INTEGRATED WEED MANAGEMENT PLAN

Haymeadow Open Space Dedication
Town of Eagle, Colorado

prepared for:

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&

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REVISED APRIL 2019

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1.0 INTRODUCTION

Abrika Properties, LLC is constructing a residential development on the 660-acre Haymeadow property, located in the Town of Eagle in Sections 2, 3, 4, 9, 10, and 11 of Township 5 South and Range 84 West in Eagle County, Colorado (Figures 1 & 2).

As Haymeadow is developed in phases, large tracts of open space will be dedicated to the Town of Eagle (Figure 3). Portions of this future open space dedication were previously identified as being low quality, weed-dominated habitats in the Vegetation Assessment Report prepared by Heather Houston of Birch Ecology for Western Ecological Resource in July, 2006. The March 25, 2014 Final Haymeadow PUD-ADA requires the developer to submit a plan to control the noxious and undesirable weeds and reclaim the highly disturbed habitats in the area of the open space dedication on Tract E and near a proposed trailhead. The PUD-ADA also requires a plan to minimize the use of pesticides, herbicides, and other chemicals when controlling noxious weeds throughout the development.

In accordance with these requirements, this Integrated Weed Management Plan identifies a range of biological, mechanical, cultural, and chemical methods to control the existing stands of noxious and undesirable weeds present in the restoration areas referenced in the PUD-ADA. It provides techniques that may be used to control noxious weeds in preparation for the restoration seeding, and for the future management of open space lands at Haymeadow. This report compliments the September 2018 Ecological Restoration Plan for the Haymeadow Phase I Open Space Dedication that contains the specifications for revegetating the highly disturbed habitats on Tract E with desirable native species, and detailed recommendations for weed management in the Trailhead project area.

In addition, this Integrated Weed Management Plan serves as a reference for controlling noxious weeds in the wetlands and riparian habitats at Haymeadow. The Species Profiles in Section 7.0 include detailed information on the noxious weeds known to occur in both wetland and upland environments. Please note, all Tables in this report are included with the text; Figures are in Section 4.0; and Photos are in Section 5.0. Appendix A contains the State of Colorado's Noxious Weed List.

2.0 ENVIRONMENTAL SETTING

The 660-acre, irregularly shaped Haymeadow property is located in the Brush Creek Valley. The property is bounded by Brush Creek Road to the south, by undeveloped agricultural property and the Eagle Pool & Ice Rink to the west, by U.S. Bureau of Land Management (BLM) lands to the north, and by agricultural lands on the Adam's Rib property to the east. Elevations of the Haymeadow property range from a high of approximately 6,954 feet on the ridge in the northeastern corner to a low of approximately 6,658 feet along Brush Creek Road at the southern boundary.

The Haymeadow property encompasses a broad, gently sloping valley bottom north of Brush Creek and portions of the steep south-facing gypsum hills along the northern property boundary. Brush Creek is located just south of the project site across Brush Creek Road.

Portions of the historic channel of Brush Creek are located on the Haymeadow property just north of the road, and are used to convey irrigation water.

The project site has an agricultural land use history. For more than 100 years, it has been flood irrigated and used for hay production and livestock grazing. Most of the native vegetation has been replaced by introduced agricultural grasses and forbs in hayfields dissected by an extensive network of irrigation laterals (Photo 1). The laterals are fed by four irrigation ditches, all diversions from Brush Creek. These include the Love and White Ditch, the Mathews Ditch, the Wilkinson Ditch, and the Hernage Ditch (Figure 2). Over time, changed irrigation practices, including the termination of irrigation in some areas, has resulted in the conversion of grassy hayfields to weed-dominated habitats with low vegetation cover (Photo 2). In addition, these areas have been disturbed by ground squirrels and elk grazing, which further reduced vegetation cover and contributed to topsoil erosion.

3.0 EXISTING CONDITION

3.1 Tract E Open Space Dedication

Tract E, the 32.73-acre open space parcel in the western portion of the Haymeadow property, will be dedicated to the Town of Eagle for a recreation and future school site. As described above, changed irrigation practices in this area, coupled with wildlife disturbances, have resulted in an extremely disturbed, poorly vegetated habitat that supports large areas of state-listed noxious weeds and other non-native species (Photo 2). In particular, there are dense stands of the noxious weeds Russian knapweed *(Acroptilon repens)*, musk thistle *(Carduus nutans ssp. macrolepis)* and plumeless thistle *(Carduus acanthoides)* (Photos 3 & 4). Large areas between these stands support little vegetation other than the noxious weed Russian thistle *(Salsola iberica)* (Photo 5). Other problematic weeds in this area include white top *(Cardaria draba)*, tumble mustard *(Sisybrium altissimum)*, Canada thistle *(Cirsium arvense)*, curly dock *(Rumex crispus)*, flixweed *(Descurainia sophia)*, and a small amount of burdock *(Arctium minus)* (Photo 6). Most of these plants are listed as noxious by the State of Colorado. A few grasses are sparsely represented, primarily the native Basin wildrye *(Elymus cinereus)* and the reclamation grass crested wheatgrass *(Agropyron cristatum)*, a non-native. The irrigation laterals that cross this parcel are also dominated by non-native grasses, specifically reed canarygrass *(Phalaris arundinacea)* and smooth brome *(Bromus inermis)* (Photo 7). Along the toe of the slope between the hayfield and the gypsum hills to the north, the noxious weed cheatgrass *(Bromus tectorum)* is also present, but does not cover large areas (Photo 8). There are several native shrub species that occur primarily along the toe of the slope, including Parry's rabbitbrush *(Chrysothamnus parryi)*, four-wing saltbush *(Atriplex canescens)*, winterfat *(Krascheninnikovia lanata)*, and basin big sagebrush *(Artemisia tridentata ssp. tridentata)* (Photo 9). Table 1 lists the vascular plant species observed in the disturbed, weed dominated areas of the Haymeadow project site in August 2018.

TABLE 1
Vascular Plant Species List
Haymeadow Tract E and Trailhead
Ecological Restoration Areas

Scientific Name	Common Name	Family	Origin*
Shrubs			
Artemisia tridenta var. tridentata	Big sagebrush	Asteraceae	N
Atriplex canescens	Fourwing saltbush	Chenopodiaceae	N
Chrysothamnus parryi	Parry's rabbitbrush	Asteraceae	N
Krascheninnikovia lanata	Winterfat	Chenopodiaceae	N
Perennial Graminoids			
Agropyron cristatum	Crested wheatgrass	Poaceae	I
Bromus inermis	Smooth brome	Poaceae	I
Elymus cinereus (Leymus)	Basin wild rye	Poaceae	N
Phalaris arundinacea	Reed Canarygrass	Poaceae	I
Perennial Forbs			
Acroptilon repens	Russian knapweed	Asteraceae	I+
Cardaria draba	White top	Brassicaceae	I+
Cirsium arvense	Canada thistle	Asteraceae	I+
Medicago sativa	Alfalfa	Fabaceae	I
Rumex crispus	Curly dock	Polygonaceae	I
Solidago canadensis	Canada goldenrod	Asteraceae	N
Annual/Biennial Graminoids			
Bromus tectorum	Cheatgrass	Poaceae	I+
Annual/Biennial Forbs			
Arctium minus	Common burdock	Asteraceae	I+
Carduus acanthoides	Plumeless thistle	Asteraceae	I+
Carduus nutans ssp. macrolepis	Musk thistle	Asteraceae	I+
Chorispora tenella	Purple mustard	Brassicaceae	I
Descurainia sophia	Flixweed	Brassicaceae	I
Kochia scoparia	Kochia	Chenopodiaceae	I
Melilotus albus	White sweet clover	Fabaceae	I
Melilotus officinalis	Yellow sweet clover	Fabaceae	I
Salsola australis (S. iberica)	Russian thistle	Chenopodiaceae	I
Sisymbrium altissimum	Tumble mustard	Brassicaceae	I

* Origin: N = Native; I = Introduced; I+ = Colorado State-Listed Noxious Weed

3.2 Trailhead Project Area

A second area of concern is located around an existing, unoccupied residence that will be a part of the future open space dedication to the Town of Eagle. As illustrated by the Site Plan (Figure 3), a trailhead and parking area are planned in this location. Weeds are common in the disturbed habitat around the house, as identified in the 2006 Vegetation Assessment. In the area just east of the house and driveway, the noxious weed purple mustard *(Chorispora tenella)* is common within a stand of Basin wildrye and rabbitbrush (Photo 10). Near the house, the gravel driveway supports a dense stand of kochia *(Kochia scoparia)*(Photo 11). Behind the house on the north side, there is a dense stand of flixweed *(Descurainia sophia)* (Photo 12). In moister soil near the Love & White Ditch, which is just south of the house, there are stands of Russian knapweed and white top. Both yellow and white sweet clover *(Melilotus officinalis; M. albus)* are sparsely represented along the side of the gravel driveway. Although they are not listed as noxious, these species are aggressive invaders of disturbed habitats that have the potential to become problematic at Haymeadow, and should be eradicated.

4.0 MONITORING

4.1 Monitoring Plan

The Haymeadow Open Space Tracts will be regularly monitored to identify new stands of weeds and to evaluate the effectiveness of weed control treatments. As discussed above, the GIS-based Weed Map prepared during the weed inventory will be an important tool for managing weeds at Haymeadow. This map can be updated over time to track the effectiveness of weed control treatments and identify new and ongoing priority areas.

4.2 Monitoring Review

Monitoring reports shall be peer reviewed by a third party approved by the Town or reviewed and approved by the Open Space Manager. All costs associated with the third-party peer

review shall be paid by the Developer. Prior to the acceptance of dedicated land on behalf of the town, the land shall be inspected per the success criteria provided herein. If the success criteria do not pass final inspection, a punch list will be provided so that the Developer will meet the respective criteria.

5.0 WEED MANAGEMENT OBJECTIVES

The following Weed management objectives are performance standards designed to measure the effectiveness of weed management techniques. They can be used to identify when more intensive management may be warranted. These standards will apply to Tracts OS-A, OS-B, E, and F. In addition, the level drainage bottoms and the toeslope and flat topography of Tracts OS-C and H would be included. Please note, it is not the intent of this plan to commit to controlling all of the existing weeds on the hilly topography of Tracts OS-C and H.

Weed Management Objectives for Haymeadow Open Space Tracts:

1) There are no State of Colorado List A Noxious Weeds present in the open space tracts when deeded to the Town of Eagle.

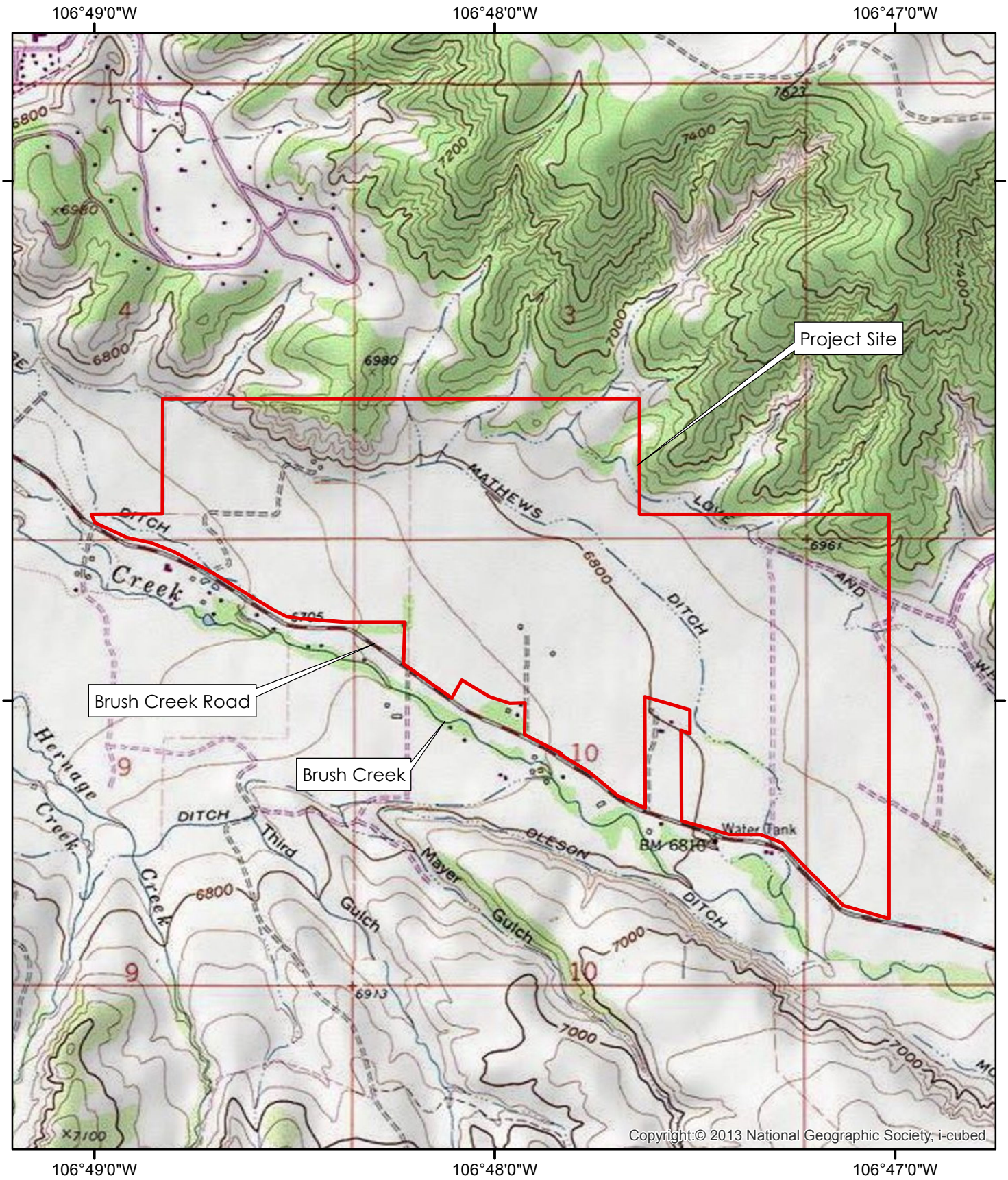
2) There are no areas greater than 100 square feet which are dominated by State of Colorado List B and List C Noxious Weeds. Quackgrass *(Elytrigia repens)* will be excluded from this requirement, since it is abundant in the wetlands and irrigated areas of Haymeadow and cannot be effectively eradicated from the area.

3) The absolute cover of noxious weeds in the open space dedications specified above is less than 5%.

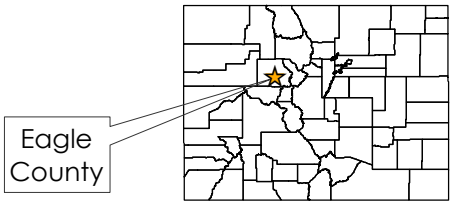
6.0 ONGOING STEWARDSHIP

Once a parcel is deeded to the Town of Eagle, and the above three criteria are met for such parcel, weed management would become the responsibility of the Town.

7.0 FIGURES



BASE: USGS 7.5' Eagle Quadrangle, Colorado



N

1:24,000

Figure 1. Project Location Map
Haymeadow

Prepared by:
Birch Ecology LLC
429 Main Street
P.O. Box 170
Lyons, CO 80540
(720) 350-2530
www. birchecology.com

106°49'0"W 106°48'0"W 106°47'0"W

39°38'0"N

Pool & Ice Rink
Tract E Restoration Area
Mathews Ditch
Trailhead Restoration Area
Hernage Ditch
Love & White Ditch
Sylvan Lake Road
Brush Creek
Wetland A
Phase I Wetland
Enhancement Area
Wilkinson Ditch
Eagle Ranch
Brush Creek Road

bing

106°49'0"W 106°48'0"W 106°47'0"W

LEGEND

Haymeadow Property

N

1:14,000
Date: September 2018

Figure 2. Aerial Photograph
Haymeadow
Eagle County, CO

Prepared by:
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Pool / Ice Rink
Connect to Existing Trails
BMX Track
Future Road Access
TRACT E
Town of Eagle Recreation and School Site
Trail alignment located to protect wetlands
Neighborhood "A1"
Future Trailhead parking and access
Neighborhood "A2"
Future road connection
Neighborhood "B"
TRAILHEAD RESTORATION AREA
Future trailhead parking and access
Trail alignment located to protect wildlife corridor
Wetlands
Fire
Landscape buffer
Neighborhood "C"
Neighborhood "D"
Brush Creek
Trailhead/ Community Park
Quail Lane
Brush Creek Road
Wildlife Corridor
Wildlife berms; Reference exhibit
Existing gravel ranch road for tank and trailhead access.
Connect to Existing Trails

LAND USE SUMMARY

Parcel	Acreage	MF Units	SF/Duplex	Total
A1	41.7	146 (64%)	82 (36%)	228
A2	46.4	86 (45%)	103 (55%)	189
B	61.0	48 (23%)	161 (77%)	209
C	47.1	64 (40%)	97 (60%)	161
D	58.6	0 (0%)	50 (100%)	50
Subtotal:	254.8	344 (41%)	493 (59%)	837

	Tract	Acreage	Use
T.O.E Recreation/ School	E	32.733	
Community Park	F	20.501	Recreation Open Space
Fire Station	G	1.675	Fire Station
Subtotal:		54.83	
Road ROW		15 Ac.	

Development Parcels	254.8 Ac.
Tracts	54.83 Ac.
ROW	15.00 Ac.
Open Space	335.37 Ac.
Total:	**660.00** Ac.

Multi-Family

Single Family / Duplex Lots

Haymeadow

PUD DEVELOPMENT PLAN DRAWING

dhm design | berglund architecture | pylman assoc. | alpine engineering

scale = 1" = 300' Revised 03.25.14

N

See Haymeadow PUD Development Plan Application Book dated 12/2013 for general descriptions, as amended by the approved Haymeadow PUD Annexation Development Agreement.

APPROVAL OF THIS PLAN CONSTITUTES A VESTED PROPERTY RIGHT PURSUANT TO SECTION 24-68-103,C.R.S., AS AMENDED

Figure 3. Haymeadow PUD Development Plan

8.0 PHOTOS

Photo 1. The irrigated portion of the Haymeadow property is dominated by introduced grasses including smooth brome. (8/27/18).

Photo 2. Areas of Tract E which are no longer irrigated are highly disturbed, have low vegetation cover, and are dominated by weeds. (8/27/18).

Photo 3. Russian knapweed and thistles grow in the foreground with green, irrigated hayfields in the background. (8/27/18).

Photo 4. Large stand of musk thistle and plumeless thistle on Tract E. (8/27/18).

Photo 5. Russian thistle covers large areas of Tract E where little else is growing. (8/27/18).

Photo 6. The noxious weed whitetop grows in a disturbed area of Tract E. This stand is in fruit. (8/27/18).

Photo 7. The irrigation laterals are lined by reed canarygrass and smooth brome. (8/27/18).

Photo 8. Stand of cheatgrass near the toe of the slope at the northern edge of Tract E. (8/27/18).

Photo 9. Rabbitbrush grows with the noxious weed Russian knapweed. (8/27/18).

Photo 10. Purple mustard is common between the bunches of Basin wildrye, a native grass. Purple mustard blooms early in the spring. (8/27/18).

Photo 11. Kochia grows in the gravel driveway near the old house. (8/27/18).

Photo 12. Flixweed forms a dense stand at the base of the hillside behind the house. (8/27/18).

9.0 STATE OF COLORADO NOXIOUS WEEDS

According to the Colorado Noxious Weed Act, a noxious weed is an alien plant or parts of an alien plant that have been designated by rule as being noxious or has been declared a noxious weed by a local advisory board, and meets one or more of the following criteria:

- Aggressively invades or is detrimental to economic crops or native plant communities;
- Is poisonous to livestock;
- Is a carrier of detrimental insects, diseases, or parasites;
- The direct or indirect effect of the presence of this plant is detrimental to the environmentally sound management of natural or agricultural ecosystems.

The Noxious Weed Act requires all Colorado residents to control noxious weeds using integrated methods to manage noxious weeds if the same are likely to be materially damaging to the land of neighboring landowners (Colorado Department of Agriculture, 2016). The list includes three categories of designated noxious weeds, known as List A, List B, and List C. In addition, the Colorado Department of Agriculture has identified a noxious weed "Watch List" of species that are not formally regulated as noxious weeds, but are under consideration for future listing. The Noxious Weed List is periodically updated to reflect changing conditions.

There are currently 25 List A noxious weeds classified by the State of Colorado. These species have been designated by the Commissioner for eradication on all County, State, Federal and Private Lands. Some of the List A species are not yet known to occur in Colorado, but their presence in neighboring states presents a significant threat such that they have been included proactively. Other List A weeds that are currently found in Colorado are considered uncommon statewide and their eradication is feasible. **None of the List A noxious weeds are known to occur at Haymeadow.**

The List B noxious weeds are species for which the Commissioner, in consultation with the state noxious weed advisory committee, local governments, and other interested parties, develops and implements state noxious weed management plans designed to stop the continued spread of these species. **There are currently 36 List B noxious weeds in Colorado; eight of these are known to occur in the open space restoration areas at Haymeadow.**

List C noxious weeds are species for which the Commissioner, in consultation with the state noxious weed advisory committee, local governments, and other interested parties, will develop and implement state noxious weed management plans designed to support the efforts of local governing bodies to facilitate more effective integrated weed management on private and public lands. The goal of such plans will not be to stop the continued spread of these species but to provide additional education, research, and biological control resources to jurisdictions that choose to require management of List C species. **There are currently 16 List C noxious weeds in Colorado. The opens space restoration areas at Haymeadow currently support four List C noxious weeds.**

Table 2 is a summary of the State of Colorado List A, B, and C noxious weeds and other problematic introduced plants known to occur at Haymeadow. In addition, Appendix A includes an illustrated list of the State of Colorado's List A, B, and C noxious weeds and the Watch List Species, as available on the Colorado Department of Agriculture's website at: https://www.colorado.gov/pacific/agconservation/noxious-weed-species#a

9.1 Integrated Weed Management Techniques

The Colorado Natural Areas Program describes Integrated Weed Management as "a process by which one selects and applies a combination of management techniques (biological, chemical, mechanical, and cultural) that, together, will control a particular weed species or infestation efficiently and effectively, with minimal adverse impacts to non-target organisms." Rather than focusing simply on the symptoms of the weed infestation, Integrated Weed Management differs from traditional weed management in that it uses an ecological approach to address the ultimate causes of weed infestation, and considers the biological and ecological characteristics of individual weeds to determine effective means of control. One important objective of Integrated Weed Management is to use a combination of techniques to reduce the need for chemical herbicides over the long-term. However, herbicides are still an important management tool and will be necessary for effective weed management at Haymeadow.

9.1.1 Cultural Control

Cultural control methods for weed management seek to limit disturbances that provide opportunities for weed invasion, while establishing and maintaining healthy communities of desirable plant species that are resistant to weed invasion. Proper grazing management can be an important component of cultural weed control. By controlling cultural conditions, weed abundance can be reduced.

9.1.2 Biological Control

Biological control utilizes deliberately introduced organisms, usually insects, to control weeds by harming them in some way and thereby suppressing their growth. Biological control can weaken undesirable weeds and reduce seed production, but does not typically result in eradication. This method has limited applicability since biocontrol agents are only available for a few species of noxious weeds, and the results have been mixed.

Biological control agents are available from the Colorado Department of Agriculture's Request-A-Bug Website: www.colorado.gov/pacific/agconservation/request-bug. Currently, biological control agents for ten species of noxious weeds are available to private landowners for free or for a small fee of $30-35, depending on the species.

9.1.3 Mechanical Control

Mechanical control methods include physically disturbing or removing weeds. Tilling, mowing, hand pulling, raking with an action hoe, and cutting with a line trimmer are all examples of mechanical control. These techniques can be used to kill plants if they are small and can be removed entirely, or mechanical control can be used in combination with other

techniques to reduce seed production and deplete the belowground reserves of perennial weeds.

9.1.4 Chemical Control

Chemical control methods utilize herbicides to kill or injure unwanted weeds. Over the years, numerous classes of herbicides have been synthesized that act upon different pathways within the plant to cause death or injury. In addition, some herbicides are available that have been derived from plants. The herbicide classes correspond to their mode of action: growth regulators, amino acid inhibitors, grass meristem destroyers, cell membrane destroyers, root and shoot inhibitors, and amino acid derivatives that interfere with plant metabolism.

Herbicides should be carefully selected based on the target weed species, the presence of desirable native species in the area to be treated, soil texture and pH, and environmental conditions, such as the proximity to open water, among other factors. Consultation with a Licensed Commercial Pesticide Applicator is recommended.

9.2 Integrated Weed Management at Haymeadow

As described above in Section 3.0, noxious weeds and other undesirable species are abundant in the Tract E open space parcel and in the future trailhead area near the old house. As per the PUD requirements established by the Town of Eagle in 2014, the noxious and undesirable weeds in these two areas will be controlled or eradicated using integrated weed management techniques, and an Ecological Restoration Plan will be implemented to establish desirable native vegetation. This document will provide a foundation for eliminating the existing weedy vegetation to prepare the site for restoration, but will also be a resource for the future management of these areas and other open spaces within Haymeadow.

The Integrated Weed Management recommendations contained in this report include chemical control as well as mechanical, cultural, and options for biological control, when available. Due to the existing conditions and levels of infestation, chemical control methods will play a larger role during the initial years of the restoration project and are a necessary tool. In the future, as weed abundance is reduced to a more manageable level and desirable vegetation is established, the need for chemical herbicides will be reduced. Mechanical control methods will be used throughout the restoration process to induce seed germination, prevent flowering, deplete the belowground reserves, and compliment chemical methods.

Section 7.0 provides recommendations based on integrated weed management techniques for 20 noxious weeds and undesirable introduced species that occur at Haymeadow. In addition to the noxious weeds identified in the Tract E restoration area and near the trailhead, profiles are included for the noxious weeds that are known to occur in the moist soil habitats in and around the wetlands, irrigation ditches, and hayfields.

10.0 WEED SUMMARIES AND RECOMMENDATIONS

TABLE 2 - INDEX
State-Listed Noxious and Troublesome Weeds
Haymeadow Ecological Restoration Areas

Scientific Name	Common Name	Colorado Noxious Weed Status	Section & Page No.
Trees			
Elaeagnus angustifolia	Russian olive	List B	10.1 Pg. 25
Perennial Grasses			
Elytrigia repens	Quackgrass	List C	10.2 Pg. 29
Perennial Forbs			
Acroptilon repens	Russian knapweed	List B	10.3 Pg. 31
Cardaria draba	White top	List B	10.4 Pg. 33
Cirsium arvense	Canada thistle	List B	10.5 Pg. 35
Lepidium latifolium	Broadleaf pepperweed	List B	10.6 Pg. 39
Rumex crispus	Curly dock	---	10.7 Pg. 41
Sonchus arvensis	Perennial sowthistle	List C	10.8 Pg. 45
Annual/Biennial Graminoids			
Bromus tectorum	Cheatgrass	List C	10.9 Pg. 47
Annual/Biennial Forbs			
Arctium minus	Common burdock	List C	10.10 Pg. 51
Carduus acanthoides	Plumeless thistle	List B	10.11 Pg. 53
Carduus nutans ssp. macrolepis	Musk thistle	List B	10.11 Pg. 53
Chorispora tenella	Purple mustard	---	10.12 Pg. 57
Cynoglossum officinale	Houndstongue	List B	10.13 Pg. 59
Descurainia sophia	Flixweed	---	10.14 Pg. 61
Kochia scoparia	Kochia	---	10.15 Pg. 63
Melilotus albus	White sweet clover	---	10.16 Pg. 67
Melilotus officinalis	Yellow sweet clover	---	10.16 Pg. 67
Salsola australis (S. iberica)	Russian thistle	---	10.17 Pg. 69
Sisymbrium altissimum	Tumble mustard	---	10.18 Pg. 71

10.1 Russian Olive *(Elaeagnus angustifolia)*

Identification and Characteristics

Russian olives are recognized by the State of Colorado as a List B noxious weed. These small trees reach up to 30 feet in height, have reddish-brown bark, and long thorns that can reach 2 inches or more in length. The leaves are 2-3 inches long, light green on the top and silvery white on the lower surface, with smooth edges and an alternate leaf arrangement. The small yellow flowers have four sepals and produce a sweet fragrance in May and June. Fruits mature from September to November and are shaped like small olives. Seeds can remain viable in the soil seed bank for three years.

Distribution

Russian olives are native to Europe and Asia. They were introduced to the western United States in the late 1800's for use as an ornamental species, and for windbreaks and erosion control. Russian olives escaped cultivation and became naturalized in Colorado during the 1950's (Columbia University IBIS, 2016). Today they are common in riparian areas, wetlands, and moist habitats across eastern Colorado at elevations below 7,500 feet (CNAP, 2000).

Ecology and Impacts

Russian olives have significant impacts on the ecology of riparian areas. They form dense stands that crowd out other native species including cottonwoods and willows, and their shade tolerance allows them to colonize the understory of established riparian habitats. They spread quickly, via seeds and suckers from their roots, and can form dense impenetrable thickets. The fruits are readily eaten by birds, who distribute seeds to new habitats. Although Russian olives are an important food source for birds, ecological studies have documented that bird diversity is higher in areas with native riparian vegetation. In fact, Russian olive trees have been called an ecological menace to riparian woodlands, because they out-compete native vegetation, interfere with natural plant succession and nutrient cycling, and choke the flow of water irrigation canals as well as native streamcourses. The displacement of native species and critical wildlife habitats has undoubtedly affected native birds and other species (Columbia University IBIS Summary Report, 2016). The heavy dense shade created by the canopy of Russian olive trees eliminates the sunlight needed by native riparian species, inhibiting their growth once the Russian olives are established, thereby influencing ecological succession. In addition, Russian olives are nitrogen fixers that alter soil chemistry. They are mildly alkaline tolerant.

Integrated Weed Management Summary

Cultural Controls:

- Replace Russian olives with native trees.
- Prevent the establishment of new trees by removing seedlings and saplings before they mature.
- Burning can kill small seedlings.

Biological Controls

- Tuburcularia canker is an unapproved biological control. It overwinters on infected stems and spreads to open wounds on the bark. Over time, the disease can deform or kill stressed plants.
- This is not known to be an effective control method.

Mechanical Controls

- Seedlings can be hand pulled, or a weed wrench may be used to pull larger saplings.
- Trees can be cut or girdled with chainsaws but will re-sprout from the root system.

Chemical Controls

- The cut-stump method is the most effective means of controlling mature Russian olive trees. This method implements both mechanical and chemical controls. Under this method, the trees are cut and herbicide is immediately applied to the freshly cut surface to kill the root system and prevent suckering.
- Foliar herbicide applications may also be used, but are less effective because they often do not kill the entire root system.

Recommended Management Actions for Russian Olives at Haymeadow

The mature Russian olive trees should be cut and hauled offsite. Care should be taken to limit the dispersal of fruits during tree removal. The cut surface of the trunk should immediately be treated with an approved herbicide, such as Roundup concentrate. Following the removal of mature trees, a consistent effort will be needed to remove seedlings and saplings that emerge from the soil seed bank. To reduce the need for chemical herbicides, hand-pulling should be completed several times during the growing season, when the soil is moist. Young trees quickly develop tap roots, so it is best to complete hand-pulling on a regular basis; 4-6 week intervals could be helpful in areas with large numbers of germinating seedlings.

All trees should be carefully checked for the presence of active bird nests prior to removal for compliance with the Migratory Bird Treaty Act. If nests are present, removal should be postponed until the young have fledged and the nest is no longer active.

10.2 Quackgrass *(Elytrigia repens)*

Identification and Characteristics

Quackgrass is a List C noxious weed in Colorado. It is a perennial, sod-forming, cool-season grass that grows up to 4 feet tall. It has flat leaf blades that are often constricted about 1-2 inches from the pointed tip. The leaves are ¼ - ½ inch wide, drooping, 4-12 inches long, and green or occasionally with a bluish waxy coating. The flowers are in spikes, with alternately arranged spikelets on opposite sides of a flattened central axis (rachis). Seed production can range from 25-40 seeds per stem, and the seeds can remain viable for 1-6 years (OMAFRA, 1993).

Distribution

Quackgrass is a native of Eurasia that is now widely distributed across the United States. It is listed as a noxious weed in ten states, including Colorado (USDA Plants, 2016). Within Colorado, it is most problematic in the southern San Luis Valley (CNAP, 2000). However, it is found across much of the state at elevations between 4,000-10,000 feet (Ackerfield, 2015). It occurs in moist mountain meadows, roadsides, pastures, riparian areas, and along ditches, in crop fields, and other disturbed areas with moist soil. Although it prefers moist sites, quackgrass is fairly drought- and salt-tolerant.

Ecology and Impacts

This highly competitive perennial grass displaces more desirable native species, and can form monocultures. It is a rapid invader that quickly dominates moist soil in disturbed areas. However, it is palatable and is considered a desirable forage plant in some arid rangelands where few other species are able to survive (Di'Tomaso, et al., 2013). It is a problem in agricultural settings where it reduces productivity of crops, rangelands, and pastures, and it invades gardens and landscapes in cool climates across much of North America (Whitson et al., 2000). It is also known to be allelopathic, secreting toxic compounds into the soil that inhibit the growth of other plant species. Quackgrass is adapted to neutral to slightly alkaline soil, is fairly drought tolerant, and can withstand high quantities of salt (OMAFRA, 1993).

Integrated Weed Management Summary

Cultural Controls:

- Minimize disturbances that create bare soil, particularly in moist areas, to limit the opportunities for quackgrass to become established.
- Promptly eradicate quackgrass as soon as it is detected to limit impacts to desirable species. Quackgrass is very difficult to eradicate where it occurs with desirable grasses.
- Fire may reduce the vigor and abundance of quackgrass.

Biological Controls

- There are no known biocontrols for quackgrass (Rutledge and McLendon, 1998 in CNAP, 2000).

Mechanical Controls

- Quackgrass is very difficult to control mechanically, due to its dense network of brittle rhizomes that break off and grow to form new plants.
- Repeated tilling can be used to deplete the belowground reserves, but timing is critical for this method to be effective.
- Small infestations that can be thoroughly dug out can be controlled by hand.
- Seedlings and young plants should be pulled before they start to spread, but they may be difficult to detect amongst other grasses.
- Mowing can reduce seed production of quackgrass, but can also stimulate bud production the following year (Rutledge and McLendon, 1998 in CNAP, 2000).

Chemical Controls

- Quackgrass is difficult to eradicate when it occurs with desirable grasses.
- The selective herbicides that would kill quackgrass would have limited use in the restoration area once desirable grasses are also being established.
- A non-selective herbicide such as Roundup can be used to eradicate quackgrass from areas where native vegetation is to be established, but will also kill any desirable vegetation that is present.

Recommended Management Actions for Quackgrass at Haymeadow

Quackgrass is naturalized in the moist soil in and adjacent to the wetlands and irrigation laterals and occurs in areas of the irrigated hayfields. No active management of these stands is recommended, due to the intensive treatments that would be required and the low probability of long-term success.

10.3 Russian Knapweed *(Acroptilon repens)*

Identification and Characteristics

Russian knapweed is List B noxious weed in Colorado. It is a deep-rooted perennial that aggressively spreads via creeping rhizomes to form dense colonies. Short, gray hairs on the stems and leaves give the plant a bluish-green color. The rosettes and lower leaves are deeply lobed; the upper leaves are narrower, sessile and are not lobed. The flowers are in urn-shaped heads and are pink to purple in color. The flower heads are solitary at the tips of the upper branches, and are subtended by several overlapping rows of smooth, papery, rounded bracts that distinguish this species from other knapweeds in Colorado. Mature plants have a bushy appearance and they can reach up to 1-3 feet in height.

Distribution

Russian knapweed is a native of Eurasia that was probably introduced to North America around 1898 (Whitson, et al., 2000), and it is now widely distributed across the western U.S. In Colorado, it is most common on the west slope but is known to occur along the Front Range urban corridor and on the eastern plains. A 2014 survey completed by the Colorado Department of Agriculture estimated there were nearly 56,000 acres infested with Russian knapweed in our state. Habitats for Russian knapweed include roadsides, ditch banks, riparian zones, pastures, rangeland, saline soils, clear cuts, and cropland. It typically invades degraded areas and sites with full sun (Colorado Department of Agriculture, 2015a).

Ecology and Impacts

Russian knapweed's aggressive creeping rhizomes and deep root system allow it to form dense colonies that crowd out more desirable vegetation. New plants can also emerge from root fragments created by tilling. Russian knapweed is known to be allelopathic; that is, it releases toxic substances into the soil that inhibit the growth of competing plants. It is toxic to horses and reduces the forage values of rangelands and pastures. It is most problematic in the semi-arid rangelands of the Great Basin and Rocky Mountains.

Integrated Weed Management Summary

Cultural Controls:

- Maintain healthy pastures and prevent overgrazing to reduce the opportunities for Russian knapweed to invade.
- Sod-forming grasses will reduce the cover of bare ground and can be an effective cultural control.
- Burning is not effective for control but can be used to remove thatch.
- Establishing dense vegetation to create shade can be helpful in reducing colonization.

Biological Controls

- The Russian Knapweed Gall Midge *(Jaapiella ivannikovi)* is available from the Colorado Department of Agriculture's Request-a-Bug program.
- This species suppresses the growth of Russian Knapweed by causing it to form galls on the stems and branches.
- This results in a smaller plant with reduced or no seed formation, but it is not an effective method for eradicating established stands.

Mechanical Controls

- Seedlings or young plants can be dug or hand-pulled but this is not effective for mature plants, since they will re-sprout from the extensive root system.
- Mowing will reduce biomass but can stimulate an increase in shoot density the following year, and should be combined with other methods.
- Root fragments will re-sprout following tillage. For tillage to be effective, it must be repeated, deep tilling to a depth of at least 1 foot, for a period 3 years or more.

Chemical Controls

- The Colorado Department of Agriculture recommends the use of Aminopyralid (Milestone) applied in the fall or early spring.
- Milestone is known to be one of the most effective herbicides for this species, however several others are also used with varying degrees of success.

Recommended Management Actions for Russian Knapweed at Haymeadow

Russian knapweed is a perennial, therefore it is important to not only prevent seed formation, but to deplete the energy reserves from the belowground portion of the plant. Mowing can be used to stress the plant, and when the plant regrows it can be treated with an herbicide such as Milestone. If project timing allows, areas of Russian knapweed can be tilled after spraying to induce seed germination and deplete the soil seed bank, but tilling must be followed by another round of herbicide treatment. After the restoration area is seeded, Russian knapweed can be pulled or spot-sprayed.

10.4 Whitetop *(Cardaria draba)*

Identification and Characteristics

Whitetop, also known as Hoary Cress, is a List B noxious weed in Colorado. It is a perennial that spreads from a creeping root system and from seeds. The newly emerged plants form rosettes with bluish-green, lance shaped leaves. Older plants have stems with alternate, clasping leaves that are lobed at the base. The flowers have four white petals that are densely arranged at the top of the plant, giving it a flat-topped appearance. The fruits are heart-shaped to roundish capsules.

Distribution

Whitetop is a native of Europe, and is now listed as a noxious weed in 15 western states. In Colorado, a 2014 survey by the Colorado Department of Agriculture found that more than 30,000 acres are infested. Whitetop occurs in fields and waste places, meadows, pastures, croplands, and roadsides. It grows particularly well on disturbed, alkaline soils and is very competitive once established.

Ecology and Impacts

Whitetop can form dense stands that crowd out desirable vegetation on moderately moist, alkaline to saline soils, often forming monotypic stands. A single plant can produce from 1,200-4,800 seeds (Colorado Department of Agriculture, 2015b).

Integrated Weed Management Summary

Cultural Controls:

- Minimize disturbance to limit the establishment of new infestations.
- Maintain healthy native plant communities to reduce opportunities for whitetop to colonize.
- Burning is not an effective method of control.

Biological Controls

- There are no biological controls for whitetop available in Colorado.

Mechanical Controls

- Mowing several times before the plants can bolt will stress whitetop and deplete the nutrient reserves from the root system.
- Mowing can be completed several times during the summer and can then be followed up with herbicide treatments.

Chemical Controls

- The Colorado Department of Agriculture reports that several herbicides are effective for whitetop, including Telar (Chlorsulfuron); Escort XP (Metsulfuron), and Plateau (Imazapic).
- Telar is known to be one of the most effective herbicides for controlling whitetop (DiTomaso et al, 2013).

Recommended Management Actions for Whitetop at Haymeadow

Whitetop is a perennial that spreads from creeping rhizomes, therefore it is important to not only prevent seed formation, but to deplete the energy reserves from the belowground portion of the plant. Mowing can be used to prevent seed formation and stress the plant, and should be followed by herbicide treatments. If project timing allows, areas of whitetop can be tilled a few weeks following spraying to induce seed germination and deplete the soil seed bank. However, tilling must be followed by another round of herbicide treatment to kill the newly emerging plants. After the restoration area is seeded, young whitetop plants can be dug out or spot-sprayed.

10.5 Canada Thistle *(Cirsium arvense)*

Identification and Characteristics

Canada thistle is a List B noxious weed in Colorado. This perennial forb has a deep and extensive root system that contributes to its invasiveness. It spreads vegetatively from horizontal roots, and from long stems that root at the nodes, and also reproduces by seed. The Colorado Weed Management Association reports that most patches spread at a rate of 3-6 feet per year through vegetative growth. The flower heads are purple or occasionally white, and ½ to ¾ inch in diameter. The stems reach 1-4 feet in height. The leaves are alternate, oblong or lance-shaped, and are divided into spiny-tipped irregular lobes. A female Canada thistle plant can produce up to 5,200 seeds in a season, but the average is about 1,500 seeds per plant (Rutledge and McLendon, 1998).

Distribution

Canada thistle is a native of Eurasia. Introduced to Canada in the late 18th century, it has become a serious pest in the United States. In Colorado, it is found statewide at elevations between 4,000-9,500 feet (Ackerfield, 2015).

Ecology and Impacts

This aggressive weed infests croplands, pastures, rangelands, disturbed roadsides, and riparian areas in Colorado. The extensive root system helps it to form monocultures that displace more desirable species. It also competes with crop species and reduces yields.

Integrated Weed Management Summary

Cultural Controls:

- Quickly eliminate new seedlings before they have the opportunity to form a well-developed root system.
- Grazing and prescribed burning have not been shown to be effective for managing Canada thistle.

Biological Controls

- There are no known effective biological control agents for Canada thistle.
- The thistle stem gall fly *(Urophora cardui)* has been reported to provide very limited control (DiTomaso et al., 2013).
- The Canada thistle stem weevil *(Ceutorhynchus litura)* is considered the most effective of the known biological control agents. It can kill plants at high enough densities but has not been shown to have a significant impact on Canada thistle (DiTomaso et. al, 2013).

- Bud weevils *(Larinus planus)* have also been used to reduce plant vigor (DiTomaso et. al, 2013).

Mechanical Controls

- Mowing or cutting can be used to suppress flower formation and seed production.
- Mowing at regular intervals can be used to deplete the nutrient reserves of established stands.
- Tilling can increase Canada thistle abundance by breaking up the root system into smaller sections that grow into new plants, and is not recommended.
- Hand pulling of mature stands is typically ineffective because the root system is not removed entirely.

Chemical Controls

- For established stands of Canada thistle, fall herbicide treatments provide the most effective control, because more of the herbicide is translocated to the root system at this time of year.
- A number of chemical herbicides have been approved for use on Canada thistle.
- One of the most commonly used herbicides for treating Canada thistle in Colorado is Milestone (Aminopyralid).
- In our experience it is the most effective herbicide for controlling this species. However, there are limitations on the amount of Milestone that can be applied to a site during each growing season.
- There are no restrictions on grazing or hay harvest following application of Milestone at labeled rates. However Milestone residue can be present in the urine and manure of animals that have grazed areas treated with Milestone for up to 3 days (Milestone Specimen Label). If moved to pastures with susceptible plants, the urine and manure can cause plant injury.

- Milestone affects many plants in the Sunflower family (Asteraceae) and Legume family (Fabaceae). It can be used to treat many types of thistles, but can also affect desirable species in these two plant families, and can impact other ornamental plants.
- For these reasons, it is important to consult with a Licensed Commercial Pesticide Applicator prior to using Milestone, and to focus on spot-spraying when possible.
- Roundup (Glyphosate) can also be used to treat Canada thistle, but follow-up treatments are necessary until the root system has been depleted of nutrient reserves. If the plant is allowed to recover between treatments, this method is not effective.

Recommended Management Actions for Canada thistle at Haymeadow

Canada thistle is a perennial that spreads from creeping rhizomes, therefore it is important to not only prevent seed formation, but to deplete the energy reserves from the belowground portion of the plant. Mowing can be used to prevent seed formation and stress the plant, however plants should not be allowed to recover between mowing treatments. Milestone herbicide is highly effective for controlling Canada thistle, particularly when applied in the fall, and can be used after mowing. If project timing allows, tilling followed by spraying can be used to deplete Canada thistle seeds from the soil seed bank.

10.6 Broadleaf Pepperweed *(Lepidium latifolium)*

Identification and Characteristics

Broadleaf pepperweed, also known as tall whitetop, is a rhizomatous perennial forb classified by the State of Colorado as a List B noxious weed. It is a tall plant that commonly reaches 1-3 feet at maturity but can be up to 5 feet tall, and is topped by dense clusters of tiny, white, four-parted flowers that appear in early summer and continue through fall. The leaves are lanceolate, bright green to grayish green, and lack hairs. The crown and lower portion of the stems are slightly woody, with wider basal leaves that are reduced in size as they ascend the stem. The roots are vigorously creeping, and can penetrate to depths of ten feet or more, although most are shallower. This species is a prolific seed producer but the seeds do not remain viable for long in the soil seed bank (Di'Tomaso et al., 2013). It does not seem to produce seedlings in field conditions, and reproduction is primarily vegetative (CNAP, 2000).

Distribution

Broadleaf pepperweed is a native of Eurasia that was introduced to the U.S. in 1900 as a contaminant in sugar beet seed (Colorado Department of Agriculture, 2016b). It now occurs in all western states, with the exception of North and South Dakota. In Colorado, it is found in disturbed areas, along ditches and roadsides, and in grasslands between 3,900-7,600 feet (Ackerfield, 2015). It is locally common in riparian areas, marshy floodplains, valley bottoms, and seasonally wet areas, and is especially prevalent in the San Luis Valley and along the South Platte River (CNAP, 2000).

Ecology and Impacts

This species is tolerant of saline soils and is commonly found in wetland areas, as well as open, unshaded riparian areas on disturbed soils. It can spread rapidly to form large, dense stands that crowd out more desirable vegetation. In particular, broadleaf pepperweed is competitive in saline soils. Over time, it can alter the ecosystem where it occurs by increasing the salinity of the soil. This occurs when the plant absorbs salts from deep in the soil, which are then excreted through the leaves. When the leaves accumulate on the soil surface, the upper soil layers become salty. Most native plants cannot tolerate these conditions and are displaced. Populations of broad leaf pepperweed can easily spread along waterways, infesting entire stream corridors (Di'Tomaso et al., 2013).

Integrated Weed Management Summary:

Cultural Controls:

- Establish desirable vegetation in disturbed areas to compete with weeds and prevent re-invasion following weed control.
- Treat new infestations as soon as they are identified. Early detection and removal are key to preventing serious problems with broadleaf pepperweed.
- Grazing by cattle, sheep, and goats can reduce the abundance of broadleaf pepperweed. In particular, the rosettes can be grazed in early spring.
- Dense stands are difficult for most species to graze, however goats seem to tolerate heavy consumption of fresh plants (Di'Tomaso et al., 2013).
- Grazing will only suppress growth, and once livestock are removed the plants will recover.

Biological Controls

- There are no approved biological control agents for broad leaf pepperweed.

Mechanical Controls

- Periodic mowing or cutting can be used to suppress plants.
- Hand pulling can be used for small stands and should be repeated regularly to remove plants that may re-sprout from the root system.

Chemical Controls

- A number of chemical herbicides are approved for use on broadleaf pepperweed.
- CNAP reports that the most effective herbicide is metsulfuron; however dicamba, glyphosate, 2,4-D, Chorsulfuron, and imazapyr are also effective.
- Larimer County recommends Escort, Pleateau/Panoramic, and Telar.
- Herbicide applications should be made in the spring at the bud to flowering stage.

Recommended Management Actions for Broad Leaf Pepperweed at Haymeadow

A combined approach of chemical and mechanical control is likely to be most effective for eliminating small stands of broadleaf pepperweed. First all stems should be pulled. Any the stems that re-sprout should be sprayed with herbicide. This will likely need to be completed several times during the growing season, and the plants should not be permitted to recover between treatments. When weed abundance is reduced to a manageable level, hand-pulling can become the primary control method.

10.7 Curly Dock *(Rumex crispus)*

Identification and Characteristics

Curly Dock is not a state-listed noxious weed, however it is an introduced plant that crowds out desirable native species in wetlands, riparian habitats, and other moist, disturbed areas. It is a coarse perennial with tall inflorescences that reach up to 2-5 feet in height, and has a deep taproot. The stems are erect and unbranched below the inflorescence, hollow, and have the jointed nodes characteristic of the Knotweed family (Polygonaceae). The leaves are primarily in a basal rosette, with ruffled or curly margins, and are 4-12 inches long. The flowers are small and occur in dense spike-like clusters at the ends of stems. The reddish brown color of the mature fruits and stems makes curly dock stand out amid the surrounding vegetation. The seeds are enclosed in papery bracts that facilitate seed dispersal by either wind or water. Curly dock is a prolific seed producer and also reproduces by re-sprouting from fragments of the taproot. Seeds of curly dock remain viable for 20 years, or perhaps as long as 50 years (Di'Tomaso et al., 2013).

Distribution

Curly dock is introduced to North America from Eurasia. It occurs primarily in wet areas. Habitats for curly dock include roadsides, ditches, wetlands, meadows, and riparian areas. In addition it is an invader of low, wet areas in pastures.

Ecology and Impacts

Curly dock is a very competitive species that can displace native plants in sensitive wetland and riparian habitats. Due to prolific seed production, it can spread rapidly in bare, moist soil. The seed is also adapted to float on water and can be spread long distances. It can accumulate soluble oxalates in the leaves that cause kidney failure in livestock, therefore curly dock is considered a poisonous plant (Larimer County Weed Management Reference Guide, 5th ed.).

Integrated Weed Management Summary

Cultural Controls:

- Limit areas of bare, moist soil to prevent establishment of curly dock.
- Grazing is not a viable control method. Since curly dock is not palatable, it increases under intensive grazing conditions.
- Burning is not an effective control method for this robust, deeply rooted perennial.

Biological Controls

- No biological control agents are available for curly dock in North America. It is a close relative of many desirable crops.

Mechanical Controls

- The deep taproot of curly dock makes it difficult to remove by pulling.
- Even small plants can quickly develop a taproot that makes pulling difficult.

- Digging must remove the entire taproot to prevent it from re-sprouting.
- Regular mowing can be used to suppress seed production, but due to the moist soil habitats where curly dock often grows, mowing may not be possible.
- Likewise, tilling is not usually an option in the wet environments that support curly dock.

Chemical Controls

- A wide variety of chemical herbicides are approved for use on curly dock including growth regulators, amino acid inhibitors, and photosynthetic inhibitors.
- Glyphosate is available in formulations for both upland (Roundup) and wetland/aquatic habitats (Rodeo), and could be used to spot spray curly dock.
- Milestone (Aminopyralild) is also reportedly effective for curly dock, and should be applied in the spring to rapidly growing plants.

Recommended Management Actions for Curly Dock at Haymeadow

Curly dock is a perennial with a deep taproot that makes pulling and digging difficult. For effective control, it is important to prevent seed formation and to kill the belowground portion of mature plants. Cutting or mowing can be used to prevent seed formation, but should be coupled with herbicide treatments to kill mature plants. The large rosettes of curly dock make it a good candidate for spot-spraying. It is best to apply herbicide during the rosette stage before the plants start to bolt.

10.8 Perennial Sow Thistle *(Sonchus arvensis)*

Identification and Characteristics

Perennial sow thistle is a List C noxious weed in Colorado. This spiny plant is a member of the Sunflower family (Asteraceae), and reaches up to 2-4 feet tall at maturity. It is semi-succulent, has hollow stems, and releases a milky latex when injured. The prickly leaves have a clasping base, are alternately arranged, and the margins vary from nearly entire to deeply toothed. The basal leaves form a large rosette, and the stem leaves are reduced in size and widely spaced. The bright yellow composite flowers are 1-2 inches across and are subtended by glad-tipped bracts. This plant reproduces by wind-dispersed seed with a bright white pappus. It has deep taproots as well as horizontal rhizome-like roots that allow it to spread and form dense stands in moist soil. These roots can spread at a rapid rate, allowing densely packed rosettes to crowd out other more desirable species. Perennial sowthistle produces a large number of seeds that can remain viable in the soil seed bank for several years, perhaps 3 years or more (McWilliams, 2004).

Distribution

A native of Eurasia, perennial sow thistle has become widely distributed in North America and is listed as a noxious weed in thirteen states (USDA Plants Database, 2016). In Colorado, it is known from Boulder, Larimer, Adams, and El Paso Counties, and eleven other counties in western Colorado, southeastern Colorado, and the San Luis Valley (USDA Plants Database, 2016).

Ecology and Impacts

Perennial sow thistle invades ditch banks, croplands, gardens, and fertile waste areas where water is available. It seems to prefer slightly saline and slightly alkaline habitats, but can be found in other soil types (McWilliams, 2004). Sow thistle forms dense stands in riparian areas and along ditch banks, crowding out more desirable species. It causes yield losses in field crops, horticultural crops, and forage (Manitoba Agriculture, Food and Rural Development Website, 2016).

Integrated Weed Management Summary

Cultural Controls:

- Minimize disturbance to limit opportunities for sow thistle to invade new habitats.
- Promptly remove young plants as soon as they are detected, before they develop established root systems that will make removal more difficult.

Biological Controls

- No biological controls are currently known.

Mechanical Controls

- Mowing and cutting can be used to prevent flowering and deplete resources from the aboveground portion of the plant, if completed on a regular basis.
- Hand pulling must be repeated regularly due to the persistence of belowground roots that can resprout to produce new plants.
- Tilling can be combined with herbicide, hand-pulling, and digging to break up the root system. Smaller fragments will have a more difficult time forming rosettes.
- Most of the areas at where sow thistle occurs are not suitable for tilling due to the wet soil.

Chemical Controls

- Several herbicides have been shown to be effective on perennial sow thistle.
- Milestone (Aminopyralid), 2,4-D + Dicamba, and other options are available.
- Roundup is also effective on perennial sow thistle.
- A Licensed Commercial Pesticide Applicator can provide specific recommendations for the ideal herbicides and rates to be utilized.

Recommended Management Actions for Perennial Sow Thistle at Haymeadow

Careful spot herbicide treatments should be used to treat perennial sow thistle that occurs in the moist soil along Dry Creek. Roundup and Milestone are good options that can be discussed with a Licensed Commercial Pesticide Applicator. In addition, hand-pulling and/or digging can be used to compliment herbicide treatments and would be most effective for preventing isolated plants from becoming established. As the abundance of weeds diminishes, hand pulling and digging can become the primary control methods, if completed on a regular basis.

10.9 Cheatgrass *(Bromus tectorum)*

Identification and Characteristics

Cheatgrass, also known as downy brome *(Bromus tectorum),* is a List C noxious weed in Colorado. It is an annual or winter annual grass covered by soft, downy hairs. The height is variable and can range between 4-24 inches. The leaves are flat, relatively narrow, usually 2-5 mm wide, and typically have long hairs near the base. The root system is shallow and fibrous, and helps cheatgrass to compete with native vegetation for water and nutrients. The infloresence is a much branched panicle with a drooping appearance that turns reddish or purplish at maturity. The seeds become brittle and readily detach from the plant. The sharp points and the barbed awns stick to animal fur and hiker's socks, aiding in seed dispersal. The seeds can remain viable in the soil seed bank for several years. Reports vary, but many studies indicate 3-5 years of viability in the seed bank.

'Distribution

Cheatgrass is native to the Mediterranean region in Europe, where it grew on the decaying straw of thatched roofs (NRCS, 2008). It was introduced to the United States in packing material, and was first found near Denver, Colorado in the late 1800's (Whitson, et al., 2000). By the 1930's, cheatgrass was becoming the dominant grass over vast areas of the Pacific Northwest; in the Intermountain West it had become the most serious rangeland weed (NRCS, 2008). Now widely distributed throughout North America, it was rapidly spread by disturbances associated with overstocking of rangelands, homesteading, and winter wheat cultivation (NRCS, 2008). In Colorado, cheatgrass is common in fields, grasslands, meadows, shrublands, forests, disturbed areas, and on dry slopes at elevations between 3,800-10,500 feet, and is found in every county (Ackerfield, 2015).

Ecology and Impacts

Cheatgrass is a weed of roadsides, cropland, hayfields, pastures, rangelands, and waste places; usually occurring on dry, sometimes weakly alkaline, clayey to loamy to sandy or gravelly soils (NRCS, 2008). Cheatgrass has developed into a severe weed in western pastureland, rangeland, and winter wheat fields. It is an aggressive invader that out-competes native grasses and forbs in sagebrush shrublands, mountain brush, and pinyon-juniper habitats, as well as grasslands. The thick layers of dried plant litter produced by cheatgrass alter the fire cycle of native habitats and increase fire frequency. Cheatgrass relies on these deep litter

layers to enhance seed germination and seedling survival by helping to retain soil moisture. This litter also inhibits the growth of desirable perennial grasses.

This species is a winter annual that germinates from seed in the fall and overwinters in a dormant state. Because it initiates growth earlier in the spring most native grasses, cheatgrass can outcompete and displace native vegetation (NRCS, 2008). The fibrous root system helps it to compete for nutrients and water. By depleting the soil moisture, it can suppress seedlings of desirable, perennial grasses (Melgoza et al., 1990 in CNAP, 2000).

Integrated Weed Management Summary

Cultural Controls:

- Maintain healthy native plant communities with cover of perennial grasses to decrease cheatgrass invasion.
- Limit disturbance and control stands early, before they become difficult to manage.
- When timed properly, livestock grazing can be used to reduce the cover of cheatgrass. CNAP reports that two grazing periods are required for at least two consecutive years. Plants should first be grazed at the stage just before the inflorescences emerge, then grazed again before panicles emerge (about 3-4 weeks later). Grazing intensity should be light enough to leave at least a 3-inch residual height to protect desirable grasses (Mosely, 1996 in CNAP, 2000). Winter grazing can reduce mulch, hindering establishment of cheatgrass seedlings (CNAP, 2000).
- Grazing is also known to stress ecosystems in a way that facilitates cheatgrass invasion, by increasing bare ground gaps between desirable perennial bunch grasses (Reisner, et al., 2013). Properly managing grazing is important for preventing cheatgrass invasion and establishment.

Biological Controls

- There are no established biological control agents for cheatgrass. Studies are being conducted to determine the effectiveness of a rhizobacterium (Di'Tomaso, et al., 2013).

Mechanical Controls

- An action hoe can be used to uproot and kill young seedlings, however when they become densely crowded and begin to develop a larger fibrous root system that mats them together, this method becomes ineffective.
- Mowing is not an effective control method, since additional short tillers and seeds will be produced close to the soil surface, maintaining the stand.
- Hand pulling is effective for smaller infestations, but will need to be repeated for years until the seeds are depleted from the soil seed bank.

Chemical Controls

- Several types of herbicides are approved for use on cheatgrass. These include both pre-emergent and post-emergence herbicides in a variety of classes.
- Pre-emergent herbicides are not compatible with restoration seedings.
- Since it is a grass, cheatgrass is more difficult to control with foliar herbicide treatments when it occurs amid desirable vegetation.
- By timing herbicide application, cheatgrass can be controlled with the non-selective herbicide glyphosate (Roundup) in the fall or early spring, when desirable native grasses are dormant.

Recommended Management Actions for Cheatgrass at Haymeadow

Cheatgrass is an annual, so preventing seed formation and depleting the soil seed bank are the keys to effective control. Since it is a winter annual, if there are large areas of cheatgrass they can be sprayed with a non-selective herbicide such as Roundup during the cooler months when desirable grasses are dormant. It is difficult to control cheatgrass once it invades stands of desirable grasses, but pre-emergent herbicides can be used to inhibit seed germination in established stands of grasses. However, pre-emergents are not compatible with restoration seedings. Fortunately, cheatgrass was not abundant in the restoration area and is mostly restricted to the toe of the slope at the northern end. Roundup may be the best option for eliminating cheatgrass in these small, concentrated areas.

10.10 Common Burdock *(Arctium minus)*

Identification and Characteristics

Common burdock is a List C noxious weed in Colorado. It is a biennial forb in the sunflower family (Asteraceae). During its first year of growth, it forms a rosette of large, heart-shaped, hairy leaves with wavy margins, and grows a deep taproot. In the second year, it grows into a highly branched, coarse plant between 3-10 feet tall. The leaves are alternately arranged, broadest at the leaf base, with toothed or wavy margins, woolly on the underside when young and green on top. The flower heads are thistle-like, purple to whitish, and are subtended by an involucre of long hooked spines. These spines form a bur when the fruit is mature, which attaches to fur, hair, feathers, and clothing, aiding in seed dispersal. Seed production can range from 6,000 - 16,000 seeds per plant (CNAP, 2000).

Distribution

A native of Eurasia, common burdock is now established throughout much of the United States. It is found across much of western Colorado and along the Front Range Corridor of the eastern slope, from Wyoming to New Mexico. It is common in the moist soil of waste places, ditch banks, pastures, and riparian areas disturbed by grazing. In Colorado it occurs at elevations between 4,500-7,500 feet (Ackerfiled, 2015).

Ecology and Impacts

Common burdock invades the moist soil of riparian habitats and displaces native species. It is intolerant of regular cultivation, because it has a two-year life cycle. Hence it is not a weed of agricultural crops. Livestock consume the leaves of burdock, and if large quantities are eaten their milk can have a bitter taste (CNAP, 2000). The burs can become entangled on sheep and decrease the quality and value of wool.

Integrated Weed Management Summary:

Cultural Controls:

- Minimize disturbance to prevent burdock from becoming established.
- Eliminate seed production and maintain healthy native plant communities.

Biological Controls

- There are no known biocontrol agents for common burdock in Colorado.

Mechanical Controls

- First year plants in the rosette stage can be killed by tilling, or they can be pulled or dug if the taproot is removed.
- Mowing or cutting can be used to prevent seed production of plants in their second year, after the bolting stage.

Chemical Controls

- Herbicides are most effective when applied to plants in their first year, during the rosette stage.
- Some of the herbicides that are effective on common burdock include 2,4-D, picloram, dicamba, and glyphosate (CNAP, 2000).

Recommended Management Actions for Burdock at Haymeadow

Burdock is sparsely present in the moist soil near the eastern part of Tract E. Since it is a biennial, preventing seed formation is an effective method for controlling this plant. Tilling or herbicide treatments can be used to kill plants in the rosette stage. Once plants have bolted, they should be mowed or cut before seeds are produced. It is important to limit dispersal of the burs. At Haymeadow, the low number of burdock plants makes digging or spot spraying a viable option.

10.11 Musk Thistle & Plumeless Thistle *(Carduus nutans ssp. macrolepis; C. acanthoides)*

Identification and Characteristics

Musk thistle and Plumeless thistle are biennial, or occasionally winter annual forbs in the sunflower family (Asteraceae). The state of Colorado recognizes both of these species as List B noxious weeds. During the first year, both species form a rosette with a fleshy taproot. In musk thistle, the rosette leaves are deeply lobed and spiny, with white margins and light colored midveins. Plumeless thistle has a smaller rosette with leaves that are wavy, with white margins edged with yellow spines. During the second year, the plants grow up to 4-5 feet tall, flower, and produce seed. Both plants have stems are covered in leaf-like, winged spines that extend down from the alternate, sessile leaves. In plumeless thistle, the wings extend up the stem to the base of the flower heads, and the leaves are hairy on the underside. The purple to deep rose-colored flower heads are subtended by an involucre composed of broad, spine-tipped bracts. Musk thistle has larger flower heads that are terminal and solitary, reaching 1½-3 inches in diameter. As they mature, the flower heads of musk thistle nod, which helps to distinguish it from its close relative plumeless thistle. The flower heads of plumeless thistle are smaller, about 1-2 inches in diameter, and can be either solitary or in clusters of 2-5. Its wind-dispersed seed is topped by a white pappus (similar to a dandelion) that helps it colonize new areas. Plumeless thistle is a prolific seed producer – a mature plant can produce up to 9,000 seeds (Fact Sheet). Viability in the soil seed bank is 10 years or more (CNAP, 2000).

Distribution

Musk thistle is native to southern Europe and western Asia (Whitson et al., 2000). It was introduced to the United States in the early part of the century and is now found in nearly every state. In Colorado, it invades disturbed, overgrazed habitats, riparian areas, roadsides, ditches, pastures, and other moist, disturbed habitats at elevations between 3,500-8,500 feet (Ackerfield, 2015). Ackerfield reports that musk thistle is a recent introduction to Colorado, but that it is now widely distributed on both the east and west slopes. A survey conducted by the Colorado Department of Agriculture in 2009 estimated that more than 46,491 acres were infested with musk thistle.

Plumeless thistle is native of Eurasia (Whitson et al., 2000). It listed as a noxious weed in 14 states (USDA Plants Database). Plumeless thistle was first documented in Colorado in 1957 from a collection in Jefferson County, and is now known to occur in Eagle, Douglas, Jefferson, and

Pitkin Counties (Ackerfield, 2015). It is found in disturbed places, open fields and along roadsides at elevations between 6,900-8,300 feet (Ackerfield, 2015).

Ecology and Impacts

Musk thistle is an extremely competitive species that invades disturbed areas, pastures, rangelands, forests, croplands, and waste areas throughout most of the United States (CNAP, 2000). It spreads rapidly to form extremely dense stands, which crowd out more desirable native species and forage plants (Whitson et al., 2000). It invades moist areas of pastures, but is unpalatable to livestock (CNAP, 2000). As a result, once a pasture becomes infested with musk thistle, the livestock carrying capacity is significantly decreased (Colorado Department of Agriculture, 2008).

Plumeless thistle is one of the most aggressive thistle species due to its high seed production (Colorado Department of Agriculture, 2015c). It outcompetes native species and most forage crops. It has been known to invade both native and restored grasslands, and is highly aggressive in disturbed areas (CNAP, 2000). It is unpalatable to livestock and can reduce the forage value of rangelands where it grows densely.

Integrated Weed Management Summary

Cultural Controls:

- Control livestock stocking rates to prevent overgrazing, and minimize disturbance to limit opportunities for musk thistle and plumeless thistle to become established.
- Maintain a healthy cover of native perennial species to resist colonization.

Biological Controls

- The crown weevil *(Trichosirocalus horridus)* is available from the Colorado Department of Agriculture's Request-a-Bug program for musk thistle control, and is reportedly also effective for plumeless thistle (Fact Sheet).
- There are drawbacks to its use since the weevil will attack other native thistle species, including some rare species (Louda et al., 1997 in CNAP, 2000).

Mechanical Controls

- Limiting seed production is important for controlling musk thistle and plumeless thistle. Cutting or mowing can be used to prevent seed production of second-year plants.
- Rosettes can be dug, but care must be taken to remove the entire crown and as much of the taproot as possible to limit the potential for re-sprouting.

- The seeds can still mature and become viable after the plants are cut, so it is important to cut the plants to the ground just before flowering.
- Repeated cutting treatments completed over the course of several years can be used to eliminate a plumeless thistle or musk thistle infestation.

Chemical Controls

- Herbicides are most often used to control these thistles, and are most effective when the plant is in the rosette stage (CNAP, 2000).
- A number of herbicides are known to be effective, and should be applied before the plant has bolted.
- Aminopyralid (Milestone) and glyphosate (Roundup) are among several herbicides known to be effective on musk thistle and can be applied to rosettes in spring or fall.

Recommended Management Actions for Plumeless & Musk Thistle at Haymeadow

Both plumeless and musk thistle are biennials, and they can be mowed during the second year to prevent flowering. However this will not kill the first year plants, so a secondary treatment will be needed; either mowing the next year after they have started to bolt, or follow up herbicide treatments. It is likely that there is a significant seed bank of both plants at Haymeadow. Therefore, several rounds of tilling and spraying should be used to deplete the soil seed bank. After the restoration seeding is complete, cutting the second year plants and/or spot spraying the rosettes should be used to control musk thistle. The large rosettes will facilitate spot spraying.

10.12 Purple Mustard *(Chorispora tenella)*

Identification and Characteristics

Purple mustard, also known as blue mustard or crossflower, was formerly on the State of Colorado's noxious weed list, but has since been removed. It is a noxious weed in California. This winter annual is in the Mustard family (Brassicaceae). It is a short, branched plant that reaches heights of 6-18 inches. It is covered by gland-tipped hairs that give it a rough surface on the leaves and stems. The leaves are alternately arranged on the stem, oblanceolate shaped, with wavy or coarsely toothed margins. The light purple flowers have four petals that are arranged in the shape of a cross, a characteristic of the Mustard family. As an annual, it has a shallow taproot and is easily hand-pulled. Seeds are produced in elongate, beaked pods that split open to disperse the seed.

Distribution

Purple mustard was introduced to the United States from Siberia in 1929 (Klein et al., 1985 in CNAP, 2000). Since that time, it has spread to become a problematic weed in agricultural crop fields, disturbed sites, roadsides, and waste areas. It can tolerate a wide range of environmental conditions and soil types (CNAP, 2000), which contributes to its invasiveness. It is found throughout the western and midwestern United States (USDA Plants, 2016). In Colorado, purple mustard is commonly found on open slopes, along roadsides, in fields and vacant lots, and in other disturbed areas at elevations between 4,000-9,500 feet (Ackerfield, 2015). In years with adequate rainfall, purple mustard can be abundant on the shale badlands in western Colorado (CNAP, 2000).

Ecology and Impacts

Purple mustard invades croplands, lawns, and disturbed waste areas. If grazed, it can give milk a disagreeable flavor. It reduces crop yields and affects crop quality. In western Colorado, it is problematic in areas disturbed by energy development.

Integrated Weed Management Summary

Cultural Controls:

- Crop rotations can be altered to control purple mustard in agricultural fields.
- Maintain a healthy lawn to prevent purple mustard establishment.
- Promptly remove new stands to prevent seed production and dispersal

Biological Controls

- There are no known biological controls for purple mustard.

Mechanical Controls

- This annual weed is easily hand pulled. Pulling should be completed before the fruits ripen to limit seed dispersal. Plants with fruits should be bagged and disposed of offsite.
- Tillage can be used to kill young plants prior to flowering, and to induce seed germination.

Chemical Controls

- A variety of herbicides reportedly provide effective control for purple mustard (CNAP, 2000).
- It is important that herbicides be applied early enough to prevent seed set, and this species flowers in the spring.
- The Larimer County Weed District reports that Escort, Matrix, Plateau, and Telar all provide excellent control of mustards, including purple mustard.
- It is also susceptible to glyphosate (Roundup).

Recommended Management Actions for Purple Mustard at Haymeadow

Purple mustard is an annual, so preventing seed formation and depleting the soil seed bank are the keys to effective control. Since the purple mustard in the Trailhead project area at Haymeadow is in a stand of the native grass Basin wildrye, spraying will likely be the preferred means of control. Purple mustard emerges early in the spring, so herbicide treatments should be scheduled in advance to be sure it is treated before it can set seed. Use of a selective herbicide will allow purple mustard control without killing the native grass. If purple mustard appears in other areas, repeated tillage could be used. Individual plants that appear in the restoration area can be easily hand-pulled before they develop fruits. Plants with flowers or fruits should be bagged and hauled offsite.

10.13 Houndstongue *(Cynoglossum officinale)*

Identification and Characteristics

Houndstongue is a List B noxious weed in Colorado. It is a biennial or short-lived perennial forb in the Borage Family (Boraginaceae). During its first year of growth, it produces a rosette of hairy, rough-textured leaves with impressed veins which are oblong to lance shaped. During the second year, the plants bolt and reach a height of 1-4 feet. The leaves are alternately arranged on the stem, 1-3 inches wide and 1-12 inches long, with entire margins. The five-parted flowers are reddish purple to blue and change color as they mature. The fruits of houndstonge are distinctive. Each flower forms four nutlets with a rough barbed surface that functions like Velcro to fasten the fruits to fur, hair, and clothing, aiding in seed dispersal. Mature plants can produce up to 2,000 seeds; the seeds remaining on the dried stems of the parent plant may remain viable for 2-3 years, whereas viability in the soil is rarely longer than one year (Butterfield et al., in CNAP, 2000). A few of the nutlets drop from the plant, but most remain attached to the dead parent plant for many months or even years, until they are picked up by a passing animal (Di'Tomaso et al., 2013).The plants have a thick, dark, woody taproot that can reach up to 3-4 feet deep (Colorado Department of Agriculture, 2018).

Distribution

Houndstongue is a native of Europe that is now found across much of North America. It was accidentally introduced to North America in the late 1800s as a seed contaminant in cereal grain (Di'Tomaso et al, 2013). Houndstongue is listed as a noxious weed in six states, including Colorado (USDA Plants Database, 2016). In 2013, a survey conducted by the Colorado Department of Agriculture estimated that more than 73,608 acres were infested by houndstongue in the state (CDA Website, 2018). Houndstongue occurs in open to shady, disturbed areas with moist soil along trails and roadsides, in fields, pastures, and rangelands, forests, sand dunes and ditch banks. It prefers moist areas, but often grows on sandy or gravelly alkaline soil up to 9,000 feet elevation (CDA, 2008). Areas with more than 10% bare ground are particularly vulnerable to being invaded by houndstongue (CDA, 2008).

Ecology and Impacts

Houndstongue is toxic and can kill livestock. It contains pyrrolizidine alkaloids, which cause liver cells to stop reproducing (Whitson et al., 2000). Ranges and pastures can be severely degraded by the establishment of houndstongue, since it displaces more desirable forage.

Integrated Weed Management Summary

Cultural Controls:

- Limit disturbance to reduce opportunities for houndstongue to become established.
- Prevent overgrazing that creates bare ground and maintain healthy pastures.

Biological Controls

- A root-mining flea beetle *(Longitarsus quadriguttatus)* and the houndstongue root-mining weevil *(Mogulones cruciger)* have been tested as biological control agents for houndstongue (Di'Tomaso et al., 2013).
- The root-mining weevil has shown some success in Canada but is not approved for release in the U.S. (Di'Tomaso et al., 2013).

Mechanical Controls

- Digging, pulling, and cutting can be effective if the root crown is severed.
- Rosettes should be cut below the crown in fall or early spring.
- Regular cultivation can be used to kill young rosettes in their first year.
- Second-year plants can be cut close to the soil surface to limit flowering and seed production.
- Mechanical control must be completed frequently to have any effect and is only feasible for small infestations (Di'Tomaso et al., 2013).

Chemical Controls

- Many classes of herbicides have shown to be effective for treating infestations of houndstongue. Herbicides should be applied in the rosette stage.
- The Larimer County Weed District reports that the most effective herbicides for controlling houndstongue are Dicamba, Escort, Telar, 2,4-D, Plateau, and Tordon.
- Glyphosate (Roundup) has also been shown to be effective and does not have any residual soil activity.

Recommended Management Actions for Houndstongue at Haymeadow

Individual houndstongue rosettes should be dug out, and any second-year plants should be cut to prevent seed formation. If digging is not a feasible option, then isolated houndstongue plants should be carefully spot-sprayed with herbicide. If the plants are in flower, they should be immediately cut to prevent seed formation.

10.14 Flixweed *(Descurainia sophia)*

Identification and Characteristics

Flixweed was formerly listed as a noxious weed in Colorado, but it is not on the current list. It is a winter annual forb in the Mustard family (Brassicaceae) that grows 8-24 inches tall. The fern-like leaves are 2-3 times pinnately compound, with narrow to linear segments. The small, yellow to greenish flowers have four petals and are arranged in long racemes at the top of the plant. The fruits are elongate slender pods that are oriented upward at the top of the plant. It produces abundant seed, and large plants are estimated to produce as many as 700,000 seeds (Rutledge and McLendon, 1998), with seeds that can remain viable for up to 3 years. Flixweed has only a slender taproot that allows it to be pulled easily.

Distribution

A native of Europe, flixweed is now common throughout North America. It inhabits waste places, fields, overgrazed areas in pastures, roadsides, and other disturbed areas. Although it grows in a variety of soil types, flixweed is most abundant on dry, disturbed sites (CNAP, 2000). It is often found along roadsides and ditches where mineral soil has been exposed by excavation, and often occurs with field pennycress (Howard, 2003). In Colorado, it occurs statewide in disturbed areas, fields, grasslands, and shrublands at elevations between 3,500-10,000 feet (Ackerfield, 2015).

Ecology and Impacts

Flixweed is a problematic species in croplands, where it can crowd out agricultural species and compete for resources, reducing yields. In particular, it is a problem in alfalfa fields in Colorado (CNAP, 2000). It is a rapid colonizer that invades native plant communities from the disturbed areas where it first establishes. It can form dense stands in restoration areas that have not yet developed the desired plant cover.

Integrated Weed Management Summary

Cultural Controls:

- Limit areas of exposed soil to reduce opportunities for flixweed to become established.

Biological Controls

- There are no known biological controls for flixweed.

Mechanical Controls

- Flixweed is shallow-rooted and is easily removed by hand-pulling.
- An action hoe can be used to kill young plants.
- Mustards with fruits on them, even if they are not yet mature, should be bagged and hauled offsite since they can continue to ripen and disperse seed after they are pulled.
- Tilling can be used to induce seed germination and deplete the soil seed bank.

Chemical Controls

- A variety of herbicides reportedly provide effective control for flixweed (CNAP, 2000).
- It is important that flixweed be sprayed early enough to prevent seed set. There is no value in spraying plants that are already setting seed, since this is an annual weed that will die after flowering.
- The Larimer County Weed District reports that Escort, Matrix, Plateau, and Telar all provide excellent control of mustards.

Recommended Management Actions for Flixweed at Haymeadow

Flixweed is an annual, so preventing seed formation and depleting the soil seed bank are the keys to effective control. Most of the flixweed observed in the restoration areas at Haymeadow is growing in a dense stand behind the house in the Trailhead project area. This area will likely not be tilled or graded until the trailhead is constructed. Therefore a springtime herbicide treatment should be scheduled for this dense stand to be sure the plants are not allowed to flower or set seed. Individual flixweed plants can be easily hand-pulled before they set seed. Plants with fruits should be bagged and hauled offsite, even if they are not mature.

10.15 Kochia *(Kochia scoparia)*

Identification and Characteristics

Kochia was formerly a noxious weed in Colorado, but has been removed from the list. Its removal is not indicative of a reduction in kochia's abundance – rather it is the opposite. This species is a serious weed across much of the western U.S. and it is listed as noxious in three states.

Kochia is an annual forb with a variable growth habit. It germinates in the early spring and begins to form small, rounded rosettes of soft, hairy, ovate to lance-shaped leaves with a grayish-green appearance. As the plants mature, the can develop a highly branched bushy form, reaching 1-6 feet tall. The stem leaves are alternately arranged, lance shaped, ½-2 inches long, with smooth margins, and white hairs on the underside. The taproot of mature plants can penetrate to depths of 6-8 feet (CNAP, 2000). The greenish, inconspicuous flowers are borne in the axils of upper leaves and form short, dense spikes with numerous long, narrow green bracts. Seedlings that germinate later in the growing season will not attain the tall, bushy growth form but can flower and produce seed as small plants less than six inches high. In addition, in saline conditions, kochia exhibits a stunted growth form. A single kochia plant will typically produce more than 14,500 seeds per year (CNAP, 2000). They reportedly have little longevity in the soil seed bank.

Distribution

Kochia is a native of Asia, and was introduced to North America from Europe. It was planted as an ornamental and escaped cultivation to become a troublesome weed in North America (Whitson et al., 2000). It is very common in cultivated fields, gardens, roadsides, ditch banks, and waste areas throughout the west (Whitson et al., 2000). It is tolerant of both alkaline and saline soil. Kocha is widely distributed in Colorado, and is common in disturbed places and along roadsides, often on alkaline soil, at elevations between 3,400-9,700 feet (Ackerfield, 2015).

Ecology and Impacts

Kochia is a colonizing species of disturbed areas and it is an aggressive competitor. It can dominate sites following disturbance and can spread into adjacent undisturbed habitats under certain conditions. For example, shortgrass prairie habitats are susceptible to kochia due to the low stature of grasses that provide an ideal environment for kochia rosettes to establish. Kochia forms tumbleweeds when dry that blow across rangelands and prairies, distributing seeds. In several towns in southern Colorado, kochia tumbleweeds have piled up and blocked rural roads, irrigation canals, homes, and an elementary school, with costly removal expenses for municipalities in recent years (Banda, 2014).

Integrated Weed Management Summary

Cultural Controls:

- Limit exposed bare soils where kochia can colonize.
- Eliminate small plants in the rosette stage to 4-6 inches high, while treatment is manageable and prior to flowering and seed formation.
- Grazing is not an effective control method for kochia since it will not prevent seed production.

Biological Controls

- There are no known biological controls for kochia available in the U.S.

Mechanical Controls

- Kochia can be mowed or cut to reduce the amount of seed formation, but this is not an effective method for eradicating kochia. It will flower and produce seeds within an inch or two of the soil surface after mowing, perpetuating the stand.
- Mowing should be used as a last resort as a part of integrated weed management, when necessary, if it is too late in the growing season for herbicide to prevent seed formation.

Chemical Controls

- Kochia is best controlled with herbicide when it is between 2-6 inches tall, although applications at other times can be effective.
- Foliar herbicide treatments should only be used to prevent flowering, since kochia is an annual.
- Pre-emergent herbicides can be used to kill germinating kochia seeds, but can interfere with the establishment of desirable vegetation in areas that have been seeded.
- Many herbicides are labeled for use on kochia, however there are known problems with herbicide resistance. It is best to consult with a Licensed Commercial Pesticide Applicator.
- Glyphosate (Roundup) is effective, and is best used on young plants that can be more easily spot-sprayed.
- Vista and Hardball are two other herbicides that are effective, and can be used in combination to kill kochia.

Recommended Management Actions for Kochia at Haymeadow

Kochia is an annual, so preventing seed formation and depleting the soil seed bank are the keys to effective control. Most of the kochia in the restoration areas is located in the Trailhead Project Area in the gravel driveway near the existing house. This area could be sprayed with a non-selective herbicide such as Roundup, or a selective herbicide. If kochia invades the restoration area, individual plants can be pulled or cut off at the soil surface, since they will not resprout. However cutting must be right at the soil surface to prevent seed formation. Mowing is not effective for eliminating kochia since many seeds will be produced along the lower branches within a few inches of the ground. Dense areas of seedlings could be killed by tilling or an action hoe.

10.16 Yellow and White Sweet Clover *(Melilotus officinalis; M. albus)*

Identification and Characteristics

Yellow and white sweet clover are not listed as a noxious weeds in Colorado or elsewhere in the U.S., but they are aggressive, non-native competitors that can become invasive. Sweet clover is an herbaceous biennial, or sometimes winter annual, in the Pea Family (Fabaceae). The plants form rosettes in their first year, then develop a widely branched, bushy habit and reach 2-6 feet tall in their second year. They have a strong taproot that can make large plants difficult to pull. The leaves are alternately arranged and have a similar appearance to alfalfa. They are three-parted, oval shaped, and with slightly serrated margins that extend along most of the leaf edge. The stems are topped by spikes of densely crowed, bright yellow or white flowers that produce a sweet fragrance. Yellow sweetclover can produce a significant soil seed bank with seed viability of up to 30 years (Minnesota DNR, 2016).

Distribution

Yellow sweet clover was introduced to North America from Europe in the late 1600's (Minnesota DNR, 2016). In some parts of the country, it is still used as a forage crop and to increase soil nitrogen, as a wildlife cover crop, and for the production of honey. It grows abundantly in disturbed areas, roadsides and abandoned fields, and pastures; in Colorado it is found throughout the state, at elevations between 3,500-9,000 feet (Ackerfield, 2015).

Ecology and Impacts

Sweet clover invades and degrades native grasslands by overtopping and shading native sun-loving plants thereby reducing diversity (Minnesota DNR, 2016). However, it is considered economically important for its use as forage and in honey production, and continues to be cultivated. If it becomes moldy, however, the hay can be toxic.

Integrated Weed Management Summary

Cultural Controls:

- Limit disturbances and opportunities for sweet clover to become established.
- Do not use it in reclamation or pasture seedings, as it can escape cultivation and become a serious weed.
- Prescribed burning can be an effective control method, but should be completed two years in a row, since additional sweet clover seeds will germinate following the first burn (Missouri Dept. of Conservation, 2016).

Biological Controls

- There are no known effective biological controls for sweet clover.

Mechanical Controls

- First-year plants and smaller second-year plants can be pulled or dug when the soil is moist.
- Mowing to a low height can be effective in preventing flowering, but mop-up work should be completed after the initial mowing since some plants will still flower.

Chemical Controls

- The Larimer County Weed District recommends a tank mix of Milestone + 2,4-D, or Milestone + Escort (brand name - Opensight) for sweet clover control.

Recommended Management Actions for Sweet Clover at Haymeadow

Yellow and white sweet clover are biennials, and only a few plants were observed near the gravel driveway and house in the Trailhead Project Area. These plants were in flower, so there will likely be new rosettes in the area next year. The rosettes can be spot sprayed. Due to the taproot, it is difficult to dig out the plants as they mature, but young ones can be dug. If mowing is used, follow-up treatments will be necessary since the plants will re-sprout. Yellow sweet clover is abundant in other moist soil habitats around the ditches and hayfields. These areas will likely require treatment with a selective herbicide such as Milestone.

10.17 Russian thistle *(Salsola iberica)*

Identification and Characteristics

Russian thistle is a highly problematic weed in Colorado that has been removed from the State noxious weed list. It is a bushy, spiny summer annual that grows up to three feet tall. The seedlings have long, narrow, semi-succulent leaves. Mature plants are characterized by stiff, upward curving branches with reduced, scale-like leaves that are tipped by a stiff spine. They stems are typically striped with red or purple. The inconspicuous flowers are formed in the axils of the upper leaves. The mature plants break off at ground level to form tumbleweeds that scatter seeds.

Distribution

Russian thistle was introduced from Russia in the late 1800's, and it has become one of the most troublesome weeds in the drier regions of North America (Whitson, et al., 2000). It is found in disturbed waste areas, overgrazed rangelands, along roadsides, and fields. It can tolerate both arid and alkaline soils, but is also found in irrigated croplands. It is widely distributed across Colorado at elevations between 3,500-9,000 feet (Ackerfield, 2015).

Ecology and Impacts

Russian thistle is a colonizer of barren areas that support little other vegetation. When mature, the plants break off at ground level to form tumbleweeds that can accumulate along fence rows and structures, creating a fire hazard. Russian thistle is associated with livestock poisonings. Specifically, it can accumulate toxic levels of nitrites and oxalates, which can be harmful to cattle and sheep. Nitrites can cause acute respiratory difficulty in and sudden death, and oxalates are a cause of kidney failure (CSU Extension Fact Sheet No. 6.314).

Integrated Weed Management Summary

Cultural Controls:

- Maintain a healthy cover of desirable plants to reduce opportunities for colonization.
- Remove and dispose of tumbleweeds.
- Limit traffic through infested areas to reduce seed dispersal.

Biological Controls

- Several biological control agents have been tested for Russian thistle, including the leaf mining moth and the stem-boring moth *(Coleophora klimeschiella; C. parthenica)*. Their effectiveness has been poor.
- Currently there are no approved biological control agents for Russian thistle available in Colorado.

Mechanical Controls

- Young seedlings can be easily killed by tilling.
- Hand pulling is effective for small infestations.
- Mowing can reduce the growth of Russian thistle but must be properly timed, ideally when the plant is just beginning to bloom. Mowing will need to be repeated for several years in order to be effective.

Chemical Controls

- The Colorado State University Extension reports that 2,4-D, dicamba, and glyphosate are all effective against Russian thistle.
- 2,4-D and dicamba are selective herbicides that can be used when desirable grasses are present; however glyphosate is non-selective and it can injure or kill most vegetation.

Recommended Management Actions for Russian Thistle at Haymeadow

Russian thistle is an annual, so effective control will be achieved by preventing seed formation and depleting the soil seed bank. The areas of Tract E that are dominated by Russian thistle have little other vegetation, and could be tilled several times to induce seed germination and to kill young plants. Once the restoration seeding is in place, individual plants can be hand-pulled or spot sprayed.

10.18 Tumble mustard *(Sisymbrium altissimum)*

Identification and Characteristics

Tumble mustard is an annual or biennial forb that grows between 2-4 feet tall. The lower leaves are divided into broad, pinnate lobes and the upper leaves are more finely divided with narrow lobes, on the much-branched upper part of the stem. The yellow flowers have four petals and are followed by elongate fruits between 2-4 inches long. The dried stems of tumble mustard break off at ground level, dispersing seed as they blow in the wind.

Distribution

Tumble mustard is a native of Europe, and is now widely distributed across the western US. It grows in fields, rangelands, disturbed habitats and along roadsides. It is found throughout Colorado at elevations between 3,500 – 9,000 feet (Ackerfield, 2015).

Ecology and Impacts

Tumble mustard is an annual that reproduces from seed distributed by tumbleweeds. A prolific seed producer, a single tumble mustard plant can produce up to 1.5 million seeds. This allows tumble mustard to form dense stands. In restoration areas, it can quickly form a tall canopy that inhibits the growth and germination of the desired native species. It forms a persistent seed bank that can be viable for 40 years or more (High Plains Integrated Pest Management).

Integrated Weed Management Summary

Cultural Controls:

- Limit disturbance to reduce opportunities for weed invasion.
- Grazing can be helpful if it is timed to prevent seed production. Sheep are preferred, since they will graze lower on the plant. Meat and milk can become tainted when cows consume large quantities.
- Burning can be effective but should be completed before seed production; however burning is not typically recommended because the fuel needed to carry a fire and to burn hot enough to kill mustard seeds would typically be present after seed production.

Biological Controls

- There are no biological controls for tumble mustard available in Colorado.

Mechanical Controls

- Hand pulling is effective but is best applied to small populations.
- An action hoe is effective for young rosettes.
- Mowing can be used to prevent seed production and slowly deplete the seed bank.
- Cultivating can be used to kill plants before they produce seed.

Chemical Controls

- Numerous herbicides are available to control mustards.
- The Larimer County Weed Control District reports that Escort, Matrix, Plateau, and Telar provide excellent control of mustards.

Recommended Management Actions for Tumble Mustard at Haymeadow

Tumble mustard is an annual or biennial. Controlling seed production and eliminating the soil seed bank are the keys to effective control. Tumble mustard is present in Tract E in areas that will be tilled in preparation for the restoration seeding. Several rounds of tilling should be used to kill the young plants and deplete the soil seed bank. However, since it emerges fairly early in the spring, the soil will likely be too moist for tilling the first flush of plants. An early-season herbicide treatment focusing on mustards should be completed in early- to mid-April. Successive rounds of tilling can be completed in Tract E during the summer months. Individual plants can be hand-pulled from the restoration area after it is seeded, or spot sprayed with herbicide.

11.0 NOTES ON CHEMICAL WEED CONTROL

A Licensed Commercial Pesticide Applicator should provide specifications for the tank mixes and rates to be used during chemical weed control at Haymeadow. The comments regarding herbicides provided in this document are based on personal observations or recommendations included in the sources cited in Section 8.0.

Herbicides with residual soil activity should be used sparingly. and pre-emergents should not be used since they will interfere with the restoration seeding. Pre-emergent herbicides that kill germinating seedlings can persist in the soil and may conflict with restoration activities by killing the desirable native seed. Therefore the use of pre-emergent herbicides at Haymeadow is not recommended unless they become necessary to control species such as cheatgrass, once the restoration seeding is well-established following several growing seasons.

12.0 SUMMARY

This Integrated Weed Management Plan is structured to provide a background in the biology and ecology of weeds which can be used to inform weed management at Haymeadow during the ecological restoration project and for many years to come.

Prior to the restoration seeding, a dedicated effort will be required to eradicate the existing stands of noxious and undesirable weeds and deplete the soil seed bank. Due to the current conditions and levels of infestation, chemical control will play a larger role during the initial years of the restoration project and is a necessary tool. In the future, as weed abundance is reduced to a more manageable level and desirable vegetation is established, the need for chemical herbicides will be reduced, and mechanical and cultural controls can be the primary weed control methods. Biological controls can be explored and may also play a role. However biological controls are primarily used to suppress, rather than eradicate weeds, and would likely be a small component of a larger Integrated Weed Management program.

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APPENDIX A. STATE OF COLORADO NOXIOUS WEED LIST

COLORADO DEPARTMENT OF AGRICULTURE
NOXIOUS WEED LIST

List A species
List A species in Colorado that are designated by the Commissioner for eradication.

List B species
List B weed species are species for which the Commissioner, in consultation with the state noxious weed advisory committee, local governments, and other interested parties, develops and implements state noxious weed management plans designed to stop the continued spread of these species.

List C species
List C weed species are species for which the Commissioner, in consultation with the state noxious weed advisory committee, local governments, and other interested parties, will develop and implement state noxious weed management plans designed to support the efforts of local governing bodies to facilitate more effective integrated weed management on private and public lands. The goal of such plans will not be to stop the continued spread of these species but to provide additional education, research, and biological control resources to jurisdictions that choose to require management of List C species.

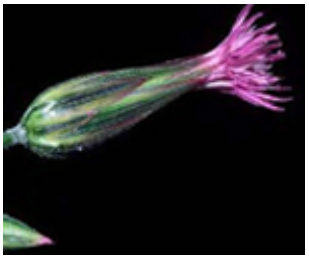
Watch List species
Watch List weed species that have been determined to pose a potential threat to the agricultural productivity and environmental values of the lands of the state. The Watch List is intended to serve advisory and educational purposes only. Its purpose is to encourage the identification and reporting of these species to the Commissioner in order to facilitate the collection of information to assist the Commissioner in determining which species should be designated as noxious weeds.

List A Species

African rue
Peganum harmala

Bohemian knotweed
Polygonum x bohemicum

Camelthorn
Alhagi pseudalhagi



Common crupina
Crupina vulgaris

List A Species

Cypress spurge
Euphorbia cyparissias

Dyer's woad
Isatis tinctoria

Elongated mustard
Brassica elongata

Flowering rush
Butomus umbellatus

Giant knotweed
Polygonum sachalinense

Giant reed
Arundo donax

Giant salvinia
Salvinia molesta

Hairy willow-herb
Epilobium hirsutum

Hydrilla
Hydrilla verticillata

Japanese knotweed
Polygonum cuspidatum

Meadow knapweed
Centaurea pratensis

Mediterranean sage
Salvia aethiopis

Medusahead
Taeniatherum caput-medusae

Myrtle spurge
Euphorbia myrsinites

Orange hawkweed
Hieracium aurantiacum

Parrotfeather
Myriophyllum aquaticum

List A Species

Purple loosestrife
Lythrum salicaria

Rush skeletonweed
Chondrilla juncea

Squarrose knapweed
Centaurea virgata

Tansy ragwort
Senecio jacobaea

Yellow starthistle
Centaurea solstitialis

List B Species

Absinth wormwood
Artemisia absinthium

Black henbane
Hyoscyamus niger

Bouncingbet
Saponaria officinalis

Bull thistle
Cirsium vulgare

Canada thistle
Cirsium arvense

Chinese clematis
Clematis orientalis

Common tansy
Tanacetum vulgare

Common teasel
Dipsacus fullonum

Corn chamomile
Anthemis arvensis

Cutleaf teasel
Dipsacus laciniatus

Dalmatian toadflax
Linaria dalmatica & genistifolia

Dame's rocket
Hesperis matronalis

Diffuse knapweed
Centaurea diffusa

Eurasian watermilfoil
Myriophyllum spicatum

Hoary cress
Cardaria draba

Houndstongue
Cynoglossum officinale

List B Species

Hybrid knapweed
Centaurea x psammogena

Hybrid toadflax
Linaria vulgaris x Linaria dalmatica

Jointed goatgrass
Aegilops cylindrica

Leafy spurge
Euphorbia esula

Mayweed chamomile
Anthemis cotula

Moth mullein
Verbascum blattaria

Musk thistle
Carduus nutans

Oxeye daisy
Chrysanthemum leucanthemum

Perennial pepperweed
Lepidium latifolium

Plumeless thistle
Carduus acanthoides

Russian knapweed
Acroptilon repens

Russian-olive
Elaeagnus angustifolia

Salt cedar
Tamarix chinensis, T. parviflora, and T. ramosissima

Scentless chamomile
Matricaria perforata

Scotch thistle
Onopordum acanthium

Spotted knapweed
Centaurea maculosa

List B Species

Sulfur cinquefoil
Potentilla recta

Wild caraway
Carum carvi

Yellow nutsedge
Cyperus esculentus

Yellow toadflax
Linaria vulgaris

List C Species

Bulbous bluegrass
Poa bulbosa

Chicory
Cichorium intybus

Common burdock
Arctium minus

Common mullein
Verbascum thapsus

Common St. Johnswort
Hypericum perforatum

Downy brome
Bromus tectorum

Field bindweed
Convolvulus arvensis

Halogeton
Halogeton glomeratus

Johnsongrass
Sorghum halepense

Perennial sowthistle
Sonchus arvensis

Poison hemlock
Conium maculatum

Puncturevine
Tribulus terrestris

Quackgrass
Elytrigia repens

Redstem filaree
Erodium cicutarium

Velvetleaf
Abutilon theophrasti

Wild-proso millet
Panicum miliaceum

Watch List Species

Asian mustard
Brassica tournefortii

Baby's breath
Gypsophila paniculata

Bathurst burr /
Spiney cocklebur
Xanthium spinosum

Brazilian elodea
Egeria densa

Common bugloss
Anchusa officinalis

Common reed
Phragmites australis

Garlic mustard
Alliaria petiolata

Garden loosestrife
Lysimachia vulgaris

Himalayan blackberry
Rubus armeniacus

Hoary alyssum
Berteroa incana

Japanese blood grass/
Cogongrass
Imperata cylindrical

Meadow hawkweed
Hieracium caespitosum

Onionweed
Asphodelus fistulosus

Purple pampasgrass
Cortideria jubata

Scotch broom
Cytisus scoparius

Sericea lespedeza
Lespedeza cuneata

Colorado Department of Agriculture Noxious Weed List effective March 31, 2017.
https://www.colorado.gov/pacific/agconservation/noxious-weed-species.

Watch List Species

Swainsonpea
Sphaerophysa salsula

Syrian beancaper
Zygophyllum fabago

Water hyacinth
Eichhornia crassipes

Water lettuce
Pistia stratiotes

White bryony
Bryonia alba

Woolly distaff thistle
Carthamus lanatus

Yellow flag iris
Iris pseudacorus

Yellow floatingheart
Nymphoides peltata