The mission of the U.S. Fish and Wildlife Service is working with others to conserve, protect, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people.

The mission of the National Wildlife Refuge System is to administer a national network of lands and waters for the conservation, management, and, where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations.


Cover Photo: Rich Keen
INTEGRATED PEST MANAGEMENT PLAN

FOR

ROCKY MOUNTAIN ARSENAL NATIONAL WILDLIFE REFUGE COMPLEX

Prepared by: ______________________________ ________________
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*Concurred by: ______________________________ ________________
National Pest Management Coordinator Date

*Approved by: ______________________________ ________________
Refuge Supervisor Date

* Plan is approved for a period of five years and covers only pest control techniques and strategies contained herein.
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1.0 Introduction / Background

This environmental assessment (EA) is for the implementation of a comprehensive integrated pest management (IPM) program on the Rocky Mountain Arsenal National Wildlife Refuge Complex. The complex includes the Rocky Mountain Arsenal National Wildlife Refuge, Rocky Flats National Wildlife Refuge and Two Ponds National Wildlife Refuge. This EA examines potential environmental consequences of the proposed action, no action, and alternatives to those actions. The purpose and need for the action; laws, policies, and authorities affecting the EA and the refuges; the EA process; and public participation process for the EA are all described in this text.

The U.S. Fish and Wildlife Service (Service) at the Rocky Mountain Arsenal National Wildlife Refuge Complex (Complex) is charged with managing wildlife and their habitats, both during and following cleanup of contaminants. This management includes mitigation for damage done to existing wildlife habitats through site-specific habitat restoration plans and pest species (weed) control in and around habitat restoration areas. This IPM plan identifies primarily pest plant (weed) control sites, sets priorities, and outlines a general strategy to manage weeds across the Complex. Specifically, the IPM is a necessary tool as described in the draft Habitat Management Plan for the Rocky Mountain Arsenal NWR (U.S. Fish and Wildlife Service 2013b) and in support of the Refuge’s Habitat Restoration Plan (U.S. Fish and Wildlife Service 1999). In addition, this IPM Plan includes methods to control insect pests and disease vectors in support of other Complex management goals and objectives. The IPM program greatly benefits the overall mitigation/habitat restoration program on the Complex by preventing the spread of noxious weed species in restoration and remediation project sites. The program also protects restored and remnant native prairie and wetland areas from potential invaders.

The Service recognizes the economic and ecological damage caused by noxious weeds and other pests on Complex resources. This IPM Plan is developed under the authority of the Federal Plant Protection Act of 2000, the Federal Noxious Weed Act of 1974, and Executive Order 13112 on Invasive Species. This plan conforms to Department of the Interior Pesticide Use Policy (517 DM 1.1), Pest Management Policy and Responsibilities (30 AM 12), and Service policy found in the Refuge Manual (7 RM 14.3). These policies outline an “integrated approach” to pest management using mechanical/physical, cultural, biological, and chemical control methods to meet defined resource management objectives. In addition, the policies stress that the use of pesticides (chemical control) should only be considered when this use represents the most feasible, lowest risk alternative for controlling a pest other than by mechanical, cultural or biological means. Normally, the greatest success is seen when combining multiple methods of an IPM program such as chemical / mechanical, etc…

Most of the weeds identified in this plan are on the State of Colorado, Adams County and Jefferson County Noxious Weed Lists. These species include the following: Canada thistle (Cirsium arvense), Scotch thistle (Onopordum acanthium), bull thistle (C. vulgare), Russian thistle (Salsola kali), musk thistle (Carduus nutans); cheatgrass (Bromus tectorum); houndstongue (Cynoglossum officinale), Johnsongrass (Sorghum halepense), jointed goatgrass (Aegilops cylindrica), puncturevine (Tribulus terrestris), cereal rye (Secale cereale); Russian (Centaurea repens), spotted (C. maculosa), and diffuse (C. diffusa) knapweed; dalmatian (Linaria genistifolia) and yellow (L. vulgaris) toadflax; field bindweed (Convolvulus arvensis); salt cedar (Tamarix ramosissima); common mullein (Verbascum thapsus); Russian olive (Elaeagnus angustifolia); kochia (Kochia scoparia); rush skeletonweed (Chondrilla juncea); St. Johnswort (Hypericum perforatum); absinth wormwood (Artemisia absinthium); hoary cress (Cardaria draba); and leafy spurge (Euphorbia esula). Other invasive or exotic species such as crested wheatgrass (Agropyron cristatum), reed canarygrass (Phalaris arundinacea), cattails (Typha spp.), and elm trees (Ulmus spp.) are identified and controlled on the Complex as needed.

Noxious weed populations and other invasive species are routinely monitored and mapped as part of constant vigilance to determine the extent of infestations. Monitoring is achieved by simple stem counts of small or woody infestations and by using Global Positioning System (GPS) equipment to measure the acreage of a weed population and to map infestations throughout the Complex. This is done annually, especially examining areas that are near and in spots that were previously
sprayed to prevent a chance of reoccurrence. Weeds can also be monitored by using fixed photo points to depict the expansion (or demise) of a population.

This plan includes disease and weed prevention strategies employed by the Complex, such as conducting weed surveys along drainages to locate new infestations of noxious weeds such as purple loosestrife (*Lythrum salicaria*), though purple loosestrife has not been documented on the Complex to date. RMANWR staff routinely follow-up on weed sightings reported by others on the Refuge and works with the U.S. Army’s long-term maintenance contractor to eradicate rare, small populations of noxious weeds, such as Dalmatian and yellow toadflax, diffuse and spotted knapweed, salt cedar, leafy spurge, and St. Johnswort before large scale control efforts are needed. RMANWR staff works closely with the U.S. Army to control weeds in the Central Remediation Area where access is limited due to completed cleanup activities and liability issues, and with the Adams County Weed Supervisor to control weeds along right-of-ways bordering the Refuge. Refuge staff also actively coordinate with the Department of Energy on weed control on the RFNWR.

1.1 Rocky Mountain Arsenal National Wildlife Refuge Complex

The Complex consists of three units located within the Denver metropolitan area and all units are managed centrally from a headquarters located at the Rocky Mountain Arsenal NWR.

*Rocky Mountain Arsenal NWR*

The United States Department of the Interior, through the United States Fish and Wildlife Service and the Rocky Mountain Arsenal National Wildlife Refuge Act of 1992 (Public Law 102-402), specified eight purposes for which Rocky Mountain Arsenal National Wildlife Refuge (RMANWR) was established:

1. To conserve and enhance populations of fish, wildlife, and plants within the refuge, including populations of waterfowl, raptors, passerines and marsh and water birds.

2. To conserve species listed as threatened and endangered under the Endangered Species Act and species that is candidates for such listing.

3. To provide maximum fish and wildlife orientated public uses at levels compatible with the conservation and enhancement of wildlife and wildlife habitat.

4. To provide opportunities for compatible scientific research.

5. To provide opportunities for compatible environmental and land use education.

6. To conserve and enhance the land and water of the refuge in a manner that will conserve and enhance the natural diversity of fish, wildlife, plants and their habitats.

7. To protect and enhance the quality of aquatic habitat within the refuge.

8. To fulfill international treaty obligations of the United States with respect to fish and wildlife and their habitats.

*Two Ponds NWR*

The Two Ponds National Wildlife Refuge (TPNWR) was established under the authority of the Emergency Wetland Resource Act of 1986 (Public Law 99-645) and further clarified in the Refuge’s 1997 comprehensive management plan (U.S. Fish and Wildlife Service 1997) providing the following purposes:
“It is the purpose of this Act to promote, in concert with other Federal and State Statutes and programs, the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions…”

- To restore, enhance, and preserve a diversity of upland and wetland habitats for migrant and resident wildlife, fish, and invertebrates,
- To provide opportunities for environmental education with emphasis on the inherent values of wetlands and wildlife in an urban environment, and
- To provide interpretive facilities and opportunities related to wildlife such as viewing, study, and photography.

Rocky Flats NWR

The Rocky Flats National Wildlife Refuge (RFNWR) was established by the Rocky Flats National Wildlife Refuge Act of 2001 (Public Law 107-107) which provides the following purposes for the Refuge:

The refuge shall be managed for the purposes of—
1. restoring and preserving native ecosystems;
2. providing habitat for, and population management of, native plants and migratory and resident wildlife;
3. conserving threatened and endangered species (including species that are candidates for listing under the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.)); and
4. providing opportunities for compatible scientific research.

In managing the refuge, the Secretary of the Interior shall—
1. ensure that wildlife-dependent recreation and environmental education and interpretation are the priority public uses of the refuge; and
2. comply will all response actions.

1.2 Proposed Action

In order to fully abide by the directives set forth in statute and policy, it is necessary that the RMANWR Complex develop an IPM plan that incorporates all the currently acceptable methods and strategies utilizing best management practices. The Service will also add aerial spraying to the currently utilized techniques on the Complex except for Two Ponds NWR.

An IPM Plan must comply with certain policy requirements of the U.S. Department of the Interior. The management of its’ lands and waters under its jurisdiction, it is Department of the Interior policy to “…use pesticides only after full consideration of alternatives... including chemical, biological, and physical methods and no action...” and to “…adopt integrated pest management (IPM) strategies whenever practicable...” (U.S. Department of the Interior 2007).

Pests are defined as “…living organisms that may interfere with the site-specific purposes, operations, or management objectives or that jeopardize human health or safety” from Department policy 517 DM 1 (U.S. Department of the Interior 2007). The Colorado State Noxious weed list includes 77 weed species, many of which occur or have occurred on the Complex. Weed species pose a significant threat to habitat restoration efforts on the Complex by displacing native species that are less aggressive.

1.3 Decisions to Be Made

This EA is being prepared to meet the requirements under the National Environmental Policy Act of 1969 (NEPA). NEPA requires that if a proposed action by a federal agency is not categorically excluded, then an EA must be prepared. This EA has been developed to allow other agencies and the public to provide comments on whether implementation of an IPM
program on the Rocky Mountain Arsenal NWR Complex would have significant impacts to the environment. After the public comment period has concluded, comments will be reviewed, and incorporated as necessary.

Then, based on the analysis provided in this final EA, the Service will make two decisions:

1. Determine whether the Service should implement an integrated pest management program for managing invasive plants and other nuisance species on the Rocky Mountain Arsenal National Wildlife Refuge Complex.

2. If yes, determine whether the selected alternative will have a significant impact on the quality of the human environment. This decision is required by the National Environmental Policy Act (NEPA). If the quality of the human environment would not be affected, a “finding of no significant impact” will be signed and will be made available to the public. If the preferred alternative would have a significant impact, an environmental impact statement will be prepared to further address those impacts.

The use of an Integrated Pest Management Program including aerial application is included in the preferred alternative for operation on the Complex.

1.4 Relation to Statutes, Regulations, and Other Plans

The primary statutory authority for management of the Complex is the National Wildlife Refuge System Administration Act of 1966 (Public Law 89-669), as amended by the National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57). In accordance with Service policy, 7 RM 14 (Pest Control), wildlife and plant pests on units of the National Wildlife Refuge System can be controlled to assure balanced wildlife and fish populations in support of refuge-specific wildlife and habitat management objectives. Pest control on federal (refuge) lands and waters also is authorized under the following legal mandates:

_National Wildlife Refuge System Administration Act of 1966, as amended_
The National Wildlife Refuge System Administration Act of 1966 (16 USC 668dd-668ee), as amended in 1976 (Public Law 94-233), designated the Service as the agency required to administer units of the Refuge System.

_National Wildlife Refuge System Improvement Act of 1997_
On October 9, 1997, President Bill Clinton signed a bill (Public Law 105-57) to improve the management of the National Wildlife Refuge System. This new law amends the National Wildlife Refuge System Administration Act of 1966. This act legislates the mission of the refuge system. Section 4 of the Act states:

“The mission of the system is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.”

_Migratory Bird Treaty Act of 1918_
The Migratory Bird Treaty Act (16 USC 1531-1544) is the domestic law that affirms or implements the United States' commitment to four international conventions (with Canada, Japan, Mexico, and Russia) for the protection of a shared migratory bird resource. Each of the conventions protects selected species of birds common to the U.S. and one or more of the above-mentioned countries (i.e., they occur in two or more of the treaty countries at some point during their annual life cycle).

_Endangered Species Act of 1973_
The Endangered Species Act (16 USC 1531-1544) provides for the protection of endangered and threatened species and the habitats upon which they depend. Section 7 of the act requires federal agencies to consult with the Secretary of the Interior or the Secretary of Commerce in cases where the agencies’ action may affect a listed species, to ensure that actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of threatened or endangered species or result in the destruction or adverse modification of critical habitat for these species.

National Environmental Policy Act
NEPA (42 USC 4321-4370f) requires federal agencies to examine the environmental impact of their actions, incorporate environmental information, and utilize public participation, as appropriate, in the planning and implementation of their actions. NEPA compliance is required only when a federal agency takes an action.

Plant Protection Act of 2000
The Plant Protection Act of 2000 (7 USC 7701 et seq) consolidates and modernizes all major statutes pertaining to plant protection and quarantine (Federal Noxious Weed Act, Plant Quarantine Act) and permits APHIS to address all types of weed issues. It also authorized APHIS to take both emergency and extraordinary emergency actions to address incursions of noxious weeds.

Noxious Weed Control and Eradication Act of 2004
The Noxious Weed Control and Eradication Act of 2004 (7 USC 7781-7786) requires the Secretary of Agriculture to establish a program to provide assistance to eligible weed management entities to control or eradicate noxious weeds on public and private land.

Federal Insecticide, Fungicide, and Rodenticide Act of 1996
The Federal Insecticide, Fungicide, and Rodenticide Act of 1996 (7 USC 136-136y) provides federal control of pesticide distribution, sale, and use. All pesticides used in the United States must be registered (licensed) by Environmental Protection Agency (EPA). Registration assures that pesticides will be properly labeled and that, if used in accordance with specifications, they will not cause unreasonable harm to the environment. Use of each registered pesticide must be consistent with use directions contained on the label or labeling.

Executive Order 13112
The Executive Order 13112, signed by President Clinton on February 3, 1999, requires that a Council of Departments dealing with invasive species be created to prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause.
1.5  Integrated Pest Management Plan

This Integrated Pest Management Plan (IPM) is a “step-down” plan from the RMANWR Comprehensive Management Plan (CMP) completed in 1996 (U.S. Fish and Wildlife Service 1996a;b), TPNWR CMP completed in 1997 (U.S. Fish and Wildlife Service 1997), and the RFWNWR Comprehensive Conservation Plan (CCP) completed in 2005 (U.S. Fish and Wildlife Service 2004;2005).

1.5.1  Goals and Objectives

The overall goal of this plan is to use an integrated pest management approach for the prevention, early detection, monitoring, and control (or eradication) of invasive plant species and other pests on the Complex. This goal will be achieved through adaptive management by outlining species-specific objectives and prioritizing methods and strategies that will be used to obtain those objectives. See Table 3 for a summary explanation. This plan is integral to the restoration effort as the species richness of native plants has generally been higher where introduced species were either rare or not found (Bach Allen and Knight 1984).

1.5.2  Summary of IPM System

The following is a summary of the four practices utilized both past and present on the Complex in an IPM system:

**Biological Control.** There are 3 major uses of biological control agents; 1) control of invertebrate pests using predators, parasitoids and pathogens, 2) control of weeds using herbivores and pathogens and 3) control of plant pathogens using antagonistic micro-organisms and induced plant resistance (Ellenberg et al. 2001).

Biological control is used primarily when site access is limited and weeds occur as small infestations (less than 5 acres). Most biological control on the Complex took place prior to 2002 except for at Rocky Flats NWR (Flats) where research is on-going. A variety of biological agents such as leaf beetles, flea beetles, flower weevils, root weevils, stem weevils, moths, and gall mites have been applied to smaller weed patches of St. Johnswort, leafy spurge, common mullein, Russian and spotted knapweed, and Canada thistle with mixed results. More recently (spring of 2009); a nursery was established for field bindweed mites (*Aceria malherbae*) on the west side of the intersection at 7th and C Street on the Arsenal (RMANWR unpublished data).

<table>
<thead>
<tr>
<th><strong>Table 1.</strong> Bio-control agents and target species used at the Rocky Mountain Arsenal NWR Complex since 1995</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Control Agent</strong></td>
</tr>
<tr>
<td><em>Aceria malheibae</em></td>
</tr>
<tr>
<td><em>Gymnetron tetrum</em></td>
</tr>
<tr>
<td><em>Larinus minutus</em></td>
</tr>
<tr>
<td><em>Chrysolins quadrigemina</em></td>
</tr>
<tr>
<td><em>Urophora cardui</em></td>
</tr>
<tr>
<td><em>Agapeta zoegana</em></td>
</tr>
<tr>
<td><em>Aphthona flava</em></td>
</tr>
<tr>
<td><em>Aphthona lacertosa</em></td>
</tr>
</tbody>
</table>

When considering the use of biological control agents as part of an IPM plan, there are a few traits that are preferred; such as their ability to locate the target species in an area where the target species is spread out, will it target the host you want to eliminate, will it reproduce rapidly on its own and the ability to inhabit the same niche as the target host (Pickett and Bugg 1998). These will all be considerations that staff will look at when deciding on whether biological control is a viable option for a particular species.
There are also important considerations as to the effect on the habitat where the host is located. Is there the potential to directly or indirectly affect the area, is there a natural enemy to the pest and where it is located, and the yearly variation in the pest and predators population (Pickett and Bugg 1998).

**Cultural Control.** Refuge staff has identified three methods of cultural control that are currently employed in restoration projects; mowing, mechanical tillage, and prescribed fire.

Mowing is utilized for two primary purposes: 1) minimize competition for light by preventing new grasses from getting overtopped and shaded by competitive broadleafed weeds, and 2) eliminate or delay the formation of seedheads of noxious weeds and undesired grasses. Mowing to reduce competition is always done during the early life of the newly seeded stand, usually two or three times during each of the first three growing seasons. This can be important as the nitrogen and carbon content are affected by mowing (Dyer et al. 1991). When weedy cover is exceptionally dense, the use of tractor-operated flail shredders is preferred over standard batwing rotary mowers. The swinging blades on shredders pulverize material to be removed and prevent the formation of windrows on the ground, which can shade out and/or smother new grass seedlings. Height of the clipping is determined by the height of the grasses, but as plants develop toward the end of the first growing season the final mowing is not less than 12” in height. Mowing also serves to prevent the formation of weed seed heads. “Spot” mowing may be required for several years to delay or prevent the spread of many weed species. However, mowing cheatgrass to prevent seedhead formation has little effect as plants will simply produce new seedheads on much shorter stems. Spot treating patches of noxious weeds in restoration sites is often most successful when mowing and chemical application are used in combination with each other.

Mechanical tillage has two purposes where it is used primarily for weed control on new seedbeds to incorporate the weeds and organic residues into the soil, and to influence the soil structure for seedbed preparation (Balesdent et al. 2000). Initial plowing of the site using moldboard plows is helpful in burying the top layer of weed seed to a 12” depth where it cannot germinate. Disking and/or chiseling are used after the site has been plowed to smooth the site and eliminate subsequent weedy flushes prior to seeding. Disking of cheatgrass and field bindweed is most effective when the weeds are very short (under 1”). If they are taller, then disking either “chops” up viable stems and stimulates establishment of additional plants or, when cheatgrass reaches a 3-5” height, disking merely rolls strips of the plant over into the dirt and does not kill them. The use of herbicides on these species provides much more effective control.

The tilling of soil is believed to have influence in the changing of soil climate, the mixing of soil organic matter into the soil and the temporary disruption of soil structure (Balesdent et al. 2000). This can be important as soil climate has an effect on microbial activity in the soil which can affect vegetative growth. With currently used tilling techniques, plowing will mix organic residues to a depth of 11” while diskimg and chiseling will mix it to 4” with untilled residue remaining at the surface (Reicosky et al. 1995).

Depending on fuel load and continuity, prescribed fire can be used to eliminate standing weed seed, unwanted standing weedy residue, and surficial weed seed. If amounts of surface residue are too high or too dense to facilitate mechanical or chemical control, prescribed fire can serve as an effective tool to remediate this. Dense, continuous fuels can produce the heat necessary to destroy surficial seed and weedy plant parts. Experience at the RMANWR has shown that prescribed fire can reduce the amount of cheatgrass in mixed grass communities, but only when fuels are continuous.

By contrast, fuels which are not consistently continuous will cause a fire to “mosaic” across the landscape, leaving islands of standing biomass that in many cases will allow patches of weeds and weed seeds to survive. In addition, lack of continuous fuels will generally not produce the heat required to damage or destroy surficial seed or newly germinating weedy plants. Under these conditions, prescribed fire is not used as a tool for weed control, as it may in fact promote a quick establishment of weedy species after burning.
Physical Control. This type of control on the Arsenal involves the physical pulling, cutting or sawing of weedy or woody species in areas that are difficult to access with machinery. Physical control is limited to small areas ranging from several stems to patches that are a couple acres in size. This also includes treatments involving chainsaws or saws to cut down trees such as Russian olives and apply herbicide to the stump. The use of backpack or hand sprayers is also utilized to contain small areas of weeds. Removal locations are documented with GIS technology to allow inspection of the area the following year to determine if control was obtained.

Chemical Control: Herbicides are utilized on the RMANWR when the area of infestation is too large for removal by hand and is seen as the most cost-effective means. Herbicides are typically applied by ground spray rigs (either a spray coupe or truck); however contiguous areas greater than ten acres comprising a total collective acreage of at least 1,000 acres have received aerial application using a contracted helicopter. From 2007 to 2012, the area that has been treated by aerial application has typically been from 1,000 to 5,000 acres annually. In addition to the use of conventional ground-application spray rigs and aerial application, smaller areas of invasives are treated using UTV’s with mounted tanks or by crews using backpack or hand sprayers. Herbicide usage is reported and documented according to all required federal and state requirements, including limiting applications to periods when wind speeds are less than ten miles per hour (in order to minimize drift) and when temperatures are below 85° F (in order to minimize volatilization of the herbicide, which can reduce its effectiveness and increase the chance of non-target species damage). Label rates and safety precautions, including the appropriate personal protective gear, are always followed and no restricted-use herbicides are used at this time. The Service strategy at the Arsenal has been to use herbicides that provide the greatest effectiveness with the lowest risk (Table 1) and GIS technology is used to identify locations treated to determine if additional treatment is needed the following year. All herbicides used on the Complex have pesticide use proposals (PUPs) associated with them. There are currently 19 pesticides approved for use on the Complex. The most commonly used are listed in Table 2.

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Trade Name</th>
<th>Target Species</th>
<th>Environmental Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aminopyralid</td>
<td>Milestone</td>
<td>thistles</td>
<td>Slightly toxic to mammals, practically non-toxic to birds, fish, and aquatic invertebrates</td>
</tr>
<tr>
<td>Dicamba</td>
<td>Banvel</td>
<td>broadleafed weeds, primarily kochia and Russian thistle</td>
<td>Practically non-toxic to mammals and birds; slightly toxic to fish and aquatic invertebrates</td>
</tr>
<tr>
<td>Glyphosate</td>
<td>Roundup</td>
<td>weedy forbs and grasses</td>
<td>No restriction on ground use for invasive species control</td>
</tr>
<tr>
<td>Imazapic</td>
<td>Plateau</td>
<td>cheatgrass, field bindweed</td>
<td>Slight acute fish and mammalian toxicity, and practically no acute avian toxicity. Risk quotients for birds, fish and mammals are well below EPA levels of concern for endangered species indicating negligible risk to those taxa resulting from direct exposure.</td>
</tr>
<tr>
<td>Metsulfuron</td>
<td>Escort</td>
<td>common mullein</td>
<td>Practically non-toxic to mammals, birds, fish and aquatic invertebrates</td>
</tr>
<tr>
<td>Triclopyr</td>
<td>Garlon</td>
<td>Russian olive</td>
<td>Practically non-toxic to birds, mammals, fish, and aquatic invertebrates</td>
</tr>
<tr>
<td>2,4-D amine</td>
<td>many</td>
<td>kochia, Russian thistle, broadleafed weeds</td>
<td>Slightly toxic to fish and aquatic invertebrates, moderately toxic to birds, and practically non-toxic to mammals.</td>
</tr>
</tbody>
</table>

Data taken from March 25, 2010 memorandum to all Refuge Project Leaders in Region 6, Delegation of Pesticide Use Proposal Authority and Integrated Pest Management and Pesticide Usage Compliance and Safety
1.5.3 Methods

1. Early detection, identification, and monitoring strategies:
   a. Conduct annual walking weed surveys along Complex waterways.
   b. Follow-up on weed sightings and eradication of small populations (under 5 acres) of toadflax, leafy spurge, knapweed, St. Johnswort, salt cedar, houndstounge, and other noxious weed species as they are discovered.
   c. Monitor and map weeds with GPS, simple counts, and photo points to track effectiveness of control methods and expansion (or demise) of weed populations.
   d. Map active prairie dog colonies and monitor spread of plague outbreaks.

2. Physical weed control:
   a. Physical weed control methods include hand pulling, digging, swing-blading and cutting.
   b. Most hand-pulling, digging, cutting, and swing-blading is conducted by Service staff, interns, and volunteers to rid small areas (under 5 acres) of noxious weeds such as thistles, diffuse and spotted knapweed, dalmatian toadflax, crested wheatgrass, mullein, St. Johnswort, hounds tounge, and small salt cedar and Russian olive trees. Hand tools such as shovels, swing-blades and mechanized “weed whackers” will be used. These methods are usually employed when the plants are flowering and the seed heads and/or the entire plant is removed to prevent seed release.
   c. Physical removal of large woody species, such as Russian olive, salt cedar, and elm trees, will be conducted by first removing most of the trunk and branches with a chainsaw, and then either pulling out the remaining trunk and roots with heavy equipment or “stump-painting” with a herbicide.
   d. Mowing with a push mower, riding lawn mower or tractor-driven (PTO) mower is used to control larger areas of a wide variety of invasive species, especially in habitat restoration areas where the use of herbicides are limited.
   e. The Service conducts prescribed burns under a revised Refuge Fire Management Plan (U.S. Fish and Wildlife Service 2013a). The burns are conducted primarily on habitat restoration sites with mature grass communities (at least 5 - 10 years old) or to remove vegetative cover to prepare a site for restoration. However, prescribed burns also are conducted on remnant native prairie sites to control weeds by invigorating the native plant communities or to remove vegetative growth/litter to make target pest plants more susceptible to other control methods.
   f. Prescribed burns, combined with appropriate water management, are used to manage invasive cattails and reed canary grass on Refuge wetlands.

3. Cultural weed control:
   a. Cultural weed control methods include soil tillage (e.g., plowing, diskimg, harrowing, mowing, raking), sweeping, seeding, fertilizing, mulching, thinning or pruning, water management, and other agronomic techniques.
   b. These methods are used extensively on the Arsenal to control weeds and other non-native invaders such as crested wheatgrass, and to prepare the soil for restoration to a more suitable native habitat for wildlife. The use of “weed-free” seed mixes, topsoil, and mulches is required for all restoration activities.

4. Biological weed control:
   a. Biological control involves the release and establishment of natural enemy populations (usually insects) to control invasive weed populations.
   b. Biological control varies according to the weed population to be controlled and the availability of insects approved by the U.S. Department of Agriculture.
   c. Biological control insects and their weed hosts are listed in Table 1. Insects to control diffuse/spotted knapweed, common mullein, Canada thistle, musk thistle, Russian thistle, St. Johnswort, leafy spurge, and field bindweed have been released (depending on availability) and monitored since 1995. Collections from established Arsenal populations of insects to control St. Johnswort and diffuse/spotted knapweed have been made to relocate the insects to weed hosts in other parts of the Arsenal.
5. Chemical pest control:
   a. Chemical control will involve applying an appropriate pesticide to eradicate or control a weed, flea or mosquito population.
   b. Pesticide Use Proposals (PUPs) are prepared and approved by the Refuge Project Leader or the Regional IPM coordinator. PUPs are written for all EPA registered pesticides used on the Complex.
   c. Pesticides are applied under the supervision of a Certified Pesticide Applicator by hand sprayers or boom sprayer (Spray Coupe, truck, ATV). Applications on woody species may be injected or “stump-painted”.
   d. Herbicides are used to control weeds when determined to be the most effective method. Glyphosate herbicides will be used to control a variety of weeds throughout the Complex. Imazapic, 2, 4-D, or Clethodim may be used to control broadleaf weeds and weedy grasses such as cheatgrass and crested wheatgrass. Trichlopyr or Imazapyr may be used by itself as a “stump-paint “or in a tank mix as a foliar spray treatment to control salt cedar and Russian olive. Metsulfuron methyl may be used to control mullein and thistle in appropriate upland sites. Specific herbicide applications for each calendar year are outlined in annual PUPs.
   e. The Service works with the PMC to approve the use of other pesticides on weed, insect, or rodent pests that need to be controlled in areas under their responsibility. These areas include the Central Remediation Area and Army infrastructure areas such as in and around buildings, wells, etc.

6. Prevention:
   a. Weeds will be cleared promptly along right-of-ways to prevent seed spread by vehicles and machinery.
   b. Machinery used for weed control and other restoration activities (mowers, tractors, spray equipment) will be decontaminated at the site before moving to other projects or locations.
   c. Areas with bare or disturbed soil will be seeded with native species or effective interim cover crops to prevent weed establishment.
   d. Refuge education programs for visitors, volunteers, and staff will increase the awareness of weeds and the importance of preserving native plant communities.
   e. Refuge staff will work with surrounding municipalities to reduce or eliminate weed infestations on adjacent land.

Outreach and Education
Refuge staff will include noxious weed awareness in education and interpretive programs for the general public. The refuge staff will be informed of pest control being performed on the Refuge, introduced to recognizing noxious weeds, made aware of procedures that will minimize the spread of weed seeds, and the procedure for reporting the presence of noxious weeds. Volunteers involved with recreation and education programs will be made aware of the problems that invasive weeds pose to native plants, wildlife, and agriculture, as well as ways to prevent weeds establishment and spread. Volunteers and students involved in prairie restoration, wildlife habitat improvement, and general Refuge operations will be trained to identify weed species, pest management techniques, and work procedures that will minimize the spread of weed seeds. When aerial spraying is used, surrounding public entities including schools, housing developments, and commercial businesses will be notified via a news release of the date, time, location and type of chemical used as well as what species are being targeted. This has been the protocol when aerial spraying has been done in the past. There will also be a posted sign at the visitors’ center as to any spraying in areas accessible to the public.

The Refuge staff will work with the state, county, and local municipalities to control weeds along the Refuge boundary. Personnel involved in vegetation management will participate in cooperative weed awareness and education programs, weed control networks, and continuing education in order to stay current on integrated pest management techniques.

The Integrated Pest Management Plan and Pesticide Use Proposals are kept in the station files and the staff will be aware of the file’s location. Pesticide labels and Material Safety Data Sheets (MSDS) will be available to all staff. The labels and MSDSs for all pesticides in use or in storage will be kept in a consolidated file - one copy in the pesticide storage and
handling area, one in a location available to the general staff. Employees handling pesticides will be State or Federal certified applicators or working under the supervision of a certified applicator.

**Best management practices**

The use of all pesticides will be in accordance with the manufacturer’s recommendations as indicated by the Product Label and MSDS. The manufacturer’s instructions include personal protection equipment, storage and disposal practices, application rates and equipment, environmental precautions and locations, and target species. Material Safety Data Sheets contain additional safety, environmental, and health information. The Pesticide Use Proposal prepared each year for specific products elaborate on application frequency and rate, target species, locations, local environmental conditions, re-entry times, and restrictions.

Various soil types and vegetation communities exist at the different Refuges. To avoid ground and surface water contamination, herbicides will be selected and used according to the manufacturer’s recommendations; technical bulletins, and updated scientific evidence to match the environmental conditions. For example, glyphosate will be used wherever practical due to its soil binding capability and relatively rapid breakdown in the environment. Aquatic formulations of agents will be used near surface water if needed. The more permeable soil types will be treated with herbicides with low leaching potential at the proposed application amounts. Mechanical and biological control methods will be used whenever practical in aquatic and permeable soil areas. Information regarding herbicide use and application methods and equipment, distance to surface and ground water, slope, soil types, weather condition, and other specifics will be explained in the Pesticide Use Proposal.

Adverse effects to non-target species will be avoided by using selective herbicides, timing the applications to when desirable plants are dormant or at an unsusceptible life stage, the use of bio-control agents with target pest specificity, and avoiding sensitive areas. Treatment areas will be carefully scrutinized as to the boundaries and extent of infestation before a control method is applied; treatment will be targeted for the specific area only. Treatments that remove vegetation cover with resulting erosion, excessive dust, or sedimentation will be avoided if mitigation is not possible.

The schedule for the work varies considerably for the individual weed or insect species and control methods. In general, pest management is highly dependent upon weather, and pest and biological control insect morphology and life cycles. In addition, habitat use by wildlife, especially nesting migratory birds, in pest control areas will alter pest control techniques and schedules.

Areas subject to human visitation will be marked with warning flags if entry restrictions after chemical application are required. Signs will be placed at biological control release sites to prevent inappropriate mechanical or chemical applications and to facilitate effective monitoring.

Specific Weed Control Plans located in this IPM document detail treatments.

### 1.5.4 Insect control

*Mosquitos.* The approximately 15,988 acres comprising the RMANWR include roughly 2,500 acres of seasonal and perennial wetlands, riverine/riparian, and lacustrine habitats. In the spring and summer months, these areas provide a significant amount of breeding habitat for mosquitos (principally *Aedes* species). The Service began to work with the U.S. Army and Tri-County Health Department in 1989 to monitor and moderate mosquito populations on RMANWR (7 RM 14.7 C). The protection of human and wildlife health and well-being, and the restoration and maintenance of native wetland habitat may necessitate occasional suppression of mosquito populations. Up until last year, the City of Arvada, Colorado monitored and controlled mosquito populations at TPNWR. They had used the same larvicide that has been used on the RMANWR as well.
as spraying to control the population. Mosquito control efforts at RFNWR were completed by the Department of Energy during the cleanup, but have stopped since. There are no current mosquito detection or control efforts planned.

Control of mosquitos on the RMANWR has included the use of a larvicide – *Bacillus thuringiensis israelensis* or BTI (Vectobac-G or Teknar-G); and the introduction of carnivorous fish – mosquito fish (*Gambusia affinis*). BTI is a bacterium that is specific for infecting and killing mosquito larvae. Mosquito fish are highly adapted to varying environmental conditions and have been proven effective in curbing mosquito proliferation in many areas of Colorado. The use of non-native mosquito fish will be used until there is a native fish commercially available.

A 2002 draft of the Service’s Mosquito Management Policy stated that mosquitos are considered a natural part of biological communities. In 2007, the Service issued a draft rule on mosquito control stating “we will allow populations of native mosquito species to function unimpeded unless they cause a human and/or wildlife health threat” (Federal Register 2007b). As such, the future management of mosquitos will be conducted as advised by the U.S. Public Health Service or local public health agencies when a clearly definable threat to public health exists. Approval for mosquito management can and will be sought, on a case-to-case basis, when large breeding mosquito populations are identified on the Complex (based on local health departments thresholds for action) and an unusually high number of nuisance complaints are received from neighboring communities.

1.5.5 Weed control

*Agropyron cristatum* (crested wheatgrass)

**Priority:** High: Crested wheatgrass was previously seeded in many areas of the RMANWR and has little value to wildlife. These locations are high priority off-site mitigation sites that undergo extensive restoration to convert the monotypic wheatgrass stands into native prairie communities. Crested wheatgrass is prolific in dry upland habitats where it was planted to retard erosion or discourage wildlife use, and can slowly spread into areas that lack healthy native plant communities. Action is being taken to reduce or eliminate crested wheatgrass on the RMANWR.

**Description:** Crested wheatgrass is a cool season perennial grass that grows from 24 - 40 inches tall in dense tufts. Leaf blades are flat and smooth. Mature seed heads are 1½ to 3 inches long with flattened, overlapping spikelets. It competes with more desirable perennial grasses for moisture because of its fall, winter semi-dormant, and early spring growth habit.

**Current Distribution on the Complex:** Crested wheatgrass is widely distributed throughout the Complex.

**Measurable Objectives and Goal:** Prevent competition with newly seeded native plants in habitat restoration sites.

**Objectives:**

a) Monitor all native revegetation areas for the presence of crested wheatgrass during routine mowing, maintenance and vegetation monitoring activities.

b) Treat 100% of remnant wheatgrass plants - targeting for elimination - to reduce competition with native plants germinating in the spring. Reseed control areas with native species where cover is needed.

c) Maintain healthy stands of native perennial plants by mowing, scything, herbicide treatment, or fire.

**Control Options:** Crested wheatgrass is most commonly controlled by deep-plowing in habitat restoration sites. This cultural control method is very effective in soils that are easily turned over and bury the wheatgrass plants. Other soil preparation methods such as discing and harrowing act to further break up and kill the plants. These sites are then seeded and maintained as native plant communities. Prescribed burns in the spring or fall also may help to control crested wheatgrass by stimulating native perennial grass growth.
The chemical treatment of crested wheatgrass with an appropriate herbicide also provides effective control in the spring before no-till seeding. Currently, glyphosate is the herbicide used to control crested wheatgrass on the complex. This method is used especially in sandy soils that are not easily turned over prior to seeding or in areas where crested wheatgrass remained after seeding with natives. The plants may be sprayed in early spring while native warm-season species are still dormant. Glyphosate is soil binding, inexpensive, and a low threat to groundwater quality.

Clethodim may be used for invasive grass treatment along fence lines, rights of way and restoration sites where crested wheat is mixed in with desirable native shrubs. Clethodim is considered less toxic to avian and other wildlife species than other selective grass herbicides (quizalofop, fluazifop-p-butyl, sethoxydim and metribuzin). Clethodim has a short half-life in soil and the EPA considers the chemical a low threat to groundwater quality. Other chemicals will be added as needed and be approved at the required level.

Mechanical control of crested wheatgrass also is conducted on the Complex with mixed results. Mowing before seed ripening probably prevents some re-seeding and removes plant material for a subsequent cultural or chemical treatment.

**Treatment Schedule:** Control methods are most effective in the spring or fall during active growing periods. Mowing to prevent seed production is conducted in June - August.

*Cynoglossum officinale* (houndstongue)

**Priority:** **High:** Houndstongue is a primary succession plant - colonizing disturbed areas from seeds. The success of this plant is dependent on its seeds which can survive for up to ten years. It can be difficult to control due to its prolific seed production. Houndstongue is found in dry, gravelly, coarse-textured soils of pastures, meadows, along fence rows, waste areas, and river bottoms. Houndstongue is targeted for eradication.

**Description:** Houndstongue is a biennial erect forb. A rosette of green fuzzy leaves is formed the first year; the following year’s growth is a single thick stem 1½ to 4 feet tall. The inflorescence is a terminal cluster. The flowers are dark red to purple and bloom from June to August.

**Current Distribution on the Complex:** Houndstongue is mainly in the southern management zone along some irrigation ditches and lake areas and in and around locust groves and tree thickets.

**Measurable Objectives and Goal:** Prevent further spread into newly seeded native restoration sites, along other ditches or other disturbed soil areas.

**Objectives:**
- Monitor known infestation sites, newly seeded areas, roadways, and other disturbed sites (e.g., remediation areas, wildfire areas) depleted of native perennial plants.
- Seed disturbed sites with native species.
- Treat 100% of houndstongue plants - targeting for elimination - to reduce competition with native plants.
- Maintain healthy stands of native perennial plants.

**Control Options:** Mechanical control includes hand pulling of small infestations, mowing or herbicide application on larger patches. The removal of the 1st year rosettes, and 2nd year stems require removal to at least 2 inches below the root crown to kill the plant and prevent seed production.
The chemical treatment of houndstongue with an appropriate herbicide provides relatively effective control. Currently, metsulfuron methyl and imazapic are the herbicides used to control houndstongue on the Complex. Imazapic is used in dry upland sites and on soils with low leaching potential. This chemical can be broadcast in restoration areas where the establishment of native grasses and herbicide resistant native broadleafs are essential for restoration success. Metsulfuron methyl is very effective for biennial thistle, mullein and houndstongue control and is the preferred treatment in restoration areas with a high infestation level. Other chemicals will be added as needed and be approved at the required level.

Cultural control of houndstongue is an important control method. The key to controlling spread is by decreasing seed production in established patches, preventing the buildup of a seed bank, and preventing infestation. Methods that assist in these control strategies are minimizing soil disturbance, maintaining healthy native vegetation, control seed formation with a combination of mechanical and chemical techniques.

Treatment Schedule: The pulling of 1st year rosettes may occur when they are large enough to grasp (June - August). Mowing of 2nd year plants may occur in early bolt (April - June). Chemical application may occur during the early bolt (April - June) and rosette stages (June - August).

Bromus tectorum (cheatgrass, downy brome)

Priority: High/Medium: Cheatgrass is widely distributed throughout the Complex in habitat restoration sites, along roadways, and has invaded remnant native prairie and shrubland communities. Cheatgrass is prolific in dry upland habitat and competes with native plant species; especially in disturbed soils such as those found in habitat restoration sites that have been recently seeded. It interferes with primary habitat management goals across the landscape, but the infestation is too large to eradicate with available technology. If the current population of this species exceeds its existing level, action will be taken to reduce or eliminate it as per its priority ranking.

Description: Cheatgrass is a winter annual grass that grows from 4 - 30 inches tall, reproducing by seed. Leaf sheaths and flat blades are covered with dense soft hairs. Mature cheatgrass seed heads are slender; 2 - 6 inches long and usually droop to one side. It easily competes with more desirable perennial grasses for moisture because of its fall, winter semi-dormant, and early spring growth habit. Seeds mature in mid to late June and plants dry and cure by the end of June, leading to hazardous fire conditions.

Current Distribution on the Complex: Cheatgrass is widely distributed throughout the Complex and especially prolific in disturbed soils.

Measurable Objectives and Goal: Prevent competition with newly seeded native plants in habitat restoration sites and other disturbed soil areas.

Objectives:
   a) Monitor all newly seeded areas and other disturbed sites (e.g., remediation areas, wildfire areas, road cuts) depleted of native perennial plants.
   b) Seed disturbed sites with native species.
   c) Control cheatgrass to reduce competition with native plants germinating in the spring. Cheatgrass will be kept to comprising less than 40% of the live vegetation ground cover and spreading beyond its original infestation area.
   d) Maintain healthy stands of native perennial plants.

Control Options: The chemical treatment of cheatgrass with an appropriate herbicide provides the most effective control. Currently glyphosate, clethodim and imazapic are the herbicides used to control cheatgrass on the Complex. The identified chemical control agents were selected on their versatility and selectivity in prairie restoration areas. Glyphosate is soil
binding, inexpensive, and a low threat to groundwater quality. Imazapic is used in dry upland sites with low leaching potential. This chemical can be broadcast in restoration areas where the establishment of native grasses and herbicide resistant native broadleafs are essential for restoration success. Clethodim is considered as a selective herbicide for use in grasslands, restoration areas, fence lines and rights of way, and is considered less toxic to avian and other wildlife species than other selective grass herbicides (quizalofop, fluazifop-p-butyl, sethoxydim and metribuzin). Clethodim has a short half-life in soil and the EPA considers the chemical a low threat to groundwater quality. Other chemicals will be added as needed and be approved at the required level.

Mechanical control of cheatgrass also is conducted on the Complex with mixed results. Mowing before seed ripening probably prevents some re-seeding, but oftentimes the plants produce new stems and seeds at the mowed height. Mowing after seed ripening will kill adult plants, but dropped seeds are already viable. Repeated mowing during the growing season may be the most effective mechanical treatment, but is very labor-intensive and only practical on small infestations. Mowing is not possible in areas where cheatgrass starts seeding at a height too low for the mower and areas along fence lines. Prescribed burns in the spring or fall also help to control cheatgrass if they are followed up with an herbicide treatment.

The cultural methods of plowing, discing, etc. often cause an initial flush of cheatgrass growth that is usually controlled with herbicides before seeding with native perennial species. After restoration, the maintenance of healthy native plant communities and the minimization of disturbance help to prevent the spread of cheatgrass back into the area.

Treatment Schedule: Cheatgrass should be sprayed in the fall or early spring when plants are less than 10 cm tall and actively growing, and non-target plants are dormant. Imazapic can be used as a pre-emergent in the late summer and early fall before the germination of cheatgrass seeds.

Cardaria draba (hoary cress, whitetop)

Priority: Medium: Hoary cress is widely distributed along RMANWR waterways (especially First Creek) and small infestations have been found in upland habitat restoration sites. Hoary cress is prolific in riparian habitat and competes with native and exotic plant species on stream and ditch banks. It interferes with primary habitat management goals in these areas and the infestation will need to be controlled to accomplish any type of riparian restoration on First Creek. If the current population of this species exceeds its existing level, action will be taken to reduce or eliminate it as per its priority ranking.

Description: Hoary cress is a deep-rooted perennial that grows up to 2 feet tall. It reproduces both from root segments and seeds which mature by mid-summer. The lance-shaped leaves are blue-green in color and many white flowers bloom in May, giving the plant a white, flat-topped appearance. Hoary cress is common on alkaline and disturbed soils and spreads rapidly to form dense stands once established.

Current Distribution on the Complex: Most of First Creek and the North Bog are infested. Patches of hoary cress also can be found along most other RMANWR waterways and in some upland areas.

Measurable Objectives and Goal: Prevent competition with newly seeded native plants in habitat restoration sites, along waterways, and other disturbed soil areas.

Objectives:
  a) Monitor newly seeded upland areas and other disturbed sites (e.g., remediation areas, wildfire areas) depleted of native perennial plants.
  b) Immediately control small upland and streambank infestations to prevent further spread. 100% of infestation areas will be treated and targeted for elimination. Larger infestation patches will be mapped and measured using
geographic information software and a global positioning system device. Patches will be treated to prevent increase in the infestation area.

c) Seed controlled sites with native species to increase competition with hoary cress.

d) Maintain healthy stands of native perennial plants.

**Control Options:** The cultural methods of plowing, discing, etc., often cause an initial flush of hoary cress that may be controlled with herbicides before seeding with native perennial species. After restoration, the maintenance of healthy native plant communities and the minimization of disturbance help to prevent the spread of hoary cress into the area.

The chemical treatment of hoary cress with an appropriate herbicide also provides effective control. Currently, imazapic is the herbicide used to control small hoary cress infestations in upland areas on the Complex. This chemical may leach into groundwater systems and its use should be evaluated along streambanks depending on flows, soil permeability, depth to groundwater and other environmental factors. Imazapic is used in dry upland sites and soil types with low leaching potential.

This chemical can be broadcast in restoration areas where native grasses and resistant native broadleafs are essential for restoration success. Glyphosate is also used to control hoary cress. Glyphosate is soil binding, inexpensive, with low groundwater contamination potential. Glyphosate is a nonspecific herbicide and the use of it should be accompanied by seeding, planting, or spot use in areas where native vegetation is prolific. Additional herbicides are being investigated for use in upland sites. Metsulfuron or tank-mix of 2, 4-D and dicamba are also indicated for white top control. Metsulfuron is used in other capacities on the Complex and could be considered for future use on white top on soils with low leaching potential.

This chemical has similar use restrictions to imazapic. Dicamba has low wildlife toxicity, but is not recommended for use near water sources or leachable areas. Other chemicals will be added as needed and be approved at the required level.

**Treatment Schedule:** Hoary cress could be treated in early spring prior to restoration or at flowering to prevent seed production.

**Carduus nutans** (musk thistle)

**Priority:** Medium: Musk thistle is widely distributed throughout the RMANWR and RFNWR in habitat restoration sites, along roadways, and has invaded remnant native prairie and shrubland communities. Musk thistle is prolific in dry upland habitat and competes with native plant species in disturbed soils such as those found in recently seeded habitat restoration sites. It interferes with primary habitat management goals across the landscape, but the infestation is too large to eradicate with available technology. If the current population of this species exceeds its existing level, action will be taken to reduce it as per its priority ranking.

**Description:** Musk thistle is a biennial which grows up to 6 feet tall. Leaves are dark green, deeply lobed, spiny, and extend onto the stem. Flowers are 1 1/2 to 3 inches in diameter and are usually deep rose, violet or purple. Musk thistle spreads rapidly to form dense stands that crowd out desirable plants.

**Current Distribution on the Complex:** Musk thistle is widely distributed throughout the RMANWR and RFNWR in habitat restoration sites, along roadways, and has invaded remnant native prairie and shrubland communities and is especially prolific in disturbed soils.

**Measurable Objectives and Goal:** Prevent competition with newly seeded native plants in habitat restoration sites, along roadways, and other disturbed soil areas.

**Objectives:**

a) Monitor all newly seeded areas, roadways, and other disturbed sites (e.g., remediation areas, wildfire areas) depleted of native perennial plants.
b) Seed disturbed sites with native species if ground cover is needed.

c) Control musk thistle to reduce competition with native plants germinating in the spring. Patches of musk thistle will be kept to less than one acre in area and less than 40% of live vegetation cover.

d) Maintain healthy stands of native perennial plants.

**Control Options:** Mechanical control of musk thistle has been successful in preventing seed production and subsequent spread. Musk thistle is mowed at flowering in habitat restoration sites, along roadways, and in disturbed areas undergoing remediation. Dense stands are often mowed twice when new flowers appear. Repeated mowing during the growing season may be the most effective mechanical treatment, but is very labor-intensive. Small infestations of musk thistle rosettes also are removed by hand digging when labor is available.

The biological control agent, *Rhinocyllus conicus* (seed head weevil) was released in Colorado over 10 years ago and is well established on the Arsenal. The larvae of this weevil eat the seeds in mature flower heads. This biocontrol is probably effective in reducing musk thistle seed production by up to 50% based on casual observation and personal conversation with local IPM coordinators (BD). Infestations of individual plants or widely dispersed individuals will be examined for the presence of the *Rhinocyllus conicus* larvae and adults and left in place if infected. These infected plants can be used as farm plants for the insects with the harvested individuals relocated to larger thistle patches. Another insect, *Trichosirocalus horridus* (musk thistle weevil) has also been released at the Arsenal on a small musk thistle population in 1999 and helped to almost eradicate this isolated infestation by 2001.

The chemical treatment of musk thistle with an appropriate herbicide also provides effective control. Currently aminopyralid, glyphosate, metsulfuron methyl and imazapic are the herbicides used to control small musk thistle infestations on the Complex. Glyphosate is soil binding, inexpensive, with low groundwater contamination potential. Imazapic and aminopyralid are used in dry upland sites with low leaching potential. Aminopyralid is extremely effective on all plants in the thistle family while metsulfuron is extremely effective on thistle and common mullein plants. Imazapic, aminopyralid and metsulfuron can be broadcast in restoration areas where native grasses and resistant native broadleafs are essential for restoration success. 2, 4-D, dicamba, and picloram are also effective for thistle control.

As with all herbicides, 2, 4-D has been detected in groundwater although the sources of contamination are associated with inappropriate use and spillage. Dicamba has low toxicity for wildlife but is not recommended for use near water. Aquatic formulations of glyphosate serve as weed control near water. Restricted use pesticides are not used on the Complex at this time. Other chemicals will be added as needed and be approved at the required level.

The cultural methods of plowing, discing, etc., often cause an initial flush of musk thistle rosettes that may be controlled with herbicides before seeding with native perennial species. After restoration, the maintenance of healthy native plant communities and the minimization of disturbance help to prevent the spread of musk thistle back into the area.

**Treatment Schedule:** Musk thistle should be repeatedly mowed at flowering to prevent seed production and/or sprayed in the rosette stage in fall or early spring and when non-target plants are dormant.

*Centaura diffusa* (diffuse knapweed)

**Priority:** High: The spread of diffuse knapweed is an increasing problem along the Front Range of the Rocky Mountains. It is considered one of the most important rangeland weeds in North America. The State of Colorado considers this species one of the top ten priority weeds targeted for control. Diffuse knapweed infests disturbed areas where it forms dense colonies in pastures, croplands, waste places, and rights-of-way. It is a prolific seed producer, fast spreading, and highly agonistic with native plants – often out-competing them. If the current population of this species exceeds its existing level, action will be taken to reduce or eliminate it as per its priority ranking.
Description: Diffuse knapweed grows as an annual or short-lived perennial forb. The diffusely branched stems of mature plants are 1 to 2 feet tall, rough to the touch, and tipped with numerous slender, white to purplish flower heads. Prominent yellow bracts with comb-like margin projections subtend the flower. The leaves are pinnately divided near the plant’s base; the leaf margins appear entire towards the inflorescence. Flowering occurs from July through September.

Current Distribution on the Complex: Small infestations of diffuse knapweed are situated on the perimeter and along roadways of the Complex. Individual plants have been identified in the native seeded areas in Section 2.

Measurable Objectives and Goal: Prevent competition with newly seeded native plants in habitat restoration sites, along roadways, and other disturbed soil areas.

Objectives:
   a) Monitor known infestation sites, newly seeded areas, roadways, and other disturbed sites (e.g., remediation areas, wildfire areas) depleted of native perennial plants.
   b) Seed disturbed sites with native species.
   c) Treat 100% of diffuse knapweed plants - targeting for elimination - to reduce competition with native plants and prevent establishment of knapweed and knapweed seed bank. Larger infestation patches will be mapped and measured using geographic information software and a global positioning system device. Patches will be treated to prevent increase in the infestation area.
   d) Maintain healthy stands of native perennial plants.

Control Options: Hand pulling or digging is a feasible control of small infestations and individual plants. The taproot will be removed to at least 2 inches below the ground surface.

Insect species that target diffuse knapweed include the seedhead weevils (*Cyphocleonus achates*), broad-nosed seedhead weevil (*Bangasternus fausti*), and the seedhead-targeting Sulphur knapweed moth (*Agapeta zoegana*). These insects reduce seed production which assists in slowing or eliminating spread. Biological agent will be an option in areas that are prohibited to other forms of control and pending the availability of the insect. Biological control of diffuse knapweed on the Arsenal has been attempted in the past. On long standing infestations, a combination of weevils and moths has slowed patch expansion.

The chemical treatment of diffuse knapweed with an appropriate herbicide provides relatively effective control. Currently, aminopyralid and glyphosate are the herbicides used to control diffuse knapweed on the Complex. Glyphosate is soil binding, inexpensive, and a low threat to groundwater quality. Aminopyralid is used in dry upland sites and on soils with low leaching potential. These chemicals can be broadcast in restoration areas where the establishment of native grasses and herbicide resistant native broadleafs are essential for restoration success. Other recommended chemical treatments for diffuse knapweed are clopyralid, dicamba, and 2, 4-D. Restricted use pesticides are not used on the Complex at this time. Clopyralid is not recommended for use on permeable soils due to potential groundwater contamination. Dicamba has low toxicity for wildlife but is not recommended for use near water. Aquatic formulations of glyphosate currently serve for weed control near water. 2, 4-D may be used for future knapweed control with its effectiveness monitored and the herbicide reevaluated for broader uses. As with all herbicides, 2, 4-D has been detected in groundwater although the sources of contamination are associated with inappropriate use and spillage. Other chemicals will be added as needed and be approved at the required level.

Treatment Schedule: Hand removal may be conducted 2 to 3 times during the growing season, the first removal occurring early in the season (June) before bolt. Established areas too large to practically control by hand, or in areas prohibited to chemical control, may be mowed monthly to prevent floret emergence and seed production.
The release of seed head weevils should occur as the leaves of the plants appear in June to the budding stage. Control is less effective if seeds have already formed.

The application of aminopyralid or glyphosate may occur during the growing season (June - November). The most effective time of control is during the rosette or bolt stage before budding. Annual treatment is necessary as long as there is a viable seed source.

_Centaurea maculosa_ (spotted knapweed)

**Priority:** High: The State of Colorado considers this species one of the top ten priority weeds targeted for control. Spotted knapweed infests disturbed areas where it forms dense colonies in pastures, croplands, waste places, and rights-of-way. It is a prolific seed producer, fast spreading, and highly agonistic with native plants – often out-competing them. Populations enlarge by peripheral expansion of existing stands. Biodiversity, livestock and wildlife forage quality are reduced with infestations of spotted knapweed. If the current population of this species exceeds its existing level, action will be taken to reduce or eliminate it as per its priority ranking.

**Description:** Spotted knapweed is a biennial or short-lived perennial forb with a deep taproot. Plants reach 1 to 3 feet with one or more branched stems. The basal leaves vary in morphology from entire to pinnate and elliptical to oblanceolate. The principal stem leaves are pinnately divided. Flowers are primarily light purple (rarely white). Involucral bracts are stiff with a finely branched, dark tip. Flowering occurs from June through September.

**Current Distribution on the Complex:** Small infestations of spotted knapweed have been found in sections 19 and 20. At these locations, spotted knapweed is associated with diffuse knapweed. The sites are loamy soil with stands of crested wheatgrass and weedy forbs.

**Measurable Objectives and Goal:** Prevent competition with newly seeded native plants in habitat restoration sites, along roadways, and other disturbed soil areas.

**Objectives:**

- a) Monitor known infestation sites, newly seeded areas, roadways, and other disturbed sites (e.g., remediation areas, wildfire areas) depleted of native perennial plants.
- b) Seed disturbed sites with native species.
- c) Treat and control 100% of spotted knapweed plants - targeting for elimination - to reduce competition with native plants and prevent establishment of knapweed and knapweed seed bank. Larger infestation patches will be mapped and measured using geographic information software and a global positioning system device. Patches will be treated to prevent increase in the infestation area.
- d) Maintain healthy stands of native perennial plants.

**Control Options:** Hand pulling or digging is a feasible control of small infestations and individual plants. The taproot will be removed to at least 2 inches below the ground surface. Entire plants will be removed from the site to limit the source of available seeds.

No biological control of this species has been conducted on the RMANWR. Biological control of spotted knapweed is not effective in eliminating stands. Insect larvae are available that target flowers, roots, shoots, and leaves leading to reduced seed production. Two commonly used organisms that target spotted knapweed roots are the sulphur knapweed moth (_Agapeta zoegana_) and the knapweed weevil (_Cyphocleonus achates_). Biological control will be used in new and current infestations that cannot be controlled by hand or chemical treatment.
The chemical treatment of spotted knapweed with an appropriate herbicide provides relatively effective control. Currently, aminopyralid and glyphosate are the herbicides used to control spotted knapweed on the Complex. Other recommended chemical treatments for spotted knapweed are clopyralid, dicamba, and 2, 4-D. Restricted use pesticides are not used on the Complex at this time. Clopyralid is not recommended for use on permeable soils due to potential groundwater contamination. Dicamba has low toxicity for wildlife but is not recommended for use near water. Aquatic formulations of glyphosate currently serve for weed control near water. 2, 4-D may be used for future knapweed control with its effectiveness monitored and the herbicide reevaluated for broader use. As with all herbicides, 2, 4-D has been detected in groundwater although the sources of contamination are associated with inappropriate use and spillage. Other chemicals will be added as needed and be approved at the required level.

**Treatment Schedule:** Hand removal may be conducted 2 to 3 times during the growing season, the first removal occurring early in the season (June) before bolt. Established areas too large to practically control by hand, or in areas prohibited to chemical control, should be mowed monthly to prevent floret emergence and seed production.

Spotted knapweed root-mining insects, if used, should be applied during the active growing season.

Aminopyralid or glyphosate may be applied during the growing season (June - November). The most effective time of control is during the bolt to bud stage. Annual treatment is necessary as long as there is a viable seed source.

**Centaurea repens** (Russian knapweed)

**Priority:** High: The State of Colorado considers this species one of the top ten priority weeds targeted for control. Russian knapweed invades open, disturbed areas. This species forms monotypic stands, suppressing the growth of other vegetation. Rapidly creeping rhizomes and deep taproots (up to 8 feet) make this species difficult to control. Reproduction is primarily by adventitious roots. If the current population of this species exceeds its existing level, action will be taken to reduce or eliminate it as per its priority ranking.

**Description:** Russian knapweed is a perennial forb with openly branched stems, 18 to 36 inches tall. Basal and lower leaves are deeply lobed; upper leaves are entire or serrate. Flowers are pink with rounded, papery involucral bracts. Plants grow in dense, spreading mats due to rhizomatous roots. Flowering occurs June through September.

**Current Distribution on the Complex:** Infestations of Russian knapweed have been discovered at several locations on the Complex. Most of the infestation sites are in cheatgrass and weedy forb vegetation that are scheduled for restoration. Small areas of Russian knapweed are situated on the east perimeter of the RMANWR.

**Measurable Objectives and Goal:** Prevent competition with newly seeded native plants in habitat restoration sites, along roadways, and other disturbed soil areas.

**Objectives:**
- a) Monitor known infestation sites, newly seeded areas, roadways, and other disturbed sites (e.g., remediation areas, wildfire areas) depleted of native perennial plants.
- b) Seed disturbed sites with native species.
- c) Treat and control 100% of Russian knapweed plants - targeting for elimination - to reduce competition with native plants and prevent establishment of knapweed and knapweed seedbank. Larger infestation patches will be mapped and measured using geographic information software and a global positioning system device. Patches will be treated to prevent increase in the infestation area.
- d) Maintain healthy stands of native perennial plants.
Control Options: Removal of the above-ground tissue by mowing or hand-scything weakens the plant, reduces root growth, and prevents seed production.

No biological control has been conducted since 1997. In 1996 and 1997, nematodes (*Subanguina picridis*) were released on the Arsenal with resulting little effect on the knapweed.

The chemical treatment of Russian knapweed with an appropriate herbicide provides relatively effective control. Currently, aminopyralid or glyphosate are the herbicides used to control Russian knapweed on the Complex. Glyphosate is soil binding, inexpensive, with low groundwater contamination potential. Glyphosate is a nonspecific herbicide and the use of it should be accompanied by seeding or planting. Aminopyralid is used in dry upland sites and on soils with low leaching potential. This chemical can be broadcast in restoration areas where the establishment of native grasses and herbicide resistant native broadleafs are essential for restoration success. Additional herbicides are being investigated that do not have a propensity to leach and contaminate groundwater. Clopyralid and 2, 4-D is also effective on knapweeds. Restricted use pesticides are not used on the Complex at this time. Clopyralid is not recommended for use on leachable soils. 2, 4-D may be used on the Complex with its effectiveness monitored. As with all herbicides, 2, 4-D has been detected in groundwater although the sources of contamination are associated with inappropriate use and spillage. Other chemicals will be added as needed and be approved at the required level.

The reseeding of disturbed areas is effective in preventing the infestation of Russian knapweed.

Treatment Schedule: Top growth should be removed before bolting during the growing season (June - mid-August) to weaken Russian knapweed plants. Plants that re-emerge (mid-August to September) are smaller and more vulnerable to further top removal and herbicide effect.

Glyphosate may be applied once or twice during the growing season (June - November). Aminopyralid can be applied in spring and summer to plants that are in bud to flowering stage, and to dormant plants in the fall. Top-growth of Russian knapweed can be controlled by applying herbicide during the bud stage. Root control is achieved by timing applications to the late bud and fall growth stage.

*Cirsium arvense* (Canada thistle)

Priority: Low to Medium: The priority for controlling this species is dependent upon location. The State of Colorado considers this species one of the top ten priority weeds targeted for control. Canada thistle can form monocultures, crowding out desirable species. Extensive horizontal roots give rise to shoots. This species infests roadsides, pastures, cropland, disturbed areas, and riparian areas. The dense growth pattern and spiny leaves of Canada thistle deters passage and consumption by wildlife. If the current population of this species exceeds its existing level, action will be taken to reduce or eliminate it as per its priority ranking.

Description: Canada thistle is a dioecious, colony-forming perennial forb. Stems reach 1 to 4 feet with branching tops. Flowers are purple with spineless bracts. The leaves are irregularly lobed and tipped with tiny spines. Flowering occurs July through August.

Current Distribution on the Complex: Canada thistle is widely distributed on the Complex, found in various soil types and vegetation communities. This species invades re-seeded restoration areas, waste areas, and riparian zones.

Measurable Objectives and Goal: Prevent competition with newly seeded native plants in habitat restoration sites, along roadways, and other disturbed soil areas.
Objectives:

a) Monitor known infestation sites, newly seeded areas, roadways, and other disturbed sites (e.g., remediation areas, wildfire areas) depleted of native perennial plants.

b) Seed disturbed sites with native species.

c) Canada thistle control applied to keep infestations to less than 1 acre in area and weedy species comprising 40% or less of live vegetation cover.

d) Maintain healthy stands of native perennial plants.

Control Options: The extensive nature of the Canada thistle infestation on the Complex makes it impractical to control with simple hand methods. The removal of shoots by mowing is a viable option. The continued removal of above ground photosynthetic tissue has been shown to weaken plants and limit their spread through carbohydrate starvation.

The stem-and-shoot gadfly (*Urophora cardui*), Canada thistle beetles (*Ceutorhyncus litura*), and Canada thistle flower head weevils (*Larinus planus*) are biological agents that has been used in wetland areas at the Arsenal. The agents have proved to reduce the density of mature plants in the application area. The use of these insects is an option in areas that are sensitive to chemical or mechanical control methods.

The chemical treatment of Canada thistle with an appropriate herbicide provides relatively effective control. Currently, aminopyralid or glyphosate are the herbicides used to control Canada thistle on the Complex. Glyphosate is soil binding, inexpensive, with low groundwater contamination potential. Glyphosate is a nonspecific herbicide and the use of it should be accompanied by seeding or planting. Aminopyralid is used in dry upland sites and on soils with low leaching potential. This chemical can be broadcast in restoration areas where the establishment of native grasses and herbicide resistant native broadleafs are essential for restoration success. Other herbicides that are shown to be effective on Canada thistle are clopyralid, and 2, 4-D. Restricted use pesticides are not used on the Complex at this time. Clopyralid is not recommended for use on leachable soils. 2, 4-D may be used on the Complex with its effectiveness monitored. As with all herbicides, 2, 4-D has been detected in groundwater although the sources of contamination are associated with inappropriate use and spillage. Other chemicals will be added as needed and be approved at the required level.

Treatment Schedule: Hand pulling or digging of plants in the rosette stage is effective for small infestations. Monthly mowing or scything of bolted plants in moist soil areas or areas with a high water table (riparian/wetlands) are effective in limiting spread.

The stem-and-shoot gadfly may be released in June through July for new and existing invaded wetland areas where chemical and mechanical controls are not feasible.

Chemical control may occur in spring and fall, 1-2 times per season (June-October), particularly in the fall when shoot to root translocation is highest. This species is sensitive to moisture content. Application of pesticide should occur when moisture condition is higher.

*Cirsium vulgare* (bull thistle)

Priority: **Low to Medium:** The priority for controlling this species is dependent upon location. Bull thistle grows in moist to dry areas, particularly in loamy or clay soils. It is a rapidly proliferating transient species in disturbed, open sites. Native vegetation and wildlife habitat value are compromised by infestation. If the current population of this species exceeds its existing level, action will be taken to reduce or eliminate it as per its priority ranking.
**Description:** Bull thistle is a biennial forb with a rosette forming the first year. A short tap root supports a 2 to 5 foot many-branched stem during the second year. The leaves are pinnately lobed, prickly, with a cottony underside. The involucre of the light purple flower is covered with long spines. Flowering occurs from July through September.

**Current Distribution on the Complex:** Bull thistle has not produced major infestations on the Complex.

**Measurable Objectives and Goal:** Prevent competition with newly seeded native plants in habitat restoration sites, along roadways, and other disturbed soil areas.

**Objectives:**
- a) Monitor known infestation sites, newly seeded areas, roadways, and other disturbed sites (e.g., remediation areas, wildfire areas) depleted of native perennial plants.
- b) Seed disturbed sites with native species.
- c) Control Bull thistle to reduce competition with native plants by preventing seed production and keeping infestations to less than 1 acre and less than 40% of live vegetation cover.
- d) Maintain healthy stands of native perennial plants.

**Control Options:** Small stands of Bull thistle may be mowed, scythed, or hand cut to remove the bolted, but not flowered stem. Hand cutting will include removing the stem and root crown.

The bull thistle seedhead gall fly (*Urophora stylata*) is effective in reducing stand density. This bio agent is not available in Colorado at the present time.

The chemical treatment of Bull thistle with an appropriate herbicide provides relatively effective control. Currently, aminopyralid or glyphosate are the herbicides used to control Bull thistle on the Complex. Glyphosate is soil binding, inexpensive, and a low threat to groundwater quality. Aminopyralid is used in dry upland sites and on soils with low leaching potential. This chemical can be broadcast in restoration areas where the establishment of native grasses and herbicide resistant native broadleaves are essential for restoration success. Other herbicides indicated for thistle control are dicamba, and 2, 4-D. Restricted use pesticides are not used on the Complex at this time. Dicamba is not for use near water. As with all herbicides, 2, 4-D has been detected in groundwater although the sources of contamination are associated with inappropriate use and spillage. Other chemicals will be added as needed and be approved at the required level.

**Treatment Schedule:** Mechanical and hand removal may occur during bolt but before flowering (late June - July). Late bolting plants need removal before flowering to prevent seed formation. Herbicides may be applied during the growing season (April - November). Application should occur during the rosette stage or after mowing or scything.

**Chondrilla juncea (rush skeletonweed)**

**Priority:** Low: Rush skeleton weed establishes in well drained soils, preferring areas with winter and spring moisture. Waste places and disturbed sites are most vulnerable to infestation. Once established, skeletonweed forms dense monocultures. An extensive taproot makes this species difficult to control. Skeletonweed competes with native vegetation and reduces the quality of wildlife forage. This species is well established in the western U.S. and is increasing its range. If the current population of this species exceeds its existing level, action will be taken to reduce or eliminate it as per its priority ranking.

**Description:** Rush skeletonweed is a perennial forb with inconspicuous, narrow leaves. The many branched stems appear to be leafless. The plants grow from 1 to 4 feet tall. The yellow flower heads are less than one inch in diameter and scattered on the branches. Leaves and stems ooze a milky latex when opened. Flowering occurs from mid-July until frost.
**Current Distribution on the Complex:** There are no infestations recorded on the Complex.

**Measurable Objectives and Goal:** Prevent competition with newly seeded native plants in habitat restoration sites, along roadways, and other disturbed soil areas.

**Objectives:**

a) Monitor for infestation — especially in newly seeded areas, roadways, and other disturbed sites (e.g., remediation areas, wildfire areas) depleted of native perennial plants.

b) Seed disturbed sites with native species.

c) Control rush skeletonweed to reduce competition with native plants by keeping infestation to less than 20% of live vegetation cover and preventing spread of infestation.

d) Maintain healthy stands of native perennial plants.

**Control Options:** Hand pulling is effective in controlling small infestations.

The chemical treatment of rush skeletonweed with an appropriate herbicide provides relatively effective control. Currently, glyphosate is the herbicide intended to control rush skeleton weed on the Complex. Glyphosate is soil binding, inexpensive, and a low threat to groundwater quality. This chemical can be broadcast in restoration areas where the establishment of native grasses and herbicide resistant native broadleaves are essential for restoration success. Other herbicides indicated for rush skeleton weed control are dicamba, and clopyralid. Restricted use pesticides are not used on the Complex at this time. Dicamba has low wildlife toxicity but is not for use near water. Clopyralid is not recommended for use on soil types and locations with high leachability. Other chemicals will be added as needed and be approved at the required level.

**Treatment Schedule:** Pulling may be conducted at least twice during the growing season (May - October) to prevent extensive root formation.

Herbicide may be applied during the growing season (May - October). Chemicals should be applied after bolting but before flowering. Applications will continue annually until the infestation is eliminated.

**Convolvulus arvensis** (field bindweed)

**Priority:** Low to Medium: Field bindweed is highly competitive species with prodigious powers of regeneration from roots and rhizomes. Bindweed can survive a wide range of environmental conditions, but disturbed soil is a necessity for invasion. Bindweed is a threat to the regeneration of native vegetation. If the current population of this species exceeds its existing level, action will be taken to reduce or eliminate it as per its priority ranking.

**Description:** Field bindweed is perennial forb growing as a climbing and prostrate vine that forms dense mats. The taproot is deep, forming an extensive root system. The leaves are sagittate; flowers are bell-shaped and pink to white. Blooming occurs from June until frost.

**Current Distribution on the Complex:** Bindweed is widely spread throughout the Complex, invading disturbed areas, waste places, and restoration areas.

**Measurable Objectives and Goal:** Prevent competition with newly seeded native plants in habitat restoration sites, along roadways, and other disturbed soil areas.

**Objectives:**
a) Monitor known infestation sites, newly seeded areas, roadways, and other disturbed sites (e.g., remediation areas, wildfire areas) depleted of native perennial plants.
b) Seed disturbed sites with native species.
c) Control field bindweed to reduce competition with native plants by keeping any infestation at less than 40% of live vegetation cover.
d) Maintain healthy stands of native perennial plants.

Control Options: Mechanical and hand methods of control are impractical and ineffective due to the species’ distribution and ability to regenerate from severed roots and rhizomes.

The chemical treatment of field bindweed with an appropriate herbicide provides relatively effective control. Currently, glyphosate and quinclorac are the herbicides used to control field bindweed on the Complex. Glyphosate is soil binding, inexpensive, and a low threat to groundwater quality. These chemicals can be broadcast in restoration areas where the establishment of native grasses and herbicide resistant native broadleafs are essential for restoration success. Other herbicides indicated for field bindweed control are dicamba, and 2, 4-D. Restricted use pesticides are not used on the Complex at this time. Dicamba has low wildlife toxicity but is not for use near water. As with all herbicides, 2, 4-D has been detected in groundwater although the sources of contamination are associated with inappropriate use and spillage. Other chemicals will be added as needed and be approved at the required level.

The field bindweed moth (Tyta luctuosa) and the field bindweed mite (Aceria malherbae) have been used to control field bindweed at the RMANWR. These agents were first released in 2001 and have proved to be effective.

Treatment Schedule: Herbicides may be applied during the growing season (June - November). The period of highest chemical effectiveness is in the early flowering stage. Invaded sites will be monitored to determine the local variation in conditions that lead to the plants’ flowering time. Multiple year applications may be necessary.

The field bindweed moth and field bindweed mite can be released to heavily infested bindweed sites during the early growing season (June through August). The release of bioagents will be dependent on the insects’ availability.

Elaeagnus angustifolia (Russian olive)

Priority: Medium to High: The priority for controlling this species is dependent upon location and degree of infestation. Russian olives were introduced as an ornamental shade tree into North America from Europe. This species is prolific, especially in low-lying and riparian areas. Despite providing some habitat for wildlife, Russian olives crowd-out native vegetation and reduce available water and wildlife habitat in riparian and palustrine areas. If the current population of this species exceeds its existing level, action will be taken to reduce or eliminate it as per its priority ranking.

Description: Russian olives are fast-growing trees reaching up to 25 feet. Leaves are lanceolate, leathery, and silvery-green color. The branches and trunk have 1 to 2 inch woody thorns. Flowering trees omit a powerfully sweet odor. Mature fruits are oval, tan, and about ½ inch in length.

Current Distribution on the Complex: Russian olives are most numerous in areas around the lakes, spillways, and old homestead sites.

Measurable Objectives and Goal: Prevent competition with newly seeded and established native plants in habitat restoration sites, along roadways, other disturbed soil, and wetland areas.
Objectives:

a) Monitor for infestation — especially in riparian, newly and established seeded areas, roadways, old homesites, areas formerly planted with ornamentals, and other disturbed sites (e.g., remediation areas, wildfire areas) depleted of native perennial plants.
b) Seed disturbed sites with native species.
c) Control 100% of Russian olive to reduce competition with native plants by methodical removal and stump treatment of established trees and preventing the establishment of saplings.
d) Maintain healthy stands of native perennial plants.

Control Options: The above ground portions of living trees can be removed by hand or chain sawing. This action provides an immediate increase in light exposure to the understory. Trees will regenerate from below ground if the roots are not killed. To prevent regrowth, smaller trees may be dug out by hand. Larger trees may be removed with mechanical equipment (e.g. backhoe) if access to the site can be made without significant impact.

Glyphosate, glyphosate/imazapyr mix, imazapyr/triclopyr and triclopyr are effective in controlling Russian olives in all stages of growth. Glyphosate is soil binding, inexpensive, and has a low threat to groundwater quality. A combination of chemical and mechanical treatment is also highly effective — stumps are painted or whole trees and stumps are injected with herbicide. Tebuthiuron is an effective woody plant control agent but has propensity to leach in coarse soils.

Treatment Schedule: Mechanical removal of trees may occur during all seasons.

Foliar chemical treatment may be conducted during the growth period (July - October). Mechanical and chemical combination treatment may be conducted any time of year, but is most effective during the growing season.

Euphorbia esula (leafy spurge)

Priority: High: Leafy spurge is an aggressive colonizer of disturbed and undisturbed areas. After spurge invasion, native vegetation is quickly out-competed. This species produces an allelopathic compound that inhibits the growth of other plants. Leafy spurge poses a threat to successful native vegetation restoration. This non-native spurge is generally unpalatable and in some grazing species severely irritating and disruptive to digestion; therefore, the habitat value of infested areas is reduced. Leafy spurge is on the State of Colorado’s list of top ten priority weeds targeted for control. If the current population of this species exceeds its existing level, action will be taken to reduce or eliminate it as per its priority ranking.

Description: Leafy spurge is a perennial forb reproducing by seeds and an extensive system of lateral rootstalks. Thickly clustered stems reach up to 3 feet. The leaves are alternate and linear-lanceolate. The flowers are small, yellow and arranged in clusters. The clusters are subtended by greenish-yellow, widely ovate bracts. Flowering occurs June through July.

Current Distribution on the Complex: Small patches of spurge (totaling < 1 acre) exist on the Arsenal in Sections 1, 6, 14, 32, and 34. The environments are disturbed cottonwood woodland and open areas reseeded with native perennial grasses.

Measurable Objectives and Goal: Prevent competition with newly seeded native plants in habitat restoration sites, along roadways, disturbed soil areas, and any other area the plants are found.

Objectives:

a) Monitor known infestation sites, newly seeded areas, roadways, and other disturbed sites (e.g., remediation areas, wildfire areas) depleted of native perennial plants.
b) Seed disturbed sites with native species.
c) Treat 100% of leafy spurge plants - targeting for elimination - to reduce competition with native plants and stop the spread of infestations.

d) Maintain healthy stands of native perennial plants.

e) Perform regular surveys and collect field observations to detect newly invaded sites.

**Control Options:** Mechanical treatment of leafy spurge is not effective due to the extensive and deep root system. The chemical treatment of leafy spurge with an appropriate herbicide provides relatively effective control. Currently, glyphosate and imazapic are the herbicides used to control leafy spurge on the Complex. Glyphosate is soil binding, inexpensive, and a low threat to groundwater quality. Imazapic is used in dry upland sites and on soils with low leaching potential. This chemical can be broadcast in restoration areas where the establishment of native grasses and herbicide resistant native broadleafs are essential for restoration success. Restricted use pesticides are not used on the Complex at this time. Other chemicals will be added as needed and be approved at the required level.

Effective biocontrol of leafy spurge is limited due to the plants’ thick latex sap that tends to clog the mouth parts of sucking insects. The brown-legged spurge flea beetle (*Apthona lacertosa*) and the amber spurge flea beetle (*A. flava*) have been released on RMANWR with moderate success. A combination of biocontrol and chemical application resulted in the elimination of one small patch.

**Treatment Schedule:** Herbicide may be applied during the growing season. One application in the spring, before seed formation, will reduce the available seed bank. Fall spraying (September-October) will reduce food storage in the roots. The release of biological agents’ occurred during the early to mid-growing season of 1999.

**Hypericum perforatum** (St. Johnswort)

**Priority:** Medium to High: St. Johnswort invades disturbed sites along roadsides, over-grazed pastures and range areas. It prefers dry, sandy to gravelly soil. St. Johnswort forms a deep, laterally spreading root system that forms new plants vegetatively from root buds. Dense growth of these plants inhibits regeneration of native species. If the current population of this species exceeds its existing level, action will be taken to reduce or eliminate it as per its priority ranking.

**Description:** St. Johnswort is a perennial shrub-like forb. The stems produce numerous branches and reach 1 to 3 feet high. Leaves are up to one inch long, opposite, entire, and contain numerous transparent dots. Flowers are yellow arranged in open, flat-topped cymes.

**Current Distribution on the Complex:** St. Johnswort has been identified at three locations on the Arsenal—sections 2, 28, and 29 and covering a total of 2.5 acres.

**Measurable Objectives and Goal:** Prevent competition with newly seeded native plants in habitat restoration sites, along roadways, and other disturbed soil areas.

**Objectives:**

a) Monitor known infestation sites, newly seeded areas, roadways, and other disturbed sites (e.g., remediation areas, wildfire areas) depleted of native perennial plants.

b) Seed disturbed sites with native species.

c) Treat 100% of St. Johnswort plants - targeting for elimination - to reduce competition with native plants and stop the spread of infestations.

d) Maintain healthy stands of native perennial plants.

**Control Options:** Small infestations of new plants will be pulled by hand or dug out.
Glyphosate is effective in controlling St. Johnswort. Glyphosate is soil binding, inexpensive, and a low threat to groundwater quality. Other herbicides indicated for effective St. Johnswort control are metsulfuron methyl and 2, 4-D. Restricted use pesticides are not used on the Complex at this time. As with all herbicides, 2, 4-D has been detected in groundwater although the sources of contamination are associated with inappropriate use and spillage. Other chemicals will be added as needed and be approved at the required level.

Biological control of St. Johnswort with the Klamath weed beetle (*Chrysolina quadrigemia*) has been very effective in North America. These beetles were first released on the Arsenal in section 28 (in 2000), successfully established, and transferred to the infestation in section 29 in 2001. Due to the success of these beetles in controlling St. Johnswort, their continued use for established and new infestations is the preferred method of control.

**Treatment Schedule:** Removal and disposal of plants should be done in early spring (before flower formation).

Spot spraying with glyphosate before flowering can be an effective control method if repeated applications are made. Bolting and flowering occur early and continue through late summer (June - September). Patches need to be monitored for newly sprouted plants throughout the summer.

The release of Klamath weed beetles should be made in July to new or non-beetle infested areas.

Beetles (if available) established in an area on the Complex will be harvested and used as colonizers.

*Kochia scoparia* (kochia)

**Priority:** Low: Kochia is a rapid colonizer of disturbed sites, potentially suppressing other vegetation. It grows in a variety of soil types and prefers open, unshaded areas. If the plants are vigorous, kochia will invade undisturbed prairie, floodplains, riparian, and arid environments. Dense growth of these plants inhibits the regeneration of native species and may threaten the success of prairie restoration projects. Seed production varies according to environmental conditions; with adequate moisture a single plant may produce over 500,000 seeds. If the current population of this species exceeds its existing level, action will be taken to reduce or eliminate it as per its priority ranking.

**Description:** Kochia is a many-branched annual forb reaching 1 to 6 feet high. The stem is softly hirsute and tinged with red. The lanceolate leaves are alternate, and the edges and bottom sides are covered with soft hair. The flowers are inconspicuous and form spikes in the axils of the upper leaves. Flowering is from July to October.

**Current Distribution on the Complex:** Kochia is wide spread throughout the Arsenal. It occupies disturbed, reseeded restoration areas, riparian, and waste areas.

**Measurable Objectives and Goal:** Prevent competition with newly seeded native plants in habitat restoration sites, along roadways, and other disturbed soil areas.

**Objectives:**

a) Monitor known infestation sites, newly seeded areas, roadways, and other disturbed sites (e.g., remediation areas, wildfire areas) depleted of native perennial plants.

b) Seed disturbed sites with native species.

c) Control kochia to keep infestations less than 40% of live vegetation cover and to reduce competition with native plants.

d) Maintain healthy stands of native perennial plants.
**Control Options:** Small infestations can be pulled by hand. Mowing or scything of seed heads will deplete the seed bank. Imazapic is an effective herbicide for kochia control. Imazapic is used in dry upland sites and on soils with low leaching potential. This chemical can be broadcast in restoration areas where the establishment of native grasses and herbicide resistant native broadleafs are essential for restoration success. Other herbicides effective for kochia control are glyphosate, dicamba, and metsulfuron methyl. Glyphosate is not practical for use in restoration sites due to its broad specificity. The number of plants sensitive to dicamba is high which could jeopardize establishment of native species in restoration projects. Metsulfuron methyl which is used on the Complex for thistle and mullein control is effective for kochia. A tank mix of dicamba and 2, 4-D has proved effective for kochia control. As with all herbicides, 2, 4-D has been detected in groundwater although the sources of contamination are associated with inappropriate use and spillage. Other chemicals will be added as needed and be approved at the required level.

**Treatment Schedule:** Hand removal, mowing, and scything of plants may be conducted as they emerge (April - June) and before seed formation (July - October).

Herbicide may apply in the spring (April - June) to minimize flowering and seed production.

**Linaria dalmatica** (dalmatian toadflax)

**Priority:** High: Dalmatian toadflax is an aggressive, colony-forming invasive. This species is opportunistic in invading disturbed sites, but it can also press into established vegetation communities in good condition. Native communities and restored sites may be jeopardized by the creeping expansion of Dalmation toadflax adventitious root buds. Competition between natives and toadflax may make the community more vulnerable to other invasive species. Dalmation toadflax produces a toxic substance and is unpalatable to livestock and wildlife. If the current population of this species exceeds its existing level, action will be taken to reduce or eliminate it as per its priority ranking.

**Description:** Dalmatian toadflax is a perennial forb reaching up to 3 feet in height. Reproduction is by seed and underground root stalks. Leaves are alternate and variable in shape - ovate to lanceolate. Leaves and stems are robust, glabrous with whitish or bluish cast. Flowers grow at the axils of the upper leaves. The spurred-flower is yellow with an orange center. Flowers bloom late June through October.

**Current Distribution on the Complex:** Small patches (total of 0.021 acres) of Dalmation toadflax have been identified on the Arsenal in sections 2, 11, 32, 33. A few sites only have one or two plants; all of the sites have been treated. Toadflax has invaded nearly all of the RFNWR.

**Measurable Objectives and Goal:** Prevent competition with newly seeded native plants in habitat restoration sites, along roadways, and other disturbed soil areas.

**Objectives:**

a) Monitor known infestation sites, newly seeded areas, roadways, and other disturbed sites (e.g., remediation areas, wildfire areas) depleted of native perennial plants.

b) Seed disturbed sites with native species.

c) Treat 100% of Dalmation toadflax plants - targeting for elimination - to reduce competition with native plants.

d) Maintain healthy stands of native perennial plants.

**Control Options:** Hand pulling individual plants before seed set decreases seed production. Scything or mowing of stands before seed set is also effective. These methods do not kill the plant; just affect its reproductive potential.
The chemical treatment of dalmation toadflax with an appropriate herbicide provides relatively effective control. Currently, glyphosate and imazapic are the herbicides used to control Dalmation toadflax on the Arsenal. Glyphosate is soil binding, inexpensive, and a low threat to groundwater quality. Glyphosate is appropriate for spot treatments, but its broad specificity precludes broadcast applications. Imazapic is used in dry upland sites and on soils with low leaching potential. This chemical can be broadcast in restoration areas where the establishment of native grasses and herbicide resistant native broadleafs are essential for restoration success. Restricted use pesticides are not used on the Complex at this time. As with all herbicides, 2, 4-D has been detected in groundwater although the sources of contamination are associated with inappropriate use and spillage. Other chemicals will be added as needed and be approved at the required level.

**Treatment Schedule:** The removal of above ground portions of the plant before seed set should be done in April through July. The seeds are long-lived; annual removal of plants for up to ten years is necessary to deplete the seed bank. Applications of glyphosate and imazapic may be made during the growing season (April - November). Fall applications are particularly effective in decreasing the available stored carbohydrates in the roots.

*Linaria vulgaris* (yellow toadflax)

**Priority:** High: Yellow toadflax is an aggressive, colony-forming invasive. This species is opportunistic in invading disturbed sites, but it can also press into established vegetation communities in good condition. Native communities and restored sites may be jeopardized by the creeping expansion of yellow toadflax adventitious root buds. Competition between natives and toadflax may make the community more vulnerable to other invasive species. Yellow toadflax produces a toxic substance and is unpalatable to livestock and wildlife. If the current population of this species exceeds its present level, action will be taken to reduce or eliminate it as per its priority ranking.

**Description:** Yellow toadflax is a perennial forb, 1 to 2 feet, with pale green, alternate, linear leaves. The base of the branched stem is woody. Stems and leaves are pale green. Flowers are spurred and yellow with an orange center.

**Current Distribution on the Complex:** A small patch (0.003 acres) of yellow toadflax has been treated in section 8 on the RMANWR.

**Measurable Objectives and Goal:** Prevent competition with newly seeded native plants in habitat restoration sites, along roadways, and other disturbed soil areas.

**Objectives:**

a) Monitor known infestation sites, newly seeded areas, roadways, and other disturbed sites (e.g., remediation areas, wildfire areas) depleted of native perennial plants.

b) Seed disturbed sites with native species.

c) Treat 100% of yellow toadflax plants - targeting for elimination - to reduce competition with native plants.

d) Maintain healthy stands of native perennial plants.

**Control Options:** Hand pulling individual plants before seed set decreases seed production. Scything or mowing of stands before seed set is also effective. These methods do not kill the plant.

The chemical treatment of yellow toadflax with an appropriate herbicide provides relatively effective control. Currently, glyphosate and imazapic are the herbicides used to control yellow toadflax on the Complex. Glyphosate is soil binding, inexpensive, and a low threat to groundwater quality. Glyphosate is appropriate for spot treatments, but its broad specificity precludes broadcast applications. Imazapic is used in dry upland sites and on soils with low leaching potential. This chemical can be broadcast in restoration areas where the establishment of native grasses and herbicide resistant native broadleafs are
essential for restoration success. 2, 4-D, and dicamba are also indicated for effective control of yellow toadflax. Restricted use pesticides are not used on the Complex at this time. As with all herbicides, 2, 4-D has been detected in groundwater although the sources of contamination are associated with inappropriate use and spillage. Other chemicals will be added as needed and be approved at the required level.

**Treatment Schedule:** The removal of above ground portions of the plant before seed set should be done in April through July. The seeds are long-lived; annual removal of plants for up to ten years is necessary to deplete the seed bank.

Applications of glyphosate and imazapic can be made during the growing season (April - November). Fall applications are particularly effective in decreasing the available stored carbohydrates in the roots.

*Xopordum ancanthium* (Scotch thistle)

**Priority:** Medium to High: Scotch thistle aggressively invades disturbed and moist areas. This thistle, due to its size and spinous leaves, presents a passage barrier. Infestation decreases the value and area of wildlife habitat. Scotch thistle seeds have a water-soluble germination inhibitor that facilitates its own propagation and expansion along irrigation canals and other wet areas. Scotch thistle reproduces by seed. If the current population of this species exceeds its present level, action will be taken to reduce or eliminate it as per its priority ranking.

**Description:** Scotch thistle is biennial forb that grows to 12 feet high. Leaves are large, green, and spiny. Fine hairs give the leaves a cottony appearance. First-year rosettes are 10 to 12 inches in diameter. Leaves of the mature plant may be two feet in length with a prominent white mid-rib. Flower heads are numerous and terminal. Flowers are 1 to 2 inches in diameter, pale purple to red in color.

**Current Distribution on the Complex:** Single plants and assemblages of a dozen plants or less are spread throughout the Arsenal in riparian areas, disturbed sites, and along roadways.

**Measurable Objectives and Goal:** Prevent competition with newly seeded native plants in habitat restoration sites, along roadways, other disturbed soil areas, and riparian and other moist areas.

**Objectives:**

a) Monitor known infestation sites, riparian and moist areas, newly seeded areas, roadways, and other disturbed sites (e.g., remediation areas, wildfire areas) depleted of native perennial plants.

b) Seed disturbed sites with native species.

c) Control Scotch thistle to reduce competition with native plants by keeping infestations to less than 1 acre and less than 40% of live vegetation cover.

d) Maintain healthy stands of native perennial plants.

**Control Options:** Mechanical treatment will include hand pulling or cutting of individual plants and small stands. The taproot will be cut 1-2 inches below the ground surface. Scything and mowing will be options for larger stands. The removal of the top material before flower production decreases the number of seeds available for spreading and propagation. Preventing flowering by mechanical means in conjunction with herbicide application for root killing is most effective in eliminating and controlling Scotch thistle.

The chemical treatment of Scotch thistle with an appropriate herbicide provides relatively effective control. Currently, glyphosate, aminopyralid and metsulfron methyl are the herbicides used to control Scotch thistle on the Complex. Glyphosate is soil binding, inexpensive, and a low threat to groundwater quality. Glyphosate is appropriate for spot treatments, but its broad specificity precludes broadcast applications. Aminopyralid is used in dry upland sites and on soils.
with low leaching potential. This chemical can be broadcast in restoration areas where the establishment of native grasses and herbicide resistant native broadleaves are essential for restoration success. Metsulfuron methyl is very effective for thistle and mullein control and is the preferred treatment in restoration areas with a high infestation level. Other herbicides indicated for thistle control are dicamba, and clopyralid. Restricted use pesticides are not used on the Complex at this time. Other chemicals will be added as needed and be approved at the required level.

**Treatment Schedule:** Mechanical treatment should target plants before flowering (April to mid-June). Herbicides may be applied before bolting in the spring (April to June), possibly in conjunction with mechanical control, or to rosettes in fall (September -November).

**Phalaris arundinacea** (reed canarygrass)

**Priority:** Low to Medium: The priority for controlling this species is dependent upon location and degree of infestation. Reed canarygrass is an aggressive species that regenerates from large rootstocks. Excessive proliferation of reed canarygrass can lower the groundwater level, reduce the amount of surface water, reduce habitat for wildlife dependent on open water, and interfere with water flow through drainages. If the current population of this species exceeds its present level, action will be taken to reduce or eliminate it as per its priority ranking.

**Description:** Reed canarygrass is a perennial grass with stems reaching 7 feet. The stems have a waxy coating. Leaves are flat, 1/4 to 3/4 inch wide. Ligules surround the stem, auricles are blunt. Reproduction is by creeping rhizomes. The panicle is 3 to 8 inches long, initially compact but opening upon maturity.

**Current Distribution on the Complex:** Reed canarygrass is found in all wetland areas (sections 1, 2, 5, 6, 7, 8, 11, 12) and throughout the Arsenal in drainage areas with adequate soil moisture.

**Measurable Objectives and Goal:** Prevent competition with newly seeded native plants and established native communities in disturbed moist soil, riparian, and wetland environments.

**Objectives:**
- a) Monitor known infestation sites - riparian, wetland, and moist areas for significant adverse effects on water flow and wildlife habitat.
- b) Seed disturbed sites with native species.
- c) Control reed canarygrass to reduce competition with native plants and significantly altering the environment. Treatment applied to keep infestation to less than 40% of live vegetation cover and prevent infestations from increasing in area.
- d) Maintain healthy stands of native perennial plants.

**Control Options:** Fire is a method of cultural control that has been used on the RMANWR. The use of fire will be addressed in fire management and restoration plans.

Chemical control with glyphosate is used on the Complex for effective control of reed canarygrass. Glyphosate is soil binding, inexpensive, a low threat to groundwater quality, and used to target numerous weed species.

**Treatment Schedule:** Cultural and chemical control is best performed when the plants carbohydrate stores are lowest. Treatment will be conducted 1 to 2 times per season - once in the early summer (June - July) and/or once in the fall (September - October).

**Salsola kali** (Russian thistle)
**Priority:** Low: Russian thistle is highly adapted to colonizing arid areas, disturbed rangelands, shrublands, waste places. It grows in sunny exposed areas with dry, well-drained soils. This thistle species cannot tolerate excessive moisture. Due to its habit of invading areas that do not support many plant species, it can easily crowd and eliminate natives. Seeds are the form of reproduction. A single plant can produce 250,000 seeds. Seed dispersal occurs by tumbleweed action; when the seeds are mature; the plant detaches from the root and is carried by the wind across the landscape. If the current population of this species exceeds its present level, action will be taken to reduce or eliminate it as per its priority ranking.

**Description:** Russian thistle is a much branched, bushy annual forb. Stems are green with purple stripes. Leaves of seedlings are long and fleshy. Leaves of the mature plant are scale-like terminating in a spine. Leaf axils support small, inconspicuous green flowers that bloom in late summer.

**Current Distribution on the Complex:** Russian thistle is widespread. Colonization has occurred in restoration sites reseeded with native perennial grasses, roadways, and many disturbed sites.

**Measurable Objectives and Goal:** Prevent competition with newly seeded native plants in habitat restoration sites, along roadways, and other disturbed soil areas.

**Objectives:**

a) Monitor known infestation sites, newly seeded areas, roadways, and other disturbed sites (e.g., remediation areas, wildfire areas) depleted of native perennial plants.

b) Seed disturbed sites with native species.

c) Control Russian thistle to reduce competition with native plants by keeping infestations at less than 40% of live vegetation cover and reducing weed seed production.

d) Maintain healthy stands of native perennial plants.

**Control Options:** Mowing of large infested areas will occur. Plants in small, newly infested areas will be removed by hand or scythed if necessary.

The chemical treatment of Russian thistle with an appropriate herbicide provides relatively effective control. Currently, glyphosate and imazapic are the herbicides used on Russian thistle on the Complex. Dicamba is considered an effective treatment for Russian thistle. Glyphosate is already used on the Complex to target a wide variety of weeds. Glyphosate is soil binding, inexpensive, and a low threat to groundwater quality. Glyphosate is appropriate for spot treatments, but its broad specificity precludes broadcast applications. Imazapic is used in dry upland sites and on soils with low leaching potential. This chemical can be broadcast in restoration areas where the establishment of native grasses and herbicide resistant native broadleafs are essential for restoration success. Other chemicals will be added as needed and be approved at the required level.

The larvae, pupae, and adults of *Coleophora klimeschiella* are known to be effective in limiting the seed production of Russian thistle. *C. klimeschiella* and larvae and pupae of *C. parthenica* have been released in a thistle infestation in section 2; the success of these bio agents has not been accessed.

**Treatment Schedule:** Mechanical treatment will occur before seed set (May through July).

Herbicide can be applied at the seedling stage if possible (May - June).

The release or transplant of *C. klimeschiella* will be conducted around the time of seed set (July - August).
**Secale cereale** (annual/cereal rye)

**Priority:** Medium: Annual or cereal rye is a domesticated grass that has been used primarily as a cover crop. Where this grass escapes cultivation, native vegetation areas can be quickly overtaken. Disturbed sites, roadways, and open rangeland are particularly vulnerable to invasion. Annual rye presents a threat to adequate native perennial grass reestablishment in restoration areas. If the current population of this species exceeds its present level, action will be taken to reduce or eliminate it as per its priority ranking.

**Description:** Annual rye is a domesticated annual cereal grain resembling wheat. The stem grows from 24 to over 40 inches; leaf blades are flat. The inflorescence is a dense spike with 2-flowered spikelets. Lemmas are ciliated and sharply keeled, tapering to a long awn. The mature spike is somewhat nodding.

**Current Distribution on the Complex:** Patches of annual rye are present along the RMANWR perimeter fence in sections 4, 8, 11, 12, 19, and 20, as well as several sites on the RFNWR uplands.

**Measurable Objectives and Goal:** Prevent competition with newly seeded native plants in habitat restoration sites, along roadways, and other disturbed soil areas.

**Objectives:**
- a) Monitor known infestation sites, newly seeded areas, roadways, and other disturbed sites (e.g., remediation areas, wildfire areas) depleted of native perennial plants.
- b) Seed disturbed sites with native species.
- c) Treat 100% of annual rye plants - targeting for elimination - to reduce competition with native plants.
- d) Maintain healthy stands of native perennial plants.

**Control Options:** Mechanical control includes the removal of the inflorescence before seed formation by mowing or scything.

The chemical treatment of annual rye with an appropriate herbicide provides relatively effective control. Currently, glyphosate and imazapic are the herbicides used to control annual rye on the Complex. The plants may be sprayed in early spring while native warm-season species are still dormant. Glyphosate is soil binding, inexpensive, and a low threat to groundwater quality. Imazapic has been shown to be effective on wither annual grasses if applied pre-germination or just post germination. Clethodim may be used for invasive grass treatment along fence lines, rights of way and restoration sites. Clethodim is considered less toxic to avian and other wildlife species than other selective grass herbicides (quizalofop, fluazifop-p-butyl, sethoxydim and metribuzin). Clethodim has a short half-life in soil and the EPA considers the chemical a low threat to groundwater quality. Other chemicals will be added as needed and be approved at the required level.

**Treatment Schedule:** Mechanical control may occur June through August.

The application of herbicide may occur 1 to 2 times during the growing season (June - September). It has been reported that annual rye can exhibit a biennial habit. Spraying in the late summer and fall may kill any plants in the first year stage.

**Tamarix ramosissima** (salt cedar, tamarisk)

**Priority:** High: Salt cedar grows in a broad range of moist soil types. These woody, aggressive invaders crowd out natives in riparian and wetland habitats. The environment can be greatly altered by salt cedar invasion: trees increase the salinity of surface soil, dries up springs, wetlands, and riparian areas, alters surface water level, widens flood plains, increases sediment in watercourses, and causes changes in the diversity of wildlife habitat. Reproduction occurs by seed and root spread. If the
current population of this species exceeds its present level, action will be taken to reduce or eliminate it as per its priority ranking.

**Description:** Salt cedar is a deciduous or evergreen shrub or small tree. Heights vary from 5 to 20 feet. Weedy plants can grow 9 to 12 feet in a season. Bark of saplings and stems is smooth and reddish-brown. Leaves and stems (highly branched) are slender, imbricate and light green. Flowers are white to pink and arranged in panicles.

**Current Distribution on the Complex:** Salt cedar has not been widely established on the RMANWR. Small patches have been discovered and treated in Havana Pond area in section 11.

**Measurable Objectives and Goal:** Prevent competition with newly seeded native plants and established native communities in disturbed moist soil, riparian, and wetland environments.

**Objectives:**
- a) Monitor known infestation sites - riparian, wetland, and moist areas for significant adverse effects on water flow and wildlife habitat.
- b) Seed disturbed sites with native species.
- c) Treat 100% of salt cedar plants - targeting for elimination - to reduce competition with native plants and significantly altering the environment.
- d) Maintain healthy stands of native perennial plants.

**Control Options:** Bulldozer, backhoe, or fire can be used to open large stands of salt cedar. Smaller areas can be cleared with hand or chain saws, with the stumps chemically treated then removed mechanically.

Chemical control can be effective with imazapyr, glyphosate, or triclopyr applied directly to foliage of resprouted or sapling trees. Stumps and live trees are effectively killed with imazapyr, imazapyr or triclopyr injected into cambium or painted onto the cut surface of a stump. Imazapyr, glyphosate and triclopyr are very effective for salt cedar control and their use as stump paint or foliage spray in areas with little leaching potential is appropriate. Glyphosate is soil binding, inexpensive, and a low threat to groundwater quality. Other chemicals will be added as needed and be approved at the required level.

**Treatment Schedule:** Live and dead trees and stumps will be mechanically removed during all parts of the year. Fire will be conducted during the growing season (July - October). The use of fire will be addressed in fire management and restoration plans.

The use of herbicides requires application during the growing season. Treatment will be conducted July through October.

**Typha spp. (cattails)**

**Priority:** Low: Native species of cattails are natural invaders of wetlands. These plants provide valuable functions in reducing the amount of surface water (flood control), taking up heavy metals from water, and providing wildlife habitat. Excessive proliferation of cattail fields can lower the groundwater level, reduce the amount of surface water, reduce habitat for wildlife dependent on open water, and interfere with water flow through drainages. If the current population of this species exceeds its present level, action will be taken to reduce it as per its priority ranking.

**Description:** Cattails are erect perennial forbs with simple, cylindrical stems. Leaves are long, broad, and linear. The inflorescence is a tightly packed brown spike resembling a cat’s tail. Mature seeds, released in the fall, are dark brown with tan-colored tufts.
Current Distribution on the Complex: Cattails are found in all wetland areas of RMANWR (sections 1, 2, 5, 6, 7, 8, 11, 12) and throughout the Complex in drainage areas with adequate soil moisture.

Measurable Objectives and Goal: Prevent the exclusion of wildlife habitat, blockages and impediments to drainage, and competition with newly seeded native plants and established native communities, maintain appropriate water levels, in moist soil, riparian, and wetland environments.

Objectives:
- a) Monitor known infestation sites - riparian, wetland, and moist areas for significant adverse effects on water flow and wildlife habitat.
- b) Seed disturbed sites with native species.
- c) Control 100% of cattails where drainage is impeded in dams, flumes, spillways, and where native plants are inhibited. Control will be applied in any area where water level and wildlife habitat is unacceptable due to cattail growth (greater than 80% of shorelines at 30 feet). Target control is based on specific situations.
- d) Maintain healthy stands of native perennial plants.

Control Options: Mechanical removal of cattails can be made by removing individual plants by hand or scything (machete, “weed whacker”). Removal of the top portions of the plant will assist in cultural control. Covering the remaining stems and leaves with water will eventually kill the plant. Preventing seed formation and spread by mechanical removal of plant tops is also a control option.

Fire is a method of cultural control that has been used on the RMANWR. The use of fire will be addressed in fire management and restoration plans.

The chemical treatment of cattails with an appropriate herbicide such as diquat or glyphosate provides relatively effective control. Currently, glyphosate is the herbicide used to control cattails on the Complex based on its versatility and use to control other weed species. Glyphosate is soil binding, inexpensive, and a low threat to groundwater quality. Diquat is considered relatively safe to use in the control of aquatic vegetation but when it binds with clay it is resistant to degradation and has the potential to accumulate in the environment. Other chemicals will be added as needed and be approved at the required level.

Treatment Schedule: The removal of cattails by hand may occur during the growing season. The timing of mechanical preparation for drowning depends upon the availability of water. Timing cutting to correspond with the runoff and the raising of water levels resulting from spring storms is an option. Cattails in areas that receive water from controlled gates (lake outlets, canal) can be cut and flooded as water is available.

Ulmus spp. (elm)

Priority: Low: The primary target of Ulmus species control is Chinese or Siberian elm (Ulmus pumilus). Siberian elms were introduced into North America for use as shade and ornamental trees. Trees sprout from root buds resulting in groves of spindly, shrubby forms. Groves of elms compromise prairie restoration projects by shading the understory, preventing the growth of native perennial grasses and shrubs. If the current population of this species exceeds its present level, action will be taken to reduce or eliminate it as per its priority ranking.

Description: Siberian elms are deciduous, growing in small tree or shrubby form. Trees can grow to 45 feet high. The bark is dark gray and rugorous in texture. Leaves are 1½ to 3½ inches long, dark green on the top surface, and leathery. The oblique base of typical elm leaves is not obvious in this species. The seed is encased in a samara.
**Current Distribution on the Complex:** Siberian elms are scattered throughout the Complex specifically in areas of past human occupation - old homesteads, shelter belts, recreation areas, and ornamental plantings. Trees have been removed in sections 1, 3, 34, 35, 25 of RMANWR in the vicinity of structures or previous structures.

**Measurable Objectives and Goal:** Prevent competition with newly seeded native plants in habitat restoration sites, future restoration areas, and native wildlife habitat.

**Objectives:**

a) Monitor known infestation sites, newly seeded areas, roadways, sites of previous human occupation, and other disturbed sites (e.g., remediation areas, wildfire areas) depleted of native perennial plants.

b) Seed disturbed sites with native species.

c) Control 100% of exotic elms to reduce competition with native plants and maintain native wildlife habitat. Established trees will be removed and stump treated. The establishment of saplings will be prevented.

d) Maintain healthy stands of native perennial plants.

**Control Options:** Bulldozer, backhoe, or fire can be used to open large stands of elms. Smaller areas can be cleared with hand or chain saws, with the stumps mechanically removed.

Chemical control can be effective with imazapyr, glyphosate/imazapyr mix, or triclopyr applied directly to foliage of resprouted or sapling trees. Stumps and live trees are effectively killed with imazapyr, triclopyr, or tank mixes of imazapyr and triclopyr or glyphosate injected into cambium or any of the previous preparations painted onto the cambium of a freshly cut stump. Imazapyr and triclopyr are very effective for elm control and their use as stump paint or foliage spray in areas with little leaching potential is appropriate. Glyphosate is soil binding, inexpensive, a low threat to groundwater quality, and is used for a wide range of weed species control. Tebuthiuron is also an effective woody plant control but has propensity to leach in coarse soils. Other chemicals will be added as needed and be approved at the required level.

**Treatment Schedule:** Live and dead trees and stumps will be mechanically removed during all parts of the year. Fire will be conducted during the growing season (July - October). The specific use of fire will addressed in fire management and restoration plans.

The use of herbicides requires application during the growing season. Treatment will be conducted July through October.

**Verbascum thapsus (common mullein)**

**Priority:** Low: Common mullein is a primary succession plant - colonizing disturbed areas from preexisting seeds. The success of this plant is dependent on its seeds which can survive for up to ten years. It can be difficult to control due to its prolific seed production. Common mullein is found in dry, gravelly, coarse-textured soils of pastures, meadows, along fence rows, waste areas, and river bottoms. If the current population of this species exceeds its present level, action will be taken to reduce or eliminate it as per its priority ranking.

**Description:** Common mullein is a biennial erect forb. A rosette of light green fuzzy leaves is formed the first year; the following year’s growth is a single thick stem 2 to 6 feet tall. The inflorescence is a terminal single or multiple spikes. The flowers are small, yellow and bloom from June to August.

**Current Distribution on the Complex:** Common mullein is wide-spread on the Complex, especially in areas recently seeded with native perennial grasses, waste places, roadsides, and disturbed areas.
**Measurable Objectives and Goal:** Prevent competition with newly seeded native plants in habitat restoration sites, along roadways, and other disturbed soil areas.

**Objectives:**
- a) Monitor known infestation sites, newly seeded areas, roadways, and other disturbed sites (e.g., remediation areas, wildfire areas) depleted of native perennial plants.
- b) Seed disturbed sites with native species.
- c) Control common mullein to 20% of live vegetation cover in infestation sites to reduce competition with native plants.

**Control Options:** Mechanical control includes hand pulling of small infestations, mowing or scything larger patches. The removal of the 1st year rosettes, and 2nd year stems require removal to at least 2 inches below the root crown to kill the plant and prevent seed production.

The chemical treatment of common mullein with an appropriate herbicide provides relatively effective control. Currently, metsulfuron methyl is the herbicide used to control common mullein on the Complex. It can be broadcast in restoration areas where the establishment of native grasses and herbicide resistant native broadleafs are essential for restoration success. Metsulfuron methyl is very effective for thistle and mullein control and is the preferred treatment in restoration areas with a high infestation level. Tebuthiuron is also an effective long-term control agent for mullein control but has a propensity to leach in coarse soils and kill or suppress woody plants. Other chemicals will be added as needed and be approved at the required level.

Biological control with the mullein seed head weevil (*Gymnetron tetrum*) has been effective in reducing seed production by up to 50% in use in North America. This agent has been released on the Arsenal.

Cultural control of common mullein is an important control method. The key to controlling spread is by decreasing seed production in established patches, preventing the buildup of a seed bank, and preventing infestation. Methods that assist in these control strategies are minimizing soil disturbance, maintaining healthy native vegetation, control seed formation with a combination of mechanical, chemical, and biological techniques.

**Treatment Schedule:** The pulling of 1st year rosettes may occur when they are large enough to grasp (June - August). Scything or mowing of 2nd year plants may occur in early bolt (April - June).

Chemical application may occur during the early bolt (April - June) rosette stages (June - August).

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<td>X</td>
<td>- Knapweed weevil (<em>Cyphocleonus achatas</em>)</td>
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<td></td>
<td></td>
<td></td>
<td>- Knapweed flowerhead weevil (<em>Larinus minutus</em>)</td>
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<tr>
<td>Diffuse and spotted knapweed</td>
<td>High</td>
<td>X</td>
<td>- Field bindweed moth (<em>Tyta luctuosa</em>)</td>
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<td></td>
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<td></td>
<td>- Field bindweed mite (<em>Aceria malherbae</em>)</td>
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<tr>
<td>Elm</td>
<td>Low</td>
<td>X</td>
<td>- Brown-legged spurge flea beetle (<em>Aphona lacertosa</em>)</td>
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<td></td>
<td>- Amber spurge flea beetle (<em>A. flava</em>)</td>
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<tr>
<td>Field bindweed</td>
<td>Low to Medium</td>
<td>X</td>
<td>- Seed head weevil (<em>Rhinocyllus conicus</em>)</td>
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<td></td>
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<td></td>
<td>- Musk thistle weevil (<em>Trichosirocalus horridus</em>)</td>
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<tr>
<td>Hoary cress/whitetop</td>
<td>Medium</td>
<td>X</td>
<td>- Russian thistle moth (<em>Coleophora klimeschiella and C. parthenica</em>)</td>
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<td>Houndstongue</td>
<td>Low</td>
<td>X</td>
<td>- Klamath weed beetle (<em>Chrysolina quadrigemia</em>)</td>
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<tr>
<td>Kochia</td>
<td>Low</td>
<td>X</td>
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<td>Leafy spurge</td>
<td>High</td>
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<td>Low</td>
<td>X</td>
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<td>Russian knapweed</td>
<td>High</td>
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<td>Russian olive</td>
<td>Medium to High</td>
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<tr>
<td>Russian thistle</td>
<td>Low</td>
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<tr>
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<tr>
<td>St. Johnswort</td>
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2.0 Description of Alternatives

This section describes the two alternatives analyzed by the Service to on whether or not to adopt and implement an integrated pest management program:

- no-action alternative
- proposed action, giving the Service the authority to implement an integrated pest management program for managing invasive plants and other nuisance species on the Rocky Mountain Arsenal National Wildlife Refuge Complex.

These alternatives were developed according to NEPA §102(2)(E) requirements to “study, develop, and describe appropriate alternatives to recommend courses of action in any proposal which involves unresolved conflicts concerning alternatives uses..."
of available resources.” The alternatives consider the effects of planned actions to control invasive plants and other nuisance species within the boundaries of specific units managed by the Rocky Mountain Arsenal National Wildlife Refuge Complex.

In addition, several alternatives that were eliminated from further analysis are briefly discussed.

An EA is not a decision document but rather a tool to be utilized regarding management decisions concerning Refuge goals. The EA will introduce the no action alternative or current management option, the alternative that is being proposed along with other alternatives considered but rejected. Later in the environmental consequences section, the effects of both the no action and preferred action alternatives will be examined.

2.1 Alternative A – (no action)

Under this alternative, Refuge staff would continue to manage invasives with the integrated pest management techniques currently utilized on the Complex. This alternative is not the preferred as all the currently available integrated pest management tools would not be implemented which would decrease the efficiency of invasive species control. Continued use of current management options, while successful, does not employ the most efficient and cost effective methods available. Ground application of pesticides is time consuming and costly. This option would have impacts on the refuge as the inability to destroy the weeds and the weed seed bank found on the complex would reduce the refuge's ability to meet habitat objectives for migratory birds and other wildlife species as part of the restoration effort. The infestations could spread to neighboring properties causing increasing economic impacts along with a negative perception of the refuge system.

2.2 Alternative B – (proposed action)

The proposed action would keep utilizing the techniques currently employed at the Complex, but with the addition of new techniques and the addition of aerial spraying. Arial spraying would provide an additional, efficient tool for use in invasive species control. Larger areas would be covered with similar if not better kill rates at a reduced staff effort, allowing other restoration projects to be completed.

Aerial spraying has been tremendously effective in the killing of invasive species on the RMANWR, utilized under a categorical exclusion currently in effect. The use of contract aerial spraying on the RMANWR and RFNWR by local agricultural crop dusters using specially equipped helicopters assures an accurate, effective and professional job. The reduced amount of time needed to spray and having a more efficient system, combined with larger acres covered, allows for a favorable cost-benefit ratio. Depending on the proximity of sites, the helicopter can spray at a rate of about 100 acres per hour. The use of GPS technology when spraying prevents “striping”, a phenomenon typically associated with ground-spraying rigs, when not enough overlap between spray passes occurs. One day of spraying by a helicopter can cover over 1,000 acres, is pinpoint accurate, and treats only focus areas to minimize off-target applications and prevent drift. This helps assure that only target species are affected. The environmental and health aspects of spraying will be discussed in the environmental effects section of this document.

2.3 Alternatives Considered but Eliminated from Further Analysis

Natural Processes

Under this alternative, nothing would be done to control the spread of noxious weeds or invasive species on any of the refuges. The Colorado State Noxious weed list includes 77 weed species may of which occur or have occurred on the Complex.

Weed species pose a significant threat to habitat restoration efforts on the Arsenal as they are more aggressive than the native species and are adapted to colonizing disturbed areas. The Service therefore employs an integrated pest management (IPM)
approach to weed control which utilizes mechanical, biological, chemical, and cultural weed control methods as appropriate throughout the Refuge complex. This alternative would have severe economic and legal consequences so was not considered as a viable option.

3.0 Affected Environment

3.1 General Setting

*Rocky Mountain Arsenal NWR*

The RMANWR is managed by the Service and is located 10 miles from downtown Denver in Adams County, Colorado. It covers an area of 25 square miles consisting of roughly 15,988 acres. Most of the site was intensively farmed (both dryland and irrigated) during the late 1800's and early 1900's. Farming removed most of the native vegetation, although areas that were only grazed retained some of the native vegetative components. These farms were acquired by the U.S. Army in 1942, at which point factories (South Plants) were built in the interior area for production of chemical weapons. Portions of South Plants were later leased to Shell Chemical Company for the production of pesticides and herbicides. A second factory complex (North Plants) was constructed and managed by the Army during the 1950's for the production of chemical weapons. All chemical production at the Arsenal ceased in the 1980's.

While the Arsenal was listed as an EPA Superfund site, a massive cleanup was conducted and the disturbed areas are being actively restored back to native vegetation. During the production years, by-products from the factory complexes were discharged into both natural and artificial drainage basins resulting in extensive soil and groundwater contamination. The groundwater varies in depth, but is at least 30 feet down across the majority of the site. Pesticide residues reside in the alluvial aquifer but show little mobility. Some contaminated groundwater flow is interrupted before leaving the Arsenal by subterranean containment systems. The intercepted water is treated to meet EPA and State standards and released into recharge trenches. The manufacturing and disposal practices produced considerable soil contamination in the central part of the Refuge (Central Remediation Area); however, most of the buffer zone surrounding production and disposal areas remained relatively uncontaminated and has been used extensively by wildlife.

Ten major soil types exist on the RMANWR. The soils in the southwestern half of the RMANWR are primarily sandy loams. The soils in the northeastern half of the Refuge can be generally characterized as clay loams. Many of the wetter areas, in particular the First Creek riparian corridor, are dominated by aquic haplustolls.

The Refuge lies within the shortgrass prairie zone of the Great Plains of North America. Before intensive agriculture, other prairie types also existed within the broad shortgrass prairie zone wherever conditions allowed. Sandy soils were often dominated by sandhill prairie species. Some riparian areas had pockets of tallgrass communities (albeit reduced in height due to lower soil moisture), and transition zones of mixed-grass prairie often lay between standard shortgrass prairies and other grassland types. Service staff suspect that much of the northeastern portion of the site was originally typical shortgrass prairie, most of the southwestern area was sandhills prairie, and many other sites were more of a mixed-grass community. Some sites along First Creek and a few other locations were probably dominated by riparian vegetation (including some tallgrass and woody species) and wetland communities. Shrubland probably existed in many soil types as well.

Thirteen major vegetation types and eight major habitat types are currently identified at the RMANWR. The species composition of most of this vegetation is likely a result of agriculture (and to a lesser extent, Army land management) rather than soil types or pre-European settlement native plant communities. A few remnants of the native prairie still exist where sites were grazed but not tilled.

Almost 60% of the RMANWR is dominated by nonnative weedy forbs and weedy grasses. Approximately 24% of the RMANWR has been classified as native perennial grassland; most of these areas have a significant weedy component. The
shrubland/succulent community is the next prevalent class – covering 6% of the site. Each of the other 5 habitat classes (disturbed, wetlands, riverine/riparian, upland trees, lacustrine) as identified in the habitat management plan account for less than 3% of the total acreage (Morrison-Knudsen Environmental Services Inc. 1989).

The exotic plant species inhabiting the RMANWR are not unusual in the Denver area. The Arsenal’s history of land disturbance from agriculture, construction, military activities, hazardous material removal, and prairie restoration projects contribute to the invasion and establishment of noxious weeds. Exotic grasses like crested wheat grass and annual rye were planted for ground cover in past years. Cheatgrass competes with reintroduced native species and diminishes the quality of wildlife habitats. Wind, water, vehicles, birds and other wildlife are possible transporters of weed seeds within the site and from surrounding areas.

The Service has been conducting habitat restoration projects since 1989. To date, more than 100 sites and sub sites have been used as habitat restoration/mitigation areas, consisting mainly of prairie seeding sites, shrub restoration, habitat protection projects (e.g., fencing), and weed control areas. These projects have met with varying degrees of success, often depending on the amount of summer precipitation during establishment and the amount of weed control conducted on the site.

Rocky Flats NWR

The RFNWR encompasses 6,740 acres managed by the Service roughly 2 miles east of the Foothills escarpment in Jefferson County, Colorado. It is a former Department of Energy site that was involved in the production of plutonium triggers for the United States’ nuclear arsenal. It varies in elevation from 5,500 feet in the southeastern corner to 6,200 feet at the western gate.

Two Ponds NWR

TPNWR is a 72 acre refuge consisting of 63 acres of upland habitat and 9 acres of wetlands. In 1990, the Two Ponds Preservation Foundation solicited the Service to acquire the land on which the refuge resides. The refuge is managed by the Fish and Wildlife Service located in the city of Arvada, Colorado. There are many land uses surrounding the refuge including an open space and residential homes along the south, east and north boundaries. There are also retail businesses found to the north and west. It was once utilized for livestock grazing and plowing of prairie sod for crops by settlers.

3.2 Geology and Soils

Rocky Mountain Arsenal NWR

The RMANWR is located in the Denver basin, which runs north to south stretching from Cheyenne, Wyoming to Colorado Springs, Colorado all along the Front Range. The surface deposits are unconsolidated river sediments (alluvium) deposited by the South Platte River tributaries. The uppermost layer is called the Denver formation, which is roughly 900 feet thick. This formation is made of mostly clay, sandstone, shale, siltstone and coal. Beneath the Denver formation are a few geologic strata, sand stone and shales. The Pierre shale formation is 1,200-1,700 feet below the surface and is 6,200 feet thick.

The surface topography is a result of erosion caused by the South Platte River and its’ tributaries. The topography ranges from gently rolling hills with less than a 3% slope to terraces with up to 15% slopes. The wind deposited material is thickest in the south and southwest sections of the refuge. Elevations on the refuge vary from 5,138-5,250 feet above sea level.

The soil profile on the refuge consists of clay to loamy sands with some cobble on hills in the Northern sections. There are dark colored soils with high organic matter content. The Bresser soil type is the most common soil series, which is deep and well drained with medium to coarse textures. Weld soils are commonly found in the Northeast sections of the refuge. They were formed by alluvial and wind deposits and are finer-textured soils (U.S. Fish and Wildlife Service 1996a).

Rocky Flats NWR

There is a combination of unconsolidated surficial deposits in the western portions consisting of Rocky Flats Alluvium, clayey and sandy gravels maxing out at 100 feet thick. This is on top of the Arapahoe Formation which is composed of
sandstones, siltstones and claystones that can range from 0-50 feet thick. Beneath the Arapaho Formation is the Laramie Formation which is composed of silty to clayey sandstones and claystones (U.S. Fish and Wildlife Service 2004;2005). The Rocky Mountain Alluvium is thought to be the only mineral resource that has the potential to be developed. In the past, uranium, coal and natural gas were extracted on or near this site.

The soils at the RFNWR are formed from stream-deposited alluvium, gravity-deposited colluvium and exposed bedrock material. Most of the soils on the western side are composed of the alluvium deposits. Soils on the western portion are composed of Flatirons and Nederland soils. These have cobbly to stony-loam surface soils and clayey sub-soils and are deep and well-drained. Soils on the eastern portion of the refuge are primarily composed of Denver, Kutch, Midway, Haverson and Nunn soils. They are mainly soils with loamy surfaces and clayey subsoils (U.S. Fish and Wildlife Service 2004;2005).

Two Ponds NWR
Soils here are composed of three different types. The Nunn-Urban land complex soils have a slope of 5-9% while the Englewood clay loam has a slope of 0-2 %. The Leyden-Standley-Primen cobbly clay loams make up the final component of the soil structure with slopes of 5-9%. The plant litter has accumulated in the wetlands over time affecting the substrate making a rich, organic material ideal for growing wetland plants.

3.3 Water Resources

Rocky Mountain Arsenal NWR
The RMANWR is located within several drainage basins that are all tributaries of the South Platte River system. These consist of Irondale Gulch, First Creek and Second Creek. Most of the water on the refuge goes through a series of ditches and lakes due to previously constructed diversions and drainage channels.

The surface water on the refuge is gained through direct precipitation, runoff, and inflow from drainage basins to the south along with the tributaries surface flows, which are intermittent. The daily and monthly water flows vary with the highest monthly flows in the late spring and early summer, and lowest in the winter.

Most of the surface water has been used for the cleanup of the RMANWR and remediation of contaminated areas. As well as irrigation of some seeded restoration areas along with refuge purposes such as maintaining lake levels.

The Irondale gulch drainage basin encompasses the majority of the watershed area on the RMANWR, with the largest area of the basin north of the Refuge which contains industrial and residential areas. Six impoundments are in this drainage basin on the Arsenal including Upper and Lower Derby lakes, Lake Ladora, Lake Mary, Havana pond and Rod and Gun Club pond. The First Creek drainage basin is long and narrow and flows from southeast to northwest for about 5.5 miles. It was channelized extensively along much of its course by the U.S. Army, and has an intermittent surface flow (U.S. Fish and Wildlife Service 1996a).

In the past, both off-site and on-site activities have contributed to the contamination of surface water on the refuge. Organic constituents from man-made sources such as runoff from residential areas and past industrial manufacturing of chemical compounds were major contributors. In the Irondale gulch basin, the surface water is the principal migration pathway for pesticides and organic compounds such as arsenic, mercury, cyanide and trace metals (U.S. Fish and Wildlife Service 1996b). Some organic compounds have been detected entering the refuge from outside residential and industrial areas. Overall, the water quality in all refuge lakes and ponds is considered acceptable by EPA standards.

The Denver groundwater basin has surficial and wind deposited soils with water in several bedrock aquifers. The shallow aquifers are less than 20 feet thick under the basins to 70 feet elsewhere. The water levels can range from 500-600 feet and flows to the north and northwest.
Changes that include combinations of human activities and ongoing cleanup operations have altered the water table and flow directions on the refuge. Because of the boundary containment and treatment systems, recharge from both surface water impoundments and water depression due to well pumping for irrigation and other uses have affected the water table (U.S. Fish and Wildlife Service 1996a).

North, central and western parts of the refuge have contaminated groundwater in very distinct plumes. According to the RMANWR Comprehensive Management Plan (1996a), most have one or more contaminants moving together with elevated levels of organic compounds, pesticides and hydrocarbons. Inorganic contaminants such as arsenic, mercury, trace metals, chloride and fluoride also persist. The sources of the contamination were surface and wastewater discharges, chemical sewer leakages and leaching from solid waste burial sites. A concerted effort has been made by the Departments of the Interior and Defense to remediate these problems.

**Rocky Flats NWR**

There are three drainages that originate close to or on the RFWNR including: Rock Creek, Walnut Creek, and Woman Creek. The stream levels will fluctuate seasonally but are controlled by groundwater discharge. There are 16 ponds located on Rocky Flats of which 12 will be maintained by the Department of Energy. The other ponds include the two Lindsay ponds on Rock Creek and ponds D-1 and D-2 found on Smart Ditch.

Rock Creek drains the northwestern portion of the refuge with a relatively flat headwater area to the west with steep gullies to the east. Surface water originates from precipitation and shallow ground water discharge. It continues northeast where it joins Boulder creek basin.

Walnut Creek has 3 tributaries that drain the central portion of the refuge. These later converge near the eastern refuge border before continuing on to the east. It is usually dry during most of the year.

Woman creek drains the southern portion of the refuge and has 2 main branches that begin off to the southwest. This typically has no stream flow in the late spring and summer and is lost to groundwater in the warmer months (U.S. Fish and Wildlife Service 2004).

**Groundwater at Rocky Flats NWR.** There are three distinct units including: the upper alluvial aquifer, lower aquitard and the Laramie-Fox Hills aquifer. The upper alluvial aquifer is comprised of unconsolidated materials that can be up to 100 feet thick in the western portion of Rocky Flats. It is recharged from precipitation or surface water and is usually found roughly 11 feet below the surface. The lower aquitard consists of the deeper claystones and siltstones in the Laramie and Arapahoe Formations. The recharge occurs from the downward flow through the upper aquifer as well as through precipitation where bedrock is exposed. Below this is the Laramie-Fox Hills aquifer which consists of lower sandstone units of the Laramie foundation. Levels of this groundwater are usually more than 100 feet (U.S. Fish and Wildlife Service 2004).

**Two Ponds NWR**

The refuge has a ¾ share of water from the Farmers High Line Canal from which the ponds are filled offsetting evaporation requiring roughly 2 acre-feet of water. This water supply should be able to maintain the resources on the refuge including the ponds, native prairie and the marsh/pond complex (U.S. Fish and Wildlife Service 1997).

### 3.4 Climate and Air Quality

**Rocky Mountain Arsenal NWR**

44
The semi-arid conditions at the RMANWR provide low humidity with wide variations in seasonal temperatures. Precipitation is 12-16” annually with May being the wettest month. Winds are commonly from the south at night and from the north during the day with the average wind speed at 8.7 mph (U.S. Fish and Wildlife Service 1996a).

The Denver metro area has an ongoing problem with carbon monoxide, ozone and particulate matter contributing to air pollution with visibility problems due to temperature inversions. These prevent atmospheric mixing resulting in pollutant accumulation, contributing to the formation of the brown cloud. The major contributors to these problems are motor vehicles, wood burning, industrial and agricultural operations.

The RMANWR is located in a non-attainment area for ozone; carbon monoxide and extremely fine particulates. The categorization of the Arsenal being in a non-attainment area means that the state standards for pollutants are not currently being met (U.S. Fish and Wildlife Service 1996a).

**Rocky Flats NWR**
The RFNWR is located within the boundary of the Denver Metropolitan Area (DMA) for the purpose of air quality planning. There has been recent improvement in the levels of carbon monoxide, ozone and particulate matter air pollution found in the DMA attaining most of the health standards except for ozone. There are five air monitoring stations operated by the CDPHE of which two are located downwind of Rocky Flats at the northeast and southeast boundary along Indiana Street (U.S. Fish and Wildlife Service 2004).

**Two Ponds NWR**
The refuge is found in Arvada, Colorado which is a suburb of metropolitan Denver. The mean annual precipitation is roughly 16 inches with the annual evaporation rate at 40 inches which leads to a net loss of water. Air quality is consistent with condition found in most Denver suburbs similar to those found at the RMANWR and RFNWR.

### 3.5 Noise Pollution

**Rocky Mountain Arsenal NWR**
Noise levels on the Refuge vary widely depending on location. On the western and southern perimeter, the sounds are mainly from commercial, development, traffic and residential sources. In a small portion of the east perimeter of the RMANWR, noise from Denver International Airport air traffic can reach up to 60 decibels.

**Rocky Flats NWR**
Noise levels on the Refuge can vary widely depending on location. Levels on the north, west and east perimeters are affected by traffic noise along the boundary. Noise levels are higher along the western perimeter due to the existence of Highway 93 which is closest to the refuge border. Wind conditions can play a role in the amount of noise at the Refuge as the overall ambient levels are higher in windier conditions (U.S. Fish and Wildlife Service 2004).

**Two Ponds NWR**
Noise on the Refuge is mainly from sounds normally associated with traffic, construction and other normal city activities.

### 3.6 Vegetation

**Rocky Mountain Arsenal NWR**
The vegetation that is supposed to be on RMANWR is that which occurs on the western side of the high plains, mostly comprised of warm season, shortgrass, and mixed grass prairie vegetation. Most of the original vegetation has been altered or disturbed by human activities such as agricultural practices, industrial development and cleanup activities. Native prairie restoration is an ongoing process at RMANWR which will eventually lead to re-establishment of native plant species.
Shortgrass species for this area include blue grama (Bouteloua gracilis), western wheatgrass (Pascopyron smithii), side-oats grama (Bouteloua curtipendula) and buffalograss (Buchloe dactyloides). Common mixed grass species include sand bluestem (Andropogon halii), switchgrass (Panicum virgatum), Indian ricegrass (Oryzopsis hymenoides), and needle-and-threadgrass (Hesperostipa comata). Common native forbs include blanketflower (Gallardia), blue flax (Linum lewisi), blazing star (Menzelia nuda), gayfeather (Liatris punctata) and silver lupine (Lupinus argenteus).

There are four primary vegetation types found on the refuge including: 1) native perennial grasses, 2) wetland and riparian, 3) shrubland and succulents, 4) upland trees and shrubs along with remnant native vegetation which is not a major category. The perennial grasses include blue grama and buffalograss. The shrublands and succulent species include rubber rabbit brush (Chrysothamnus nauseosus), yucca (Yucca glauca) and locust thickets. In the wetland and riparian systems, the species associated are Plains cottonwoods and peach-leaf willows as well as cattails in the marshes. The upland trees and shrubs include Siberian and American elm, Russian olive, and Rocky mountain juniper (RMANWR Comprehensive Management Plan 1996).

**Rocky Flats NWR**

RFNWR has a diverse vegetative community which includes xeric tall grass grassland and a tall upland shrub land both of which are considered rare to the region. Other vegetation communities found are riparian woodland, riparian shrubland, wetlands, mixed grassland, needle and thread grassland, reclaimed mixed grassland and ponderosa pine woodland. These are grouped into three management zones: 1) Xeric Tallgrass Grassland, 2) Wetlands and Riparian corridors and 3) Mixed Prairie Grassland (U.S. Fish and Wildlife Service 2004).

The xeric tallgrass prairie, a globally rare plant community that the Colorado Natural Heritage Program has designated as imperiled in the State. It is believed to be a relic of a much broader distribution when it was contiguous with more mesic tallgrass prairies hundreds of miles east in the Midwest. One particular sub-community of xeric tallgrass prairie, the Rocky Flats Bluestem Grassland, is particularly well represented on the site. This community has an unusual combination of species from eastern tallgrass prairies and western shortgrass prairies, as well as plants more commonly found at higher elevations in the Rocky Mountains (U.S. Fish and Wildlife Service 2011).

The Wetlands and Riparian corridors contains a mixture of plains cottonwood, peachleaf willow, Siberian elm, and coyote willow as well as narrowleaf willow, indigo bush which has an understory of leadplant and baltic rush. These areas account for roughly 600 acres.

The Mixed Prairie Grassland covers roughly 2,199 acres and is the largest of the vegetation communities at the RFNWR. It is characterized by western wheatgrass, blue grama, side-oats grama, prairie junegrass, Canada bluegrass, green needlegrass and little bluestem.

Since 1990, there has been an increase in the noxious weeds that are found at the RFNWR. This is especially true of diffuse knapweed, musk thistle, dalmatian toadflax, and Canada thistle. These species can negatively affect the native species due to their aggressive nature and their ability to outcompete the natives. In a 2002 Annual Vegetation Management Plan, there were 5,292 acres of these species found on the Rocky Flats NWR (U.S. Fish and Wildlife Service 2004).

**Two Ponds NWR**

There is a combination of uplands and wetlands found at TPNWR. The uplands contain grasses, mostly smooth brome covering 65% of the area. Some alfalfa as well as Yucca and rubber rabbitbrush is found along with the brome. A portion of the western part of the refuge has been replanted with native species such as blue grama, buffalo grass, needle-and-thread grass, western wheatgrass and green needlegrass. Plains cottonwood and Russian olives are found along the irrigation canal. In addition, sandbar willow and cattails are found along the edges of the canal. The shrubs common on the refuge include
winterfat, fourwing saltbush and fringed sagebrush (U.S. Fish and Wildlife Service 1997). It was once inhabited by plant communities associated with the high plains with short and mixed-grass prairie species.

3.7 Wildlife and Fisheries

**Rocky Mountain Arsenal NWR**

A variety of wildlife species exist on the RMANWR ranging from mule deer (*Odocoileus hemionus*) and white-tailed deer (*Odocoileus virginianus*), coyotes (*Canis latrans*) to black-tailed prairie dogs and a herd of American bison (*Bison bison*). Bird species include bald eagles, ferruginous hawks, prairie falcons, burrowing owls, Swainson’s hawks, American white pelicans, along with many species of migratory waterfowl and neotropical migrants.

Fish inhabit both Lakes Ladora and Mary and can be experienced through a catch and release program on the refuge. Fish species found include bluegill, channel catfish, Northern pike and largemouth bass.

**Bald eagle** (*Halialetus leucocephalus*). This species was delisted throughout the majority of the United States in 2007 (Federal Register 2007a). However, bald eagles remain a resource of concern at the RMANWR (U.S. Fish and Wildlife Service 2013b) and receive enhanced protection under the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d). A wintering bald eagle communal roost was first discovered on the Refuge in 1986. It was located in the cottonwood trees along First Creek and was used from October to April. Bald eagles will prey on fish along with black-tailed prairie dogs and small mammals. A Bald Eagle Management Area was established to protect the high-use areas of bald eagles at specific times of the year (U.S. Fish and Wildlife Service 1996a). This included roost sites, the nest site and foraging areas. The mature eagles will incubate eggs starting in mid-February with the eaglets fledging in mid-June and will disperse from the nest site by August. They are a facultative prey dependent associate to the prairie dogs.

Ferruginous hawks are found on native open grasslands. The conversion of this habitat to agriculture which led to a loss of nesting sites, and reduction of the prey base has led to a decline throughout its range. This species was listed as a species of special concern, and is found on the Refuge year round but is more common in the winter.

Mountain plovers prefer dry upland plains and prairies where it feeds on grasshoppers and other insects. With the large number of prairie dog towns found on the refuge, they have been observed on the Refuge but with no nesting activity documented.

There are no threatened or endangered or candidate species currently occurring on the RMANWR.

**Rocky Flats NWR**

The RFNWR is surrounded on three sides by a regional network of protected open space that serves as movement corridors for various species of wildlife. Species documented on the Refuge include a resident mule deer herd, a transient elk herd, an occasional white-tailed deer, coyotes, desert cottontails, white and black-tailed jackrabbits, muskrat and porcupine. There is the potential to have roughly 2,460 acres of black-tailed prairie dog habitat based on soil, vegetation and ground conditions known favorable to prairie dogs. There are currently colonies of roughly 10 acres after a plague event in 2000 lowered it from 112.8.

**Preble’s Meadow Jumping Mouse** (*Zapus hudsonius preblei*). The mouse occurs along every major drainage on the refuge. This species was listed as threatened in 1998 (Federal Register 1998) and is found in habitat next to streams and waterways. The Service designated critical habitat in 2003 (Federal Register 2003), which did not include the Rocky Flats Site as it was to become a Refuge (Federal Register 2003). In 2010, a total of 1,108 acres of critical habitat was designated on the Refuge or the threatened Preble’s meadow jumping mouse (Federal Register 2010).
Two ponds NWR
There have been approximately 120 species of birds observed at TPNWR with 15 of them nesting on the refuge. These include mallard ducks, Canada geese, red-winged blackbirds, and black-crowned night herons. The most commonly seen mammal is the red fox along with cottontail rabbits, raccoons, coyotes, muskrats and mule deer. There are several species of fish found on the refuge including largemouth bass, bluegill, common sunfish, and fathead minnows. The main two amphibians found at the TPNWR are leopard and bullfrogs with painted turtles and bull snakes representing the most common reptiles. In addition, the Refuge supports several species of raptors including red-tailed, ferruginous, and Swainson’s hawks. There are no threatened or endangered or candidate species occurring on the TPNWR.

3.8 Social and Economic Environment

Rocky Mountain Arsenal NWR
The RMANWR is located in Adams County, Colorado in the northeastern portion of the six-county Denver metro area. The area surrounding the refuge is residential and commercial development on the south, agricultural and residential development on the north, agricultural and Denver International Airport property on the east, commercial development on the southwest, industrial on the northwest and residential and commercial on the west. Adams County, the City and County of Denver and Commerce City will designate any future land use around the Refuge.

Currently a perimeter trail surrounds a majority of the Refuge where the property rights were transferred to other owners under the Refuge Act, the law which created the refuge. The perimeter fence was set back so that 56th Avenue on the south, 96th Avenue on the north and Colorado Highway 2 on the northwest could be widened and a recreational trail added.

The Adams County economy is integrated into the much larger Denver metro area economy. Adams County consists of nine cities with a land area of 1,194 square miles, 78% of which is incorporated. The county is highly urbanized with industrial areas which include areas of commercial, suburban and agricultural uses. Adams County is also one of the fastest growing counties in Colorado.

Colorado tourism will play a major role in the future attendance at the refuge with major seasonal variations occurring. It is estimated seven million individuals per year pass through Colorado with 60% exploring the Denver metro area. Currently, the refuge ranks third as a wildlife-viewing destination behind the Denver Zoo and Rocky Mountain National Park.

The current public use on or near the refuge consists of wildlife tours and a nine mile self-guided auto tour route which passes through a bison area that now contains 70 bison, environmental education presentations (more than 200 annually) and special events. There are also scouting programs, bird and deer watching, and fishing, which issue out 7000 permits per year (Melissa VanDresse, USFWS, personal communication 2009).

Rocky Flats NWR
The Refuge is located at the intersection of three counties (Jefferson, Boulder and Broomfield). It is surrounded by open space on three sides (north, east and west) and has urban development to the northeast and southeast. There are four cities that are located in the immediate area of the refuge including Arvada, Westminster, Broomfield and Superior.

Jefferson County’s population grew to 534,543 in 2010. The per capita income decreased to $35,587 a year with the largest industries consisting of services, government, and manufacturing (U.S. Census Bureau 2012).

Two Ponds
The TPNWR is located in Arvada, Jefferson County, Colorado. The main land uses are single family residential along the east, south and north boundaries with retail businesses along the north and west side of 80th Ave.

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Similar to the RMANWR, Colorado tourism will play a major role in the future attendance at the refuge with major seasonal variations occurring. Currently, the refuge is estimated at receiving approximately 15,000 visitors a year (Seth Beres, USFWS personal communication 2011).

The current public use on the Refuge consists of environmental education programs, wildlife tours, scouting projects, bird and deer watching, and special events. There is also off-site outreach programs conducted throughout the Denver Metro school districts.

### 4.0 Environmental Consequences

For alternatives A and B described in section 2, the following narrative documents the analysis of any significant environmental effects expected to occur from implementing each of the alternatives. For the purposes of this EA, the Service analyzed the potential effects of implementing each alternative on all resources protected by the Refuge, including the following:

#### 4.1 Geology and Soils

**Cumulative Impacts**

Various soil types and vegetative communities exist at the Refuges. To avoid ground contamination, herbicides are selected and used according to the manufacturer’s recommendations; technical bulletins, and updated scientific evidence to match the environmental conditions. For example, glyphosate will be used wherever practical due to its soil binding capability and relatively rapid breakdown in the environment. The more permeable soil types will be treated with herbicides with low leaching potential at the proposed application amounts. Information regarding herbicide use, application methods, equipment, slope, soil types, weather condition, and other specifics will be explained in the Pesticide Use Proposal. Qualities such as soil composition, pH, and temperature all affect the success rate of any spraying conducted, so following the recommendations are in the refuges best interest for the highest chance of success.

Tilling the soil has a disrupting influence by fracturing the soil particles and aiding in the movement of oxygen and carbon dioxide out of the soil, releasing sequestered carbon (Reicosky et al. 1995). There is also an effect on infiltration and evaporation by moving organic matter to greater soil depths. It will also affect the distribution of crop residues within the soil (Reicosky et al. 1995). This can affect soil temperature which is one of the key factors in root growth and densities (Baker et al. 2007). There have been studies that have found that while soil texture had an effect on carbon sequestration, a more important influence was that of climate. It was also found that improvements in management by conversion to pasturelands can increase soil carbon content and net soil carbon storage (Conant et al. 2001). This signifies that any short term disruption will be followed by long term gain for the restored habitat.

The effects of tilling on soil structure will be mitigated by shallow disking and disking areas along the contour of the land and thereby minimizing disruption. Plowing and harrowing will also be done along the contours of the land. Working along the contours will also reduce water erosion.

**Rocky Mountain Arsenal**

No noticeable negative effects as a result of soil tillage have been observed thus far on the RMANWR. Areas that have remnant native vegetation mixed with the weeds are treated with chemical or biological applications. Any tillage that takes place is done with the contour of the land. Shallow disking is used as a way to reduce any negative effects on the soil structure. Plowing has some short term negative consequences with releasing stored carbon and breaking up the soil particles, but the long term benefits outweigh these risks. Currently, native seed is drilled into plant stubble as part of a conservation tillage system used to manage levels of plant residue with less mechanical cultivation, therefore less disturbance is possible.
Ground applications of chemicals will follow the manufactures recommendations minimizing any risk of short term negative consequences. Long term buildup of utilized chemicals in the soil is dependent on soil type, chemistry and use, but is a consideration when deciding if chemical application is the best option. This will be mitigated by being careful as to which chemical is used and following the manufactures recommendations as to application rates and following the PUPs.

Aerial application will have no short term negative consequences, but long term buildup in the soil may also be a concern as with ground application. This is reduced by examining what is the target species and the best, least toxic chemical that can be used. Aerial application would also be done once a year over a large area, so there would be no concentrated patches where buildup could occur.

**Rocky Flats NWR**

Disking and plowing will not be utilized at this refuge as there are still concerns about radioactivity and the effects that raising soil from these activities would have. The nature of the soil structure (very rocky) also reduces the ability to till the soil effectively.

Aerial application, if utilized, will also follow all manufactures recommendations as to dilution factors so as to minimize any short term effects. This will be utilized to cover larger areas that are difficult to access through roads or topography. Buildup of chemicals in the soil is not likely as the spraying would be done over larger areas, making concentrations lower than possible with ground applications.

**Two Ponds NWR**

Tillage techniques will be done here only on a small scale. Aerial application will not be done here as to the size of the refuge and proximity to residential areas. Ground applications of chemicals will follow the manufactures recommendations minimizing any risk of short term negative consequences. Long term buildup of utilized chemicals in the soil is dependent on soil type, chemistry and use, but is a consideration when deciding if chemical application is the best option. This will be mitigated by being careful as to which chemical is used and following the manufactures recommendations as to application rates and following the PUPs.

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<thead>
<tr>
<th>Unit</th>
<th>Alternative A</th>
<th>Alternative B</th>
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<tbody>
<tr>
<td>Rocky Mountain Arsenal NWR</td>
<td>- Potential long-term negative effects due to chemical buildup in the soil</td>
<td>Same as A</td>
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<td>- Short term effects from soil disturbance and released carbon</td>
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<tr>
<td>Rocky Flats NWR</td>
<td>- Potential long-term negative effects due to chemical buildup in the soil</td>
<td>Same as A</td>
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<td>- Short term effects from soil disturbance and released carbon</td>
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<tr>
<td>Two Ponds NWR</td>
<td>- Potential long-term negative effects due to chemical buildup in the soil</td>
<td>Same as A</td>
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<tr>
<td></td>
<td>- Short term effects from soil disturbance and released carbon</td>
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4.2 Water Resources
Cumulative Impacts
Most of the modern pesticides that are currently used break down in the environment with the residue not accumulating in the sediment or on the leaves. Many that are used currently on the refuge complex also break down in water. Other IPM practices such as irrigation, mowing, tillage, burning and the planting of cover crops all have effects of water quality through runoff. There is the potential that weed management through the different techniques could increase nutrient and sediment inputs to the system through runoff which may affect water quality.

When mowing or utilizing a tillage program, buffer zones are set up so as to not get too close to the water sources. Prescribed burns are done with fire lines set up so to reduce the chance of contaminating any water sources. There is the potential to have water used for fire control to runoff into a wetland or a supply stream. If pesticide spraying needs to be done near water, it is done with by hand where there is reduced risk of drift. Specific chemicals such as 2.4-D have a propensity to leach and contaminate groundwater, but this is usually due to inappropriate use or spillage. The refuge staff will follow all manufactures recommendations, so this will be mitigated. Any aquatic herbicide use will be done in compliance with the Clean Water Act and NPDES permitting procedures as defined by the Environmental Protection Agency (EPA).

Rocky Mountain Arsenal NWR
Any ground spraying near water sources is done with hand held sprayers to minimize drift. Manufacturers recommendations are followed which minimizes risks to water sources on the refuge. An advantage of aerial spraying is the accuracy of the application, this, combined with an adequate buffer mitigates the risk of drift in to water sources.

Tillage techniques are done with a buffer zone from water sources such as First Creek so that the chance of contamination from runoff is reduced. There can be soil moved by wind during a storm after tilling is done temporarily reducing water quality providing a short term negative impact. There is the potential for runoff from a fire to get into a wetland or supply stream, but this is mitigated by setting up fire lines away from water sources and keeping control of the fire.

Rocky Flats NWR
Due to the topography of the land and the location of water sources, any spraying near riparian areas and Preble’s meadow jumping mouse habitat will be done with a hand held sprayer allowing the application to occur where desired and reduce any chance of drift. All the manufacturing recommendations will be followed as designated in the PUP. If aerial spraying is conducted, areas near water sources will be sprayed with hand held sprayers and chemicals that break down easily in water will be utilized.

Two Ponds NWR
Spraying will be done by either a hand held sprayer or using a truck mounted sprayer or a UTV with a spray tank on the back. This and an adequate buffer will allow for reduced drift occurring near the water sources. The manufactures recommendations will be followed and chemicals that break down easily in water will be used. There will be no aerial spraying done at this refuge due to its small size and proximity to residential and commercial areas.

There will be limited tillage techniques used, and if done, a buffer zone will be employed to reduce the chance of runoff into the water source.

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<tbody>
<tr>
<td>Rocky Mountain Arsenal NWR</td>
<td>- No long term effect to water quality from chemicals</td>
<td>Same as A</td>
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<tr>
<td></td>
<td>- Potential short term effects from runoff</td>
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4.3 Climate and Air Quality

*Cumulative Impacts*

In this section, the effects of pesticide inputs along with tilling use and the associated risks on air quality and the effects climate can play will be addressed. The disking and plowing of soil can have short term negative effects on air quality from the dust that may be raised during the practice. Mowing can also have a negative impact when the excess vegetation and dust is thrown from under the mower deck. This is a short term disruption with local commuter and commercial traffic playing a much more substantial role in air quality surrounding the refuges.

Ground and aerial herbicide application is affected by weather as there are limits to wind speed and temperature when spraying can occur. This is spelled out in the PUP’s and in the label directions. Air quality can be affected in the short term in that chemical odors may be detected in the air during or shortly after herbicide application.

*Rocky Mountain Arsenal NWR*

None of the current practices employed at the RMANWR significantly affect the climate of the region. Refuge personnel or contractors do not spray when weather conditions are outside the tolerance range of the herbicides label directions or PUP’s for temperature and wind speed. Air quality may be negatively affected in the short term from disking, mowing and plowing due to dust from these activities.

*Rocky Flats NWR*

Tillage techniques will not be used as described earlier due to soil conditions and public concern about radioactive dust particles in the air. Herbicide application will be conducted using the same temperature and wind guidelines stated above. A press release may be given before aerial spraying is likely to occur to inform nearby residents of the event.

*Two Ponds NWR*

There will be no aerial spraying done at TPNWR as the area is too small and close to housing developments. There will also be limited tillage due to the size of the area. There may be some effects of ground spraying with a truck or UTV spray rig.

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<tbody>
<tr>
<td>Rocky Mountain Arsenal NWR</td>
<td>- Short term negative effects from tillage techniques and spraying herbicides</td>
<td>Same as A</td>
</tr>
<tr>
<td>Rocky Flats NWR</td>
<td>- Short term negative effects from ground spraying herbicides</td>
<td>- Short term negative effects from mowing operations and spraying herbicides</td>
</tr>
<tr>
<td>Two Ponds NWR</td>
<td>- Short term negative effects from ground spraying herbicides</td>
<td>Same as A</td>
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4.4 Noise Pollution

*Cumulative Impacts*

Noise pollution is defined as the excessive or displeasing human, animal or mechanical created environmental noise that disrupts the activity or balance of life. Wildlife can be negatively affected by changing the balance in predator or prey
detection or avoidance or interfering in the use of sounds for communication. The effects of noise on the surrounding areas and within the refuges will be examined as far as disturbance to neighboring communities and wildlife found in the Complex.

**Rocky Mountain Arsenal NWR**

There will be some short term disruption when aerial spraying is occurring by the sound of the helicopter blades, but will have no effect otherwise. Ground spraying is not a significant source of noise disturbance. Tillage techniques do have a noise associated with them, but only in close proximity while in operation.

**Rocky Flats NWR**

There will be some short term disruption when aerial spraying is occurring, but will have no effect otherwise. Ground spraying is not a significant source of noise disturbance. Tillage techniques do have a noise associated with them, but only in close proximity while in operation, i.e. mower deck.

**Two Ponds NWR**

Aerial spraying will not be conducted here as the area is too small and too close to neighboring residential development. Ground spraying is not a significant source of noise disturbance. Small scale tillage and bat wing mowers may be used at Two Ponds; however, noise from equipment should not be an issue.

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<tbody>
<tr>
<td>Rocky Mountain Arsenal NWR</td>
<td>No effect</td>
<td>- Short term impact from helicopter noise</td>
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<tr>
<td>Rocky Flats NWR</td>
<td>No effect</td>
<td>- Short term impact from helicopter noise</td>
</tr>
<tr>
<td>Two Ponds NWR</td>
<td>No effect</td>
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### 4.5 Vegetation

**Cumulative Impacts**

The effects on the flora will vary as the vegetation types found at each of the refuges are different. A negative consequence of herbicide application can be that non-target vegetation is affected. This is mitigated by following the recommendations in the PUP’s and manufacturers label directions. Current vegetation will be buried by tillage techniques, which affects the vegetation, soil structure, microbial activity as well as runoff from precipitation events. Carbon storage will be negatively affected by tillage until new growth can begin carbon sequestration.

**Rocky Mountain Arsenal NWR**

Tilling the soil will result in some loss of sequestered carbon at the time of disking, plowing, etc., as well as some loss of forb and shrub species richness for a short time (Fulbright 1996). It was found that habitats have the best species richness and plant diversity when the disturbance is done with medium intensity and frequency (Fulbright 1996). Proper management and timing will be beneficial to the restoration effort, but some short term negative effects will occur. Herbicide application may negatively affect some non-target vegetation, but this is mitigated by following the PUP’s and manufactures label directions.

**Rocky Flats NWR**

Herbicide application may negatively affect some non-target vegetation due to drift, but this is mitigated by following the PUP’s and manufactures label directions. Spraying near riparian areas will be done with hand sprayers which will mitigate any non-target species being affected. Aerial application will be done in larger areas, so some non-target species may be negatively affected. This is kept to a minimum by following PUP’s and manufactures label directions. There will be no tillage done at RFNWR due to the soil composition and air quality concerns, however, mowers will be utilized, so some short term negative effects of vegetation can be expected.
Two Ponds NWR
There will not be any aerial application done here due to proximity to development and limited size of the refuge. Tillage practices will also be kept to a minimum for the same reason. Chemical application will be done with a UTV spray rig which will allow for limited non-target mortality.

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<tbody>
<tr>
<td>Rocky Mountain Arsenal NWR</td>
<td>- Short term effects from reduced carbon storage and soil climate changes and potential overspray and drift</td>
<td>Same as A</td>
</tr>
<tr>
<td>Rocky Flats NWR</td>
<td>- Short term effects from reduced carbon storage and soil climate changes and potential overspray and drift</td>
<td>Same as A</td>
</tr>
<tr>
<td>Two Ponds NWR</td>
<td>- Short term effects from reduced carbon storage and soil climate changes and potential overspray and drift</td>
<td>Same as A</td>
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4.6 Wildlife and Fisheries

Cumulative Impacts
The three main causes of species loss in native tall, mixed and short grass prairie habitats are land conversion, habitat degradation and fragmentation. All of these occurred at one point or another at the refuges in the complex due to the nature of their past uses.

Wild bird populations through their activities of seed dispersal, pollination and pest control play a key role in the proper functioning of ecosystems. They also serve as educational, observational, and recreational pathways for the public to enjoy nature through bird watching and outdoor photography. The importance of National Wildlife Refuges to migrating birds cannot be overstated. Refuges, in addition to habitat for year-round resident species, serve as areas to rest, nest, and feed until the next migration.

Issues with pesticides include drift and bio-magnification. The chemicals can bio-accumulate in insects and birds species that eat insects. There are numerous grassland bird species that are sensitive to pesticides at low doses and are shown to have significant effects, both lethal and sub-lethal, from either acute and chronic exposure or biomagnification (Cravey 2005). All of the chemicals used to treat plant pests on the complex have little or no direct impact on insects, birds, fish or mammals. Any concerns are mitigated by following the PUP’s and manufacturers label directions.

The use of herbicides to reduce spotted knapweed populations in Montana elk winter range resulted in a 2.4 fold increase in forage available for elk utilization (Bedunah and Carpenter 1989). In the third year after spraying spotted knapweed, herbicide plots averaged 47% greater elk winter forage than the control (Rice et al. 1997). Weed control has been shown to increase forage and habitat available for mammals. Tillage may result in a short term loss of wildlife diversity in an area, but once it is restored, wildlife diversity returns.

There are many factors that contribute to the retention of chemicals in aquatic ecosystems including the content of the water itself, dissolved salts, temperature range and the nature of the substrate (Cope 1966). This becomes important as microscopic plants, macrophytes, and other aquatic vegetation will hold some of the toxicants in and on their tissues after pulling it from the water medium surrounding it (Cope 1966). The aquatic animals that live in the body of water will then eat the vegetation reproduce on or within the aquatic vegetation, thus causing the bioaccumulation of toxicants.
There are many ways to observe the effects of toxicants on fisheries including behavior. Fish behavior can serve as a bridge between the physiological and ecological processes making it ideal for examining environmental pollutant effects. Fish behavior effects can include changes in forage preference or avoidance changing defensive responses, coughs and body tremors, reproduction and social hierarchies (Scott and Sloman 2004). This becomes an important tool as there are many contaminants capable of disturbing normal behavior after exposure that are not severe enough to cause any mortality but are able to witness the sub lethal impacts of it.

General adaptation syndrome (GAS), a physiological response occurring in a predictable pattern, is observable in fish once they are exposed to a stressor identifiable by 3 stages: stage 1 is physiological alarm; stage 2 is resistance where the effects of toxicants can be compensated for a period of time, but if the stressor is severe enough for an extended period of time, the third and final stage is exhaustion.

Lastly, an intra-Service Section 7 consultation (Appendix A) will be completed on the proposed action to ensure there will not be negative impacts to any species listed under the federal Endangered Species Act of 1973.

Rocky Mountain Arsenal NWR
An area that was examined was the series of lakes on the Arsenal and the fish in them. Water from the lakes was used during the production process for cooling and then returned to the lakes to be reused. There were sediment and soil samples shown to have high mercury contamination levels which were present during the production process. There were questions regarding levels of persistent chemicals in the sediment and water of the lakes including Dieldrin (a pesticide no longer in production), that were below the acute criterion but may exceed the chronic criterion for toxicity (Beyers et al. 1999).

The RMANWR has a strict catch and release fishing policy for all its lakes making the ingestion of fish by humans unlikely. Ingestion of fish by bald eagles has not shown any negative consequences from past exposures to chemicals once produced on the Refuge.

The current use of pesticides on the Arsenal is monitored very closely, utilized in low concentrations, and the chemicals used are nowhere near as toxic as those produced or used previously. Manufactures recommended dilutions are followed and applied in such a manner that significantly reduces the chance of drift or secondary exposure. Pesticide Use Proposals (PUPS) are written and approved for all currently used chemicals. Areas to be sprayed by a helicopter will be mapped out and flagged to minimize any areas being affected by spraying herbicides. Any aquatic herbicide use will be done in compliance with the Clean Water Act and NPDES permitting procedures as defined by the Environmental Protection Agency (EPA). Tilling practices may have short term effects on wildlife, but the long term benefits far outweigh any short term detriment.

Rocky Flats NWR
Riparian areas where Preble’s meadow jumping mice are found will be sprayed with a hand sprayer where the risk of drift to non-target species will be minimized. There will be a short term disruption, but the long term benefit to the habitat will outweigh it. Areas to be sprayed by a helicopter will be mapped out and flagged to minimize any non-target areas being affected. As mentioned above, there may be a temporary displacement of the deer and elk on the refuge, but they will move back into the area once spraying is complete. Ground spraying will be done by either a spray tractor or truck, which will lessen the likelihood of drift as PUP’s and manufacturers label directions will be followed. There is no fishing allowed on RFNWR in any of the lakes or streams. Any aquatic herbicide use will be done in compliance with the Clean Water Act and NPDES permitting procedures as defined by the Environmental Protection Agency.

There will be limited to no use of tillage practices on this refuge so any disruption will be minimal.

Two Ponds NWR
PUP’s and manufacturers label directions will be followed to reduce risk of drift and contamination. Aerial application will not be done here due to the proximity of residential developments. Ground application will be done with a truck or UTV mounted spray rig to minimize drift. Any aquatic herbicide use will be done in compliance with the Clean Water Act and NPDES permitting procedures as defined by the Environmental Protection Agency.

There will be minimal tillage practices done at this refuge due to the small size.

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<th>Alternative A</th>
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<tbody>
<tr>
<td>Rocky Mountain Arsenal NWR</td>
<td>- Short term effects from disturbance from tilling and spraying</td>
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</tr>
<tr>
<td>Rocky Flats NWR</td>
<td>- Short term effects from disturbance from tilling and spraying</td>
<td>Same as A</td>
</tr>
<tr>
<td>Two Ponds NWR</td>
<td>- Short term adverse impact by disturbance from ground spraying</td>
<td>Same as A</td>
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4.6 Social and Economic Environment

Cumulative Impacts

The potential effects of pesticides on human health are always something that needs to be discussed when talking about an IPM program. The wide-ranging use of pesticides beginning during World War II created public concern over the environment as well as human health and safety (Allen and Bath 1980). An IPM program looks to address both the environmental and health outcomes along with the environmental goals of the program. One of the main ways of judging whether pesticides and herbicides are used near human populations is the economic injury level (EIL) which measures the pest density where the management costs of the program equal the actual and potential costs from pest damage (Swinton and Williams 1998). This is usually done more in croplands where crop prices are a factor and cities where spraying for insects as a public health service. Pesticide toxicities are measured by the LD-50 number which is the dose of pesticide that is lethal to half of the test population, usually rats and rabbits in a laboratory setting. The risk of pesticide exposure on open areas is dependent on its ability to move through the environment through mediums such as water solubility, clay particle absorption, etc... (Swinton and Williams 1998). The common issues raised during debates about the use of pesticides concentrates on “food safety, groundwater and atmospheric contamination, increased pest resistance to pesticides, destruction of beneficial organisms and concerns about endangered species” (Thrill et al. 1991).

In examining the health effects of low level exposures to pesticides, people that were exposed to pesticides incidentally did not normally contact sufficient material to cause serious injury, though it is poorly understood over a longer time period (Draper and Street 1981). A household exposure study in a confined area that was done in northern Manhattan and the south Bronx, New York discovered that 100% of the population of pregnant women had detectable exposures to 3 different pesticides that were used in the apartment buildings where the study was conducted. These chemicals appear to be neurodevelopmental toxicants (Brenner et al. 2003).

To give this some perspective, the herbicide used in the highest concentration by the Complex is glyphosate, which can be used with a dilution as high as one gallon of chemical per acre. Glyphosate has an LD-50 rating lower than table salt. All of the rest of the herbicides are used in dilutions ranging from one quart per acre to less than three ounces per acre. An acre is approximately the size of a football field including the end zones. Pesticide Use Proposals (PUPS) and the manufacturers label directions are followed for each herbicide that is used on the complex.

The decision to propose aerial herbicide application using a helicopter directly addresses this, as the risk of incidental contact is reduced due to the precision with which a helicopter with a GPS navigation system can apply herbicide. The pilot also
takes many other factors into account. Temperature, wind direction, wind velocity, topography, and aspect are just a few of
the factors that determine how herbicides are applied.

Rocky Mountain Arsenal NWR
The area surrounding the RMANWR contains both residential and commercial development on the south and west,
agricultural land on the north and east along with Denver International Airport property, and industrial development on the
southwest and northwest. Adams County, the City and County of Denver, and Commerce City will designate any future land
use around the Refuge.

The manufactures recommendation will be followed as to application rates and dilution factors as well as following spraying
guidelines for wind speed and temperature to assure risk is minimized.

Rocky Flats NWR
At this time, the RFNWR is not open to the public, thought there are tours done occasionally for special groups. The same
factors that limit the aerial application on the RMANWR would also apply at this Refuge. Climatic conditions would have to
be favorable in order for spraying to occur. There may be a news release so the public was informed as to what was going on
and where the spraying would occur.

Two Ponds NWR
Aerial spraying will not be done at TPNWR due to the proximity to development and small acreage of the refuge itself.
Ground spraying will be conducted by a truck or UTV spray rig which will limit the potential for drift and overspray due to
the nature of the methods used and small areas covered by the rig.

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<td>Rocky Mountain Arsenal NWR</td>
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<tr>
<td>Rocky Flats NWR</td>
<td>- Short term effect based on public perception during spraying</td>
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</tr>
<tr>
<td>Two Ponds NWR</td>
<td>No effect</td>
<td>Same as A</td>
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5.0 Coordination and Environmental Review

This section describes how the Service coordinated with others and conducted environmental reviews of various aspects of
the project proposal and analysis. Additional coordination and review would be needed to carry out the proposed action, if
selected.

5.1 Agency Coordination

The Service has discussed this plan with other federal (U.S. Army and the EPA), State of Colorado (Colorado Parks and
Wildlife, Colorado Department of Public Health and Environment), local county governments, and regional entities (Tri-
County Health Department, Stapleton Redevelopment Foundation, Denver Water) through a series of meetings and
correspondence. Tribes with an aboriginal interest in the Complex were invited to participate or formally consult in the
planning process (Northern Arapaho Tribe, Northern Cheyenne Tribe, Southern Ute Tribe, and the Ute Mountain Ute Tribe).
A number of nongovernmental organizations are active in the RMANWR and were also consulted, including the Friend’s of
the Front Range National Wildlife Refuges and Two Ponds Preservation Fund.
The Service coordinated internally in the development of this EA as well. Complex staff conducted the analysis and prepared this document. An intra-service Endangered Species Act section 7 consultation was conducted, and resulted in a finding of “May affect but not likely to adversely affect” ESA protected or candidate species (Appendix A). Region 6 biological and invasive species staff assisted with the development of integrated pest management strategies (see Appendix B, List of Preparers and Reviewers).

5.2 National Environmental Policy Act

The Service conducted this environmental analysis under the authority of and in compliance with NEPA, which requires an evaluation of reasonable alternatives that will meet stated objectives, and an assessment of the possible effects on the natural and human environment.

5.3 Environmental Assessment

This EA will be the basis for determining whether the implementation of the proposed action would constitute a major federal action significantly affecting the quality of the natural and human environments. NEPA planning for this EA involved other government agencies and the public in the identification of issues and alternatives for the proposed project.

5.4 Distribution and Availability

The Service will make the draft EA to the project mailing list, which includes federal and State legislative delegations; tribes; federal, State, and local agencies; nongovernmental organizations; and interested individuals. Copies may be requested from the RMANWR.
Appendix A

Environmental Compliance

Environmental Action Statement
U.S. Fish and Wildlife Service, Region 6
Lakewood, Colorado

Within the spirit and intent of the Council on Environmental Quality’s regulations for implementing the National Environmental Policy Act and other statutes, orders, and policies that protect fish and wildlife resources, I have established the following administrative record. I have determined that the action of implementing the “Integrated Pest Management Program at the Rocky Mountain Arsenal National Wildlife Refuge Complex” is found not to have significant environmental effects, as determined by the attached “finding of no significant impact” and the environmental assessment.

____________________________________
Project Leader,
Rocky Mountain Arsenal National Wildlife Refuge
U.S. Fish and Wildlife Service
Commerce City, Colorado

____________________________________
Refuge Supervisor
U.S. Fish and Wildlife Service
Lakewood, Colorado

____________________________________
Assistant Regional Director
National Wildlife Refuge System
U.S. Fish and Wildlife Service
Lakewood, Colorado
The U.S. Fish and Wildlife Service (Service) has completed a revised integrated pest management plan to outline the goals and objectives for management of invasive plants and other nuisance species the Rocky Mountain Arsenal National Wildlife Refuge Complex (Complex). This plan continues with the current pest management program and adds improved techniques including the use of aerial spraying of herbicides as a possible method for controlling invasive plant populations. The resulting Environmental Assessment (EA) evaluates two alternatives: Alternative A, a no action alternative/current management; and Alternative B, the preferred alternative, to continue use of proven techniques and add new methods including aerial spraying to help control noxious and invasive plants.

Alternative B, the preferred alternative, was selected for implementation because it best meets the Service’s mission to sustain fish and wildlife populations. The proposed alternative would keep utilizing the techniques now employed in the current Integrated Pest Management Plan at the Complex and update those techniques to current standards and add the option of utilizing aerial spraying for invasive species control using contract equipment. This alternative would provide an additional, efficient tool for use in invasive species control. Larger areas would be covered with similar if not better kill rates at a reduced staff effort, allowing other projects to be completed.

Aerial spraying has been tremendously effective in the battling invasive species on the Rocky Mountain Arsenal National Wildlife Refuge, utilized temporarily under a categorical exclusion. The use of contract aerial spraying on the Rocky Mountain Arsenal and Rocky Flats National Wildlife Refuges by local agricultural crop dusters equipped with specialty dispersers assures an accurate, effective and professional job. The reduced amount of time needed to spray and having a more efficient system, combined with larger acres covered, allows for a favorable cost-benefit ratio.

Public Involvement
On ____, 2013, a press release was issued by the Refuge which announced the release of a draft environmental assessment for 30 days of public comment. An informal public meeting was held on ____, 2013, at the Refuge visitor center. In addition to comments presented by some of the approximately ___ people who attended this
meeting, another ___ written comments were received from individuals, organizations, and agencies. Public comments and responses are included as Appendix C of the EA.

Effects of the Proposed Action
This EA has taken a hard look at the environmental impacts to inform the public and ourselves about the consequences of the proposed action (the Service’s preferred alternative).

In determining whether this project is a major action significantly affecting the quality of the human environment, we looked at both the context and intensity of the action (40 CFR § 1508.27, 40 CFR § 1508.14) as required by NEPA. In terms of context, the preferred alternative will occur on the Rocky Mountain Arsenal National Wildlife Refuge Complex, but we have evaluated whether it will have effects on the human environment on a broader scale. Because the human environment and the relationship of people with that environment (40 CFR § 1508.14), in addition to our thorough analysis of physical environmental effects, we carefully considered the manner in which the local people and natural resources relate to the surrounding environment, though economic and social effects are not intended by themselves to require preparation of an environmental impact statement (40 CFR § 1508.14).

An adaptive management framework where the Service will apply the appropriate invasive species control method for the situation, whether that be diskimg, prescribed fire, hand pulling, biological control, or chemical application via ground or air will insure the appropriate outcome for the wildlife habitat in question. Invasive plant species can be very aggressive and may out-compete native plant species, especially in restoration sites and disturbed areas. Invasive plant species do not offer the same habitat benefits as native plants and will adversely affect native wildlife populations if they are allowed to expand. None of the IPM tools in consideration will have negative long-term impacts on the human environment, and would have only very minor inconvenient effects in the short-term. The long-term benefits may include improved habitat for wildlife, which in turn offers better wildlife viewing opportunities, along with decreased wind and water erosion. The largely beneficial impacts of this program in the long-term cannot be overstated.

Decision and Finding of No Significant Impact
The analysis indicates that there will not be a significant impact1, individually or cumulatively, on the quality of the human environment2 as a result of this proposed action. I agree with this conclusion and therefore find that an EIS need not be prepared. This determination is based on the following factors.

1. Environmental consequences of a larger program to reduce non-native plant populations including the addition of aerial spraying, may in the short term affect some susceptible native plants, but the long-term effects of invasive plant control will only benefit the habitat for all native wildlife species. Overall, effects will be beneficial

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1 40 CFR § 1508.27 “Significantly” as used in NEPA requires considerations of both context and intensity (a) Context. This means that the significance of an action must be analyzed in several contexts such as society as a whole (human, national), and affected region, the affected interests, and the locality. Significance varies with the setting of the proposed action. For instance, in the case of site-specific action, significance would usually depend upon the effects in the locale rather than in the world as a whole. Both short- and long-term effects are relevant; and (b) Intensity. This refers to the severity of impact. Responsible officials must bear in mind that more than one agency may make decisions about partial aspects of a major action.

2 40 CFR § 1508.14 “Human environment” shall be interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment. (See the definition of “effects” (40 CFR § 1508.8.) This means that economic and social effects are not intended by themselves to require preparation of an environmental impact statement. When an environmental impact statement is prepared and economic or social and natural or physical environmental effects are interrelated, then the environmental impact statement will discuss all of these effects on the human environment.
to wildlife habitat, grassland bird populations, and numerous other prairie-dependent species. Based on informal intra-Service section 7 consultation, the proposed action, will not result in the jeopardy of any federally threatened or endangered species, or adversely modify existing designated critical habitat.

2. The proposed action would pose no known risk to public health or safety.

3. The effect on the quality of the human environment is not highly controversial.

4. The proposed action will not affect sites, structures, or objects listed in or eligible for listing in the National Register of Historic Places, nor would it likely cause any loss or destruction of significant scientific, cultural, or historic resources.

5. No significant cumulative effects were identified through this assessment. The EA discussed the cumulative effects on and off the Refuge with those actions proposed by others.

Therefore, in light of the compelling science in support of the plan, and my review of the information contained in the supporting reference, I have determined that implementing an adaptive approach to integrated pest management on the Rocky Mountain Arsenal National Wildlife Refuge Complex is not a major federal action that would significantly affect the quality of the human environment with the meaning of Section 102(2)(C) of NEPA.

The Finding of No Significant Impact (FONSI) and supporting NEPA analysis will be available to the public upon request. Copies of the EA are available for all affected agencies, private groups, and other interested parties. These documents are on file at the Rocky Mountain Arsenal National Wildlife Refuge, 6550 Gateway Road, Building 121, Commerce City, Colorado 80022 (telephone: 303-289-0232).

______________________________
Regional Director, Region 6
U.S. Fish and Wildlife Service
Lakewood, Colorado

Supporting Reference:

Intra-Service Section 7 Consultation
Rocky Mountain Arsenal National Wildlife Refuge
Adams, Boulder, Broomfield, Denver, & Jefferson Counties, Colorado

Originating Person: Tom Ronning            Date Submitted: 15 April 2013
Telephone Number: 303-289-0406

I. Service Program and Geographic Area or Station Name:
Rocky Mountain Arsenal National Wildlife Refuge Complex

II. Flexible Funding Program (e.g. Joint Venture, etc) if applicable:
N/A

III. Location: Location of the project including County, State and TSR (township, section & range):
RMANWR - Adams and Denver Counties, Colorado (39.85°N, 104.86°W)
RFNWR - Boulder, Broomfield, and Jefferson Counties, Colorado (39° 53’ 0”N, 105° 13’ 0”W)

IV. Species/Critical Habitat: List federally endangered, threatened, proposed, and candidate species or designated or proposed critical habitat that may occur within the action area.

*Rocky Mountain Arsenal NWR*

Black-footed ferret (*Mustela nigripes*) - The black-footed ferret is an endangered species where it is located. At this time, no ferrets exist on the RMANWR.

Eskimo curlew (*Numenius borealis*) - The Eskimo curlew is a wide ranging bird species that favors open grassy meadows. Habitat fragmentation, loss of prey populations of grasshoppers and commercial hunting are thought to have led to their decline. The endangered Eskimo curlew has never been sighted on the Refuge, and has not been sighted in Colorado since 1965.

Ute ladies’-tresses orchid (*Spiranthes diluvialis*) - The Ute ladies’-tresses orchid is a threatened plant species found along streams, in wetlands, and in other moist habitats along Colorado's Front Range and plains areas in elevations below 6,500 feet. The Refuge contains habitat suitable for the orchid, but surveys of the Refuge have not located any populations of this species.

Platte River species - Several threatened and endangered species, such as whooping crane (*Grus americana*) and piping plover (*Charadrius melodus*) may exist on or near the South Platte River.

*Rocky Flats NWR*

Preble’s meadow jumping mouse (*Zapus hudsonius prelei*) - The Preble’s meadow jumping mouse is a native species found in the riparian areas in and around the RFNWR. The mouse occurs along every major drainage on the Refuge. This species was listed as threatened in 1998 (Federal Register 1998) and is found in habitat next to streams and waterways. The Service designated critical habitat in 2003 for the mouse (Federal Register 2003), which did not include the Rocky Flats Site as it was to become a Refuge (Federal Register 2003). In 2010, a total of 1,108 acres of
critical habitat was designated on the Refuge (Figure A-1) for the threatened Preble’s meadow jumping mouse (Federal Register 2010). In 2012, the Service disposed of 12.4 acres of designated critical habitat at the Refuge as a part of a larger conservation exchange for additional greater quality mouse habitat that is currently not designated as critical habitat (U.S. Fish and Wildlife Service 2011).

V. Project Description: Describe proposed project or action or, if referencing other documents, prepare an executive summary (attach additional pages as needed):

The proposed action is to implement a new integrated pest management plan for the Complex. The Complex includes three units: Rocky Mountain Arsenal NWR, Rocky Flats NWR, and Two Ponds NWR. The Rocky Flats NWR is the only unit with the presence of a listed species.

Implementation of the proposed action, to utilize new strategies and techniques for battling noxious weeds and other nuisance species, will also include the addition of aerial spraying of herbicides. Areas to be sprayed would be flagged as to should pilot the exact location to spray. The use of aerial spraying would reduce the chance of drift to areas that were not to be sprayed due to the specially designed equipment used by contract helicopter pilots. A buffer zone would be set up as to not get too close to riparian areas. Riparian areas that needed to be sprayed would be done only with a backpack sprayer to reduce any chance of drift or non-target mortality while reducing the disturbance to the Preble’s meadow jumping mouse habitat. Any chemicals used will be approved through the Pesticide Use Proposal (PUP) methodology with the least amount of impact on the habitat or resident species a priority.

There are currently no active weed control strategies being employed at the Rocky Flats NWR, however when they do begin, a modest amount of disturbance is expected. This will come in the form of spray equipment working near riparian areas and the walking of Service personnel in these areas spraying with backpack sprayers. There will be some short term disturbance in the available vegetation post spraying, but will lessen over time with new emergent vegetation taking its place. In a biological evaluation written in April 2006 by the Region 6 ecological services office titled “Biological Evaluation for Weed Control in Preble’s Mouse habitat at the Rocky Flats Site”, the spraying of herbicides for weed control was designated as may affect, but not likely to adversely affect.

Following the completion of this consultation, a further review would be done by the Regional IPM coordinator. This EA and associated Section 7 will also be provided for public review. Based on those assessments, the Regional Director of Region 6 of the Service may make a Finding of No Significant Impact (FONSI) determination and the proposed action would be adopted. If another alternative is selected as presented in the document, a new consultation would be required.

In addition, the IPM plan and reductions in noxious weeds will improve prairie health at the Rocky Mountain Arsenal NWR. This is considered important to establish conditions necessary to consider reintroduction of the federally endangered black-footed ferret.

VI. Determination of Effects:

(A) Description of Effects: Describe the action(s) that may affect the species and critical habitats listed in item IV. Your rationale for the Section 7 determinations made below (B) should be fully described here.

| Preble’s meadow jumping mouse (Zapus hudonius prelei) | May Effect (not likely to adversely affect) – the proposed action is not expected to have any long-term negative effects on the habitat in riparian areas. In fact, the long-term effects are expected to be positive as invasive species will be |
exterminated giving native species a chance to establish and grow. This will increase the plant biodiversity of the area allowing for more productive vegetation. Refuge staff would limit disturbance to designated critical habitat by only using backpack sprayers to spray the invasive species and also set up an adequate buffer zone to keep the cover component of habitat requirements near riparian areas.

| Black-footed ferret (Mustela nigripes) | May Effect (beneficial) – species does not exist on the Refuge at this time, but designation of approximately 2,585 acres for black-tailed prairie dogs will facilitate the stable environment necessary to consider reintroduction of a discrete population of ferrets on the Refuge. The reduction of noxious weeds is considered beneficial to prairie ecosystems necessary to support the species. The decision on whether or not to reintroduce ferrets will ultimately be determined during the revision of the CMP, but the ability to do so will is contingent upon the habitat goals outlined in the habitat management plan and integrated pest management plan. |
| Eskimo curlew (Numenius borealis) | No Effect – species has not been documented on the Refuge or in the State of Colorado in recent history |
| Ute ladies'-tresses orchid (Spiranthes diluvialis) | No Effect – species has not been documented on the Refuge; proposed action is to burn slash in an upland area behind the maintenance facility |
| Platte River species | No Effect – species are not present; proposed action will occur between 2 and 6 miles from the South Platte River |

(B) Determination: Determine the anticipated effects of the proposed project on species and critical habitats listed in item IV. Check all applicable boxes and list the species (or attach a list) associated with each determination.

Determination

No Effect: This determination is appropriate when the proposed project will not directly or indirectly affect (neither negatively nor beneficially) individuals of listed/proposed/candidate species or designated/proposed critical habitat of such species. **No concurrence from ESFO required.**

May Affect but Not Likely to Adversely Affect: This determination is appropriate when the proposed project is likely to cause insignificant, discountable, or wholly beneficial effects to individuals of listed species and/or designated critical habitat. **Concurrence from ESFO required.**

May Affect and Likely to Adversely Affect: This determination is appropriate when the proposed project is likely to adversely impact individuals of listed species and/or designated critical habitat.
Formal consultation with ESFO required.

*May affect but Not Likely to Jeopardize candidate or proposed species/critical habitat:*
This determination is appropriate when the proposed project may affect, but is not expected to jeopardize the continued existence of a species proposed for listing or a candidate species, or adversely modify an area proposed for designation as critical habitat. **Concurrence from ESFO optional.**

*Likely to Jeopardize candidate or proposed species/critical habitat:*
This determination is appropriate when the proposed project is reasonably expected to jeopardize the continued existence of a species proposed for listing or a candidate species, or adversely modify an area proposed for designation as critical habitat. **Conferencing with ESFO required.**

Signature:  
/s/ David Lucas  
Date:  
April 15, 2013
**Reviewing Ecological Services Office Evaluation** (check all that apply):

A. **Concurrence** _____  **Nonconcurrence** _____
   Explanation for nonconcurrence:

B. Formal consultation required _____
   List species or critical habitat unit

C. Conference required _____
   List species or critical habitat unit

Name of Reviewing ES Office: __________________________

Date: ______________

Name of Reviewing ES Office: __________________________

Date: ______________

Revised 3/2010
## List of Preparers

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<thead>
<tr>
<th>Author's Name</th>
<th>Position</th>
<th>Work Unit</th>
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<tbody>
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<td>Mark Kalitowski</td>
<td>Refuge GIS Specialist</td>
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<td></td>
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<td>William Kutosky</td>
<td>Biological Sciences Technician</td>
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<td>Scott Quayle</td>
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<td>Tom Ronning</td>
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## List of Reviewers

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<th>Work Unit</th>
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<tbody>
<tr>
<td>Barbara Boyle</td>
<td>Zone Refuge Supervisor</td>
<td>Regional Office (Lakewood, Colo.)</td>
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<tr>
<td>Lindy Garner</td>
<td>Regional Invasive Species Coordinator</td>
<td>Lee Metcalf NWR (Stevensville, Mont.)</td>
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<td>Bruce Hastings</td>
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<tr>
<td>Murray Laubhan</td>
<td>Zone Refuge Biologist</td>
<td>Quivira NWR (Stafford, Kans.)</td>
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<td>David Lucas</td>
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Morrison-Knudsen Environmental Services Inc. 1989. Wildlife resources of the Rocky Mountain Arsenal, Adams County, Colorado Morrison-Knudsen Environmental Services Inc.


