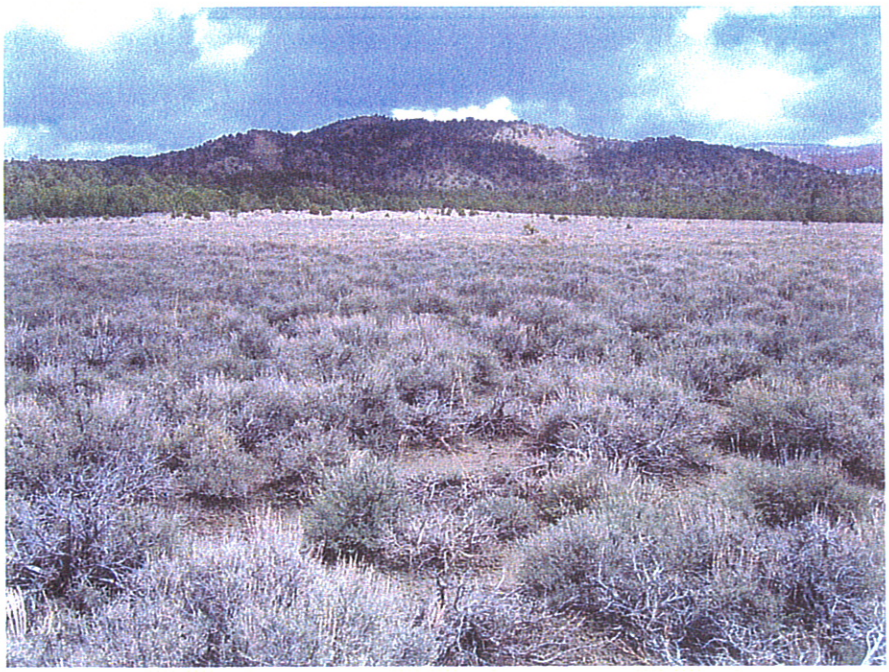

Figure 5. Sagebrush dominated plant communities located east of the country road north of Sink Valley.

Valley Floor Grasslands

Much of the valley bottoms in the Alton Amphitheater and Sink Valley areas are primarily pasture grasslands (Figure 6). These sites are dominated by grass and wet-meadow plant species that occur in fenced fields and pastures. During early spring months (March – April), surface water in the lower portions of this community type lead to ponding and surface flows (based on field observations between late March to early April). The grasses growing in these pastures are primarily introduced species, including Kentucky bluegrass (*Poa pratensis*), timothy (*Phleum pretense*), and intermediate wheatgrass (*Agropyron intermedium*). Sedge (*Carex*) species also occur in these fields, especially where water levels in the soil profile are high. Several forb species also grow in these fields including lomatium (*Lomatium* spp.), and wild iris (*Iris missouriensis*).

Figure 6. valley floor grassland communities that are dominated by pasture and fields consisting primarily of introduced grass species and native forbs. This photo was taken near the sage-grouse lek, adjacent to the Swapp Ranch house in Sink Valley.

Alton Land Use History

The Alton area has a long history of human occupation and use. Following the arrival of western civilization in this valley, the environment has undergone significant alterations.

Fire suppression and juniper expansion

Due to a prolonged history of fire prevention, this region has experienced an unnatural expansion of Utah juniper and pinyon pine along the mountain sides, foothills, and valley floor.

Crop and pasture production

Early settlers converted much of the low lying land into crop production and pasture development. Near Alton, a large portion of the land has been used for raising alfalfa hay. Irrigation has been utilized to sustain season-long hay production. Pastures extend across much of this valley for livestock and wildlife grazing. Pastures and crops have been separated by miles of fence that has been maintained for long time periods (Figure 7).

Sagebrush removal and disking

In many areas, especially south of Alton and north of Sink Valley, sagebrush was disked to remove the shrubs in order to open sites for grass establishment and growth. Introduced species seeded in these pastures included timothy, crested wheatgrass, intermediate wheatgrass and Kentucky bluegrass.

Irrigation and hydrologic modification

The original stream corridors and subsurface groundwater resources were used for irrigating crops and providing water to residents of the town. It is likely that original creek flow-paths have been significantly modified over time by farming and ranching operations.

Soil plowing and road-related disturbance

Based on current land conditions and practices, it is probable that much the soil in this area has been plowed for crop and pasture production. Where plowed, plowpans (compact soil layer) can occur which can restrict plant growth, root penetration and water infiltration. Equal to plowing, road construction has introduced a significant ecological disturbance to the area. These roads are used often, especially during the summer months by local citizens as well as tourists and other motorists. Roads provide ideal corridors for the spread of invasive plants.

City and Home Construction

The town of Alton occurs at the North end of the valley adjacent to the Alton Amphitheater. In addition to the town, a number of homes and ranches have been constructed throughout the Alton region extending to the southern end of the mining and mitigation zone. Activities associated with community life include farming, vehicle use, hunting, and other outdoor recreation and work related activities.

Figure 7. Ecological alterations to the Alton area apparent in this photo include fence construction, hay production, irrigation, road development, and juniper encroachment. This photo was taken east of Alton along the county road.

Sage-grouse Ecology

Population Dynamics

Sage-grouse (*Centrocercus urophasianus*) is a relatively long-lived bird species belonging to the pheasant family (*Phasanidea*). The average lifespan of an adult female is approximately 5-6 years, and less for males at 4-5 years. Sage-grouse vary in summer to winter migration from populations that travel only short distances throughout the year to other populations that will travel over 50 miles before returning to the lek the following spring.

Sage-grouse once occurred from Canada to New Mexico and east to the Dakotas. Today, the range in sage-grouse has decreased in both extent and population density. Figure 8 represents the level of change that has occurred since the settlement of western North America. Data indicate that since 1985, bird populations have decreased by 17-47%. Data provided by the USGS (2003) suggest that sage-grouse numbers have declined annually by 2% since the 1960's (Figure 9).

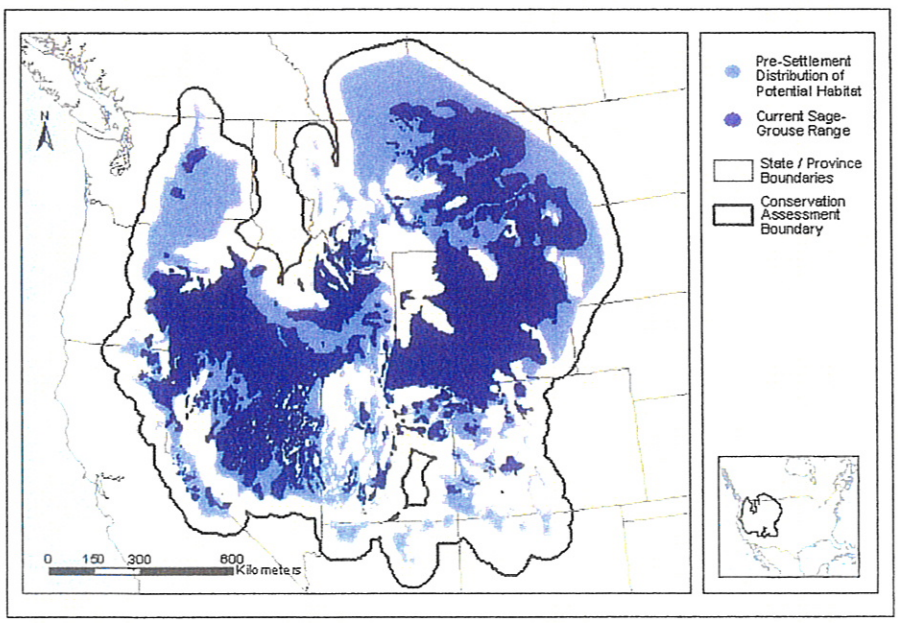

Figure 8. Range of sage-grouse during pre-settlement periods (light blue) in comparison with current sage-grouse populations. These data were provided by the USGS.

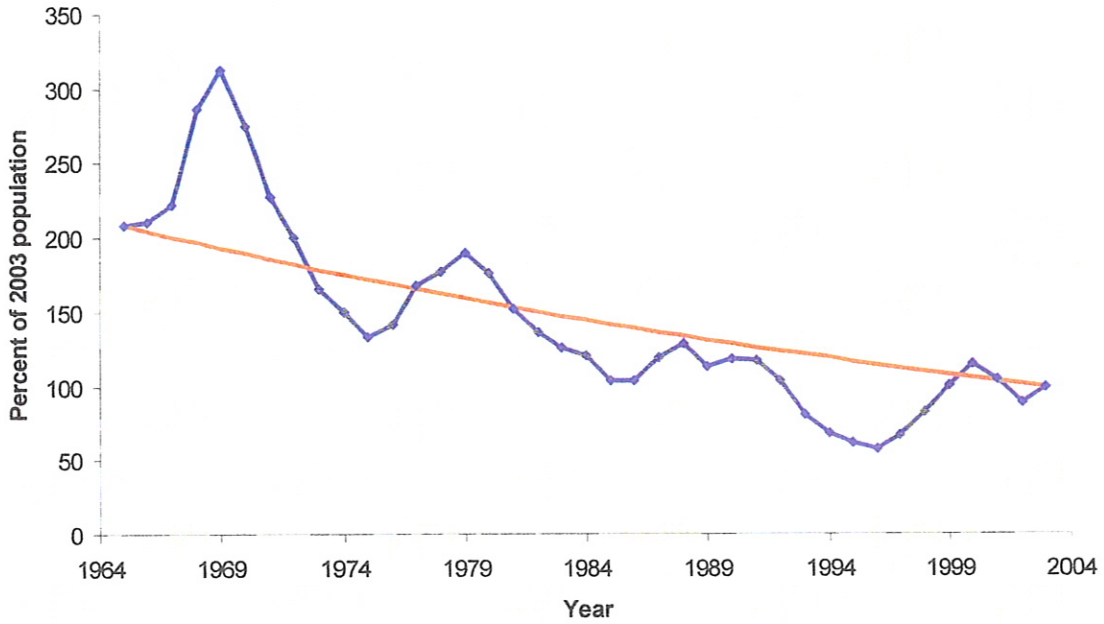

Figure 9. Trend in the sage-grouse population from 1964 to 2003. Data indicate an approximate 2% annual decline. 11 of the 13 states where sage-grouse occur have experienced long-term declines (USGS 2003).

The decline in sage-grouse breeding and nesting success, primarily during the last 50 years, has resulted in a reduction in the distribution of sage-grouse throughout North America by approximately 50% (Aldridge and Brigham 2002). This decrease has been attributed primarily to the reduction of suitable sagebrush habitat resulting from fragmentation, exotic weed invasion, conifer encroachment, overgrazing, cultivation, and altered fire regimes (Miller and Eddleman 2001, Pedersen et. al. 2003, Connelly et al. 2004). Currently, there is considerable discussion focused on strategies to maintain or restore the health of sage-grouse populations across the non-arable portions of the sagebrush biome. Researchers have begun to identify sage-grouse habitat attributes important for maintaining healthy populations throughout the year (Connelly et al. 2004, Crawford et al. 2004, Gregg et al.1994, Barnett and Crawford 1994).

Sage-grouse adult survival is relatively high which is reason for relatively stable adult populations from year to year. According to Connelly (2004), there is a 50-

75% annual survival rate for breeding-aged birds. Gregg (2006) found that female birds had on average 50-60% annual survival whereas male survival was lower (approx. 30%). Sage-grouse productivity, however, is low. Although adult birds may have high reproductive potential, hens will occasionally fail to attempt nesting or will attempt to nest, but fail in producing a viable clutch. More important however is the low juvenile survival rate. Low chick survival is attributed to predation, food and starvation, poor habitat, weather, and harvest. Periodically sage-grouse experience "boom years" in which bird production and survival is higher than average. During these years, populations can experience significant fluctuations in abundance.

Breeding and lek characteristics

Leks are confined areas where adult birds congregate for courtship and mating. From mid-March to late April, birds return to established lekking grounds where males exhibit elaborate courtship displays in attempt to attract observing females. Most adult birds, especially males, will return to the same lek year after year (Gregg et al. 1994). It is common for a lek to be revisited for many decades. Lek habitat consists of relatively short-growing vegetation that minimizes visual obstruction, necessary for performing and observing courtship displays and reducing predation from ground-based predators. Typical plant species that occur in leks are low sagebrush (*Artemisia arbuscula*) and low-growing grasses.

Examples of natural or artificial disturbances applied to a lek suggest that sage-grouse will tolerate modified conditions or will shift to alternate breeding sites. At Jackson Hole, Wyoming, observations of a lek located at the end of the local airport found that birds continued courtship and display behavior in spite of the disturbance of aircraft landing and taking off overhead. In northern Nevada, high water levels and snowpack on the lek during a single years breeding season resulted in the birds shifting breeding activities to a nearby alternate site located on an adjacent hillside. Finally, Tate et al. (1979) and Eng et al. (1979) found that when a lek was disturbed by mining activities, birds utilized a temporary artificial

alternate breeding ground. This shift was improved when audio recordings of strutting male grouse were played from audio equipment located in the alternate lek area.

Nesting and nest-site characteristics

For a 5-week period prior to nesting and after mating, birds move away from the lek and focus their attention on foraging. During this time, adult female birds eat 50-80% sagebrush leaves and 20-50% forbs (Connelly 2004). This provides an opportunity for the hens to acquire nutrients and body mass needed for maternal required during and following nesting.

Females establish nests primarily under mature sagebrush plants, often in mountain big sagebrush communities (Wallestad and Pyrah 1974). Nest sites generally occur within a couple miles of the lek, however, some birds may fly significant distances before establishing nest sites. Birds select nest sites based on canopy height and cover (Connelly 2004). Based on data collected from nest site locations, birds use stands that have on average 15-25% sagebrush cover and a minimum height of 40-80cm. Autenrieth (1981) suggests that poor reproductive success may result from a lack of key habitat structure. Delong (1994) also stated that nest failure can be caused by predation by coyotes, ravens and other small mammal and avian predators.

Post-nesting Habitat

After nesting, adult females and their brood will move to areas high in food resources, consuming mostly forbs and insects. For the first 2-3 weeks of their lives, chicks will consume almost entirely insect species, especially caterpillars, ants, and june beetles. Following this period, chicks modify foraging behavior mostly consuming a variety of forb species. As the season progresses, birds reach older and more developed growth stages, and simultaneously forb availability declines. Therefore, young birds will shift their diet toward sagebrush leaves, similar to diets of adult birds.

Winter Habitat

During late fall and into the winter, birds use medium to tall (25-80cm) sagebrush communities for hiding and foraging. Birds have been found to prefer south and west-facing slopes where air temperatures are greater during the day. During this time, birds forage almost exclusively on sagebrush leaves. Optimal sagebrush cover for winter habitat ranges between 12-43% (Connelly 2004).

Alton Sage-grouse population

Biologists from the Bureau of Land Management in Kanab, Utah captured, collared, and monitored 4 birds within a one year time period beginning in Spring 2005 (Church 2006). Based on these data, they found that the collared sage-grouse remain in the Alton area throughout their lifecycle, migrating only short distances between Sink Valley and the Alton Amphitheater.

Breeding Habitat

The only lek in the Alton area is approximately 100 yards west from the Swapp Ranch House (371533 Easting 4138811 Northing UTM Nad 27; Figure 10). The lek is located in a pasture that is enclosed by a juniper-post barb-wire fence.

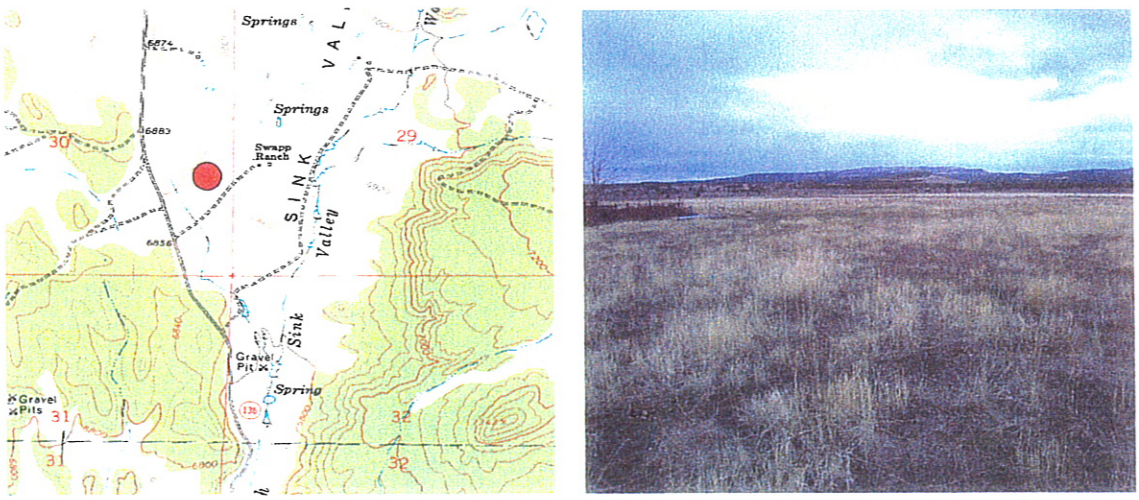

Figure 10. Location of the Sink Valley lek, located west of Swapp Ranch.

On March 30, 2006, 12 males and 4 females were observed on the lek between 6:30am to 8:00am. Adult males were observed displaying within 5-25 yards from the fence on the north-side of the pasture (Figure 11). Studies indicate that female to male ratios generally range between 1:1.5 to 1:2 birds. Therefore, the predicted number of female sage-grouse in the Alton area ranges between 18 and 24 birds and the total number of sage-grouse in the population is approximately 30-36 birds. Compared to sage-grouse populations that number in the hundreds, this population is considered relatively small.

Figure 11. Sage-grouse males displaying on the Sink Valley lek on March 30, 2006 at approximately 7:00am.

Northeast of the lek is a site used for roosting during the breeding period (371877 Easting 4139610 Northing UTM Nad 27; Figure 12a). This site was identified by a large number of localized fecal piles clustered within a common area (Figure 12b).

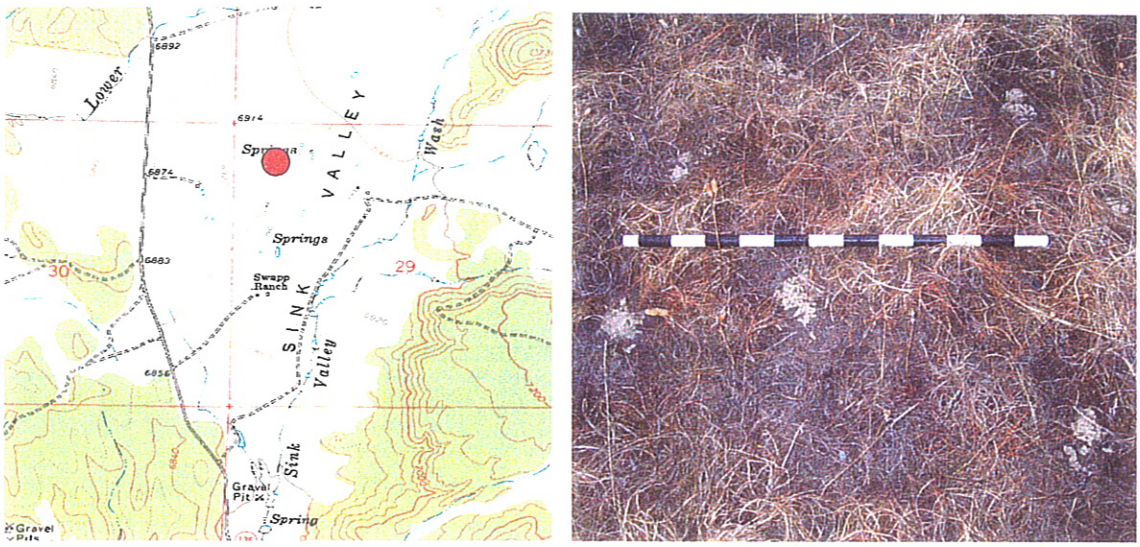

Figure 12. a) Roost site approximately 0.25 miles northeast of the Sink Valley lek (left). b) The area had dozens of tight fecal piles (right) deposited during this season's breeding period.

Nesting Habitat

Nesting is limited to infrequent stands of black and mountain big sagebrush stands. Within most of these stands, early to mid-level phases of juniper encroachment are noticeable (Figure 13). Without juniper control, intact sagebrush communities and therefore sage-grouse habitat will likely be lost from this area within the next few decades.

Summer and Winter Habitat

Within the Alton region, much of the potential sage-grouse nesting and winter habitat has been lost due to extensive juniper encroachment. As a result, during the fall of 2005 the BLM conducted a juniper removal project. This project created a narrow strip of land where all trees were cut and shreaded. Over time, this strip will become reestablish with sagebrush plants and other herbaceous plant species. Because of the short distance from juniper, it is possible that much of this area will not be used by birds for nesting or early brood-rearing. On the western end of the valley, juniper have been thinned to reduce impacts to watershed hydrology and plant structure. Since a significant number of juniper

trees were left uncut (selective harvest technique), this area remains inadequate habitat for sage-grouse nesting and brood-rearing.

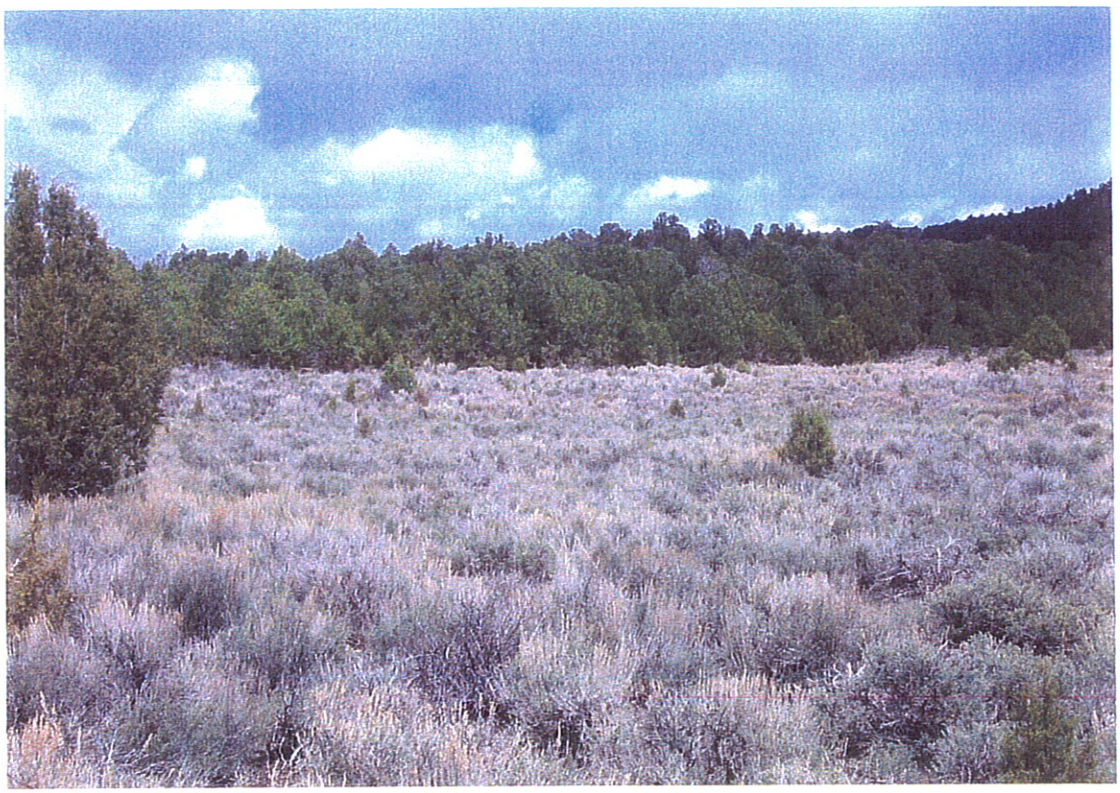

Figure 13. Juniper encroachment in a black sagebrush community in the Sink Valley area. This is typical of most of the remaining sagebrush stands in the area.

Long-term Sage-grouse Status

Because of 1) the invasion of Utah juniper and pinyon pine into the few remaining stands of intact sagebrush and 2) the lack of a contiguous sagebrush community required for nesting, brood-rearing and winter habitat, the long-term survivability of the Alton sage-grouse population is poor. Additionally, the expansion of juniper throughout the region has fragmented the Alton population from other nearby populations, limiting the ability of bird migration and therefore restricted gene flow. As a result of restricted migration potential and juniper expansion, the local sage-grouse population will likely experience population declines and even eventual local extinction.

Proposed Mitigation Plan

Habitat Assessment and Mitigation of Breeding and Roosting Sites

On March 30 and April 1, 2006, vegetation measurements were taken of plants within the lek area and nearby adjacent sites. The purpose of this study was to determine if sites exist that could potentially function as alternative lek and roosting habitat during the period that the original lek and surrounding area would be disturbed by mining activities. Sites sharing similar vegetation, topographic attributes, disturbance patterns (i.e. grazing) and close proximity to sites planned for mining were identified (Figure 14). These sites were also similar in slope, aspect, and distance to juniper trees (Table 2). Two random transects were established within the lek area, the original roosting area, and the sample sites. Plant cover was sampled by species using a point-intercept method.

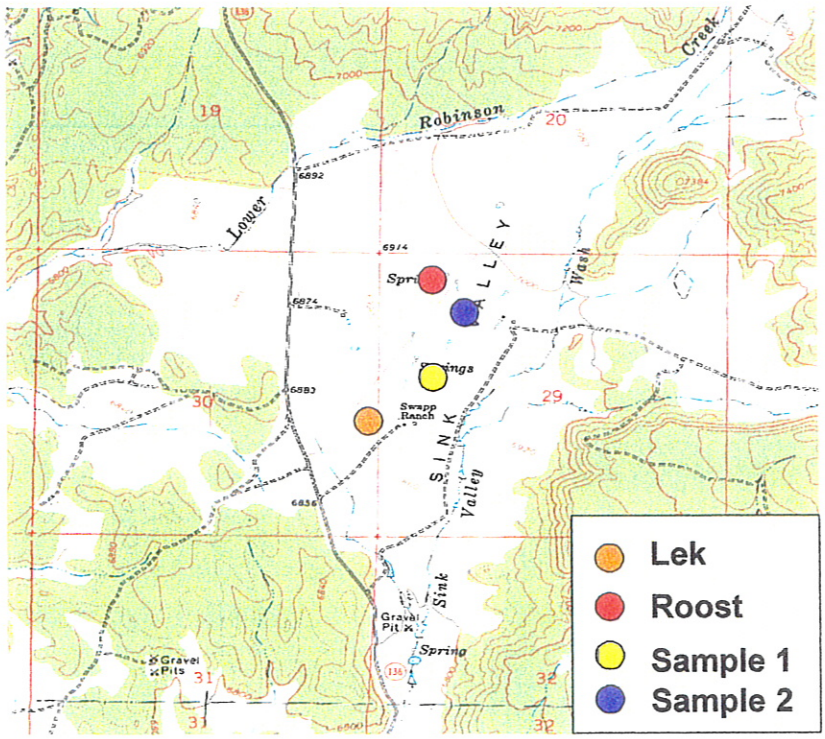

Figure 14. Location of the lek, roost, and potential alternate sites for lek and roosting habitat.

Table 2. Difference in slope, aspect, and distance to juniper at the lek, roost site, and potential alternate sites (sample sites).

	Lek	Roost	Sample 1	Sample 2
Slope (%)	3.5	4.5	4.5	4.0
Aspect (°)	204	199	201	182
Distance to Juniper (m)	>100	>150	>75	>200

Results from this work indicate that the lek and sample site 1 are similar in plant cover, bare ground, litter composition, and canopy height (figure 15). Similarly, the roosting area and sample site 2 have similar plant cover, bare ground and litter composition. Average plant height was greater in the roosting area (62%) than sample site 2 (43%). These data indicate that sites outside the mining area have similar traits to the actual lek and roost sites, and could potentially serve as alternate sites for breeding and roosting.

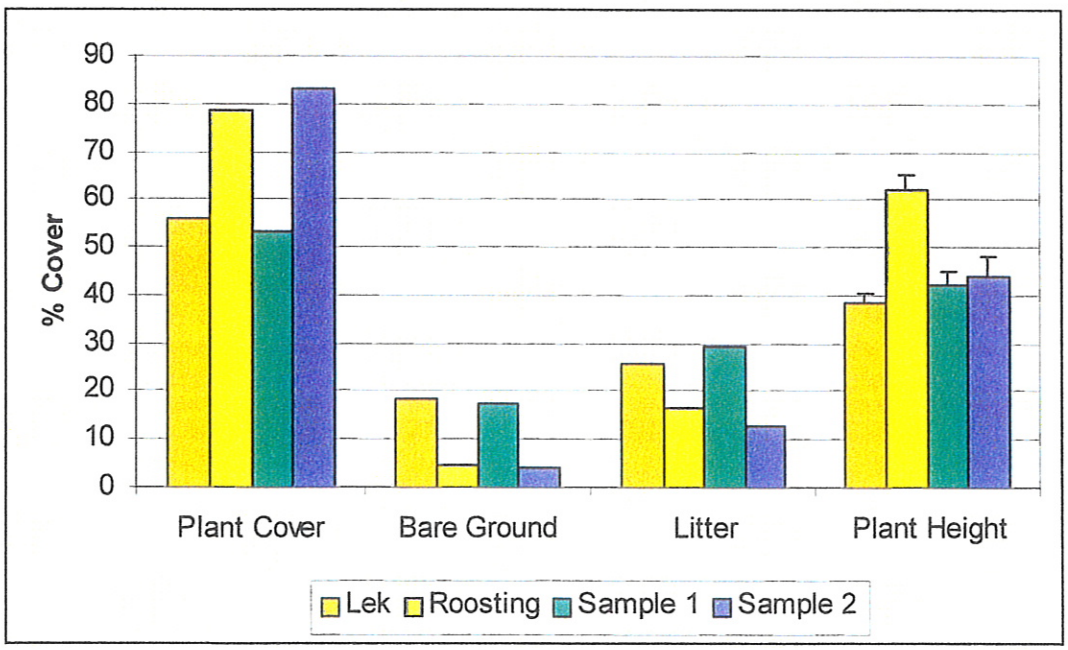

Figure 15. Percent cover of plants (combined), bare ground and litter. Plant height was measured in centimeters (right).

Creation of a Conservation Area

The current roosting area is not within the proposed mining site. This area and the alternate sample sites will be protected from any mining activity. In this "Conservation Area", habitat will be protected and enhanced for sage-grouse, especially during the breeding season. In addition to the Conservation Area, much of these grasslands and upper sagebrush stands are located along an upper terrace that provides a partial visual barrier from mining activities that will occur in the valley bottom. To create a more distinct visual barrier, spoils from mining will be stockpiled at the ridgeline (up to 20' higher) further decreasing motion and sound within the Conservation Area created during mining activities.

Short-Term Mitigation Plan

In addition to ensuring the protection of nearby grasslands and shrublands for alternate breeding and nesting areas, mining activities will be minimized so that the lowest disturbance will be created during the breeding season at areas adjacent to the original lek. After mining has been completed, reclamation specialists will return the original grade and valley form to pre-disturbance conditions. Reclamation will include seeding similar plant species with comparable plant composition, structure and function as those of the original plant community. In sites used by sage-grouse for breeding and roosting that had previous livestock grazing, livestock will be used post-reclamation to maintain similar vegetation characteristics as pre-mining conditions.

Intact sagebrush stands will be avoided for storing mining generated spoil and topsoil stockpiles. Sites will be selected for storing these materials that are distant from prime sage-grouse habitat, in particular potential nesting habitat. Coal processing equipment will be located in areas that create the least possible disturbance to sage-grouse and sage-grouse habitat. Intact sagebrush sites will be cleared of all young juniper trees with the use of chainsaws or hand tools. Trees will be removed from these stands. Juniper woodlands surrounding intact

stands can be cut back to increase patch size and increase the amount of area that has potential for nest site selection by hens.

Long-term Mitigation Plan

A significant contribution that mining can provide for enhanced sage-grouse habitat is the removal of juniper from the Alton valley. The removal of trees during mining operations with subsequent reclamation activities will create conditions that promote grass, forb and eventually sagebrush establishment. Two years after juniper was removed from plots located in eastern Oregon, Bates et al. (2000) recorded a 200-300% in percent cover and production of herbaceous vegetation. Increased plant community vigor results from decreased competition with juniper for subsurface resources (water, nutrients) and space. As a result, transpiration rates and soil surface evaporation rates will decrease and higher soil moisture will be availability for plant growth and survival. Based on anecdotal evidence, it is also possible that spring discharge will increase and seeps and spring may emerge that were lost with initial encroachment. This would provide more sites where birds would be able to obtain water during the summer and fall months.

Removing trees from extensive areas creates greater connectivity of suitable habitat. In 2005, the BLM cleared portions of the land to increase sagebrush habitat. This improvement was beneficial for improving relatively small site conditions, however, the amount of land treated was minimal compared to the level needed to sustain the sage-grouse population in the Alton area. Long-term mining plans will remove hundreds of acres of juniper woodlands, significantly increasing conditions that are more suitable to sage-grouse nesting and post-nesting requirements. This landscape-level operation could greatly enhance sagebrush restoration objectives by the BLM that is currently limited by constrained budgets and manpower.

Over time, juniper encroachment has likely been the primary factor in isolating the Alton sage-grouse population from nearby populations. According to local sources, a sage-grouse population is located approximately 6 miles north of Alton. It is likely that migration once occurred between these populations allowing an exchange of individuals and genes between the two populations. Fragmentation of the landscape by juniper has likely resulted in minimal or no movement of birds between the two populations. Similarly, two populations that once occurred further south (near Kanab) have become locally extinct, likely due to the lack of connectivity with more northern populations. According to Fuhlendorf (2001), small populations of prairie chickens became disconnected from other larger populations with increased croplands and juniper invasion. These small populations became locally extinct due to the lack of migration and gene flow potential. Therefore, by reducing the degree of fragmentation caused by expanding juniper, the potential for migration and population sustainability is increased.

Primary brood-rearing habitat in the Alton valley is associated with alfalfa fields near the town of Alton. Birds likely utilize these areas due to the availability of forbs, insects, and water. To reduce the dependency of the birds on these areas, irrigated alfalfa fields will be created in Swapp Valley (south of the Swapp Ranch house). In addition to alfalfa, many sage-grouse forage species (forbs) will be included in the seed mix. This will increase brood-rearing habitat closer to breeding and nesting habitat. This in turn will reduce potential predation that occurs near towns by ravens, crows, cats, dogs and people. It will also reduce bird mortality associated with large-scale farming practices.

The Alton sage-grouse population will be enhanced by importing birds from nearby populations that are relatively large and stable. Captured and relocated birds (initially 10-15) in the Alton area will increase genetic diversity as well as stabilize population numbers to offset losses associated with disease and emigration (unrelated to mining activities). Additionally, birds from the Alton

population (5-10) can be trapped and released in a nearby population through the mining period. Once complete, these birds can be trapped again and returned to the original Alton population. This will ensure the survival of members of the original Alton population.

Habitat Reclamation Plan

Seed mixes that are used for reclamation will consist of native grasses and forb species that provide cover and food (clover, lomatium, etc.). In order to accelerate shrub re-establishment, bareroot or potted sagebrush and bitterbrush transplants will be planted. To ensure the integrity of the planting materials, indigenous seed and cuttings will be collected for reclamation. At Bryce Canyon National Park, seed and transplants obtained from indigenous materials had greater long-term survival and higher cover and production than commercial varieties of the same species (Petersen et al. 2004).

Cursory surveys conducted on April 30th found that there is a low probability that a dominant invasive species (ie. Cheatgrass, medusahead) could establish on reclaimed sites. However, post-reclamation surveys will be conducted for undesirable invasive plants. If a breakout does occur, mechanical followed by chemical treatments will be applied.

Seeding and planting will occur in the fall season following the growing season and into dormancy. During the following growing season, vegetation sampling will be conducted to monitor reclamation success. Measurements will be continued each year until the reclamation goals have been achieved. Additional seeding can be applied during subsequent years if the minimum standards of acceptance have not been achieved. Juniper seedlings found in reclaimed areas will be removed.

Monitoring plan

Birds trapped and relocated to the Alton population will be collared with radio-colllars. Birds will be monitored throughout the year to assess bird survival, nest site and nest success, brood-rearing sites, and key winter habitat areas. Lek counts will be conducted each year to determine the number of birds at the lek. Reclamation sites will be monitored to assess restoration success. With the establishment of desirable plant communities, sagebrush obligate species habitat will be improved. Birds that depend on these communities include sage sparrows (*Oreoscoptes montanus*), sage thrasher (*Amphispiza belli*), and Brewer's sparrow (*Spizells breweri*). Also, mule deer habitat will increase, especially with the establishment of antelope bitterbrush and other palatable browse species. Grassland development will also increase forage for elk (*Cervus elephas*). Reclaimed sites will be monitored to assess utilization by these and other wildlife species.

To provide consistent monitoring and assessment, plans are being discussed to employ a graduate student from an established university to use this project as the basis for a graduate thesis. This would provide peer-reviewed research and monitoring of this project. It would also provide a mechanism for publishing the results of this project as a source of information and knowledge that can be applied to similar work in other areas.

Conclusion

The sage-grouse population in the Alton area is currently vulnerable to elimination regardless of mining activities. This is primarily to the loss of habitat required for nesting and brood-rearing. Therefore, a "no action" alternative will lead to population decline and potentially local extinction. To sustain sage-grouse levels in the valley, significant habitat modifications are required. Mining activities provide an opportunity to enhance sage-grouse habitat by adhering to a well-developed and established mitigation program. Information and knowledge

gained through this work can enhance our understanding of sage-grouse population dynamics and habitat requirements.

Literature Cited

Aldridge, C.L. and R.M. Bringham. 2002. Sage-grouse nesting and brood habitat use in southern Canada. Journal of Wildlife Management 66:433-444.

Autenrieth, R. E. 1981. Sage-grouse management in Idaho. Idaho Department of Fish & Game, Wildlife Bulletin 9. Boise, ID.

Barnett, J.K. and J.A. Crawford. 1994. Pre-laying nutrition of sage grouse hens in Oregon. Journal of Range Management 47:114-118.

Bates, J., R.F. Miller, and T.S. Svejcar. 2000. Understory dynamics in cut and uncut western juniper woodlands. Journal of Range Management 53:119–126.

Burkhardt, J.W., and E.W. Tisdale. 1969. Nature and successional status of western juniper vegetation in Idaho. Journal of Range Management 22:264–270.

Church, L. 2006. Personal communication. Bureau of Land Management District Office, Kanab, Utah. March 28, 2006.

Connelly, J.W., S.T. Knick, M.A. Schroeder, S.J. Stiver. 2004. Conservation assessment of greater sage-grouse and sagebrush habitats. Western Association of Wildlife Agencies.

Crawford, J.A., RA. Olsen, N.E. West, J.F. Mosley, M.A. Schroeder, T.D. Whitson, R.F. Miller, M.A. Gregg, and C.S. Boyd. 2004. Synthesis Paper: Ecology and management of sage grouse and sage grouse habitat. Journal of Range Management 57:2-19.

DeLong, A. K., J. A. Crawford, and D. C. DeLong, Jr. 1995. Relationships between vegetational structure and predation of artificial Sage-grouse nests. Journal of Wildlife Management 59:88-92.

Eddleman, L.E. 1983. Some ecological attributes of Western juniper. In Research in Rangeland Management, USDA, Agricultural Research Service, Special Report 682; 32-34 p.

Eng, R.L., E.J. Pitcher, S.J. Scott, and R.J. Greene. 1979. Minimizing the effects of surface coal mining on a sage grouse population by a directed shift of

breeding activities, p. 464-468. In: G.A. Swanson (tech-co-ord), The mitigation symposium. U.S.D.A. Forest Service General Technical Report. RM-65.

France, K. 2005. Masters Thesis: Interspace/under-canopy foraging patterns of beef cattle in sagebrush communities: Implications to sage-grouse nesting habitat. Oregon State University, Corvallis, Oregon.

Fuhlendorf, S.D., A.J.W. Woodward, D.M. Leslie Jr., and J.S. Shackford. 2002. Multi-scale effects of habitat loss and fragmentation of lesser prairie-chicken populations of the US Southern Great Plains. Landscape Ecology 17:617-628.

Gregg, M.A. J.A. Crawford, M.S. Drut, and A.K. DeLong. 1994. Vegetational cover and predations of sage grouse nests in Oregon. Journal of Wildlife Management 58:162-166.

Gregg, M.A. 2006. Personal conversation. Sage-grouse biologist. April 4, 2006.

Heyerdahl, E.K., R.F. Miller, and R.A. Parsons. In Press. Forest Ecology and Management.

Miller, R.F., and P.E. Wigand. 1994. Holocene changes in semiarid piñon-juniper woodlands: response to climate, fire and human activities in the U.S. Great Basin. BioScience 44:465–474.

Miller, R.F., and J.A. Rose. 1995. Historic expansion of *Juniperus occidentalis* (western juniper) in southeastern Oregon. Great Basin Naturalist 55:37–45.

Miller, R.F., T.J. Svejcar, and J.A. Rose. 2000. Impacts of western juniper on plant community composition and structure. Journal of Range Management 53:574–585.

Miller, R.F. and L.E. Eddleman. 2001. Spatial and temporal changes of sage grouse habitat in the sagebrush biome. Oregon State University Technical Bulletin 151.

Pedersen, E.K., J.W. Connelly, J.R. Hendrickson, and W.E. Grant. 2003. Effect of sheep grazing and fire on sage grouse populations in southeastern Idaho. Ecological Modeling 165:23-47.

Petersen, S.L., B.A. Roundy, and R. Bryant. 2004. Revegetation Methods for High-Elevation Roadsides at Bryce Canyon National Park, Utah. Restoration Ecology 12:248-257.

Roundy, B.A. and J.L. Vernon. 1999. Watershed values and conditions associated with pinon-juniper communities. In Proceedings: Ecology and Management of Pinon-Juniper Communities Within the Interior West. USDA Forest Service. Proceedings RMRS-P-9. Pp. 173-187.

Tate, J. Jr., M.S. Boyce, and T.R. Smith. 1979. Response of sage grouse to artificially created display ground, p. 459-463. In: G.A. Swanson (tech-co-ord), The mitigation symposium. U.S.D.A., Forest Service General Technical Report. RM-65.

Thurow, T.L. and C.A. Taylor. 1995. Juniper effects on the water yield of central Texas rangeland. In Water for Texas: Research Leads the Way. Proceedings of the 24th Water for Texas Conference, Texas Water Resources Institute, Texas A&M University, College Station. Pp. 657-665.

USGS. 2003. Sage-grouse data provided by the U.S. Geological Society. Corvallis, Oregon

Wallestad, R. O., and D. B. Pyrah. 1974. Movement and nesting of sage-grouse hens in central Montana. Journal of Wildlife Management 38:630-633.

West, N.E., R.J. Tausch, K.H. Rea, and P.T. Tueller. 1978. Taxonomic determination, distribution, and ecological indicator values of sagebrush within the pinyon-juniper woodlands of the Great Basin. Journal of Range Management 31:87-92

APPENDIX 3-2

VEGETATION OF THE SAGEBRUSH/GRASS & MEADOW AREAS

2006

FOR THE
COAL HOLLOW PROJECT

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INTRODUCTION

Alton Coal Development has proposed to surface mine coal on private land near the town of Alton, Utah. The proposed development is called the *Coal Hollow Project*. In doing so, disturbance to the plant communities that currently exist in the area will be disturbed during the mining activities. These plant communities have consecutive quantitatively sampled to provide baseline data prior to disturbance. Additionally, similar communities that will *not* be disturbed by mining have also been sampled and compared statistically to those proposed for disturbance. These areas are called "Reference Areas", and will be used for comparisons at the time of final reclamation for revegetation success standards once the property has been restored to its approximate original condition.

The Mining & Reclamation Plan (MRP) has provided information including quantitative data about the plant communities from work that was done in the same area in the late 1980's. Although this information is valuable because in provides data sets for that time, plans to re-sample the same plant communities have been made prior to any of the proposed new mining activities. Because the mining operations will be done over a period of several years, the sampling regime has been designed to focus on those plant communities that will be disturbed in consecutive order of the mining activities. Consequently, additional sampling will be conducted as the mining continues.

This document is the first in a series of reports for sampling the plant communities of the Coal

Hollow Project. Data for this report were recorded in 2006 in areas where mining activities were first planned. Since that time, the mining plan has progressed in the planning stages to a point where more is known about the sequential order in which mining will be conducted. With this refinement to the mine plan, more is known about the specific plant communities that will be disturbed over-time. Consequently, more quantitative sampling is planned in the near future, including the growing season of 2007. These data sets will also be added to the MRP and submitted to the State of Utah, Division of Oil, Gas & Mining (DOGM).

METHODS

Methodologies used for this study were performed in accordance with the guidelines supplied by the State of Utah, Division of Oil, Gas and Mining (DOGM). Quantitative and qualitative data were taken on the vegetation of the areas proposed for disturbance and their respective reference areas in August 2006.

Vegetation Maps

The first vegetation map prepared for the current MRP shows the plant communities that existed within the Coal Hollow permit area (see *Vegetation Map*, Drawing 3-1, dated 5/09/06). This map was prepared using the aforementioned existing information [the source was a 1987 map that was called: *Vegetation Community Map*, Exhibit No. 6.4-1 (7/13/87), prepared for Utah International Inc., by Cedar Creek Associates, Inc.]. This *Vegetation Map* (Drawing 3-1)

corresponds to the existing earlier data mentioned above; it has also been submitted in the MRP (see Chapter 3). Since that time, flights have been conducted to obtain new aerial photography for greater mapping detail, including a new vegetation map of the project area (*Vegetation Map*, Drawing: 3-1b, dated 12/20/06). The new data presented in this document corresponds to the new *Vegetation Map*, Drawing: 3-1b.

Sampling Design and Transect/Quadrat Placement

Transect lines for vegetation sampling were placed randomly within the boundaries of the proposed disturbed and reference areas. The transect placement technique was employed with the goal to adequately sample a representative subset of the entire site. Once the transects were established, quadrat locations for sampling were chosen using random numbers from the transect lines with the objective to record data without preconceived bias.

Cover and Composition

Cover estimates were made using ocular methods with meter square quadrats. Species composition, cover by species, and relative frequencies were also assessed from the quadrats. Additional information recorded on the raw data sheets were: estimated precipitation, slope, exposure, grazing use, animal disturbance and/or other appropriate notes. Plant nomenclature follows "A Utah Flora" (Welsh et al., 2003).

Woody Species Density

Density of woody plant species for the proposed disturbed and reference areas of the Sagebrush/Grass communities were estimated using the point-quarter method. In this method, random points were placed on the sample sites and measured into four quarters. The distances to the nearest woody plant species were then recorded in each quarter. The average point-to-individual distance was equal to the square root of the mean area per individual. The number of individuals per acre was the end results of the calculations.

Woody species density in the Meadow communities were estimated using 5 ft x 25 ft belt transects.

Sample Size & Adequacy

Sampling adequacy for cover and density was attempted by using the formula given below.

$$nMIN = \frac{t^2 s^2}{(dx)^2}$$

where,

nMIN	= minimum adequate sample
t	= appropriate confidence t-value
s	= standard deviation
x	= sample mean
d	= desired change from mean

Statistical Analyses

Student's t-tests were employed to compare the total living cover and total woody species density of each proposed disturbed area with its respective reference area.

Photographs

Color photographs of the sample areas were taken at the time of sampling and have been submitted with this report.

Threatened & Endangered Plant Species

Prior to recording quantitative data on the plant communities, a sensitive plant species survey was conducted. To initiate the study, appropriate agencies were consulted and other sources were reviewed (sensitive species files at *Mt. Nebo Scientific, Inc.*) for potential plant species that are known to be rare, endemic, threatened, endangered or otherwise sensitive in the study area.

RESULTS

Below are the results from sampling each vegetation study site for this report. Color photographs of each sample site have also been provided later in this document.

Sagebrush/Grass (Proposed Disturbed)

One plant community proposed for disturbance by Year 1 mining activities is the Sagebrush/Grass community. This community is often found near Pinyon-Juniper communities and consequently has pinyon pine (*Pinyon edulis*) and Utah juniper (*Juniperus osteosperma*) trees scattered throughout it. As shown on Table 1, the dominate plant species by cover in the proposed disturbed Sagebrush/Grass community were big sagebrush (*Artemisia tridentata* var. *tridentata*) and black sagebrush (*A. nova*). [NOTE: Positive identification of individuals in the genus *Artemisia* of the area were sometimes inconclusive. For example, some individuals of the sagebrush appeared to have been closer to *A. tridentata* var. *wyomingensis* or a hybridization of other species in the genus *Artemisia* i.e. *A. tridentata* var. *tridentata*, and *A. nova*].

The most common grass species were junegrass (*Koeleria macrantha*), Sandberg's bluegrass *(Poa secunda*), and Kentucky bluegrass (*P. pratensis*). Forb cover was low, but the species present in the quadrats were scarlet gilia *(Ipomopsis aggregata*), redroot buckwheat (*Eriogonum racemosum* var. *racemosum*), and blue flax *(Linum perenne*).

The total living cover of the community was estimated at 54.73%, of which 52.40% of it was from understory cover and only 2.33% was from overstory (Table 2-A). The understory composition was comprised of 64.09% shrubs, 34.64% grasses, and 1.28% forbs (Table 2-B).

Woody species density of the Sagebrush/Grass community was also measured. The total number of individuals per acre was 8,339, most of which was comprised of black sagebrush and big sagebrush (Table 3).

Sagebrush/Grass (Reference Area)

The plant community that will remain undisturbed and was selected for its similarity to the proposed disturbed area above will be used for future revegetation success standards. This reference area had similar cover, composition, and woody species density. Cover and frequency by species of the Sagebrush/Grass reference area is shown on Table 4. The dominant shrub plant species here were black sagebrush and big sagebrush. The most common grass species were slender wheatgrass (*Elymus trachycaulus*), cheatgrass *(Bromus tectorum*), Kentucky bluegrass, and Sandberg's bluegrass.

The total living cover of the area was estimated at 60.50%, all of which was from understory cover (Table 5-A). Woody species dominated the composition at 61.48%, whereas grasses comprised 29.86%, and forbs 8.65% (Table 5-B).

The total number of plants per acre in the woody species density measurements was 8,331 (Table 6). Big sagebrush and black sagebrush dominated the woody species in the density measurements and were nearly equally represented.

Meadow - Dry (Proposed Disturbed)

There are different meadowlands located within the permit area. These meadows have somewhat been differentiated on the *Vegetation Map* (Drawing: 3-1b) as dry, wet or some where between the two. The Year 1 mining operations would disturb a dry Meadow community on the west side of the permit area.

As shown on Table 7, the dominant species in the proposed disturbed Meadow were grass and grass-like species including sedge (*Carex* sp.), wiregrass (*Juncus arcticus*) and junegrass. Broom snakeweed (*Gutierrezia sarothrae*) was the dominant shrub, whereas the dominant forbs were yarrow (*Achillea millefolium*) and Pacific aster (*Aster ascendens*).

The total living cover was estimated at 73.00% (Table 8-A). The composition of the understory was 75.70% grasses (and grass-likes), 13.28% forbs, and 11.01% shrubs (Table 8-B). The woody species density was represented by only one plant, black sagebrush – it totaled only 817 plants per acre (Table 9).

Meadow - Dry (Reference Area)

The dominant grass and grass-like species in the dry Meadow reference area were wiregrass, sedge, and junegrass (Table 10). The dominant forbs were yarrow, Pacific aster, and cinquefoil (*Potentilla anserina*). The only shrubs present in the sample quadrats were black sagebrush and broom snakeweed.

The total living cover of this reference area was 72.00% (Table 11-A). The understory cover composition was comprised of 71.05% grasses (and grass-likes), 22.31% forbs, and 6.64% shrubs (Table 11-B). The total woody species density of the community was 1,481 plants per acre and was comprised exclusively of black sagebrush (Table 12).

Threatened & Endangered Plant Species Survey

No rare, endemic, threatened, endangered or otherwise sensitive species were found in the study areas.

Table 1: Alton Coal Project. Living Cover and Frequency by Plant Species (2006).

Sagebrush/Grass (Proposed Disturbed)	Mean Percent	Standard Deviation	Percent Frequency
OVERSTORY COVER			
Juniperus osteosperma	2.33	9.55	6.67
UNDERSTORY COVER			
TREES & SHRUBS			
Artemisia nova	14.93	17.10	50.00
Artemisia tridentata var. tridentata	15.23	20.48	26.67
Chrysothamnus depressus	2.07	5.90	16.67
Gutierrezia sarothrae	1.23	2.79	20.00
FORBS			
Eriogonum racemosa	0.33	1.25	6.67
Ipomopsis aggregata	0.33	1.25	6.67
Linum perenne	0.10	0.54	3.33
GRASSES			
Bouteloua gracilis	2.33	8.54	10.00
Bromus tectorum	0.83	3.18	6.67
Elymus smithii	0.50	1.98	6.67
Elymus trachycaulus	0.50	1.98	6.67
Hordeum jubatum	0.83	1.86	16.67
Koeleria macrantha	4.17	10.25	23.33
Poa pratensis	3.17	7.69	16.67
Poa secunda	4.00	7.00	30.00
Stipa hymenoides	1.83	3.53	23.33

Table 2: Coal Hollow Project. Total Cover and Composition (2006).

Sagebrush/Grass (Proposed Disturbed)		
A. TOTAL COVER	Mean Percent	Standard Deviation
Overstory Cover (o)	2.33	9.55
Understory Cover (u)	52.40	13.67
Litter	16.17	10.90
Bareground	26.87	11.83
Rock	4.57	6.15
TOTAL LIVING (o + u)	54.73	13.52
B. % COMPOSITION (u)		
Shrubs	64.09	22.93
Forbs	1.28	3.55
Grasses	34.64	22.43

Table 3: Coal Hollow Project. Woody Species Density (2006).
Sagebrush/Grass (Proposed Disturbed)

SPECIES	Individuals Per Acre
Artemisia tridentata	2779.73
Artemisia nova	4100.11
Chrysothamnus depressus	833.92
Chrysothamnus nauseosus	69.49
Chrysothamnus viscidiflorus	138.99
Gutierrezia sarothrae	277.96
Juniperus osteosperma	138.99
TOTAL	**8339.20**

Table 4: Alton Coal Project. Living Cover and Frequency by Plant Species (2006).
Sagebrush/Grass (Reference Area)

	Mean Percent	Standard Deviation	Percent Frequency
TREES & SHRUBS			
Artemisia nova	23.85	18.18	75.00
Artemisia tridentata	10.90	13.39	55.00
Chrysothamnus nauseosus	2.10	3.78	25.00
Gutierrezia sarothrae	0.90	2.72	10.00
Juniperus osteosperma	0.25	1.09	5.00
FORBS			
Achillea millefolium	0.25	1.09	5.00
Aster ascendens	3.00	4.58	35.00
Erigeron religiosus	0.25	1.09	5.00
Iva axillaris	1.00	2.00	20.00
Sphraelcea coccinea	0.25	1.09	5.00
GRASSES			
Bromus tectorum	4.75	6.61	45.00
Elymus smithii	0.50	2.18	5.00
Elymus trachycaulus	5.25	9.93	30.00
Juncus arcticus	0.75	3.27	5.00
Poa pratensis	3.00	7.65	15.00
Poa secunda	2.75	5.36	25.00
Stipa hymenoides	0.75	2.38	10.00

Table 5: Coal Hollow Project. Total Cover and Composition (2006).		
Sagebrush/Grass (Reference Area)		
A. TOTAL COVER	Mean Percent	Standard Deviation
Understory Cover	60.50	13.03
Litter	13.05	4.81
Bareground	25.05	13.58
Rock	1.40	1.20
TOTAL LIVING (o + u)	60.50	13.03
B. % COMPOSITION (u)		
Trees/Shrubs	61.48	17.01
Forbs	8.65	8.73
Grasses	29.86	14.18

Table 6: Coal Hollow Project. Woody Species Density (2006).

Sagebrush/Grass Community (Reference Area)	
SPECIES	**Individuals Per Acre**
Artemisia tridentata	3644.87
Artemisia nova	3957.29
Chrysothamnus nauseosus	624.83
Gutierrezia sarothrae	208.28
TOTAL	**8331.13**

Table 7: Alton Coal Project. Living Cover and Frequency by Plant Species (2006).

Meadow - Dry (Proposed Disturbed)	Mean Percent	Standard Deviation	Percent Frequency
TREES & SHRUBS			
Artemisia nova	1.00	2.00	20.00
Gutierrezia sarothrae	7.20	4.80	85.00
FORBS			
Achillea millefolium	6.40	6.42	55.00
Aster ascendens	2.00	4.00	25.00
Eriogonum racemosa	0.25	1.09	5.00
Linum lewisii	1.00	3.39	10.00
Potentilla anserina	0.25	1.09	5.00
GRASSES			
Bouteloua gracilis	2.25	6.80	10.00
Carex sp.	27.50	19.46	75.00
Elymus elymoides	0.50	1.50	10.00
Elymus smithii	0.75	2.38	10.00
Hordeum jubatum	0.50	2.18	5.00
Juncus arcticus	10.25	13.27	70.00
Koeleria macrantha	8.00	10.17	55.00
Muhlenbergia asperifolia	0.50	2.18	5.00
Poa pratensis	4.65	10.62	25.00

Table 8: Coal Hollow Project. Total Cover and Composition (2006).

Meadow - Dry (Proposed Disturbed)		
A. TOTAL COVER	Mean Percent	Standard Deviation
Understory Cover	73.00	9.67
Litter	9.40	3.28
Bareground	16.50	9.67
Rock	1.10	0.30
B. % COMPOSITION (u)		
Shrubs	11.01	8.10
Forbs	13.28	8.74
Grasses	75.70	13.81

Table 9: Coal Hollow Project. Woody Species Density (2006).

Meadow - Dry (Proposed Disturbed)

SPECIES	Individuals Per Acre
Artemisia nova	816.75
TOTAL	**816.75**

Table 10: Alton Coal Project. Living Cover and Frequency by Plant Species (2006).

Meadow - Dry (Reference Area)

	Mean Percent	Standard Deviation	Percent Frequency
TREES & SHRUBS			
Artemisia nova	3.25	6.76	25.00
Gutierrezia sarothrae	1.50	3.91	15.00
FORBS			
Achillea millefolium	5.50	5.45	60.00
Artemisia campestris	1.25	3.83	10.00
Aster ascendens	5.00	6.12	50.00
Eriogonum racemosa	0.25	1.09	5.00
Linum lewsii	0.25	1.09	5.00
Potentilla anserina	3.25	7.12	20.00
GRASSES			
Bouteloua gracilis	1.75	5.76	10.00
Carex sp.	16.50	12.05	80.00
Elymus elymoides	0.75	3.27	5.00
Elymus smithii	0.50	2.18	5.00
Elymus spicatus	1.50	6.54	5.00
Elymus trachycaulus	4.00	9.82	15.00
Juncus arcticus	15.25	16.84	70.00
Koeleria macrantha	9.50	11.06	45.00
Muhlenbergia asperifolia	0.25	1.09	5.00
Poa pratensis	1.75	4.26	15.00

Table 11: Coal Hollow Project. Total Cover and Composition (2006).		
Meadow - Dry (Reference Area)		
A. TOTAL COVER	Mean Percent	Standard Deviation
Understory Cover	72.00	8.86
Litter	11.70	5.16
Bareground	14.70	6.65
Rock	1.60	2.18
B. % COMPOSITION (u)		
Shrubs	6.64	10.29
Forbs	22.31	12.24
Grasses	71.05	12.91

Table 12: Coal Hollow Project. Woody Species Density (2006).

Meadow - Dry (Reference Area)	
SPECIES	**Individuals Per Acre**
Artemisia nova	1481.04
TOTAL	**1481.04**

SUMMARY & DISCUSSION

When the total living cover of the proposed disturbed Sagebrush/Grass community was compared statistically with the reference area using the Student's t-test, the difference was non-significant (Fig. 1). Moreover, when the woody species densities of these two stands were compared and these differences were also non-significant (Fig. 2).

FIG. 1. STUDENT'S T-TEST - **Total Living Cover**
Comparison Between the Proposed Disturbed Sagebrush/Grass Community and the Reference Area (2006).

Proposed Disturbed: $\bar{x}$=54.73; s=13.52; n=30

Reference Area: $\bar{x}$=60.50; s=13.03; n=20

t =1.500 ; df =48 , SL= N.S.

FIG. 2. STUDENT'S T-TEST - **Woody Species Density**
Comparison Between the Proposed Disturbed Sagebrush/Grass Community and the Reference Area (2006).

Proposed Disturbed:: $\bar{x}$=8339.20; s=3604.59; n=30

Reference Area: $\bar{x}$=8331.13; s=2489.88; n=20

t = 0.009; df =48 , SL= N.S.

Similarly, when the total living cover of the proposed disturbed Meadow community was compared with its reference area, the differences were also non-significant (Fig. 3). Finally, the differences in the woody species density of the proposed disturbed Meadow and the reference area were compared; the t-tests suggested that the differences were negligible (Fig. 4).

Quantitative sampling and subsequent statistical analyses comparing the total living covers and woody species densities of the plant communities proposed for disturbed with their respective reference areas suggest that the differences were negligible. These analyses, along with the plant species present in the sample quadrats and the lifeform composition, also suggest that the reference areas chosen to represent future revegetation success standards at the time of final reclamation may be appropriate to be used as such.

FIG. 3. STUDENT'S T-TEST - **Total Living Cover** Comparison Between the Proposed Disturbed Meadow (dry) Community and the Reference Area (2006).

Proposed Disturbed: $\bar{x}$=73.00; s=9.67; n=20

Reference Area: $\bar{x}$=72.00; s=8.86; n=20

t = 0.341; df =38 , SL= N.S.

FIG. 4. STUDENT'S T-TEST - **Woody Species Density** Comparison Between the Proposed Disturbed Meadow (dry) Community and the Reference Area (2006).

Proposed Disturbed:: $\bar{x}$=816.75; s=2140.40; n=20

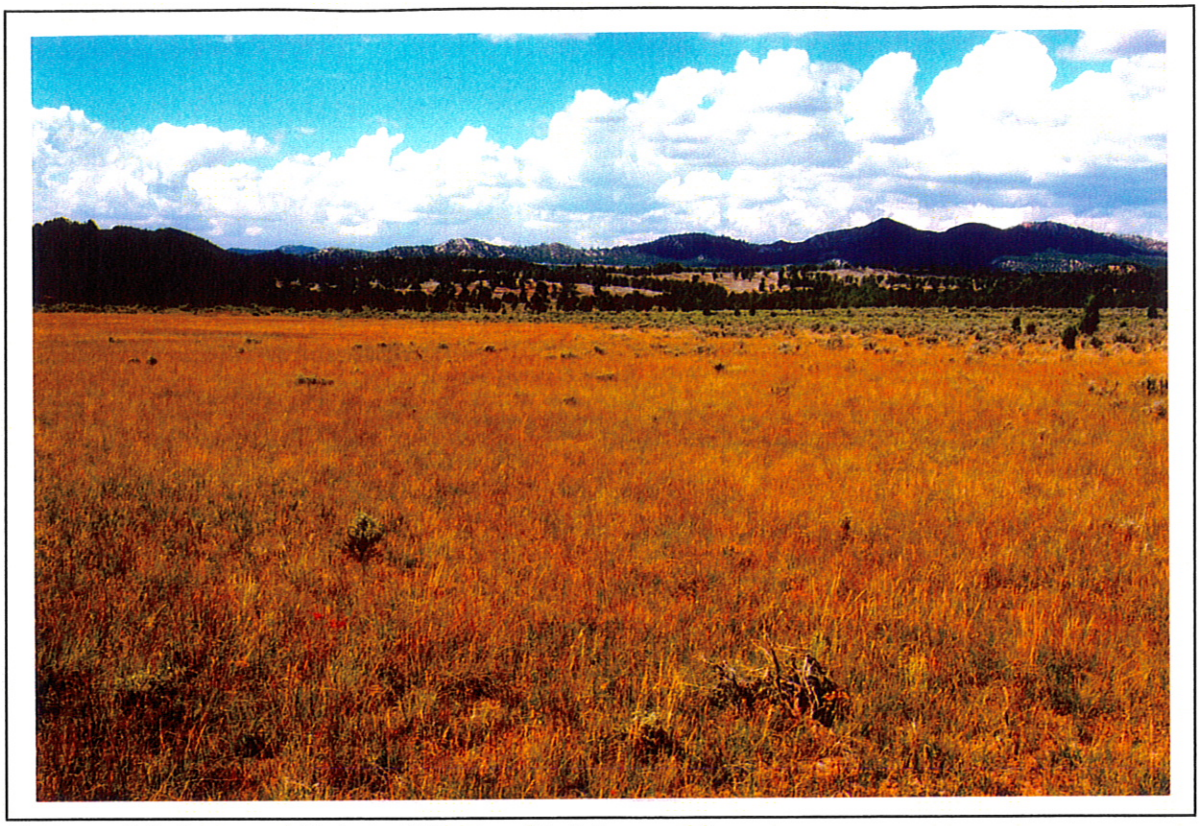
Reference Area: $\bar{x}$=1481.04; s=1999.97; n=20

t =-1.014 ; df =38 , SL= N.S.

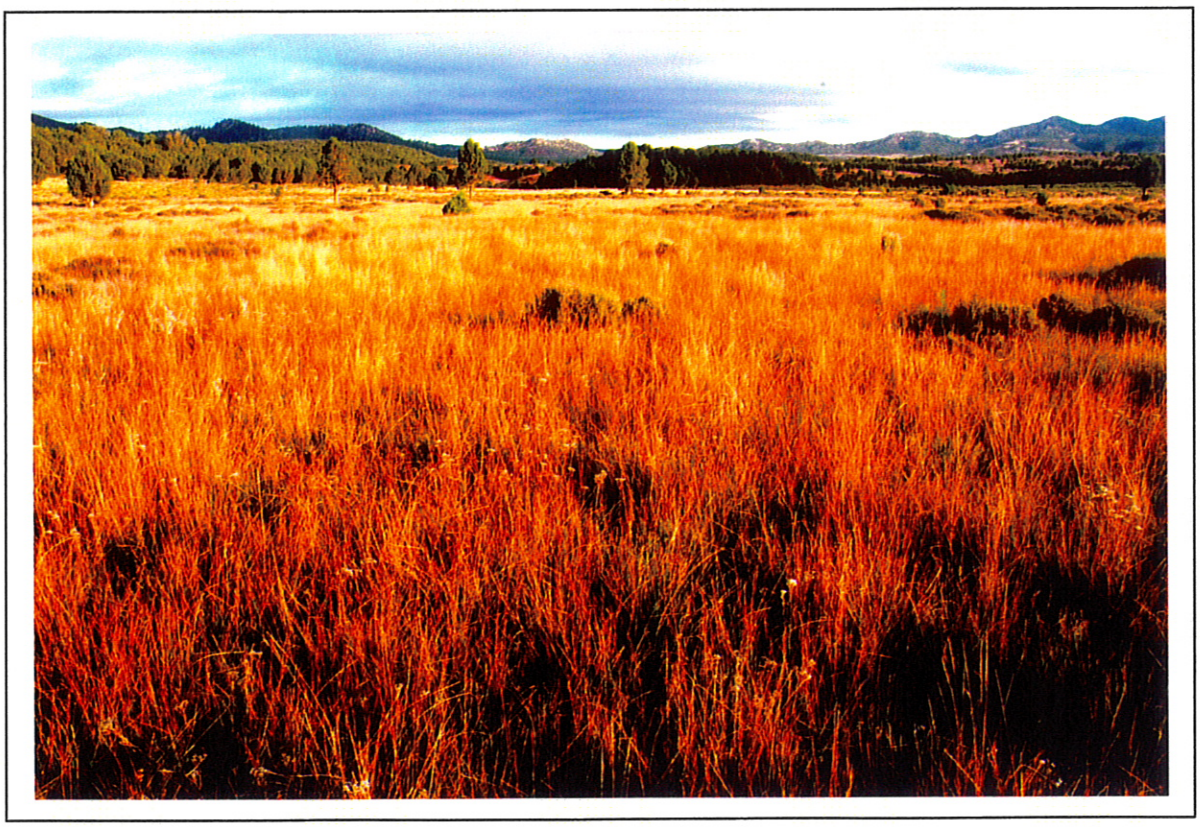
COLOR PHOTOGRAPHS
OF
SAMPLE AREAS

Photograph 1: Proposed Disturbed Sagebrush/Grass Community

Photograph 2: Sagebrush/Grass Community Reference Area



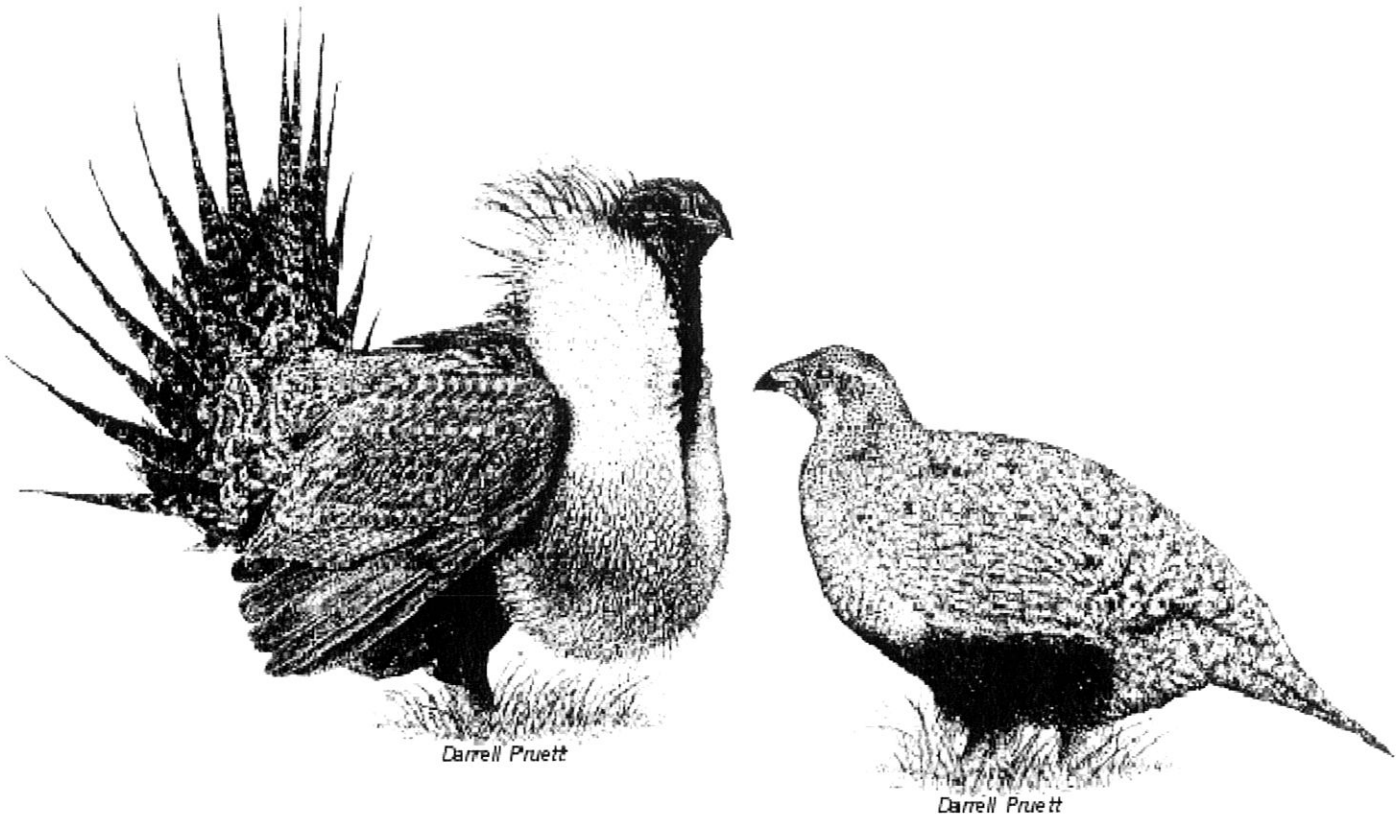
Photograph 3: Proposed Disturbed Meadow (Dry) Community



Photograph : Meadow (Dry) Reference Area

APPENDIX 3-3

SAGE-GROUSE DISTRIBUTION AND HABITAT IMPROVEMENT ALTON, UTAH



Steven L. Petersen, Ph.D.

May 2007

SAGE-GROUSE DISTRIBUTION AND HABITAT IMPROVEMENT ALTON, UTAH

Steven L. Petersen, Ph.D.

May 2007

INTRODUCTION

In 2006, the report titled "Alton Sage-grouse Habitat Assessment and Mitigation Plan" characterized the population status and habitat conditions of the greater sage-grouse (*Centrocercus urophasianus*) in the Alton, Utah region. In this document, a mitigation plan was proposed to improve sage-grouse habitat in an effort to increase bird population levels within the region and maintain optimal sage-grouse habitat for nesting, brood-rearing, summer and winter use. The purpose of this report is to provide an update of the progress made in the area since the plan was established, and to provide additional information on sage-grouse population characteristics not presented in the previous report. Specifically, this paper will discuss the following issues related to population trends and habitat improvement:

1. sage-grouse population and distribution monitoring
2. results of the 2007 sage-grouse trapping and blood sampling efforts
3. description of an attempt to lure birds from the lek to an alternative lek site
4. mitigation implementation and strategies
5. lek search and aerial habitat assessment
6. proposed habitat and predator control mitigation

SAGE-GROUSE POPULATION AND DISTRIBUTION MOINTORING

Bird observations within the Alton region have been highly variable. During the first spring trapping session, 16 birds were flushed. In the winter and early spring, larger flocks were purportedly flushed with upward of 20-30 birds per flock. However, an accurate estimate is difficult since relatively few birds were observed at the lek during the mating season (March and April). In comparison to 14 adult male sage-grouse strutting on the Sink Valley lek in 2006, only 5 birds were observed on the lek in 2007.

Two leks have been positively identified in the Alton and Hatch area, and an unconfirmed third lek has been reported southeast of the Hatch lek. The Sink Valley lek (Figure 1a) is located in a valley bottom pasture (37° 23' 21.95 N, 112° 27' 06.64 W., 6866 ft. elevation. Plant species occurring in the lek area include a mix of both native and introduced grasses and forbs The Heuts Ranch lek, located approximately 13.5 miles north of Alton, is dominated by big sagebrush (37° 35' 00.79" N, 112° 27' 29.08" W, 7073 ft. elevation; Figure 1b). Unlike Sink Valley, this lek is positioned in an open landscape, lacking extensive juniper encroachment that is characteristic of the Sink Valley region. Heuts Ranch lek is position adjacent to a relatively large sink area which ponds during the spring.

The landscape between Sink Valley and Heuts Ranch has both open flats as well as juniper encroached slopes. The hills north of Alton have been particularly encroached by juniper trees. The increase in juniper over time has likely reduced bird movement between the two populations, leading to fragmentation of these two sub-populations. Fuhlendorf suggests that limit gene flow between populations may result in a decline in population resilience and even small-scale extinction events (Fuhlendorf et al. 2003).

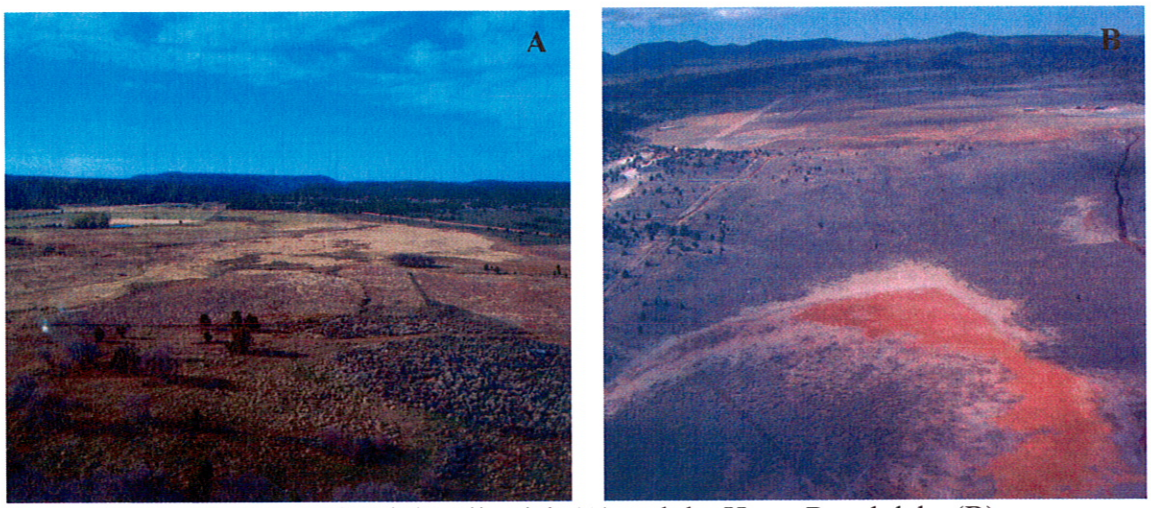


Figure 1. Aerial view of the sink valley lek (A) and the Heuts Ranch leks (B).

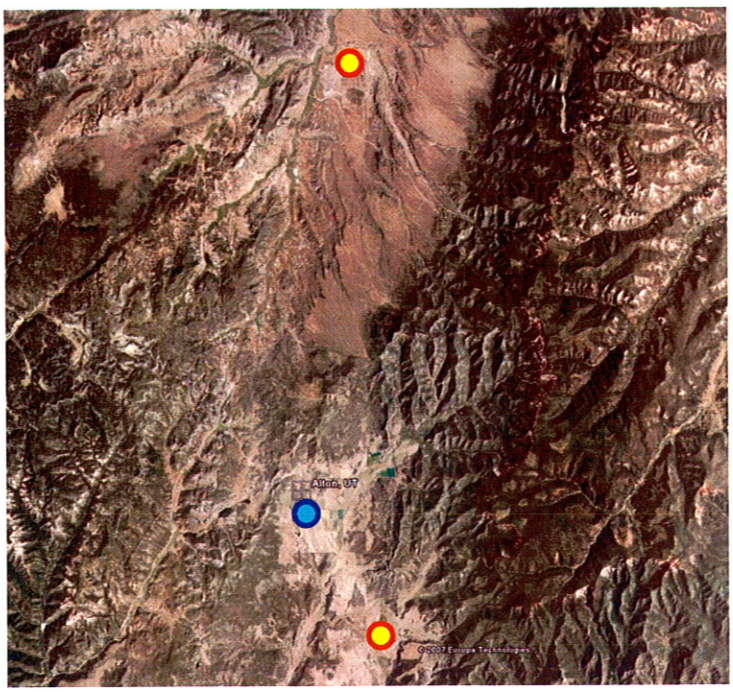


Figure 2. Topography and juniper woodlands separate Sink Valley (below) and Heuts Ranch (above) leks (Google 2007). The blue dot mark the town of Alton.

Sage-grouse in the Sink Valley area remain within the valley throughout the year. Frey and Curtis (2007) have been monitoring several birds for the last two years. They suggest that spring and summer habitat use vary only slightly from fall and winter habitat use (Figure 1).

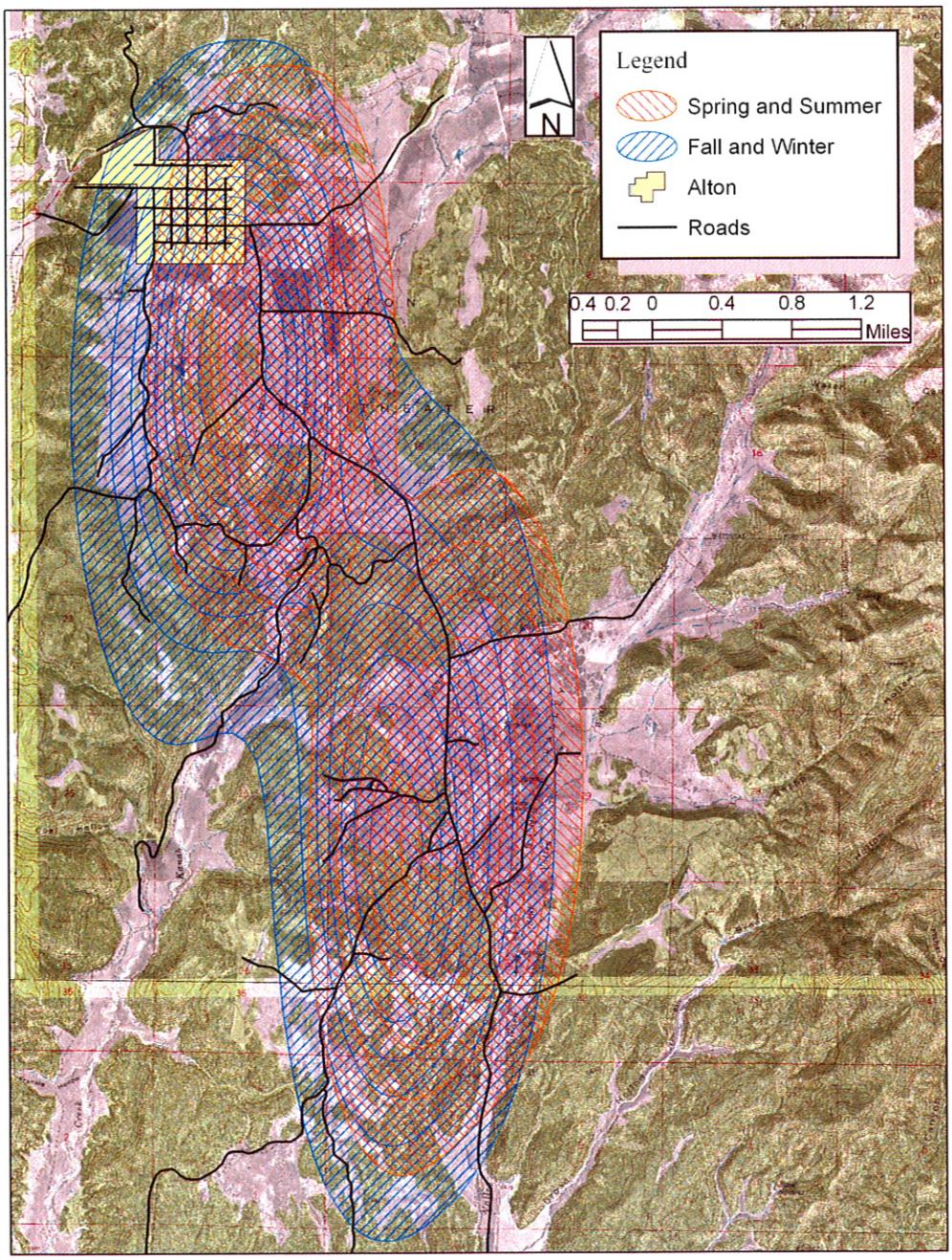


Figure 1. Distribution patterns of sage-grouse throughout the year in the Alton / Sink Valley areas. Distribution patterns were determined from collared birds that were monitored between 2005-2007.

SAGE-GROUSE TRAPPING AND BLOOD SAMPLING

Bird Trapping

Two adult males were trapped during four trapping nights within the Sink Valley area (Figure 4). Six birds were trapped at the Heuts Ranch lek on a single trapping night. Trapping was conducted during the nighttime hours, usually between 10:00 pm and 3:00 am. Four-wheelers and spotlights were used to locate birds during the first three trapping nights. A backpack generator with spotlight was used to locate birds on the last trapping night of the season.

Trapping dates and trap numbers are as follows:

March 24	2 birds trapped, 16 birds flushed. Six people formed two groups with 3 per group.
April 2	0 birds trapped, approximately 5 birds flushed (1 group, 4 trappers)
April 11	0 birds trapped, 0 birds flushed
May 3	0 birds trapped, 2 birds flushed

Figure 4. Adult male sage-grouse trapped in the Sink Valley area on March 24, 2007.

Since the number of birds trapped were low during the 2007 breeding season, additional birds will be trapped in the fall (September to October) to maintain an adequate population sample size. Since the Alton sage-grouse congregate near the alfalfa fields adjacent to the town, biologists are able to spot-light, trap and collar adult and juvenile birds during non-breading periods. Higher collared bird numbers increases the accuracy of predicting habitat use throughout the bird's life-cycle creating a more focused and effective management direction.

Since relatively little is known about habitat use by the Heuts Ranch brids, we hope to trap and monitor many birds from this population. Members of the Color Country Sage-grouse Working Group are familiar with this population and will be included as much as possible in trapping and monitoring these birds. In addition to providing a reference dataset for the Sink Valley population, these data will also assist local managers in monitoring trend and distribution patterns of the Heuts Ranch population. 30-40 collars and a backpack generator / spotlight will be purchased prior to the fall trapping season by Talon Inc. to facilitate trapping efforts and population monitoring. Talon is also willing to provide a technician as needed to monitor collared birds in both areas.

Transmitter Fitting and Blood Sampling

In the Sink Valley area, the two birds trapped were harnessed with a transmitter (collar) for monitoring throughout the next year. Chel Curtis, a wildlife technician from Southern Utah University is currently monitoring the birds and reporting this data to Nicole Frey and the Color County Sage-grouse Working Group.

Blood samples were taken from both birds trapped on march 24th. These samples will be used for genetic analyses to provide insight on genetic differentiation between Sink Valley and the Heuts Ranch populations. Additional samples will be collected from both leks during the fall and spring breeding seasons to ensure that sufficient samples have been collected in order to accurately assess genetic isolation or suppressed gene flow between the two populations. According to Craig Coleman, a geneticist at Brigham Young University, a minimum of 15-20 samples are needed from each population to reliability (statistically) characterize genetic traits of each population. Scientists at Brigham Young University have agreed to analyze the DNA samples as a collaborative research opportunity.

In time, the data generated from the genetic analysis as well as data from bird monitoring, habitat assessment and habitat improvements could potentially be further developed into a graduate research project at an established university (i.e. BYU, USU).

BIRD LURING FROM LEK

On March 24, four silhouette decoys were constructed depicting two adult female and two adult male sage-grouse. Decoys were placed at a similar site approximately 50 m away from the primary lekking region. An audio player was used to broadcast strutting calls in attempt to lure the birds to this alternate site. Strutting males did not exhibit behavior that would indicate an attempt to shift mating behavior closer to the decoys. Two females spotted near the lek also showed no obvious movement toward the decoys. Since the birds were already located on or near the original intact lek, it was not surprising that they did not shift breeding activities toward the decoys. Bird luring, however, may be a successful method when the lek has been disturbed. Under these conditions, an alternative lek may provide a suitable alternative for courtship displays and mating.

SAGE-GROUSE HABITAT: IMPROVEMENT, RESTORATION AND MITIGATION

HABITAT MITIGATION IMPLIMENTATION

Juniper removal

According to Crawford et al. (2004), the majority of sage-grouse in a population will nest within 3-5 km of the lek. Within these areas, birds generally select intact sagebrush sites with 15-25% shrub cover (Connelly et al. 2000). In most sagebrush stands in the Alton region, Utah juniper (*Juniperus osteosperma*) has encroached at varying densities and canopy cover. Encroached trees range from seedlings to mature adults. To reduce the potential impact of juniper on nesting success and ecological degradation, individual trees were removed using a Kobelco compact excavator with grappling claw (Figure 5).

Figure 5. Removal of juniper from sagebrush stands in the Sink Valley area.

During the 5 days of operation, approximately 8,000 trees were removed from a juniper encroached sagebrush and adjacent Gambel oak woodland in the northeast section of Sink valley. Extracted trees were first piled, and then loaded into a dump truck prior to being hauled to a dump site where they will be burned during the fall.

Tree removal resulted in a more continuous juniper-free sagebrush dominated plant community, which is more suitable for nesting and brood rearing (Idaho Conservation Plan 2006). By eliminating trees, raptors lack perching sites to watch for chicks and adult

birds. Juniper removal also reduces competition between juniper and sagebrush and other desirable plant species (Petersen 2006). Figure 6 shows a site before juniper removal methods were applied (above) and an adjunct site just cleared of juniper (below).

Figure 6. Comparison between sites before jniper removal (above) and post-treatment (below). Juniper was removed using a compact excavator, seen on the left side of the picture near a large extracted juniper pile.

SAGE-GROUSE LEK SEARCH AND AERIAL HABITAT ASSESSMENT

Two helicopter flights, arranged by Talon Inc., were taken on April 12 and April 20 to investigate both known leks and to search for unknown satellite leks. During these flights, approximately 20 strutting male birds were observed on the Heuts Ranch lek. During the first pass, birds remained on the lek. However, by the second pass, many birds flew to nearby cover. At Sink Valley, only a single bird was observed on the lek. After flying through the general vicinity of both known leks, no additional birds or satellite leks were detected. This included a search in other pastures, meadows, along drainages, and along open mesas. Based on the response of the lekking birds at Heuts Ranch, we assume that the birds would have been detectable had we encountered displaying males.

PROPOSED HABITAT MITIGATION

Brood-rearing habitat improvement

Based on last years bird monitoring data, many female birds bring their brood to the alfalfa fields adjacent to the town of Alton for foraging. Chicks likely consume alfalfa leaves as well as an abundance of forbs and insects. Since close proximity to Alton presents potentially hazardous conditions for young birds such as large farming equipment and high densities of predatory animals (Petersen Report 2006), a substitute alfalfa field will be established near the lek in Sink Valley. The field, located approximately 100 m southeast of the lek, will be seeded with alfalfa (*Medicago sativa*) as well as many forb species important for sage-grouse foraging. These species include western yarrow (*Achillea millifolium*), clover (Trifolium spp.), false dandelion (Agoseris glauca), microseris (*Microseris* spp.), lomatium (*Lomatium* spp.), and groundsmoke (*Gayophytum* spp.) to name a few.

Research is currently being conducted to determine plant species that host important insect species. Based on the results of these studies, additional species can be included in seed mixes that enhance insect availability. According to Gregg (2006), sage-grouse chick survival is significantly higher when prey insect species are readily available. In addition to common components of a chicks diet such as ants and beetles, Gregg found that high densities of caterpillars (moth larvae) resulted in high chick survival. Plants that provide a food base for these insects can enhance chick foraging behavior and potentially increase survival.

Predator control

Several species that prey on sage-grouse live in the Alton region (Figure 7). The density of common ravens (*Corvus corax*) and America crows (*Corvus brachyrhynchos*) are particularly high, especially near town where these birds have a consistent food supply (feed lots, garbage cans, etc.). These birds have been found to be a significant predator on chicks and eggs. Coyotes (*Canus latrans*) are common mammalian predators of sage-grouse and their eggs.

According to DeLong (1995), nest failure is closely associated with coyotes, avian predators, and small mammal species. According to Gregg (2006), areas that lacked adequate hiding cover were predisposed to high rates of raven and coyote predation.

To limit impacts to adults and chicks, predator control can be used to reduce the densities of several predator species. Arrangements will be discussed with local wildlife agencies to evaluate the potential of using predator control to increase egg and brood survival.

Figure 7. Sage-grouse predators common in the Alton region include common raven (upper left), golden eagle, American crow (lower left) and coyote.

Habitat connectivity

The citizens of Alton have started to remove juniper trees on private ground between the Sink Valley and Heuts Ranch leks with the expectation is juniper removal will enhance sagebrush habitat for wildlife. This effort may also create migration corridors between the two populations enhancing population sustainability and increasing gene flow.

REFERENCES

Connelly, J.W., M.A. Schroeder, A.R. Sands, and C.E. Braun. 2000. Guidelines for management of sage-grouse populations and habitat. Wildlife Society Bulletin 28:967-985.

Crawford, J.A., R.A. Olsen, N.E. West, J.C. Mosley, M.A. Schroeder, T.D. Whitson, R.F. Miller, M.A. Gregg, and C.S. Boyd. 2004. Ecology and management of sage-grouse and sage-grouse habiat. Journal of Range Management 57:2-19.

DeLong, A.K., J.A. Crawford, and D.C. DeLong. 1995. Relationship between vegetational structure and predation of artificial sage-grouse nests. Journal of Wildlife Management 59:88-92.

Fuhlendorf, S., A.J. Woodward, D.M. Leslie, and J.S. Shackford. 2002. Multi-scale effects of habitat loss and fragmentation on lesser prairie-chicken popuations of the US Southern Great Plains. Landscape Ecology 17:617-628.

Frey, N, and C. Curtis. 2007. USU Extension and Southern Utah University. Personal communication.

Gregg, M.A. 2006. Greater sage-grouse reproductive ecology: linkages among habitat resources, maternal nutrition, and chick survival. Ph.D. Dissertation, Oregon State University, Corvallis, Oregon.

Idaho Sage-grouse Advisory Committee. 2006. Conservation Plan for the Greater Sage-grouse in Idaho.

Petersen, S.L. 2006. Alton Sage-grouse Habitat Assessment and Mitigation Plan. Talon, Inc.

ACKNOWLEDGEMENTS

We appreciate the contribution and collaboration of Nicole Frey (USU Extension – Cedar City, Utah), Chel Curtis.(Southern Utah University), and Kevin Heaton (USU Extension – Panguitch, Utah).

Cover photograph
Image by Darrel Pruett, copied from the USGS NPWRC website
http://www.npwrc.usgs.gov/resource/literatr/grasbird/grsg/bird.gif

APPENDIX 3-4

VEGETATION SAMPLING IN THE COAL HOLLOW PROJECT AREA

2007

FOR
ALTON COAL DEVELOPMENT

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December 2007

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INTRODUCTION

A surface coal mine has been proposed near the town of Alton, Utah. The company developing the mine is called **Alton Coal Development** – the mine project is called the *Coal Hollow Project*. The proposed new mine is located entirely on private property.

Upon development of the mine, the existing plant communities within the permit area will be disturbed as a consequence of mining activities. The *proposed disturbed* plant communities have been quantitatively sampled to provide baseline data prior to any mine disturbance. Additionally, similar communities that will *not* be disturbed by mining have also been sampled and compared statistically to those proposed for disturbance. These areas, called "Reference Areas", will be used for comparisons at the time of final reclamation for revegetation success standards once the property has been restored to its approximate original condition. Additionally, sampling was conducted in other plant communities outside the permit area that will not be disturbed. This information could provide further information for related studies such as alluvial valley floor (AVF) determinations.

This document is the next report in a sequence of reports showing sampling results for the plant communities of the Coal Hollow Project. A previous report, called *Vegetation of the Sagebrush/Grass & Meadow Areas: 2006,* presented results from quantitative sampling accomplished in 2006 in an area where some of the first of the mining activities have been planned. Since that time, the mining plan has progressed in the planning stages to a point where

more is known about the sequential order in which mining will be conducted. With this refinement to the mine plan, more is known about the specific plant communities that will be disturbed over-time. Consequently, this report identifies the next plant communities to be disturbed by the Coal Hollow Project and shows the results from sampling them.

METHODS

Methodologies used for this study were performed in accordance with the guidelines supplied by the State of Utah, Division of Oil, Gas and Mining (DOGM). Quantitative and qualitative data for this report were taken within the plant communities proposed for disturbance and their respective reference areas in September 2007.

Vegetation Maps

The sample areas were mapped in the field and recorded on a GPS unit. Earlier versions of the Coal Hollow Project vegetation map have been submitted, but a new version that combines previous information with new information has been submitted in the Mining and Reclamation Plan (MRP) for this project. The most current map shows the new sample locations as well as previous sample areas [see MRP, *Vegetation Map, Drawing 3-1 (12/26/07)*].

Sampling Design and Transect/Quadrat Placement

Transect lines for vegetation sampling were placed randomly within the boundaries of the proposed disturbed, reference and other study areas. The transect placement technique was employed with the goal to adequately sample a representative subset of the entire site. Once the transects were randomly established, quadrat locations for sampling were chosen using random numbers from the transect lines with the objective to record data without preconceived bias.

Cover and Composition

Cover estimates were made using ocular methods with meter square quadrats. Species composition, cover by species, and relative frequencies were also assessed from the quadrats. Additional information recorded on the raw data sheets were: estimated precipitation, slope, exposure, grazing use, animal disturbance and/or other appropriate notes. Plant nomenclature follows "A Utah Flora" (Welsh et al., 2003).

Density

Density of woody plant species for the proposed disturbed and reference areas were estimated using the point-quarter method. In this method, random points were placed on the sample sites and measured into four quarters. The distances to the nearest woody plant species were then recorded in each quarter. The average point-to-individual distance was equal to the square root

of the mean area per individual. The number of individuals per acre was the end results of the calculations.

Sample Size & Adequacy

Sampling adequacy for cover and density was attempted by using the formula given below.

$$nMIN = \frac{t^2 s^2}{(dx)^2}$$

where,

nMIN	= minimum adequate sample
t	= appropriate confidence t-value
s	= standard deviation
x	= sample mean
d	= desired change from mean

Statistical Analyses

Student's t-tests were employed to compare the total living cover and total woody species density of each proposed disturbed area with its respective reference area.

Photographs

Color photographs of the sample areas were taken at the time of sampling and have been submitted with this report.

Threatened & Endangered Plant Species

Prior to recording quantitative data on the plant communities, a sensitive plant species survey was conducted. To initiate the study, appropriate agencies were consulted and other sources were reviewed (sensitive species files at *Mt. Nebo Scientific, Inc.*) for potential plant species that are known to be rare, endemic, threatened, endangered or otherwise sensitive in the project area.

RESULTS

Summarized below are the results from quantitatively sampling each plant community for the Coal Hollow Project during the 2007 sample period. Color photographs of each sample site have also been provided new at the end of this report. Locations of the sample areas have been added to a vegetation map [see MRP, *Vegetation Map, Drawing 3-1 (12/26/07)*].

The most recent mine plan indicates that mining will occur for three (3) years. Consequently, disturbances to the plant communities will be done in sequential order and based on the mine plan. Therefore, identifying plant communities for study was based on the mining activities and

the year a given community would be disturbed. Information about the proposed disturbed areas and the year of disturbance is given below. This report, along with the aforementioned report regarding the sampling that was done in 2006, provides data for all plant communities presently known to be proposed for disturbance in the mining operations for the Coal Hollow Project. As a side note, if a specific plant community that has been proposed for disturbance had been sampled previously in one location of the mine permit area, that dataset will also be used to represent other proposed disturbed areas of that same community. For example, sagebrush/grass communities occur in several areas proposed for disturbance, but baseline sampling only occurred in one (or sometimes two with the data combined) of the proposed disturbed sagebrush/grass communities. However, in some areas where a specific plant community has been proposed for disturbance in different mining years (year 1, 2 or 3) and they are located in very close proximity to each other, data have been recorded in the different mine years and combined together to make one dataset. These data can be easily separated in the future if desired. Finally, this report shows the results from sampling other areas that will *not* be disturbed by mining such as reference areas and additional study areas in meadow communities (this will explained later in the report).

Pinyon-Juniper Community (Proposed Disturbed)

Several areas proposed for disturbance by mining activities currently support pinyon-juniper plant communities. For a representative picture of these sample areas see Photograph 1. Pinyon-juniper communities were sampled in two areas. One such area, shown as the "Prop. Dist.

Pinyon-Juniper Sample Area (North)" on the map [see MRP, *Vegetation Map, Drawing 3-1 (12/26/07)*], is located on the east side of the permit area and *north* of another pinyon-juniper sample area. This is a site where mining activities have been planned during the first year of mining. Another pinyon-juniper sample area or the "Prop. Dist. Pinyon-Juniper Sample Area (South)" on the map, is located near the southern boundary of the permit area and also *south* of the other pinyon-juniper sample area. Disturbance from mining-related activities of the south sample area have been planned during the third year of mining. These two datasets have been combined to show the final results of the sample data for the proposed disturbed pinyon-juniper community as a whole.

Overstory cover of the pinyon-juniper community was represented by only two species in the sample quadrats and was dominated by Utah juniper (*Juniperus osteosperma*), followed distantly by pinyon pine (*Pinus edulis*). Understory cover was dominated by black sagebrush (*Artemisia nova*), followed by Utah juniper and pinyon pine (Table 1). Grasses were few and forbs were absent in the sample quadrats.

The total living cover of the pinyon-juniper community was 43.00%, of which 25.00% was from understory and 18.00% was from overstory species (Table 2-A). The understory composition by lifeform in this community was comprised of 95.88 % woody species (Table 2-B). Woody species density was measured at 2,657 individuals per acre (Table 3).

Pinyon-Juniper Community (Reference Area)

A reference area, or an area chosen to represent future revegetation success standards, was sampled in another pinyon-juniper plant community (see Photograph 2). This reference area will *not* be disturbed by the mining activities, so it may be used for data comparisons following final reclamation at the mine site. The pinyon-juniper reference area was located near the *north* proposed disturbed pinyon-juniper community [see MRP, *Vegetation Map, Drawing 3-1 (12/26/07)*].

Like the above proposed disturbed community, the overstory cover of the reference area was dominated by Utah juniper followed by pinyon pine. Likewise, understory was also dominated by black sagebrush, Utah juniper and pinyon pine (Table 4). Again, forbs were not present in the quadrats (Table 4); grasses that were present were slender wheatgrass (*Elymus trachycaulus*) and squirreltail (*Elymus elymoides*).

The total living cover of the pinyon-juniper reference area was estimated at 39.00%, 11.50% of it was composed of overstory and 27.50% was understory cover (Table 5-A). The composition of the understory in the pinyon-juniper reference area was calculated as 89.56% trees and shrubs and 10.44% grasses (Table 5-B). Woody species density was dominated by black sagebrush and Utah juniper, but the total of all species was 4,215 individuals per acre (Table 6).

Pasture Lands (Proposed Disturbed)

The areas called "pasture lands" were plant communities that have been altered to increase herbaceous cover and productivity for domestic livestock. Prior to pasture lands, these communities were probably native sagebrush/grass plant communities similar to those sampled and described in the 2006 vegetation report mentioned in the *Introduction* of this report. Although differences occur between pastures due to grazing practices and species planted in them, representative pastures were sampled for this study (see Photographs 3 and 4). The sample areas were located near the center of the permit area [see MRP, *Vegetation Map, Drawing 3-1 (12/26/07)*]. Like the community described above, different locations within this community were sampled, a *north* and a *south* area, and the data were combined for the summary tables in this report. The proposed disturbed pasture land (*north*) was an area proposed for disturbance by operations during the first year of mining activities. The proposed disturbed pasture land (*south*) was an area proposed for disturbance by operations in the second year of mining activities.

The sampling results for the north and south pasture lands indicated that the most common plant species by cover and frequency for the combined data were intermediate wheatgrass (*Elymus hispidus*), Kentucky bluegrass (*Poa pratensis*), black sagebrush (Table 7). The annual plant called poverty weed (*Iva axillaris*) was also common in the sample areas.

The total living cover, all of it from understory species, was 44.50% (Table 8-A). The composition of the pasture land consisted of 52.16% grasses, 30.19% shrubs and 17.64% forbs

(Table 8-B). Woody species density measurements show the density to be 1,349 individuals per acre with the most common species being big sagebrush *(Artemisia tridentata)*, rubber rabbitbrush (*Chrysothamnus nauseosus*) and black sagebrush (Table 9).

Pasture Lands (Reference Area)

Because the pasture lands were unnatural, or comprised of non-native conditions, a native reference area was not chosen. Appropriate standards of revegetation success will be developed using the site-specific knowledge contributed by the landowners and as well as qualified botanists representing the coal company and regulatory agencies.

Oak Brush Community (Proposed Disturbed)

An oak brush community has been proposed for disturbance by future mining operations (see Photograph 5). This community is located in the northeast region of the permit area [see MRP, *Vegetation Map, Drawing 3-1 (12/26/07)*].

Overstory of this community was greater than the understory cover. The dominant overstory species present by a wide margin was Gambel's oak (*Quercus gambelii*) with a 41.25% cover; it was present in 85.00% of the samples. The dominant understory species were big sagebrush, snowberry (*Symphoricarpos oreophilus*) and Gambel's oak (Table 10).

The total living cover in the oak brush community was estimated at 66.75%, 43.00% from overstory and 23.75% came from understory plants (Table 11-A). Woody species comprised 97.75% of the understory composition with the remaining 2.25% coming from grass species. No forbs were present in the sample quadrats (Table 11-B). Woody species density was estimated at 3,743 plants per acre and, like the cover results, the most common species consisted of snowberry, Gambel's oak and big sagebrush (Table 12).

Oak Brush Community (Reference Area)

A oak brush reference area was chosen to represent future standards for revegetation success (see Photograph 6). This reference area was located on the east side of the permit area [see MRP, *Vegetation Map*, *Drawing 3-1 (12/26/07)*]. Like the proposed disturbed area it was chosen to represent, the reference area cover was greater for overstory than that of understory. The dominant overstory species by far was Gambel's oak. Dominant understory species were Gambel's oak, Kentucky bluegrass, Utah juniper, big sagebrush and snowberry (Table 13).

Overstory cover was estimated at 53.25%, whereas understory cover was 20.00%. The total living cover of those covers combined was 73.25% (Table 14-A). Understory lifeform composition was comprised of 66.92% trees and shrubs and 33.08% grasses – no forbs were present in the samples (Table 14-B). Woody species density was estimated at 2,092 plants per acre with the most common by a wide margin being Gambel's oak, but also consisted of snowberry, big sagebrush, Rocky Mountain juniper (*Juniperus scopulorum*), pinyon pine and

Utah juniper (Table 15).

Meadow Community (Proposed Disturbed)

Meadow areas in and adjacent to the project area have been studied [see MRP, *Vegetation Map, Drawing 3-1 (12/26/07)*]. A dry meadow was studied earlier and reported in the aforementioned 2006 vegetation report. Another wetter meadow community has been studied that may also be disturbed due to the proposed mining activities (see Photograph 7).

The dominant plant species by cover and frequency in this community were wiregrass *(Juncus arcticus*), Missouri iris (*Iris missouriensis*) and Wood's rose (*Rosa woodsii*). For a list of all species present in the sample quadrats refer to Table 16. This meadow community had a total living cover of 86.00% (Table 17-A). Of this living cover 51.58% of it was comprised of grasses or grass-like species, 32.54% were forbs and 15.88% were shrubs (Table 17-B). Woody species density of the community was 384 individuals per acre, all of which were Wood's rose plants (Table 18).

Meadow Community (Reference Area)

The reference area, or area chosen to represent future revegetation success standards, was located just outside the permit area [see MRP, *Vegetation Map, Drawing 3-1 (12/26/07)*; Photograph 8]. Similar species dominated this community as were represented in the proposed disturbed area,

namely wiregrass, Missouri iris, Kentucky bluegrass and Wood's rose (Table 19). The total living cover in the reference area was estimated at 88.50% (Table 20-A). Composition here was calculated to be comprised of 51.57% grass and grasslike species, 37.38% forbs and 11.04% shrubs (Table 20-B). Woody species density in this area was estimated at 2,226 plants per acre (Table 21).

Dames' Meadow

One meadow area that *visually* appeared somewhat different than other meadow areas was located outside the permit area and within a private fenced pasture [see MRP, *Vegetation Map, Drawing 3-1 (12/26/07)*]. Unlike the above meadow areas, a tall composite plant was the most common species by cover (see Photograph 9). This plant was onehead sunflower (*Helianthella uniflora*), had a cover of 31.00% and was present in 95% of the sample quadrats (Table 22). However, other plants common in this pasture meadow were also common in other meadow e.g. wiregrass, Missouri iris, Kentucky bluegrass and Wood's rose.

Total living cover, all of it from understory cover, was estimated at 82.50% (Table 23-A). Lifeform composition was comprised fo 54.00% forbs, 41.04% grasses (or grasslike species) and only 4.97% shrubs (Table 23-B). Woody species density was not measured in the meadow because: 1) there were very few woody plants present (as suggested by the cover values for woody plants), 2) the area is outside the permit area and is therefore *not* proposed for disturbance by mining activities, and 3) total living cover, cover and frequency by species and

composition were the desired parameters to be used for comparisons and discussions regarding other studies in the meadow.

Dames' Meadow Reference Area

As mentioned above, Dames' Meadow is *not* proposed for future mining activities. Therefore, revegetation in this area will not be conducted, so a reference for future standards will not be needed.

Sorensen's Meadow

This meadow was another area that will *not* be disturbed by mining operations and was located outside the permit area. It was sampled to provide additional information about the meadow community as a whole. This meadow community was located on Sorensen's property [see MRP, *Vegetation Map, Drawing 3-1 (12/26/07)*] and is currently used for pasture and/or mowed to sustain livestock (see Photograph 10).

As shown on Table 24, the most common species in this area were wiregrass, Missouri iris, Kentucky bluegrass and aster (*Aster* sp.). The total living cover for this area was 86.50% (Table 25-A) and was comprised of 53.84% grasses or grasslike species and 46.16% forbs (Table 25-B). No woody species were present in the sample quadrats.

Woody species density in Sorensen's meadow was not measured for the same reasons as those described in the Dames' meadow. It should be noted, however, that even fewer woody plants were observed in this pasture, possibly due simply to different management techniques such as the mowing mentioned above.

Sorensen's Meadow Reference Area

As mentioned, Sorensen's Meadow has *not* been proposed for future mining activities. Therefore, revegetation in this area will not be conducted, so a reference for future standards will not be needed.

Threatened & Endangered Plant Species Survey

No rare, endemic, threatened, endangered or otherwise sensitive species were found in the study areas.

DISCUSSION & SUMMARY

Total Living Cover

The total living cover of the areas proposed for disturbance by mining and related activities were compared statistically with their respective reference areas. The statistical tests employed to make these comparisons were Student's t-tests. When the total living cover of the proposed disturbed **pinyon-juniper community** was statistically compared with the total living cover of its reference area, the differences were not significant (Figure 1-A). Likewise, when the total living cover of the **oak brush community** was compared to its reference area, the differences here were also non-significant (Figure 1-B). Finally, when the total living cover of the proposed disturbed **meadow community** was compared to the cover of the reference area, the differences again were non-significant (Figure 3-C).

Woody Species Density

Woody species densities of the proposed disturbed areas were also compared statistically to representative reference areas. When the woody species density of the **pinyon-juniper community** was statistically compared with the density of the reference area, Student's t-test suggest that the reference area supported more woody species than the pinyon-juniper community proposed for disturbance by the mining activities (Figure 2-A). Moreover, when the total density of the proposed disturbed **oak brush community** was compared to its reference area, the

differences were also significant – more woody plants occurred in the proposed disturbed area (Figure 2-B). Lastly the woody species density of the proposed disturbed **meadow community** was compared to the meadow reference area. Like the other density comparisons, the differences were statistically significant, with many more individuals per acre occurring in the meadow reference area (Figure 2-C).

Species Present and Composition

Reviewing the data summary tables show that the species present in the sample quadrats and lifeform composition proportions for the areas proposed for disturbance were relatively similar when compared to the respective reference areas.

Reference Area Considerations

Quantitative sampling was conducted in areas proposed for disturbance by coal mining-related activities at the Coal Hollow Project near Alton, Utah. Reference areas chosen to represent future standards for them were also sampled. Total cover (including total living cover, litter cover, rock cover and bareground) were recorded in the sample quadrats. Cover of each plant species were also recorded including the frequency of occurrences of these species. Additionally, lifeform composition of the understory cover was calculated. Finally, the woody species density of each sample area was measured.

Statistical tests comparing specific parameters of the proposed disturbed and reference areas were employed. When total living cover of the areas proposed for disturbance was compared to the appropriate reference areas, the differences were non-significant suggesting that the cover estimates were nearly identical. However, when woody species densities were compared, there appeared to be differences between the proposed disturbed and reference areas.

Nevertheless, the findings do suggest that the reference areas may be appropriate, especially when total living cover is concerned. Even though the woody species densities were dissimilar, these reference areas would likely still be appropriate. It is often difficult to predict the most appropriate number of woody species for wildlife habitat of animals supported on a given community. Trees and shrubs provide forage and cover for many species, but too many woody plants sometimes reduces available forage of understory herbaceous plants for other species. For example, deer and elk can benefit by having oak brush for certain habitat requirements such as cover for concealment, but too high density, or too many of these species per area, can exclude other herbaceous and smaller woody species for forage and browse. In other examples, certain landowners may prefer a minimal amount of woody species to enhance rangeland for domestic livestock. Therefore, at the time of final reclamation, although the reference areas chosen to represent standards for most parameters (i.e. cover, composition and diversity), other considerations can also be used to provide insight for woody species density standards. Collaboration by biologists representing DOGM, DWR and ACD as well as input from the landowners should be considered as a means to provide the woody species density standards. In other words, a specific number of plants per acre can be formulated for this standard – one where

botanists, wildlife biologists and landowners agree upon. For similar reasons the pasture lands were not assigned a reference area for final revegetation standards. As describe in the *Results* above, these areas were not represented in their natural or native condition within the permit area. Final standards for revegetation success can be established for species cover, production and woody species density values of these artificial plant communities with consultations by the same group mentioned above. Finally, with the above considerations, the reference areas chosen for revegetation success standards at the time of final reclamation should be appropriate.

TABLES & FIGURES

Table 1: Coal Hollow Project. Living Cover and Frequency by Plant Species (2007).

Pinyon-Juniper (Proposed Disturbed)	Mean Percent	Standard Deviation	Percent Frequency
OVERSTORY			
SHRUBS			
Juniperus osteosperma	16.75	18.66	55.00
Pinus edulis	1.25	5.45	5.00
UNDERSTORY			
SHRUBS			
Artemisia nova	17.50	14.87	70.00
Juniperus osteosperma	5.75	8.98	35.00
Pinus edulis	0.50	2.18	5.00
FORBS			
GRASSES			
Elymus elymoides	0.75	3.27	5.00
Elymus trachycaulus	0.50	1.50	10.00

Table 2: Coal Hollow Project. Total Cover and Composition (2007).

Pinyon-Juniper (Proposed Disturbed)		
A. TOTAL COVER	Mean Percent	Standard Deviation
OVERSTORY (o)	18.00	18.33
UNDERSTORY (u)	25.00	11.40
Litter	22.55	19.66
Bareground	48.40	17.18
Rock	4.05	2.27
TOTAL LIVING (o + u)	43.00	15.20
B. % COMPOSITION (u)		
Trees & Shrubs	95.88	13.26
Forbs	0.00	0.00
Grasses	4.13	13.26

Table 3: Coal Hollow Project. Woody Species Density (2007).

Pinyon-Juniper (Proposed Disturbed)	
SPECIES	**Individuals Per Acre**
Artemisia tridentata	166.03
Artemisia nova	1627.12
Juniperus osteosperma	730.55
Pinus edulis	132.83
TOTAL	**2656.53**

Table 4: Coal Hollow Project. Living Cover and Frequency by Plant Species (2007).

Pinyon-Juniper (Reference Area)	Mean Percent	Standard Deviation	Percent Frequency
OVERSTORY			
SHRUBS			
Juniperus osteosperma	9.00	13.56	40.00
Pinus edulis	2.50	10.90	5.00
UNDERSTORY			
SHRUBS			
Artemisia nova	17.75	12.70	80.00
Juniperus osteosperma	3.75	6.68	30.00
Pinus edulis	2.25	5.58	15.00
FORBS			
GRASSES			
Elymus elymoides	2.00	4.00	20.00
Elymus trachycaulus	1.75	4.26	15.00

Table 5: Coal Hollow Project. Total Cover and Composition (2007).

Pinyon-Juniper (Reference Area)		
A. TOTAL COVER	Mean Percent	Standard Deviation
OVERSTORY (o)	11.50	16.05
UNDERSTORY (u)	27.50	11.35
Litter	19.00	14.20
Bareground	46.50	19.69
Rock	7.00	2.45
TOTAL LIVING (o + u)	39.00	11.36
B. % COMPOSITION (u)		
Trees & Shrubs	89.56	14.77
Forbs	0.00	0.00
Grasses	10.44	14.77

Table 6: Coal Hollow Project. Woody Species Density (2007).

Pinyon-Juniper (Reference Area)	
SPECIES	**Individuals Per Acre**
Artemisia tridentata	158.05
Artemisia nova	3213.71
Juniperus osteosperma	632.20
Pinus edulis	210.73
TOTAL	**4214.70**

Table 7: Coal Hollow Project. Living Cover and Frequency by Plant Species (2007).

Pasture Lands (Proposed Disturbed)	Mean Percent	Standard Deviation	Percent Frequency
SHRUBS			
Artemisia tridentata	3.67	9.74	20.00
Artemisia nova	5.67	9.37	33.33
Chrysothamnus nauseosus	3.17	6.77	20.00
Rosa woodsii	0.50	1.50	10.00
FORBS			
Achillea millefolium	1.00	3.27	10.00
Aster sp.	0.83	2.61	10.00
Iris missouriensis	0.83	3.67	6.67
Iva axillaris	4.50	8.69	26.67
GRASSES (and grass-likes)			
Agropyron cristatum	3.83	6.28	30.00
Bromus inermis	1.50	7.21	6.67
Bromus tectorum	2.83	6.67	16.67
Elymus hispidus	6.50	12.12	30.00
Elymus smithii	3.00	8.23	20.00
Elymus trachycaulus	0.33	1.80	3.33
Juncus arcticus	0.50	1.98	6.67
Poa pratensis	5.83	13.85	16.67

Table 8: Coal Hollow Project. Total Cover and Composition (2007).

Pasture Lands (Proposed Disturbed)		
A. TOTAL COVER	Mean Percent	Standard Deviation
Total Living Cover	44.50	10.59
Litter	24.10	11.67
Bareground	29.63	10.53
Rock	1.77	1.48
B. % COMPOSITION (u)		
Shrubs	30.19	26.65
Forbs	17.64	22.73
Grasses	52.16	25.41

Table 9: Coal Hollow Project. Woody Species Density (2007).

Pasture Lands (Proposed Disturbed)	
SPECIES	**Individuals Per Acre**
Artemisia tridentata	618.30
Artemisia nova	348.50
Chrysothamnus nauseosus	303.53
Gutierrezia sarothrae	22.48
Rosa woodsii	56.21
TOTAL	**1349.02**

Table 10: Coal Hollow Project. Living Cover and Frequency by Plant Species (2007).

Oak Brush (Proposed Disturbed)	Mean Percent	Standard Deviation	Percent Frequency
OVERSTORY			
SHRUBS			
Juniperus scopulorum	1.75	7.63	5.00
Quercus gambelii	41.25	24.33	85.00
UNDERSTORY			
SHRUBS			
Artemisia tridentata	11.10	15.91	45.00
Juniperus osteosperma	0.50	2.18	5.00
Juniperus scopulorum	2.75	7.33	15.00
Quercus gambelii	3.40	4.91	35.00
Symphoricarpos oreophilus	5.50	9.99	35.00
FORBS			
GRASSES			
Bromus carinatus	0.25	1.09	5.00
Poa pratensis	0.25	1.09	5.00

Table 11: Coal Hollow Project. Total Cover and Composition (2007).

Oak Brush (Proposed Disturbed)		
A. TOTAL COVER	Mean Percent	Standard Deviation
OVERSTORY (o)	43.00	22.49
UNDERSTORY (u)	23.75	12.23
Litter	61.25	15.24
Bareground	13.25	9.51
Rock	1.75	1.41
TOTAL LIVING (o + u)	66.75	14.86
B. % COMPOSITION (u)		
Trees & Shrubs	97.75	6.80
Forbs	0.00	0.00
Grasses	2.25	6.80

Table 12: Coal Hollow Project. Woody Species Density (2007).

Oak Brush (Proposed Disturbed)	
SPECIES	**Individuals Per Acre**
Artemisia tridentata	888.89
Symphoricarpos oreophilus	1169.59
Gutierrezia sarothrae	46.78
Juniperus osteosperma	233.92
Juniperus scopulorum	374.27
Quercus gambelii	1029.24
TOTAL	3742.70

Table 13: Coal Hollow Project. Living Cover and Frequency by Plant Species (2007).

Oak Brush (Reference Area)	Mean Percent	Standard Deviation	Percent Frequency
OVERSTORY			
SHRUBS			
Juniperus osteosperma	3.75	11.28	10.00
Juniperus scopulorum	1.75	7.63	5.00
Quercus gambelii	47.75	23.21	85.00
UNDERSTORY			
SHRUBS			
Artemisia tridentata	2.40	6.32	15.00
Juniperus osteosperma	3.00	9.14	10.00
Juniperus scopulorum	1.75	7.63	5.00
Pinus edulis	0.50	2.18	5.00
Quercus gambelii	5.85	8.56	40.00
Symphoricarpos oreophilus	1.75	3.96	20.00
FORBS			
GRASSES			
Poa pratensis	0.75	2.38	10.00
Poa secunda	4.00	7.00	30.00

Table 14: Coal Hollow Project. Total Cover and Composition (2007).

Oak Brush (Reference Area)		
A. TOTAL COVER	Mean Percent	Standard Deviation
OVERSTORY (o)	53.25	13.63
UNDERSTORY (u)	20.00	8.37
Litter	66.70	21.24
Bareground	8.30	13.49
Rock	5.00	16.07
TOTAL LIVING (o + u)	73.25	12.68
B. % COMPOSITION (u)		
Trees & Shrubs	66.92	43.92
Forbs	0.00	0.00
Grasses	33.08	43.92

Table 15: Coal Hollow Project. Woody Species Density (2007).

Oak Brush (Reference Area)	
SPECIES	**Individuals Per Acre**
Artemisia tridentata	209.16
Juniperus osteosperma	26.14
Juniperus scopulorum	130.72
Pinus edulis	52.29
Quercus gambelii	1333.37
Symphoricarpos oreophilus	339.88
TOTAL	2091.57

Table 16: Coal Hollow Project. Living Cover and Frequency by Plant Species (2007).

Meadow Community (Proposed Disturbed)	Mean Percent	Standard Deviation	Percent Frequency
SHRUBS			
Artemisia nova	1.50	6.54	5.00
Rosa woodsii	11.75	12.07	60.00
FORBS			
Achillea millefolium	3.50	6.73	40.00
Equisetum arvensis	0.75	2.38	10.00
Iris missouriensis	24.00	13.19	95.00
GRASSES (and grass-likes)			
Carex microptera	7.75	10.43	30.00
Elymus lanceolatus	1.25	3.11	15.00
Elymus smithii	0.25	1.09	5.00
Elymus trachycaulus	0.50	2.18	5.00
Juncus arcticus	24.00	9.95	100.00
Koeleria nitida	1.50	4.77	10.00
Phleum pratensis	0.50	2.18	5.00
Poa pratensis	7.50	7.66	60.00
Poa secunda	1.25	3.11	15.00

Table 17: Coal Hollow Project. Total Cover and Composition (2007).

Meadow Community (Proposed Disturbed)		
A. TOTAL COVER	Mean Percent	Standard Deviation
Total Living Cover	86.00	7.18
Litter	8.25	4.69
Bareground	4.05	1.96
Rock	1.70	3.05
B. % COMPOSITION (u)		
Shrubs	15.88	15.08
Forbs	32.54	16.94
Grasses	51.58	13.82

Table 18: Coal Hollow Project. Woody Species Density (2007).

Meadow Community (Proposed Disturbed)	
SPECIES	**Individuals Per Acre**
Rosa woodsii	384.06
TOTAL	384.06

Table 19: Coal Hollow Project. Living Cover and Frequency by Plant Species (2007).

Meadow (Reference Area)	Mean Percent	Standard Deviation	Percent Frequency
SHRUBS			
Rosa woodsii	9.75	9.68	65.00
FORBS			
Achillea millefolium	0.25	1.09	5.00
Iris missouriensis	32.37	12.50	100.00
GRASSES (and grass-likes)			
Elymus lanceolatus	0.50	1.50	10.00
Juncus arcticus	33.00	13.55	100.00
Poa pratensis	11.00	14.20	60.00
Poa secunda	1.25	3.83	10.00

Table 20: Coal Hollow Project. Total Cover and Composition (2007).

Meadow (Reference Area)		
A. TOTAL COVER	Mean Percent	Standard Deviation
Total Living Cover	88.50	5.94
Litter	7.85	4.98
Bareground	2.65	2.03
Rock	1.00	0.00
B. % COMPOSITION (u)		
Shrubs	11.04	11.01
Forbs	37.38	13.75
Grasses	51.57	13.78

Table 21: Coal Hollow Project. Woody Species Density (2007).

Meadow (Reference Area)	
SPECIES	**Individuals Per Acre**
Rosa woodsii	2225.69
TOTAL	2225.69

Table 22: Coal Hollow Project. Living Cover and Frequency by Plant Species (2007).

Dames' Meadow	Mean Percent	Standard Deviation	Percent Frequency
SHRUBS			
Rosa woodsii	4.25	13.06	25.00
Salix exigua	0.25	1.09	5.00
FORBS			
Castilleja exilis	0.50	1.50	10.00
Iris missouriensis	13.50	17.83	45.00
Potentilla anserina	0.50	1.50	10.00
Helianthella uniflora	31.00	26.77	95.00
GRASSES (and grass-likes)			
Carex microptera	0.50	2.18	5.00
Juncus arcticus	23.50	11.41	100.00
Poa pratensis	8.50	12.85	45.00

Table 23: Coal Hollow Project. Total Cover and Composition (2007).

Dames' Meadow		
A. TOTAL COVER	Mean Percent	Standard Deviation
Total Living Cover	82.50	7.83
Litter	13.35	7.23
Bareground	3.00	1.64
Rock	1.15	0.36
B. % COMPOSITION (u)		
Shrubs	4.97	13.76
Forbs	54.00	20.34
Grasses	41.04	22.28

Table 24: Coal Hollow Project. Living Cover and Frequency by Plant Species (2007).

Sorensen's Meadow	Mean Percent	Standard Deviation	Percent Frequency
SHRUBS			
FORBS			
Aster sp.	6.00	7.18	55.00
Equisetum arvensis	1.00	2.00	20.00
Erigeron sp.	0.25	1.09	5.00
Gentiana affinis	1.25	2.68	20.00
Iris missouriensis	30.50	7.57	100.00
Potentilla anserina	0.75	1.79	15.00
Verbascum thapsus	0.25	1.09	5.00
GRASSES (and grass-likes)			
Carex microptera	3.50	9.23	15.00
Elymus smithii	0.50	1.50	10.00
Juncus arcticus	33.00	11.34	100.00
Koeleria nitida	0.50	2.18	5.00
Poa pratensis	7.00	7.31	55.00
Poa secunda	0.50	2.18	5.00
Scirpus americanus	1.50	4.77	10.00

Table 25: Coal Hollow Project. Total Cover and Composition (2007).

Sorensen's Meadow		
A. TOTAL COVER	Mean Percent	Standard Deviation
Total Living Cover	86.50	3.91
Litter	6.85	3.29
Bareground	5.60	2.60
Rock	1.05	0.22
B. % COMPOSITION (u)		
Shrubs	0.00	0.00
Forbs	46.16	8.48
Grasses	53.84	8.48

FIGURE 1. STUDENT'S T-TEST - **Total Living Cover** Comparisons Between Proposed Disturbed and Reference Areas (2007).

A.
Pinyon-Juniper

Proposed Disturbed:	$\bar{x}$=43.00; s=15.20	
Reference Area:	$\bar{x}$=39.00; s=11.36	t = 0.943; df =38 , SL=N.S.

B.
Oak Brush

Proposed Disturbed:	$\bar{x}$=66.75; s=14.86	
Reference Area:	$\bar{x}$=73.25; s=12.68	t = 1.488 ; df = 38, SL=N.S.

C.
Meadow

Proposed Disturbed:	$\bar{x}$=86.00; s=7.18	
Reference Area:	$\bar{x}$=88.50; s=5.94	t = 1.200; df = 38, SL=N.S.

$\bar{x}$ = mean
s = standard deviation
t = Student's t-value
df = degrees of freedom
SL= Significance Level
N.S.=Non-Significant

FIGURE 2. STUDENT'S T-TEST - **Woody Species Density** Comparisons Between Proposed Disturbed and Reference Areas (2007).

A.
Pinyon-Juniper

Proposed Disturbed:	$\bar{x}$=2656.53; s=1495.02	
Reference Area:	$\bar{x}$=4214.70; s=2153.56	t = -2.658; df =38, SL=p<.05

B.
Oak Brush

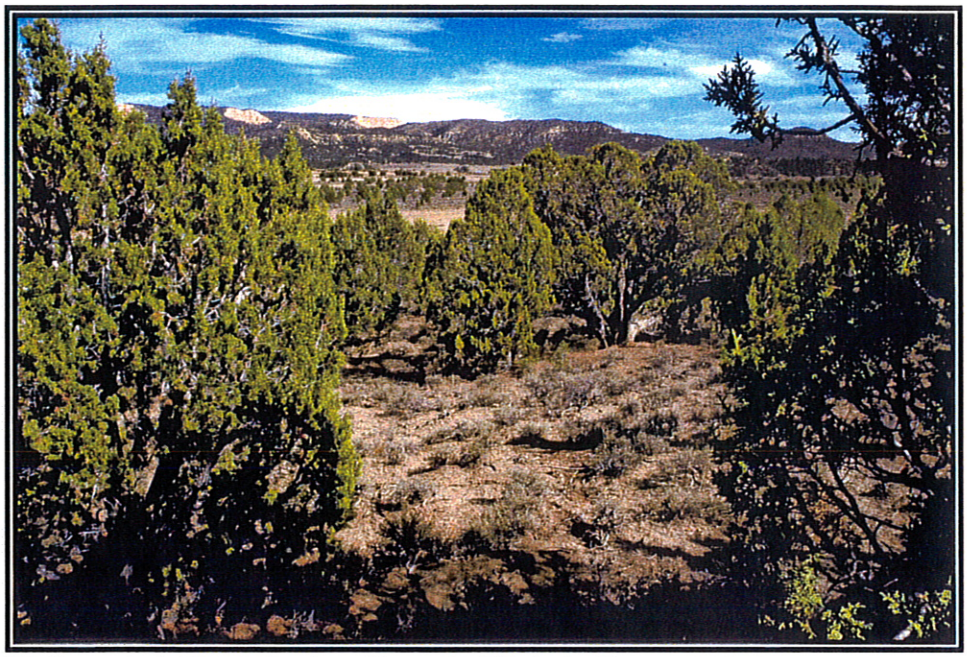
Proposed Disturbed:	$\bar{x}$=3742.70; s=1891.96	
Reference Area:	$\bar{x}$=2091.57; s=1134.18	t = 3.347; df =38, SL=p<.05

C.
Meadow

Proposed Disturbed:	$\bar{x}$= 384.06; s= 494.12	
Reference Area:	$\bar{x}$=2225.69; s=2323.34	t = -3.467; df =38, SL=p<.05

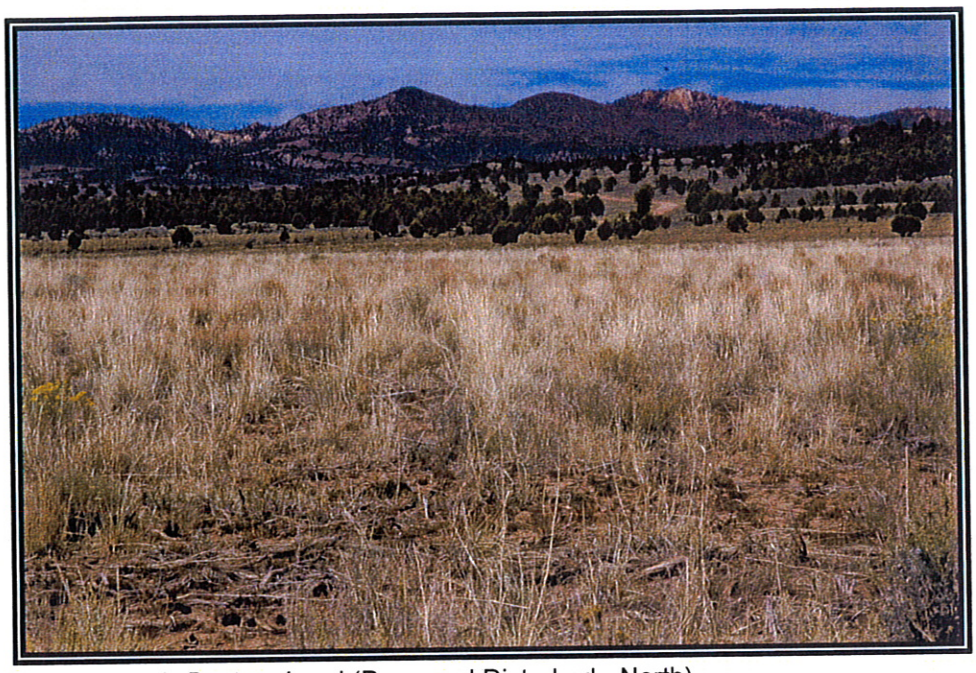
$\bar{x}$ = mean
s = standard deviation
t = Student's t-value
df = degrees of freedom
SL= Significance Level
p = probability
N.S.=Non-Significant

COLOR PHOTOGRAPHS
OF
SAMPLE AREAS



Photograph 1: Pinyon-Juniper (Proposed Disturbed)

Photograph 2: Pinyon-Juniper (Reference Area)

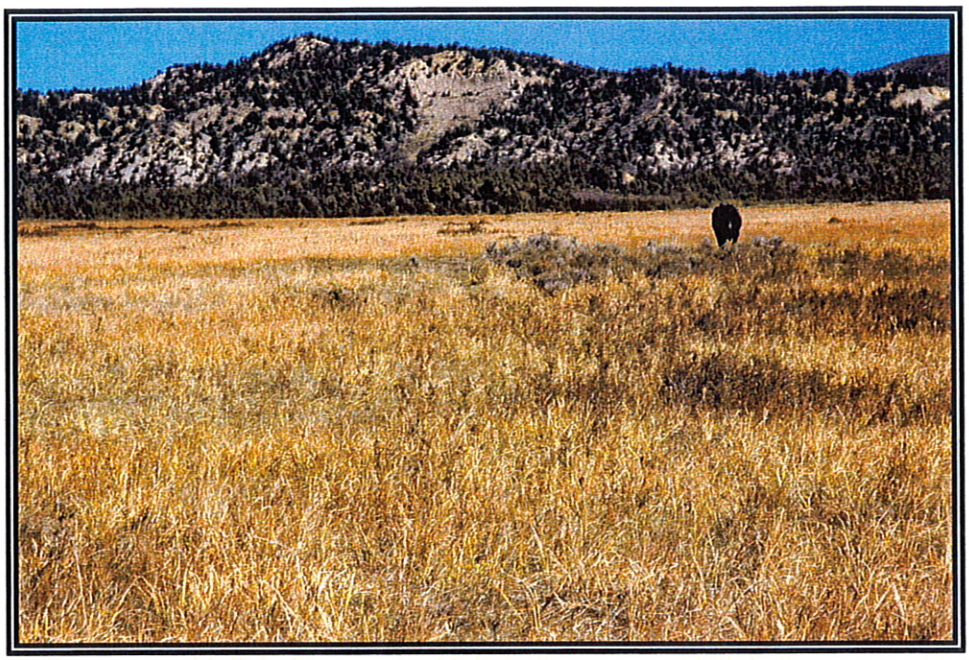


Photograph 3: Pasture Land (Proposed Disturbed - North)

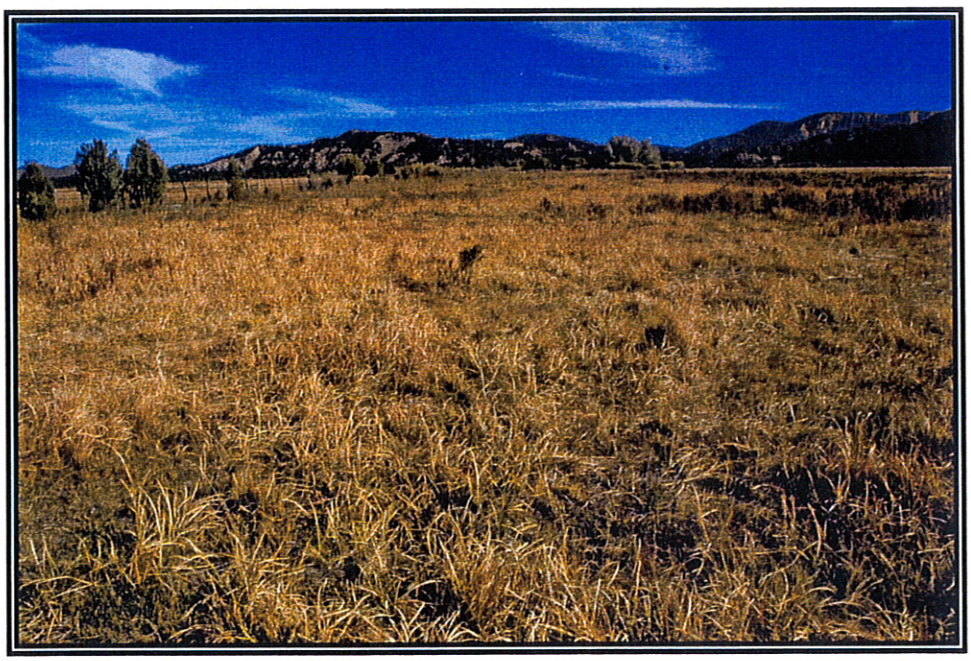
Photograph 4: Pasture Land (Proposed Disturbed - South)

Photograph 5: Oak Brush (Proposed Disturbed)

Photograph 6: Oak Brush (Reference Area)

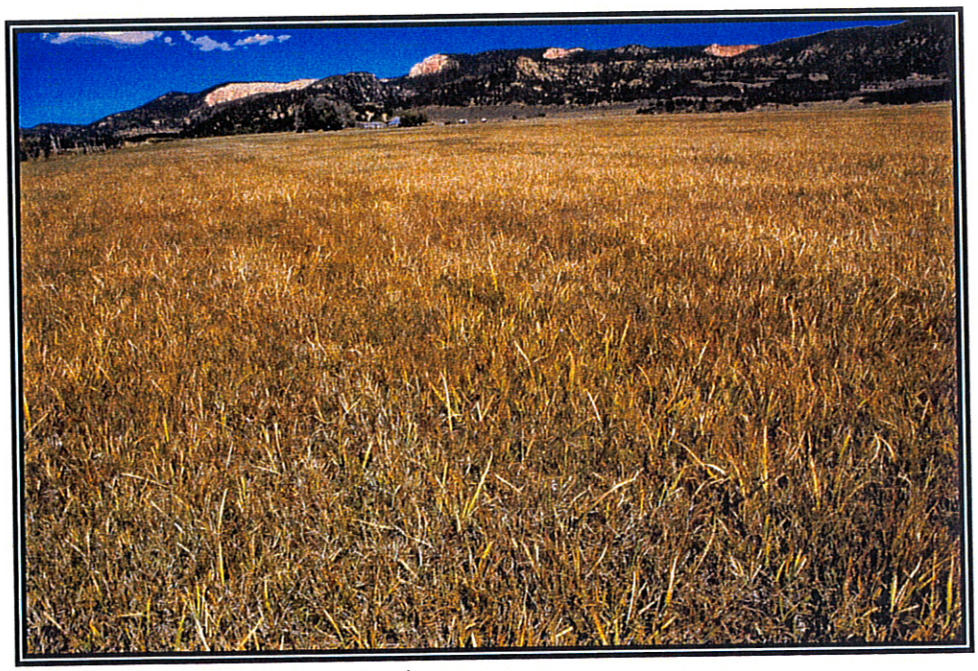


Photograph 7: Meadow (Proposed Disturbed)



Photograph 8: Meadow (Reference Area)

Photograph 9: Dames' Meadow



Photograph 10: Sorensen's Meadow