

RECOMMENDED BEST MANAGEMENT PRACTICES FOR PLANTS OF CONCERN

**Practices Developed to Reduce the Impacts of
Oil and Gas Development Activities
to Plants of Concern**



Prepared by the Colorado Rare Plant Conservation Initiative

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I. Introduction

Seventeen globally imperiled plants found in oil and gas development areas in Colorado are in danger of extinction (Table 1). Collectively, these species occupy less than 11,000 acres in Colorado (Figure 1 and Table 1). One of the biggest conservation issues for Colorado native plants is the lack of awareness of the existence and status of these rare plant species. Increasing this awareness, especially during development activities that may impact rare plants, will reduce the likelihood of future listings under the Endangered Species Act. Avoiding or minimizing impacts to these species during oil and gas development activities may help to effectively conserve their habitat and is unlikely to confer substantial impacts on oil and gas development projects. The intent of these BMPs is to inform people working in energy development areas regarding the importance of Colorado's botanical treasures, and to outline some of the ways in which they can coexist with oil and gas development.

The desired outcome of these recommended BMPs is to significantly reduce the impacts of oil and gas development to the seventeen plants of concern on federal, state, and/or private land. These BMPs are not intended to replace other BMPs written for specific species or habitats. The BMPs listed here are intended to evolve as additional information becomes available about Colorado's botanical diversity, and as resource extraction and resource conservation technologies develop.

Federal, State, and local land management agencies have developed complementary policy and guidance regarding a number of issues discussed in these BMPs. For example, BLM's Record of Decision for the National Vegetation Treatments Final Programmatic EIS (PEIS) identifies standard operating procedures to be used with all applications of herbicides on public lands (BLM 2007a). The Biological Assessment developed for BLM's PEIS outlines conservation measures for species, or groups of species, that react similarly to proposed vegetation treatments. These conservation measures for plants are found on pages 4–129 to 4–134 of the Final Programmatic Biological Assessment for Vegetation Treatments on BLM Lands in 17 Western States (BLM 2007b).

The following recommended measures are intended to complement the CDOW Actions to Minimize Adverse Impacts to Wildlife Resources (CDOW 2008, Appendix One), and are organized to provide guidance at each step of the oil and gas development process. The implementation of these recommendations may assure that development proceeds without unintended harm to globally imperiled plants.

II. Project Planning and Rare Plant Surveys

Voluntarily incorporate sensitive plant species and habitats into the preparation of CDOW 'Wildlife Mitigation Plans' or 'Comprehensive Drilling Plans' to assure all sensitive biodiversity elements are addressed (CDOW 2008).

1. Gather mapped location information for plants of concern (Table 1) in potential project areas by consulting with the Colorado Natural Heritage Program at Colorado State University, the U.S. Fish and Wildlife Service, or other known sources of rare plant spatial data.
2. If federally listed Threatened or Endangered plant species occur in a project area on federal lands, consultation with the U.S. Fish and Wildlife Service (USFWS) is necessary. If Candidate or Proposed species are found, discuss the management of these species with the USFWS to avoid complications should these species become listed Threatened or Endangered during the life of the project.
3. Conduct rare plant surveys. **Please note that information pertinent to individual species of concern is provided, where possible, in Appendix Two.**
 - a. Field botanical surveys are recommended for all projects that overlap the range of the plants of concern (Figure 2) to determine if plants of concern (Table 1) or suitable habitat are present. If possible, all plants tracked by the Colorado Natural Heritage Program should also be documented in the surveys (Colorado Natural Heritage Program 2011). Botanical surveys are generally considered valid for three years.
 - b. Prior to field surveys, maps should be provided (as hard-copy and GIS files) to a botanical surveyor showing all known locations for the plants of concern, as well as the proposed areas of disturbance. Maps should include existing and proposed infrastructure, including roads, pipelines, well pads, ponds, pits, parking lots, all other work areas, and any area liable to be subjected to ground disturbance. These maps should contain as much of this information as possible and be updated as new sites are proposed.
 - c. Field botanical surveys should be conducted by qualified individual(s) with botanical expertise, according to commonly accepted survey protocols, and using suitable GPS equipment. The Colorado Natural Heritage Program at Colorado State University can provide reference materials to assist with survey efforts, field forms, etc.
 - d. Field botanical surveys should be conducted at a time when the plant species of concern can be detected and accurately identified. In some cases multi-year surveys are necessary. For example, in dry years some ephemeral annuals (such as *Phacelia submutica*) may not germinate and produce plants, but they are still present at the site in the seedbank.
 - e. Field botanical surveys should be completed across the project disturbance area and include a 600 meter buffer around the project area. In some cases the topographic setting or land ownership patterns may impede covering the full recommended survey area. Surveys should also include areas

where direct or indirect effects may impact hydrology. Surveys should be floristic, providing a list of plant species encountered during the survey. Negative survey data should also be reported to the landowner or land manager.

- f. If plant species of concern are found within the survey area, the botanist should endeavor to determine the complete extent of the occurrence and the approximate number of individuals within the occurrence. Ideally occurrences should be delineated by GPS and the results imported to GIS for inclusion on updated project maps.
- g. Field survey results should be reported to the Colorado Natural Heritage Program at Colorado State University, and to appropriate land managers. A photograph or voucher specimen (if sufficient individuals are present) should be taken. Vouchers should be deposited in one of the region's major herbaria (e.g., University of Colorado, Colorado State University, Denver Botanic Gardens, Rocky Mountain Herbarium).
- h. Verify that adequate field surveys and all other planning phase activities have been completed. If new locations of plants listed in Table 1 were found during botanical surveys, ensure that they are shown on updated project maps.

III. Measures for Impact Avoidance and Minimization

1. General Protection Measures

- a. Provide annual educational training for oil and gas company staff and contractors on specific rare plant species of concern, (e.g., how to recognize species, appropriate survey times, etc.) and on the overall aspects of the landscape planning documents.
- b. No surface disturbance (NSD) is recommended in Areas of Critical Environmental Concern (ACECs) designated for rare plant values, or in known occupied habitat for plants listed in Table 1.
- c. Where plants of concern (Table 1) occur in a project area, an avoidance buffer of 200 meters minimum is recommended. The 200 meter buffer reduces dust transport, weed invasion, unauthorized vehicular activities, and chemical and produced-water spills. It also reduces impact to pollinators and their habitat.
- d. Where avoidance is not feasible and development is allowed within 200 meters of plant populations, impacts to the plants of concern can be reduced by placing temporary fencing or other barriers around the footprint of the project. To avoid working in habitat for the plants of concern, and drawing attention to the plants, the edge of disturbance should be fenced, not the nearby plant population.
- e. Ensure that a botanical monitor is on site when clearing of vegetation occurs in the vicinity of plant species of concern.
- f. Perform frequent and timely inspections of development sites and plants of concern occurrences to ensure that BMPs are being followed, and to identify

areas of potential conflict. Inspections of plant occurrences should be performed by a botanist or other qualified personnel.

- g.** Prevent plumes of dust and particulate matter from impacting plants of concern. While new roads should not be built within 200 meters of the plants of concern, preexisting roads with an expected increase in traffic should be graveled in these areas. The operator is encouraged to apply water for dust abatement to such areas during the flowering period. If possible, dust abatement applications should be comprised of water only, with minimal use of magnesium chloride.
- h.** *Ex-situ* techniques such as transplanting are not recommended under any circumstances.
- i.** Fire retardant chemicals should not be applied within 200 meters of plants of concern.
- j.** Alteration and disturbance of the hydrological setting for plants of concern are discouraged.
- k.** Overspray from evaporation ponds should be located such that it falls at least 200 meters from habitat for plants of concern.
- l.** Construction should take place down slope of plants of concern where feasible. Down slope ground disturbing activities should be conducted in such a way as to avoid as much as is reasonably possible undercutting and sloughing of the slopes where habitat for the plants of concern occurs. If well pads and roads must be sited upslope, buffers of 200 meters minimum between surface disturbances and plants of concern should be incorporated.

2. Non-native Species Management

- a.** Ensure that the plants of concern are protected from undue damage resulting from weed control efforts.
- b.** Control noxious weeds using integrated techniques. Mechanical or chemical control in areas with plants of concern should only be implemented very carefully by personnel familiar with rare plants to avoid damage to non-target species.
- c.** Aerial herbicide application should be kept at least 600 meters from known plant populations. Ground applications should only directly spray into habitat for plants of concern in instances where weed populations threaten habitat integrity or plant populations. Great care should be used to avoid pesticide drift in those cases.
- d.** Ensure that seed used for revegetation as well as straw and hay bales used for erosion control are certified free of noxious weeds.

3. Restoration and Revegetation

- e.** Many rare plants are adapted to live on specific substrates that may not resemble topsoil (e.g. shale barrens with very coarse and rocky substrate). Rare plants may not compete on more developed top soils, so the retention of original surface substrates in reclamation is important.
- f.** Although land management agencies may allow use of non-native species for revegetation of sensitive areas under some circumstances, **nonnative**

invasive plant species should not be used under any circumstances near rare plant populations.

- g.** Site-specific and species-specific seed mixes should be developed depending on the location of a project and the species of interest. **Appendix Two** includes lists of associated plant species that may serve as a reference for starting a seed mix, and information about pollinators, when available, for each species can be used to determine appropriate mix of forbs vs. grasses to provide flowering resources for pollinators.
- h.** Use nearby occupied rare plant habitat as reference areas for revegetation of disturbed occupied habitat to meet goals of native vegetation cover, composition and structure.

4. Monitoring

These measures, along with those included in Appendix One, assess the effectiveness of reclamation efforts, noxious species invasions and the effects of development on populations of plants of concern.

- a. Collect baseline data on rare plant metrics (cover, density, etc.) prior to any adjacent development. Although land management agencies may have specific quantitative or qualitative monitoring guidelines, an excellent reference for developing and implementing a monitoring plan is Elzinga et al. (1997). Follow up on this quantitative monitoring regularly after development has been completed.
- b. Monitor impacts from oil and gas development on plants of concern. If impacts (changes in the quality and/or condition of the occurrences) are noted, change management to address the cause of impacts.

5. Research

- a. Collaborate and/or fund research investigation into the impacts of oil and gas development activities on plants of concern and/or the survey of potential habitat for additional populations.
- b. Conduct research to better understand: the pollination ecology of the plants of concern, relationships the plants of concern have with insect pollinators, and pollinator habitat.
- c. Support research to test the effectiveness of specific Best Management Practices for plants of concern.

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Table 1. Seventeen plants of concern that are the primary focus of these BMPs. These species are either considered globally imperiled or are federally listed by the USFWS. All of these taxa are threatened with extinction, and oil and gas development activities pose significant issues relative to their long term conservation (Colorado Natural Heritage Program and The Nature Conservancy 2008, Colorado Natural Heritage Program 2011). **Additional information on each species is provided in Appendix Two.**

Scientific name	Imperilment rank (CNHP 2008)	Federal Status	Endemic to Colorado	Occupied acres in Colorado	Habitat
<i>Astragalus humillimus</i>	G1/S1	LE	No	477	Cliff and canyon
<i>Astragalus debequaeus</i>	G2/S2	BLM	Yes	1433	Pinyon-juniper
<i>Astragalus osterhoutii</i>	G1/S1	LE	Yes	793	Shrubland
<i>Cryptantha gypsophila</i>	G2/S2	BLM	Yes	525	Pinyon-juniper
<i>Eriogonum clavellatum</i>	G2/S1	none	No	4	Shrubland
<i>Eriogonum pelinophilum</i>	G2/S2	LE	Yes	1,178	Shrubland
<i>Lesquerella congesta</i>	G1/S1	LT	Yes	740	Barrens
<i>Lesquerella parviflora</i>	G2/S2	BLM	Yes	1,194	Barrens
<i>Mentzelia rhizomata</i>	G2/S2	BLM	Yes	359	Barrens
<i>Penstemon debilis</i>	G1/S1	C	Yes	60	Barrens
<i>Penstemon fremontii</i> var. <i>glabrescens</i>	G3T2/S2	none	Yes	349	Shrubland
<i>Penstemon grahamii</i>	G2/S1	BLM	No	639	Barrens
<i>Penstemon scariosus</i> var. <i>albifluvis</i>	G4T1/S1	C	Yes	124	Barrens
<i>Phacelia submutica</i>	G2T2/S2	C, FS	Yes	586	Barrens
<i>Physaria obcordata</i>	G1G2/S1S2	LT	Yes	473	Barrens
<i>Sclerocactus glaucus</i>	G3/S3	LT	Yes	1,378	Barrens
<i>Thalictrum heliophilum</i>	G2/S2	none	Yes	279	Barrens
Total Acres				10,591	

* Federal Status codes: BLM: Bureau of Land Management Sensitive, FS: Forest Service Sensitive, LE: listed Endangered, LT: listed Threatened, C: Candidate.

Most Imperiled Plants in Oil and Gas Development Areas

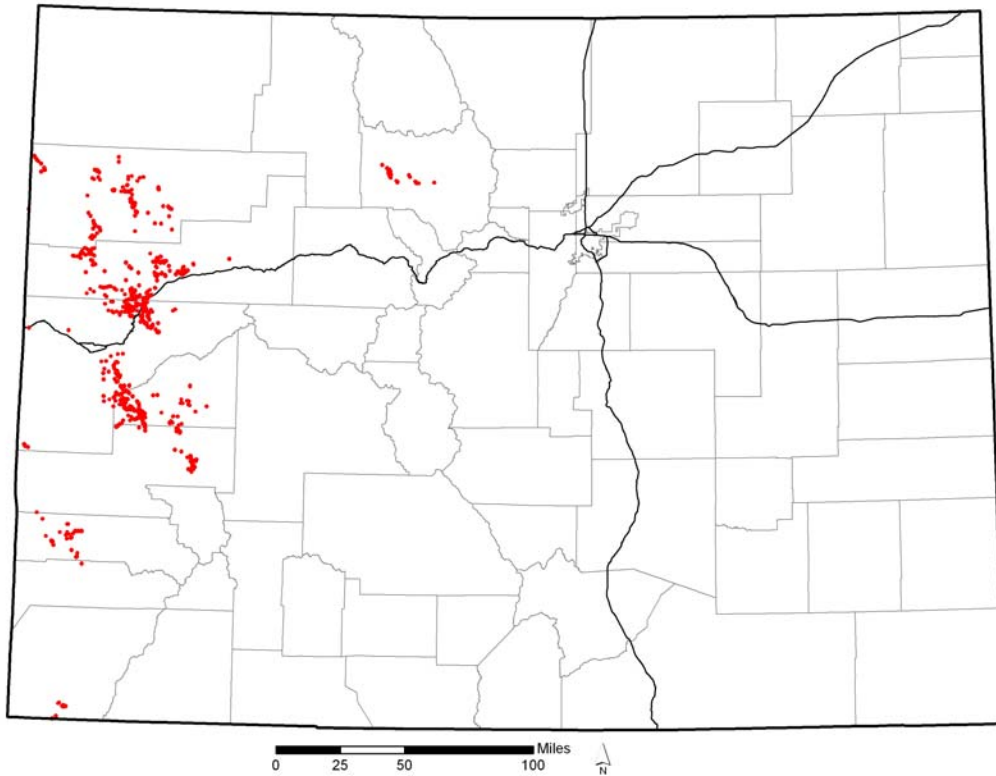


Figure 1. Occupied habitat for the seventeen plants of concern. Total occupied acreage is less than 30,000 acres (Colorado Natural Heritage Program 2008).

Recommend Survey Areas for the
Most Imperiled Plants in Oil and Gas Development Areas

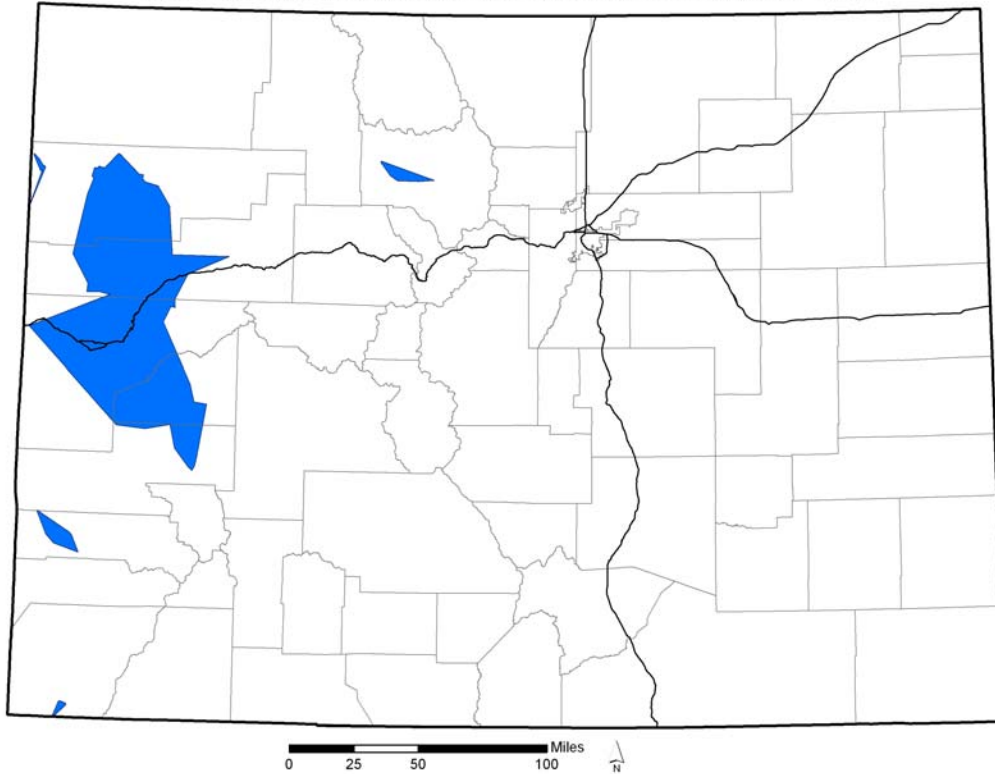


Figure 2. Areas recommended for survey for the seventeen plants of concern. These areas include the full range of the seventeen plants of concern in Colorado (Colorado Natural Heritage Program 2008).

VI. Appendix One

CDOW Recommended Actions That May Minimize Adverse Impacts to Plants of Concern. These recommended actions are taken directly or paraphrased from the CDOW Recommended Actions (CDOW 2008).

The purpose of this document is to enumerate potential actions that may avoid, minimize, and/or mitigate adverse impacts of oil and gas operations on Colorado's wildlife resources.

I. PLANNING INFRASTRUCTURE PLACEMENT AND DEVELOPMENT ACTIVITIES

1. Plan development activities at the largest scale possible (i.e. landscape level) in order to allow for phased or clustered development to avoid or minimize impacts to wildlife resources. Use unitization, operator agreements, and other agreements to improve communication, to consolidate and minimize infrastructure, and to allow for effective landscape level planning.

II. ELEMENTS OF AN IMPACT AVOIDANCE AND INIMIZATION PLAN

A. GENERAL Wildlife AND Environmental Protection Measures:

These measures are meant to educate field personnel regarding specific wildlife concerns.

1. Provide annual educational training for staff and contractors on specific wildlife issues of concern, (e.g., how to recognize lek sites, the location and importance of seasonal wildlife habitats and migratory patterns, how to locate mountain plover nests, the effects of winter range disturbance on wildlife, etc.,) and on the overall aspects of the landscape planning documents and any agreements with CDOW.

B. INFRASTRUCTURE LAYOUT WILDLIFE PROTECTION MEASURES

(including production facilities, ancillary facilities, and roads): *The purpose of these measures is to consolidate development activities and production facilities in order to minimize direct habitat loss and fragmentation, and to minimize displacement of wildlife due to audible, olfactory and visual disturbances.*

1. Avoid new surface disturbance and placing new facilities in key wildlife habitats in consultation with the Colorado Natural Areas Program (State Department of Natural Resources).
2. Phase and concentrate all development activities, so that large areas of undisturbed habitat for rare plants remain. Minimize the duration of development

and avoid repeated or chronic disturbance of developed areas. Complete all anticipated drilling within a phased, concentrated, development area during a single, uninterrupted time period.

- 3.** Develop a transportation plan to incorporate the following strategies:
 - a.** Minimize the number, length, and footprint of oil and gas development roads;
 - b.** Use existing routes where possible;
 - c.** Combine utility infrastructure (gas, electric, and water) planning with roadway planning to avoid separate utility corridors;
 - d.** Combine and share roads to minimize habitat fragmentation
 - e.** Surface roads to ensure that the anticipated volume of traffic and the weight and speed of vehicles using the road do not cause environmental damage, including generation of fugitive dust and contribution of sediment to downstream areas.
 - f.** Implement fugitive dust control measures.
 - g.** Coordinate employee transport, encourage carpooling or provide bus transport to work sites.
 - h.** Prohibit or substantially limit the amount of traffic on lease roads during important phonological periods for the plants of concern.
 - i.** Install and use locked gates or other means to prevent unauthorized vehicular travel on roads and facility rights-of-way.
 - j.** Limit parking to already disturbed areas.
- 4.** Develop and implement appropriate density caps or thresholds on wells sites, facilities and infrastructure.
- 5.** Maximize the utility of surface facilities by developing multiple wells from a single pad (directional drilling), and by co-locating multipurpose facilities (for example, well pads and compressors) to avoid unnecessary habitat fragmentation and disturbance of additional geographic areas.
- 6.** Minimize the number, size and distribution of well pads and locate pads along existing roads where possible.
- 7.** Cluster well pads in the least environmentally sensitive areas.

8. Consolidate and centralize fluid collection and distribution facilities.
9. Share/consolidate corridors for pipeline ROW's to the maximum extent possible.
10. Engineer pipelines to avoid field fitting and reduce excessive ROW widths and reclamation.
11. Adequately size infrastructure and facilities to accommodate both current and future gas production. Economize gas transportation.

C. DRILLING AND PRODUCTION OPERATIONS RARE PLANT

PROTECTION MEASURES: *The purpose of these measures is to reduce disturbance on the actual drill site and the surrounding area, to reduce direct conflict with wildlife and hunters, and to prevent wildlife access to equipment.*

1. Schedule construction, drilling, and completion activities to avoid particularly sensitive seasonal wildlife habitats in consultation with CDOW. See Appendix Two for information on important flowering and fruiting times for the plants of concern.
2. Reduce visits to well-sites through remote monitoring (i.e. SCADA) and the use of multi-function contractors.
3. Use centralized hydraulic fracturing operations.
4. Transport water through centralized pipeline systems rather than by trucking.
5. Where possible, locate pipeline systems under existing roadways, or roadways that are planned for development.
6. Maximize use of state-of-the-art drilling technology (e.g., high efficiency rigs, coiled-tubing unit rigs, closed-loop or pitless drilling, etc.) to minimize disturbance.
7. Conduct well completions with drilling operations to limit the number of rig moves and traffic.
8. Employ state-of-the-art technology to protect existing vegetation (e.g., use mats if possible to preserve topsoil/vegetative root stock).

D. INVASIVE/NON-NATIVE VEGETATION CONTROL:

The purpose of these measures is to ensure proper planning, assessment and control of weed infestations on all locations.

1. Develop an aggressive, integrated, noxious and invasive weed management plan. Utilize an adaptive management strategy that permits effective responses to monitored findings and reflects local site and geologic conditions. Use of dedicated personnel with single responsibility for weed control is often the most effective approach.
2. Map the occurrence of existing weed infestations prior to development to effectively monitor and target areas that will likely become issues after development.
3. Establish a systematic and thorough noxious and invasive monitoring program for all disturbed areas and maintain monitoring records.
4. Continue control programs for the life of the well field.
5. Use reclamation as a weed management tool. Plant competition provided by established reclamation is the most effective weed management tool. Use native plant species of local stock if possible.
6. Thoroughly clean vehicles and other equipment to remove weed seeds before moving equipment to new sites.
7. Educate employees and contractors about noxious and invasive weed issues.

E. RESTORATION, RECLAMATION AND ABANDONMENT:

The purpose of these measures is to restore disturbed sites to their pre-development conditions, using native vegetation that can be used by the indigenous wildlife. Develop a reclamation plan in consultation with CDOW, NRCS, and the land owner or land management agency that incorporates wildlife species-specific goals and that defines reclamation performance standards, including the following components:

1. Soil
 - a. Strip and segregate surface substrate prior to construction. Many rare plants are adapted to live on specific substrates that may not resemble the top soil. Appropriately configure surface substrate piles. Maintain separation between pit contents and soils.

- b.** Salvage surface substrate from all road construction and other rights-of-way and re-apply during interim and final reclamation.
- c.** Evaluate the utility of soil amendment application or consider importing topsoil to achieve effective reclamation.

2. Seed

- a.** Use only certified weed-free native seed in seed mixes,.
- b.** Test seed rigorously and frequently for purity, germination/viability, and the presence of weeds.
- c.** Use locally adapted seed whenever available, especially for species which have wide geographic ranges and much genetic variation (e.g., big sagebrush (*Artemisia tridentata*), antelope bitterbrush (*Purshia tridentata*), etc.).
- d.** Where more than one ecotype of a given species is available and potentially adapted to the site, include more than one ecotype per species in the seed mix.
- e.** Use appropriately diverse reclamation seed mixes that mirror an appropriate reference area for the site being reclaimed (see also species-specific recommendations if available).
- f.** Conduct seeding in a manner that ensures that seedbed preparation and planting techniques are targeted toward the varied needs of grasses, forbs and shrubs (e.g., seed forbs and shrubs separately from grasses, broadcast big sagebrush but drill grasses, etc.).
- g.** Emphasize bunchgrass over sod-forming grasses in seed mixes in order to facilitate forb and shrub establishment.
- h.** Seed immediately after re-contouring and spreading surface substrate. Spread surface substrate and conduct seeding during optimal periods for seed germination and establishment. Use of the same contractor for re-contouring land as used for seeding is often the most effective approach.
- i.** Do not include aggressive, non-native grasses (e.g., intermediate wheatgrass, pubescent wheatgrass, crested wheatgrass, smooth brome, etc.) in reclamation seed mixes. Site specific exceptions may be considered.
- j.** Distribute quick germinating site adapted native seed or sterile non-native seed for interim reclamation on cut and fill slopes and topsoil piles.
- k.** Plan for reclamation failure and be prepared to repeat seeding as necessary to meet vegetation cover, composition, and diversity standards.

F. MONITORING:

These measures assess the ecological condition of a disturbed area and measure the success or failure of the reclamation effort as well as measuring effects of development activities on other resources.

1. Conduct necessary reclamation and invasive plant monitoring.
2. Census and assess the utilization of the reclaimed areas by the target species.
3. Maintain pre and post development site inspection records and monitor operations for compliance.
4. Utilize GIS technologies to assess the extent of disturbance and document the reclamation progression and the footprint of disturbances.

VII. RESEARCH

These measures are suggested where questions or uncertainties exist about the degree of impact to specific resources or other aspects of oil and gas development or reclamation is unknown.

- A. Identify native species for which commercial seed sources are not available. Provide support to contractors for developing cultivation and seed production techniques for needed species.
- B. Conduct reclamation field trials to match seed mixes, soil preparation techniques, and planting methods to local conditions.

VIII. Appendix Two

Species profiles for the plants of concern that are the focus of this document.