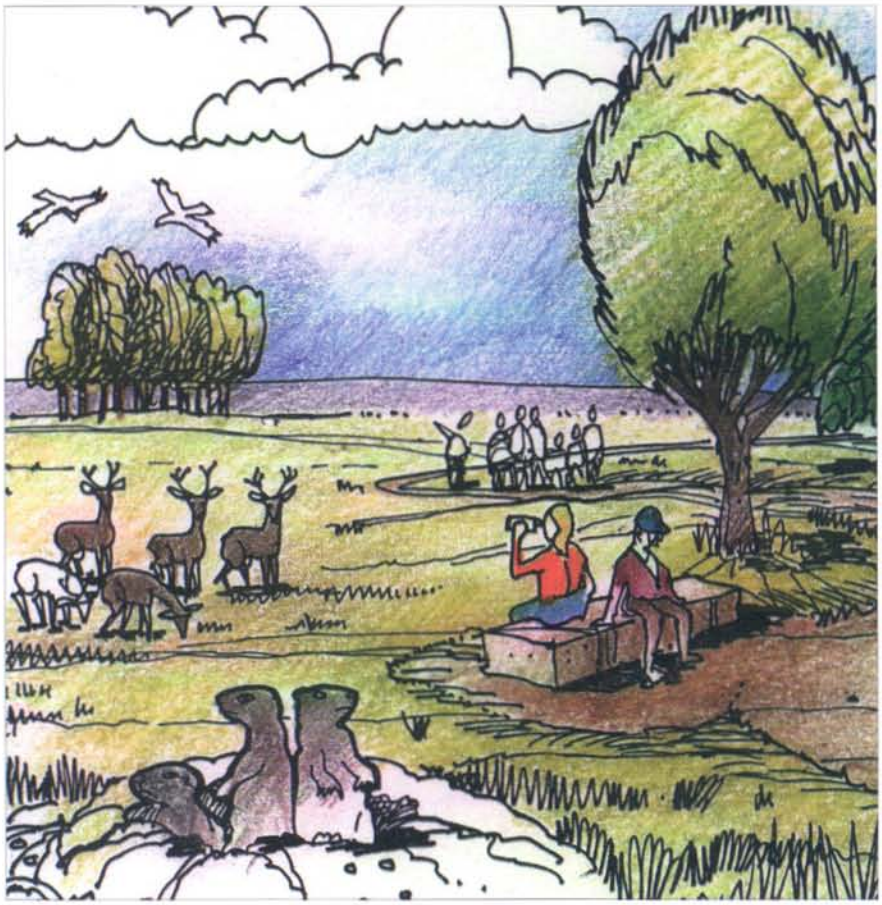
ROCKY MOUNTAIN ARSENAL NATIONAL WILDLIFE REFUGE

COMMERCE CITY, COLORADO



■ COMPREHENSIVE MANAGEMENT PLAN ■

MARCH 1996

Fellow Citizens and Interested Readers:

The U. S. Fish and Wildlife Service is proud to present to you the Comprehensive Management Plan for the Rocky Mountain Arsenal National Wildlife Refuge. This plan and its supporting documents outline a vision for the development of the Refuge and specify how one of America's newest and largest refuges will be developed to conserve wildlife while providing enjoyment to people.

Vitally important to successfully developing the Refuge will be active community participation. We invite you to learn—from this plan and from visits to the Refuge—more about the Refuge, its purposes and prospects, and to become involved in making it all that it can be.

The staff of the Rocky Mountain Arsenal National Wildlife Refuge would like to express special thanks to the National Fish and Wildlife Foundation, Shell Oil Company, and King Soopers for their financial assistance in support of this Comprehensive Management Plan. Thanks also to the all of the people who participated in public meetings and focus groups or who sent in comments during the planning process.

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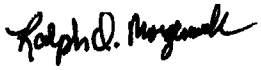

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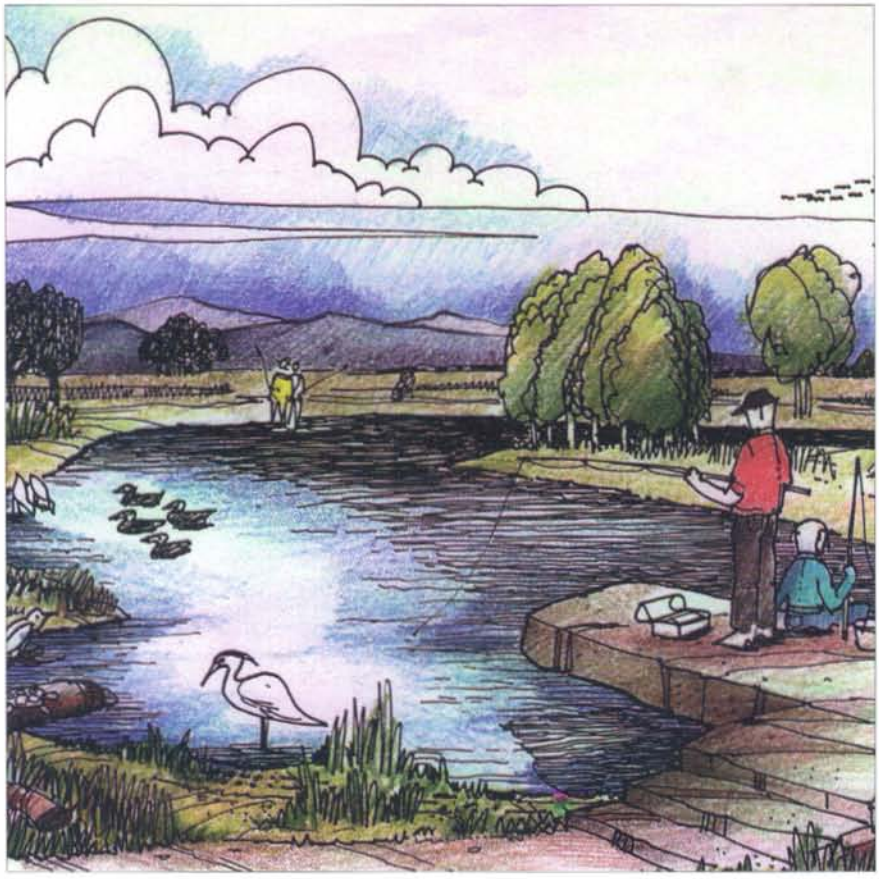
PARADOX. That's the word most often used to describe the place near Commerce City, Colorado that is becoming the **Rocky Mountain Arsenal National Wildlife Refuge**. It is both a wildlife refuge and a Superfund cleanup site. It is a large natural area—almost 27 square miles of open land—yet it is only ten miles from downtown Denver. It has been a source of contamination and concern; it is becoming a source of pride and potential. At present, portions of the site are used for **environmental education** and for **viewing wildlife** such as deer, eagles, prairie dogs, and hawks. In ten to fifteen years—after environmental cleanup is complete—almost all of the site will serve as a wildlife refuge and a permanent part of the **National Wildlife Refuge System.** Few cities have as large a **natural area** as Denver does in the Arsenal Refuge. The Refuge provides a welcome contrast to the surrounding city for both wildlife and people. The extraordinary **abundance of wildlife**—some species are found in greater numbers here than anywhere else along the Front Range—exists today because part of the site was used for forty years to make **weapons, fuel, and pesticides.** The fascinating history of the Rocky Mountain Arsenal is a story very much worth learning from.

The Rocky Mountain Arsenal is undergoing a transformation
from a military installation, a chemical production facility,
and a Superfund cleanup site ...



...into one of America's largest urban wildlife refuges, a place of refuge
for wildlife and enjoyment for people, a place to demonstrate
environmental stewardship and responsibility.

LONG AGO the site of the Arsenal was covered by **shortgrass prairie.** Later, it became **farmland**, and then an army **arsenal.** Each use has left its mark and helped shape the unique character of one of our nation's newest urban wildlife refuges. For thousands of years, the Refuge was prairie, home to a natural community of plants and animals which had evolved on the **high plains** along Colorado's Front Range. Vast herds of bison roamed freely, while bands of **pre-historic people** moved from place to place following the availability of wild foods. By the early 1800s, Plains Indians like the **Arapaho** and **Cheyenne** roamed along the Front Range, following the bison herds. Well-adapted to prairie life, these hunters on horseback made efficient use of their primary game animal—bison—which yielded food, clothing and tools. In 1942, America was gearing up for **World War II.** That year, the U.S. Army purchased nearly 20,000 acres of land north of Denver to build a weapons plant—the Rocky Mountain Arsenal. The **weapons plant** was constructed in the center of the Arsenal, with a buffer zone of open land around the perimeter. When the Army bought the site in 1942, almost all the native prairie had been plowed for growing **crops.** Farmers had built lakes and planted trees, thereby creating important **wildlife habitat.**

AFTER WORLD WAR II was won, the Rocky Mountain Arsenal's industrial plant was converted to production of **agricultural chemicals and pesticides** to aid in growing crops. In the late 1940s and early 50s, as the need for chemical weapons diminished, the Army leased portions of the Arsenal to private companies. With continued operation, the facilities would be in good repair and ready in the event of another national emergency. During this time, **Shell Oil Company** made agricultural pesticides at the site. **Cold War** tensions, exacerbated by the North Korean invasion of South Korea, resulted in the Arsenal being reactivated. During the conflict, white phosphorous-filled bombs, artillery shells with distilled mustard, and incendiary cluster bombs were manufactured. Of greater significance, though, was the decision to begin manufacturing at the Arsenal a highly toxic chemical product, known generically as **nerve agent**. The **North Plants** were constructed for this purpose with production beginning in 1953 and continuing intermittently until 1969. Cold War fears kept the Arsenal an active military base until 1982, when manufacturing operations at the Arsenal ceased. The following year the U.S. Environmental Protection Agency listed the Arsenal as a **Superfund Cleanup site**.

HAZARDOUS WASTE was a concept few people had thought much about during the 1940s and 50s. Using disposal practices typical of the time, manufacturing wastes were treated and discharged into **evaporation basins.** There were unexpected consequences related to this disposal process. By the early 1950s, chemical wastes were discovered leaching through the soil into the **ground water.** Farmers north of the Arsenal believed that well water was damaging their crops. Contamination also affected wildlife, mainly waterfowl using the lower lakes and waste basins. Cleanup engineers were faced with substantial challenges. While the final cleanup approach was being determined, **interim programs** dealt with immediate cleanup needs. More than 11 million gallons of hazardous liquids from one of the site's most contaminated areas were safely destroyed. Each year one billion gallons of **ground water** are pumped to the surface, treated, and then returned to the ground. The final Arsenal **cleanup**, to be paid for by the Department of Defense and Shell Oil Company, will take from 10 to 15 years and cost approximately **$2 billion.** The contaminated soils of greatest concern will be collected into a hazardous waste **landfill** on the site. Less problematic soils will be capped, covered with topsoil, and revegetated.

AN AMAZING DISCOVERY was made as public attention focused on environmental cleanup of the Arsenal. **Bald eagles**—then listed as an endangered species—were found using the Arsenal as a wintering site. Despite contamination in the core area, the relatively undisturbed **buffer zone** around the core production areas provided food, shelter, and freedom from human disturbance. In 1987, the **U.S. Fish and Wildlife Service** began managing the site's abundant wildlife as cleanup went forward. Five years later, in recognition of its tremendous resources, the **Rocky Mountain Arsenal National Wildlife Refuge Act** was passed by Congress. The Refuge's **biological communities** form the basis of the Refuge. They are what is to be carefully managed and they are why most people will visit the Refuge. These communities include grasslands, former homesteads, streams and other aquatic areas, and the wildlife that inhabit these places. **Grasslands** form the largest biological community on the Refuge, supporting a variety of wildlife species, such as deer, prairie dogs, and burrowing owls. The Refuge grassland communities will be managed to benefit the diverse wildlife community that presently exists, and other native species that may be reintroduced. Long before the Refuge was used for the manufacturing of ammunitions during

World War II, much of the area was farmed or grazed. Both native and non-native **trees and shrubs** were planted near homesteads. This vegetation provides important habitat for neotropical migratory songbirds, and important cover, perch, and nest sites for **raptors,** such as hawks, eagles and owls. These plants also provide cover for **deer** and other species. Several types of **aquatic communities** exist on the Refuge. Four reservoirs or artificial **lakes** are found in the southern zone. **Wetlands** are found surrounding the lakes, along First Creek, and in small ponds and drainages elsewhere on the Refuge. The lakes and wetlands provide habitat for a variety of fish and wildlife. **First Creek** flows northwest from the southeastern corner of the Refuge, exiting the Refuge at the northern boundary. It is the **cottonwood trees** along First Creek that provide a communal roost for wintering bald eagles and serve many other functions for wildlife. Several **species of special interest** are found at the Refuge: deer, bald eagles, prairie dogs, ferruginous hawks, and burrowing owls. Bald eagles and other raptors are attracted to the Refuge by the abundance of **prairie dogs** and other small mammals, the availability of water and loafing sites, and the relatively undisturbed and secure communal roost. **Ferruginous hawks**, a candidate species for listing

as threatened or endangered, use the Refuge during winter months. **Prairie dogs** are critical to the grassland biological community found throughout the Refuge. They are a **keystone species** which provides a prey base for raptors, coyotes, badgers and other predators. In addition to the species already found at the Refuge, the Service is considering reintroducing four native species that are not currently found there: **bison, pronghorn antelope, prairie chicken, and plains sharp-tailed grouse.** In addition to its impressive biological resources, important **prehistoric and historic cultural resources** also exist on the Refuge. Henderson Hill, in the northern part of the Refuge, served as a campsite for nomadic **hunter-gatherers** who migrated to North America between 40,000 and 12,000 B.C. By the early 1500s, **Apache tribes** occupied the area of the Refuge, followed by the **Comanches, Utes, Arapahoes and Northern Cheyennes**. Evidence of this use survives today as stone flakes from spearheads and knives, fire-cracked rocks used for cooking, and hammer and grinding stones. **Artifacts** of these and more recent human use, such as **buildings** associated with farming, ranching, and chemical production, may also be found on the Refuge. Most buildings, however, will be removed during environmental cleanup, because they are contaminated.

Among the more than 300 species of wildlife found at the Rocky Mountain Arsenal National Wildlife Refuge are (clockwise from upper left): great blue heron, badger, bald eagle, bullfrogs,...

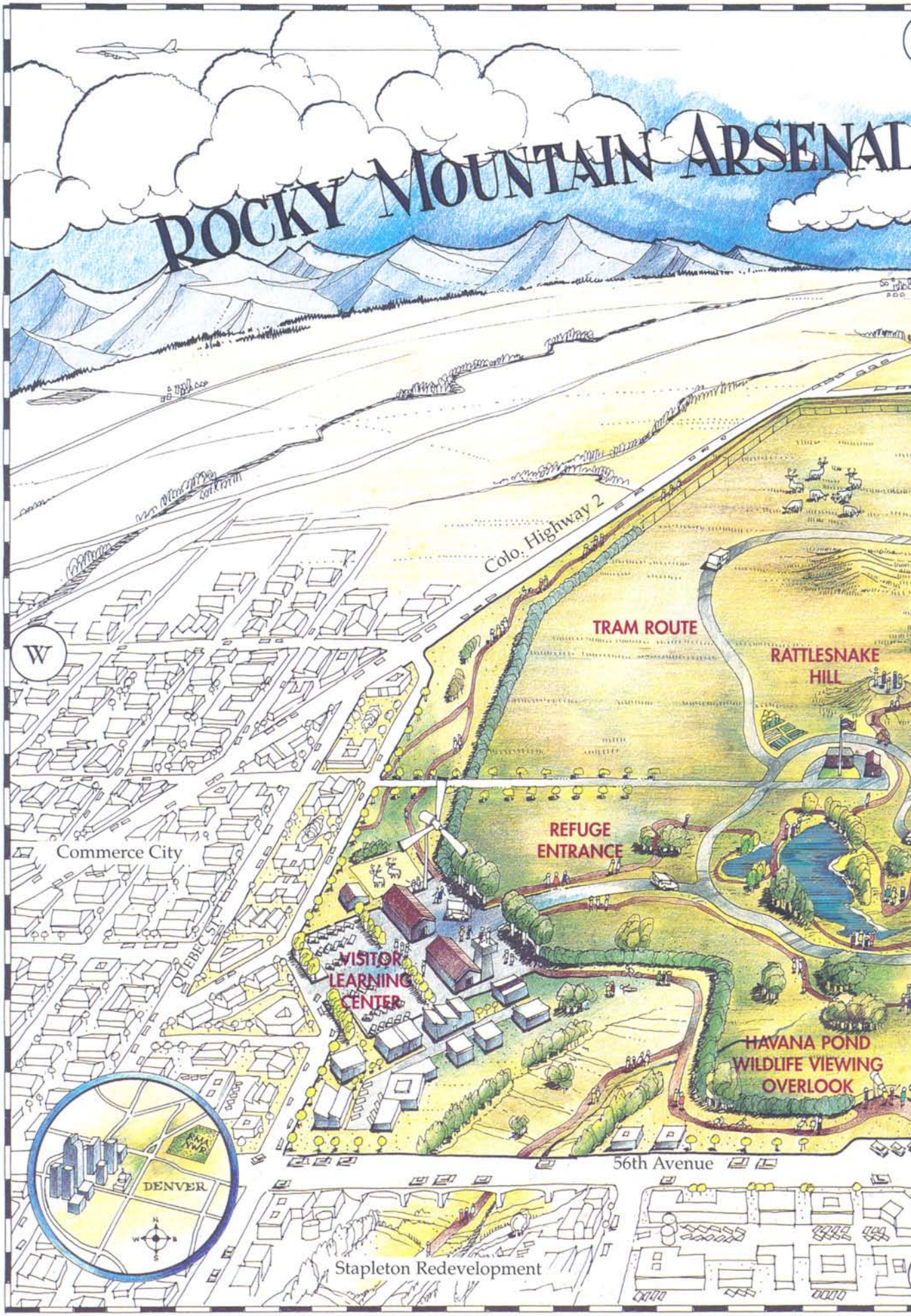
...and coyote, western tanager, racer, mule deer.

VISITORS TO THE REFUGE in the **future** will take part in a wide range of **activities** related to **environmental education, interpretation, and recreation.** School children, for example, will participate in hands-on environmental education programs. These programs will teach students concepts they can apply elsewhere, and provide a behind-the-scenes perspective on the ecology of the Refuge and how it is managed. Interpretive programs for the general public will be available on the tram, as well as on foot or bicycle. Through these and other programs, people will learn about **environmental stewardship** by seeing it demonstrated firsthand in the care being given the Refuge. The specifics of the Refuge—its wildlife, history, and even cleanup activities—will be springboards to present broader concepts of environmental responsibility. **Wildlife-oriented recreation**, such as **photographing nature** and **observing wildlife** on foot or **bicycle**, will be other activities which allow the public to experience nature firsthand. Facilities will be constructed to help people learn about and enjoy the Refuge. The **Visitor Learning Center,** for example, will be the location of many visitor programs, particularly those that include activities or concepts for which few or no physical artifacts remain on the site.

THE REFUGE COMPREHENSIVE MANAGEMENT PLAN was completed by the U.S. Fish and Wildlife Service in winter 1995-96. The plan strives to protect the needs of **wildlife** while allowing **people** to enjoy many wildlife-oriented activities—a dual goal called for in the legislative act that created the Refuge. Many people—from local children to senior citizens, from technical consultants to dedicated volunteers, from neighborhood groups to governmental agencies—helped create the plan for the future of the Refuge. The plan acknowledges the significant opportunity for appropriate **public use** of the Refuge because of its unique location within this metropolitan area. (Approximately two million people live within an hour's drive of the Refuge.) Special care will be given to keep public use **compatible** with wildlife management goals. For example, during some times of the year, such as when bald eagles are using the First Creek area for winter roosts, people will be excluded from nearby areas. This kind of careful **choreography** will make possible meaningful and enjoyable experience of the Refuge while still sustaining and enhancing wildlife and their habitats. The final plan, described in this report, outlines how and when the Refuge will be developed and what its program goals are.

TEN BROAD PLANNING PRINCIPLES emerged in discussions with the public and other interested parties: **1.** So that valuable lessons can be learned, the plan for the Refuge must be true to the history of the site, whether that history was pleasant or not. **2.** The site is extremely complex and its story should not be over-simplified. **3.** Intrusions in the Refuge—such as roads and buildings—should be kept to a minimum so that the site does not become cluttered. **4.** The ways that the Refuge is managed must demonstrate the same principle that the Refuge aims to teach—environmental stewardship. **5.** Environmental education at the Refuge must aim to move people beyond wanting to hear interesting facts about nature, to wanting to take action on behalf of the environment. **6.** The Refuge should be both a reserve for wildlife and a place for people to experience nature. **7.** There should be a continuous, special effort made to reach and involve the Refuge's neighbors. **8.** The Refuge's planning—and management—process should be open and public. **9.** Recognizing the fiscal realities of our times, the Refuge must enter into partnerships to aid in achieving its goals. **10.** The diverse goals set for the Refuge by the public and by Congress are best achieved through identifying separate management zones at the Refuge.

A STAFF of approximately 75 people will be needed to run the Refuge once it is developed at a projected cost of $65 million according to the Comprehensive Management Plan. Development will be phased over a period of years. Each phase has associated with it specific projects and project costs and corresponds to phases of environmental cleanup. Because there are many clean areas across the Refuge, people can enjoy it even now. **AN IMAGINARY TOUR** of the future Refuge follows. It is the kind of tour that will be possible perhaps five to ten years from now, once environmental cleanup is complete. Your tour starts with an exploration of the **Visitor Learning Center**. In the heart of the **Gateway** to the Refuge lies a vibrant center for science and technology, where the Visitor Center shares a campus-like setting with businesses and research and educational institutions. Start your journey by parking your car. You won't need it for this adventure. Wander on the campus through interactive **exhibits** developed jointly by cooperating organizations on the campus. You might visit a prairie dog home or travel back in time to when the Refuge played a critical role as a U.S. Army Arsenal. Have lunch in the **café.** Watch a wildlife program in the **theater.** Browse through the **bookstore**—one of many shops and activities at the Center. Head


ROCKY MOUNTAIN ARSENAL
Colo. Highway 2
TRAM ROUTE
RATTLESNAKE HILL
REFUGE ENTRANCE
VISITOR LEARNING CENTER
HAVANA POND WILDLIFE VIEWING OVERLOOK
Commerce City
QUEBEC ST.
56th Avenue
Stapleton Redevelopment
DENVER
W


NATIONAL WILDLIFE REFUGE
HENDERSON HILL
WILDLIFE VIEWING OVERLOOK
96th Avenue
E
Peña Blvd.
THE LAKES
THE WETLANDS
EAGLE
WATCH
VIEWING
AREA
WILDLIFE VIEWING AREA
Montbello Neighborhood (Denver)
ASHBY
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back to the door, and hike or bike along the miles of **trails** around and through the Refuge. Or hop on the open-air tram for a guided look at wildlife in the great outdoors. **The Lakes Area** along the southern tram route will likely be your first stop. Built originally for irrigation, these lakes and canals now attract shore birds, water birds and other migratory birds. Watch the resident Canada geese grazing on the grassy banks or the ducks diving in open water. You may see a white pelican on the lakes, or a northern oriole in one of the cottonwood trees nearby. Another stop will be the **wetlands** created to make up for habitat lost during environmental cleanup. Shore birds and wading birds like avocets can be seen dipping their bills into the water for food. Frogs and snakes also call this home. **Rattlesnake Hill** is your next stop, where a short walk will give you a panoramic view of Denver and the Rockies as well as the cleanup areas of the Arsenal. From here, another option is to take the northern tram route to get a first-hand view of what much of the Front Range looked like in earlier times—native shortgrass prairie. Look for bison, pronghorn antelope, or prairie chickens along the way. These species were once an important part of the landscape. They were reintroduced after the cleanup because they play a vital role in sustaining the prairie. When your

tram ride returns to the Visitor Learning Center, don't get back into your car. There's much more to see and do. Take the **perimeter trail** and hike, bike, jog, or roller-blade along the outside of the Refuge. As you move along the Refuge's edge, look for active prairie dog colonies attracting hawks, burrowing owls, cottontail rabbits, coyotes and other prairie wildlife. Jackrabbits take shelter beneath native brush; white-tailed deer bound across open prairie disappearing into groves of trees. The **Havana Pond Wildlife Viewing Overlook** is accessed along 56th Avenue, now a busy thoroughfare since the closing of nearby Stapleton Airport. A few parking places make it an easy stop by car. The open water attracts a variety of ducks and waterbirds like western grebes. To the west is an undisturbed area of native yucca, rabbitbrush, blue grama, and buffalo grass. This is an ideal place for a kangaroo rat! The locust trees nearby provide good homes for songbirds, magpies, owls, and hawks. Just east of here, along the perimeter trail, urban runoff water has been used to create a wetland for wildlife. The **Henderson Hill Wildlife Viewing Overlook** is the high point along the Refuge's northern edge. The entire Refuge is visible from here, including capped areas of north and south plants where weapons and pesticides were once produced. To the

southwest lies the skyline of downtown Denver; to the east, Denver International Airport; to the west and northwest, Mt. Evans, Longs Peak and the mountains in-between. Near this point, bison and pronghorn antelope graze, recreating visions of times long past. The **Eagle Watch Viewing Area** provides visitors with a close-up view of eagles roosting along First Creek during the winter months. Watching eagles from this spot is one of the most popular features of the Refuge and has been for many years. You may want to spend more time back at the **Visitor Learning Center** or explore the **western zone** it sits within. This zone is the part of the Refuge that most clearly expresses the **partnerships** that are vital to the Refuge. Here **non-profit**, as well as, **for-profit organizations** that share objectives with the Refuge, have facilities and work in collaboration. **Commerce City**, in cooperation with the Fish & Wildlife Service, took the lead in planning this area. The **Stapleton Redevelopment Foundation** and the City and County of **Denver** developed the collaborative plan that guided the development of the adjacent former Stapleton airport and helped integrate this area and the Refuge. Together each of these partners, and some still to come, are helping each day to make the Refuge better for wildlife and for people.

1 THE SITE AND ITS CONTEXT

The environmental message of the Rocky Mountain Arsenal National Wildlife Refuge grows out of what has occurred on this site through history, and what it is becoming through restoration. For this reason, an understanding of the history of the site and its context—biological, cultural, and legislative—is crucial for planning and caring for the Refuge.

CULTURAL HISTORY

Stone flakes from spearheads and knives, fire-cracked rocks used for cooking, hammer and grinding stones dating between 3,500 B.C. and 1,000 A.D. are some of the evidence of prehistoric activities near the northern boundary of the Refuge. Even earlier, nomadic hunter-gatherers who migrated to North America between 40,000 and 12,000 B.C. camped at Henderson Hill. By the early 1500s, Apache tribes occupied the area, followed by the Comanches, Utes, Arapahoes, and Northern Cheyennes.

Eventually, ranchers, farmers, and homesteaders displaced Native American populations. From the mid-1800s, prairie settlers grazed cattle and raised crops such as corn and wheat. By the 1930s, approximately 200 families lived on the Refuge site. (See Figure 1.1.) Farmers played a major role in changing the landscape—and encouraging wildlife—by building ditches and lakes and introducing water.

Figure 1.1 The Egli Family lived and farmed on the site of the future Rocky Mountain Arsenal National Wildlife Refuge. (Photo courtesy of Egli Family.)

The outbreak of World War II radically changed the lives on these seemingly remote farms and ranches and the priorities of the whole country. Although there was controversy about the country entering into the war, once that decision was made, the nation was committed to victory. The Rocky Mountain Arsenal was built as a part of that commitment. Farmers and ranchers living on the site were asked to sacrifice their homes and farms for the sake of the war. Most of the residents cooperated as their contribution to the war effort. Construction of the Arsenal began June 1942.

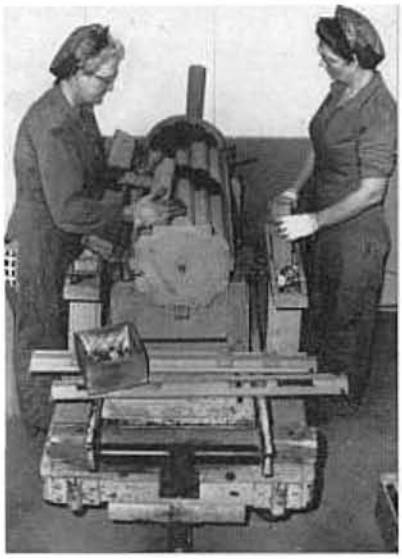


Figure 1.2 Workers place "goop" incendiary bombs in bomb clusters (Denver Post, 1952).

1942-Present

The United States had made only limited use of chemical weapons in combat. But, beginning in the 1920s and continuing until the recently concluded arms race, the possible deployment of these weapons by others forced the United States to engage in significant research and development programs for chemical weapons.

The concept of deterrent chemical weapons has been integral to America's overall military strategy throughout this century, but especially during the recent past. The United States produced massive quantities of a lethal nerve agent (German Brown), matched it with an effective delivery system, and advised the former Soviet Union that it had this capability. The Rocky Mountain Arsenal—as the only production source for this gas outside of the Soviet Union—had a significant role in national defense during the Cold War years.

When the United States entered World War II in late 1941, there was only one U.S. facility capable of manufacturing chemical agents. The need for additional arsenals had been recognized for some time and by 1942, facilities were under construction at Pine Bluff, Arkansas; Huntsville, Alabama; and Commerce City, Colorado. The site near Denver was selected because it could not easily be reached by enemy bombers, the necessary land—20,000 acres—was readily available, and it had easy access to railroads, power, and water.

Construction of the Rocky Mountain Arsenal was carried out at a feverish pace until completion on August 15, 1943. Costs totaled approximately $50 million.

There were two major chemical agents manufactured at the Arsenal during World War II: mustard gas and Lewisite. Chlorine gas was also manufactured because it was used in making both mustard gas and Lewisite. All of the process intermediates and additives, including acetylene, thionyl chloride, arsenic trichloride, sulfur monochloride, and mercuric chloride were also produced at the Arsenal.

Neither Lewisite nor mustard gas was used by the United States during World War II. But, the Germans knew of the American ability to use these agents. Crude mustard was a mixture of

The historical discussion here is drawn largely from *An Interpretive Plan for the Rocky Mountain Arsenal National Wildlife Refuge* by the National Park Service, 1995.

approximately 70 percent dichloroethyl sulfide and 30 percent sulphur and other sulfur compounds.

In addition to producing chemical agents during the war years, the Arsenal also produced and filled incendiary bombs, used with enormous effect against both Germany and Japan (Figure 1.2). The bombs were filled with napalm gel, white phosphorous, and phosgene. On March 9 and 10, 1945, U.S. forces dropped more than 1,500 tons of these weapons—all produced at the Arsenal—on Tokyo. The resulting firestorm devastated much of the city. By the end of the war, the Arsenal had produced more than 100,000 tons of incendiary bombs.

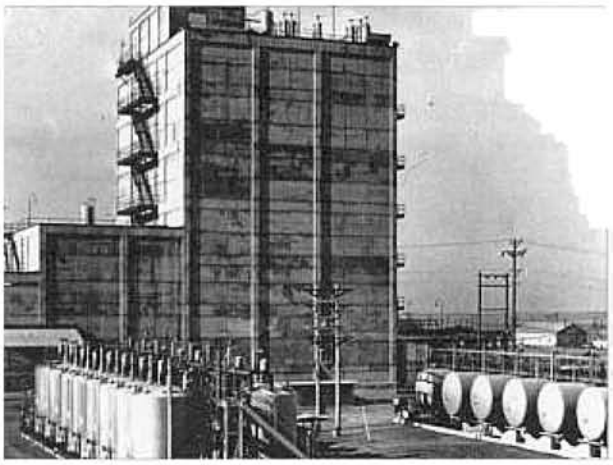


Figure 1.3 The North Plants nerve gas facility was in production from 1953 through 1969 (Denver Post, 1954).

The Chemical Warfare Service (CWS) faced a difficult decision when the war ended. The CWS recognized that the reduced need for chemical agents and incendiary bombs would result in a vastly reduced budget. Alternatives, including "mothballing" the Arsenal, were discussed, but the CWS finally decided that it would be best to lease the facility to commercial operators who could provide maintenance and improvements. This option would allow the facilities to remain in operating condition in the event of another national emergency, in which case the plant could be reclaimed by the U.S. Government.

Shell Oil Company was the major commercial operator at the Arsenal's South Plants. Shell assumed the existing lease from Julius Hyman and Company in 1952 and produced agricultural chemicals, including pesticides, until 1982.

Cold War tensions, exacerbated by the North Korean invasion of South Korea, resulted in the Arsenal being reactivated. During the conflict, white phosphorous-filled bombs, artillery shells with distilled mustard, and incendiary cluster bombs were manufactured. Of greater significance, though, was the decision to begin manufacturing at the Arsenal a highly toxic chemical product, known generically as nerve agent.

Through interviews with German military and scientific personnel, the U.S. Army learned that the Germans had discovered a five-step process for producing nerve agent during World War II. Even more ominous, the Soviet Union also had the German technology and had operating plants.

In response, the U.S. Government had the Vitro Corporation design and build a nerve agent manufacturing plant at the Arsenal. The facility, known as North Plants, consisted of 103 structures situated on a 90-acre complex. It started production in 1953 and continued intermittently until 1969 (Figure 1.3). (During this same period, Shell continued their manufacture of pesticides at the South Plants.)

The safe disposal of chemical agents and the destruction of munitions filled with these products was another aspect of the Arsenal's mission. This work started in the 1950s, but accelerated considerably following a 1968 Presidential Directive

mandating the destruction of obsolete chemical weapons. The Arsenal was chosen as the site for demilitarization of obsolete nerve and mustard gases, partly because of the expertise in the demilitarization operations already developed by Denver personnel, and partly because of the superior facilities located at North Plants. Under "Project Eagle," destruction of bulk mustard gas started in 1971. Following four years of research and development, the Arsenal began a three-year demilitarization program.

The Rocky Mountain Arsenal also contributed to the space program. Between 1961 and 1982, the rocket fuel known as "Aerozine-50" was produced. The U.S. Air Force used this product to fuel Titan missiles, and NASA used it in the U.S. Space Program.

Figure 1.4 While an environmental cleanup agreement was being negotiated, a number of interim cleanup activities resolved some of the most urgent contamination problems.

The waste products from chemical manufacturing at the Arsenal were allowed to drain into natural basins. In 1956 the Army constructed its first lined basin—Basin F—primarily for the liquid wastes from nerve gas production.

Concern about contaminated ground water migrating to adjacent community water systems intensified over the decades and by the 1970s the Colorado Health Department ordered the Army and Shell to stop polluting the water. By the early 1980s, the principals—including the Department of the Army, the Environmental Protection Agency, the State of Colorado, and Shell Oil Company—found their differences irreconcilable and filed suit against each other in Federal district court. In 1988, an interim Consent Decree was signed by all parties, except the State of Colorado, which defined their roles in the cleanup as well as apportioning costs. Besides controlling ground water migration and collecting and analyzing data, a cleanup strategy was selected for Basin F.

In 1995, all of the parties with a say in cleaning up the Arsenal reached a consensus on a solution for remediation. That plan has been presented to the public and a Record of Decision will be issued to announce the selection of final remedial alternatives. Components of the plans include:

- Continued operation of the groundwater treatment systems that are currently in place cleaning groundwater.
- Demolishing and disposing on-site of existing buildings with no future use.
- Placing some structural debris as fill in Basin A.
- Excavating, landfilling, capping, containing, or solidifying some soils, depending on location and quality.
- Constructing a wildlife barrier over selected sites to prevent burrowing animals from penetrating the caps.

The Rocky Mountain Arsenal is internationally significant for its role in weapons technology, particularly as the only manufacturing facility for German Brown nerve agent outside of the former Soviet Union. Its designation as a Superfund site, and the innovative technology developed there in response to the unique cleanup problems has influenced the discussion of hazardous materials and their impact on communities on a national level as well.

LEGISLATIVE FRAMEWORK

The construction and operation of the Arsenal and its security measures over a 40-year period provided a safe haven for a variety of wildlife on the edge of a major metropolitan area. The importance of this was recognized in the early 1990s. Once cleanup has been completed, the current 17,000 acres will be managed by the U.S. Fish and Wildlife Service as a wildlife refuge, in accordance with the Rocky Mountain Arsenal National Wildlife Refuge Act of 1992.

The Refuge Act of 1992 specifies eight purposes for which the Refuge is being established. (See Table 1.1.) The second purpose pertains primarily to bald eagles which winter at the Arsenal. It also includes ferruginous hawks and swift fox, which are candidate species. Conserving and enhancing naturally occurring species (purpose 6), as well as conserving and enhancing those other—non-native—species attracted to the site because water and vegetation were introduced, are equally important (purposes 1 and 7).

National wildlife refuges are the only federal lands managed primarily to provide habitat for the many diverse species of wildlife. Although land management for the benefit of wildlife is a function common to all refuges, individual refuges have been established under many different authorities and funding sources and for a variety of purposes. The purposes for establishing a particular refuge are specified in the authorizing document for that refuge. Each refuge has one or more primary purposes. These purposes guide the establishment, design, and management of the refuge.

The Service's efforts to manage a national wildlife refuge and determine which uses are permitted at a specific location are guided by each

Table 1.1. The Rocky Mountain Arsenal National Wildlife Refuge Act of 1992 specifies eight purposes for which the Refuge is being established:

1. *To conserve and enhance populations of fish, wildlife, and plants within the Refuge, including populations of waterfowl, raptors, passerines [songbirds], and marsh and water birds.*

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

3. *To provide maximum fish-and-wildlife-oriented 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.*

refuge's specific purposes and three broadly applicable laws—the Refuge Recreation Act of 1962, the National Wildlife Refuge System Administration Act of 1966, and the Endangered Species Act of 1973. Other laws and authorities considered in approving the use of refuge lands for various activities include the Wilderness Act of 1964, the Migratory Bird Treaty Act of 1918, the National Environmental Policy Act of 1969, the National Historic Preservation Act of 1966, Executive Order 11988 (Flood Plain Management), Executive Order 11990 (Protection of Wetlands), and Executive Order of 1994 (Environmental Justice).

The broad goals of the National Wildlife Refuge System also form part of the framework for planning each refuge. These goals are to:

- Preserve, restore, and enhance in their natural ecosystems (when practicable) all species of animals and plants that are endangered or threatened with becoming endangered;
- Perpetuate the migratory bird resource;
- Preserve a natural diversity and abundance of fauna and flora on refuge lands; and
- Provide an understanding and appreciation of fish and wildlife ecology and man's role in his environment and to provide refuge visitors with high quality, safe, wholesome, and enjoyable recreational experiences oriented toward wildlife to the extent these activities are compatible with the purposes for which the refuge was established (Figure 1.5).

Figure 1.5 One of the goals of the National Wildlife Refuge System is to provide visitors with high quality, safe, wholesome, and enjoyable recreational and educational experiences oriented toward wildlife.

Refuge Recreation Act

The Refuge Recreation Act of 1962 (16 U.S.C. 460 *et seq.*) was enacted in response to the growing public use of refuges. The Act was the first to establish the "compatibility" standard for use of refuge lands. This Act requires that any recreational use of refuge lands be compatible with the primary purpose(s) for which a refuge was established and not inconsistent with other previously authorized operations or the primary objectives of the area. The Act further requires the Secretary of the Interior to determine that sufficient funds are available to manage these recreational activities before a particular use is permitted.

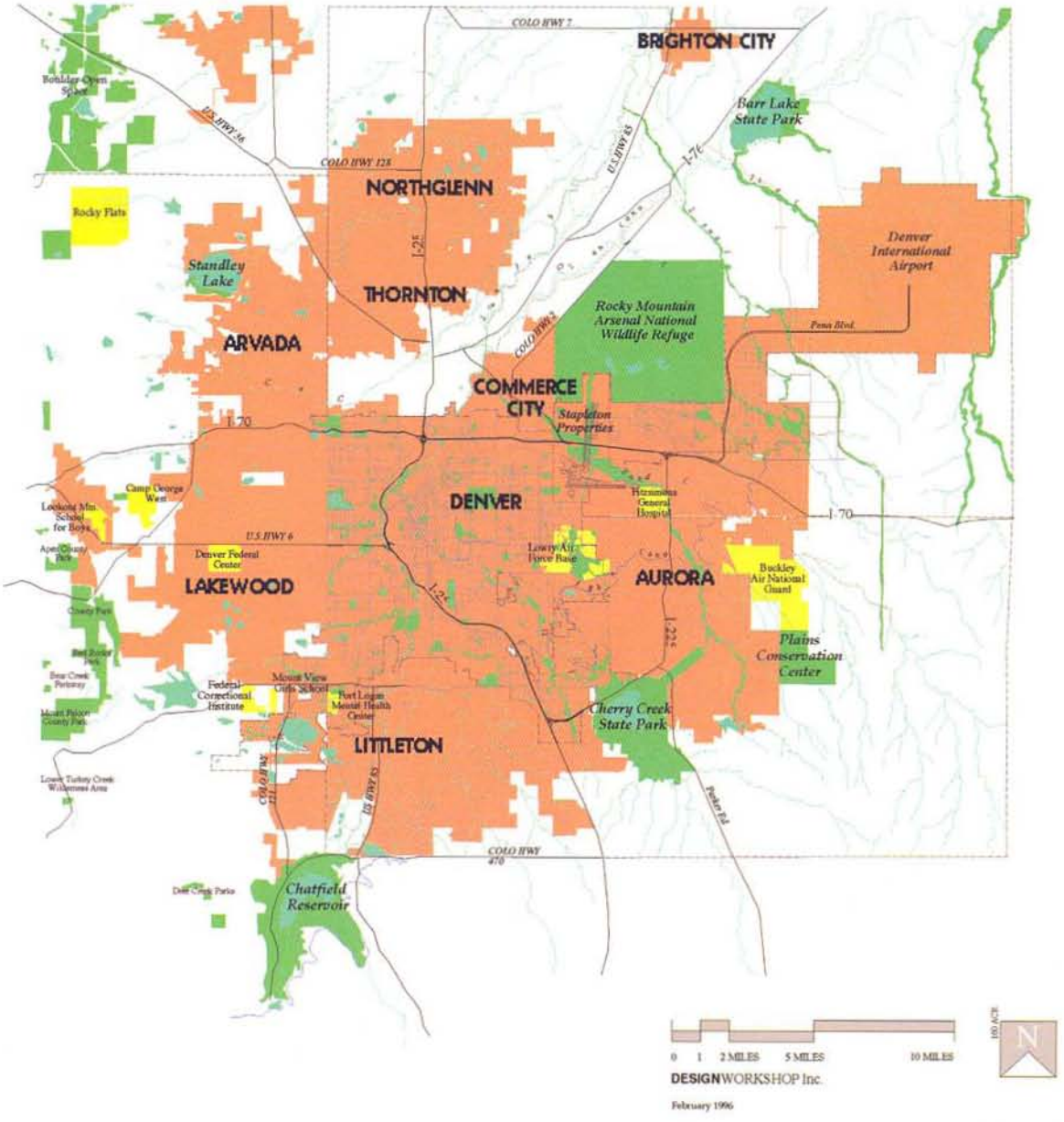
National Wildlife Refuge System Administration Act

The National Wildlife Refuge System Administration Act of 1966, as amended (16 U.S.C. 668dd *et seq.*), defined the Refuge System as it is known today. The act consolidated the various categories of lands administered by the Secretary of the Interior through the Service for the conservation of fish and wildlife into a single National Wildlife Refuge System. This consolidation brought together wildlife refuges, areas for the protection and conservation of fish and wildlife threatened with extinction, wildlife ranges, game ranges, wildlife management areas, and waterfowl production areas.

Urban Development
State/Federal Institution
Open Space/Parks

REGIONAL LOCATION
(Map 1.1)

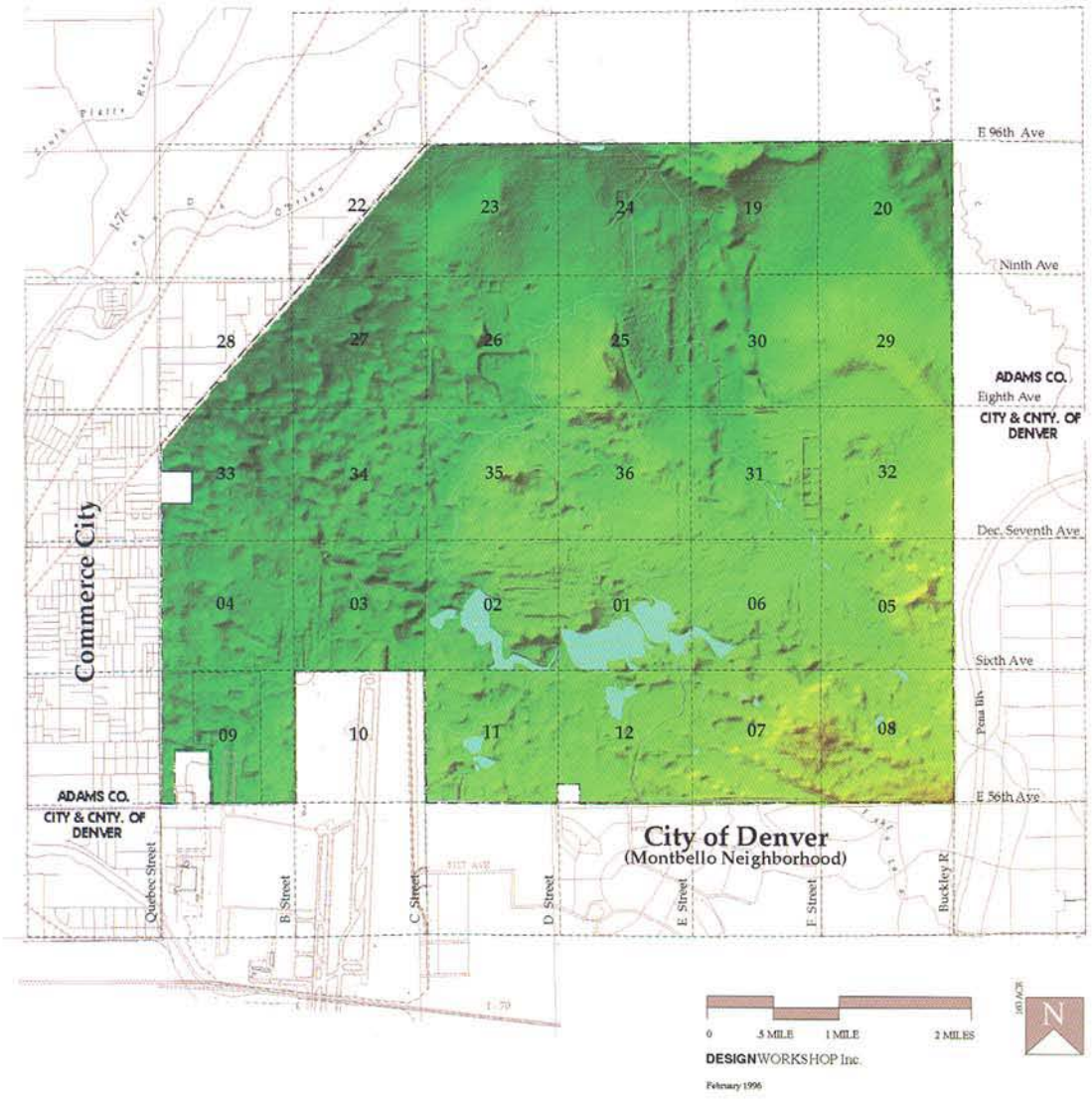
Source:
Design Workshop, *Denver Parks Study*, 1993



Highest Elevation
Lowest Elevation

BASE MAP
(Map 1.2)

Source:
GIS Elevation Map from 2 foot contours, Orthophoto mapping by Geonex Delta Aerial Surveys, June 1989.



The Refuge Administration Act reinforced and expanded the compatibility standard. It authorized the Secretary of the Interior to "permit the use of any area within the System for any purpose including, but not limited to, hunting, fishing, public recreation and accommodations, and access whenever he or she determines that such uses are

Figure 1.6 The Endangered Species Act of 1973 directs the Service to emphasize endangered and threatened species, such as this bald eagle.

compatible with the major purposes for which such areas were established."

Endangered Species Act

The Endangered Species Act of 1973, as amended, directs the Service to emphasize endangered and threatened species (Figure 1.6), in both acquiring and operating all refuges. Under the Act, the protection, enhancement and recovery of endangered and threatened species are to receive priority consideration in managing national wildlife refuges.

Environmental Justice

In 1994, President Clinton signed an executive order requiring federal agencies to address the effects of federal actions on minority and low-income populations. The Rocky Mountain Arsenal National Wildlife Refuge is urban, with potential users coming primarily from the Denver metro area, portions of which consist of minority and low-income populations.

PHYSICAL ENVIRONMENT

Geology and Soils

The Refuge is located in the Denver Basin, which is a north-south fold in the regional geology that extends along the Front Range from Cheyenne, Wyoming to Colorado Springs, Colorado (See Map 1.1 Regional Context). Surface geologic deposits consist primarily of unconsolidated river sediments (alluvium) deposited by the South Platte River system and covered partially by wind blown (eolian) sediments. The uppermost bedrock layer is called the Denver formation. This layer was originally 900 feet thick, but has eroded completely at nearby South Platte River areas, and is 500 feet thick at the southeast corner of the Refuge (Morrison-Knudsen 1988). The Denver formation is composed of stratified layers of clay, sandstone, shale, siltstone, and coal. Below the Denver formation are numerous sedimentary geologic strata such as sandstones and shales. The Pierre shale formation is found at depths of 1,200 to 1,700 feet below the surface. This formation is about 6,200 feet thick.

Surface topography resulted from river and stream erosion associated with the South Platte River and its tributaries (Map 1.2 Base Map). The land shape varies from almost level to gently rolling with slopes typically less than 3 percent and terrace escarpments with slopes up to 10 percent. Wind-deposited material is thickest in the

south and southwest sections of the Refuge (Walsh 1991). Elevation ranges from 5,138 feet along the northwest boundary to 5,250 feet at southeastern boundary. Rattlesnake Hill and Henderson Hill are prominent high points located in the central and northeastern portions of the Refuge (respectively).

Soils developed from both wind- and water-deposited material (Map 1.3 Soil Series). Soils formed from water transported material are derived from shales, sandstone, and granite.

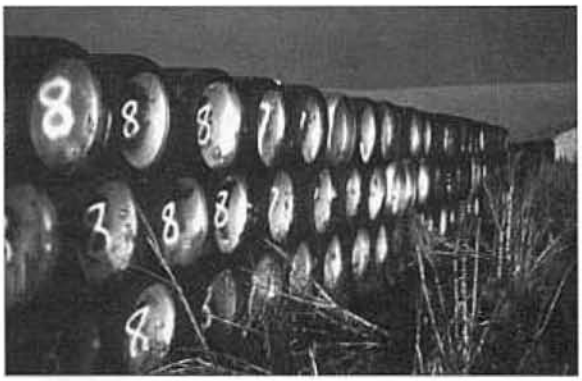


Figure 1.7 Most areas of soil contamination are found in the center of the Refuge and are currently the focus of cleanup operations.

These soils are generally of clay to loam texture, although cobbly material occurs on hills in the northern portion of the Refuge (Walsh 1991). Soils developed in wind deposited material are typically sandy in texture. Throughout the Refuge, soils formed under grassland vegetation are typically dark colored with high organic matter content.

Bresser is the most common soil series on the Refuge. These soils occur on sandy wind deposited plains in the southwestern and southern portions of the Refuge. Bresser soils are deep and well-drained with medium to coarse textures. Weld series soils also occur extensively in the northeastern portion of the Refuge. These soils are formed from alluvial and wind deposited material and have fine to medium textures. Ascalon soils are found on old alluvial terraces, escarpments and eolian plains in the central and northern areas of the Refuge. Satanta soils are similar to Ascalon but are finer textured. The well-drained Nunn soils are found in moderate distribution over the north and east portions of the Refuge. The coarse sandy textured Truckton soils are found to a limited extent in the south and west portions of the Refuge; they are highly susceptible to wind erosion. Aquic Haplustolls are deep, poorly drained soils occurring primarily along First Creek (Walsh 1991).

Disturbed areas on the Refuge include borrow pits, sedimentation and effluent basins, and fill areas. Areas of soil contamination occur in the central portion of the Refuge and are currently the focus of cleanup operations (Figure 1.7).

Refuge soils are subject to wind and water erosion. The Nunn and Satanta soils are the most susceptible to water erosion. Truckton, Bresser, and Ascalon soils have the greatest potential for wind erosion when vegetation is removed. Revegetation potential is moderate for most soils on the Refuge, although some soils may have revegetation limitations due to slope, water holding capacity, or depth.

Water Resources

Surface Water Hydrology

The Refuge is within several drainage basins that are tributary to the South Platte River, which is located less than two miles northwest of the Refuge (Map 1.4). These basins include Irondale

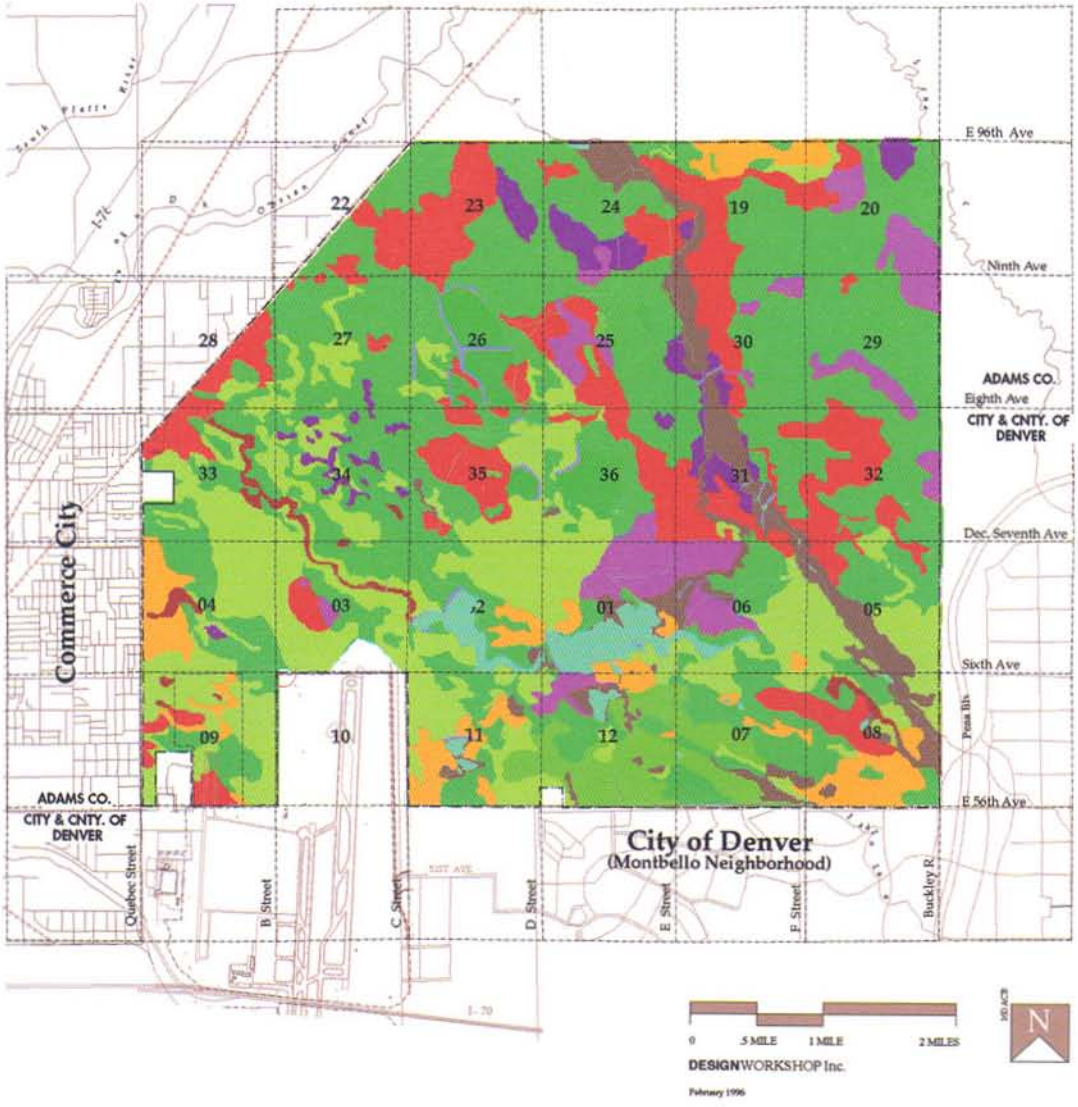
SOIL SERIES
(Map 1.3)

Ascalon Sandy Loam	As
Bresser Sandy Loam	Br
Bresser-Satanta Sandy Loam	Bs
Nunn Clay Loam	Nu
Satanta Loam	Sa
Weld Loam	We
Truckton Loamy Sand	Tr
Petrocalcic Paleustolls	Ca
Aquic Haplustolls	Fa
Typic Haplustolls	Th

Water
Basins
Dams/Dikes

Railroads
Streams
Section Lines
Refuge Boundary

Source: Morrison Knudsen Corp.



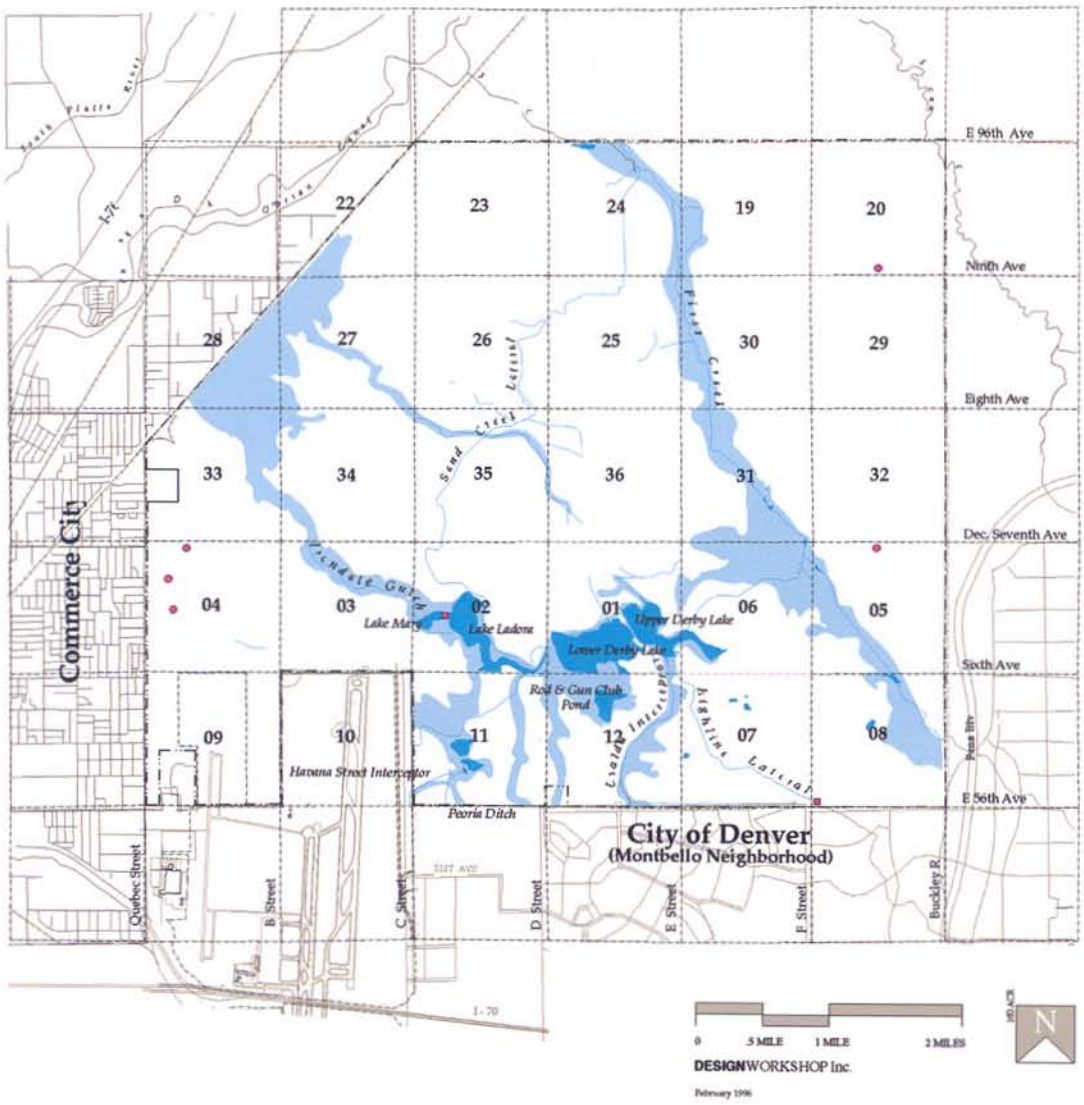
WATER RESOURCES
(Map 1.4)

100 Year Floodplain
Lakes, Ponds, Wetlands

Wells
Siphons

Streams & Ditches
Section Lines
Refuge Boundary

Source:
Digitized from figure RISR A1.5-2 in final, remedial investigation Summary Report, Appendix A



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February 1996

Gulch, First Creek, Second Creek, and several small areas that originally drained directly into the South Platte River. Due to human alterations, some of these last areas now are tributary to either Irondale Gulch or First Creek. The Irondale Gulch and First Creek basins cover more than 91 percent of the total Refuge area.

At the Refuge, water flows primarily through a network of ditches and lakes. Flows within the drainage basins of the Refuge have been greatly modified by the construction of a number of diversions (laterals) and drainage channels (interceptors). Two of the more distinct drainage features, the Sand Creek lateral and the Upper Derby Lake overflow, can transport water from Irondale Gulch to the adjacent First Creek basin.

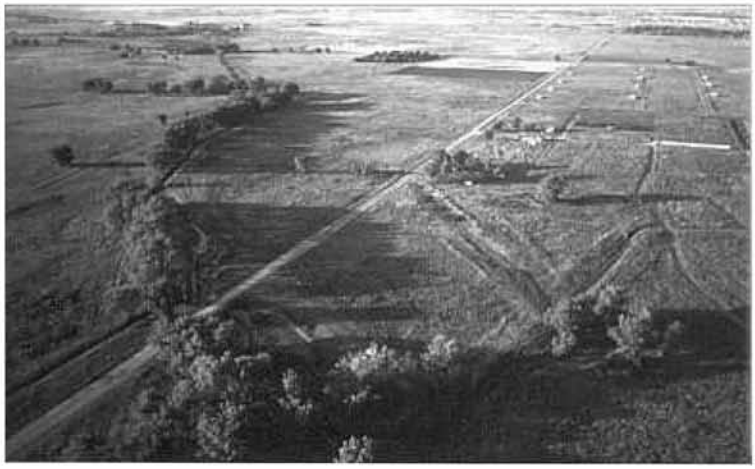


Figure 1.8 Within the Refuge, First Creek flows northwesterly for about 5.5 miles in a relatively straight channel. Headcutting of the streambed is occurring in some areas because the channel has been straightened.

Surface water originates from direct precipitation, runoff, inflow from drainage basins to the south and southeast, and ground water. All surface flows are intermittent, with streamflow occurring as a result of runoff, released or diverted flow, or direct precipitation. Localized flooding occurs from thunderstorms that produce high intensity rainfall. For drainages without diversions and inflows from controlled releases, highest monthly flows occur in late spring to early summer and lowest flows occur in winter. Daily and monthly streamflows vary widely. A large proportion of surface flow onto the Refuge is lost due to ground water seepage, evaporation and vegetation transpiration.

Prior to 1942, most of what is now the Refuge was used for agricultural purposes. Ditches and reservoirs were built to transport and store irrigation water. When the Arsenal was established by the Army, additional water impoundments were constructed and water was used primarily for industrial purposes. Irrigation and process water supplies were obtained from the Highline Canal, from which the lakes were filled. Surface water is currently used for cleanup and remediation of contaminated areas and for Refuge purposes, such as wildlife management and fishing. Expanding land development upstream of the Refuge for residential, commercial, and industrial purposes has increased runoff onto the Refuge.

The Irondale Gulch drainage basin encompasses the largest area of the watersheds on the Refuge. The majority of the basin is upstream of the Refuge and contains industrial and residential development. Generally, most of the basin is not channelized, although storm runoff channels have been constructed in developed areas south of the Refuge to direct flow onto the Refuge. Within the Refuge, the drainage basin contains four lakes (Upper and Lower Derby, Ladora and Mary), two ponds (Havana, and Rod and Gun Club), four drainage interceptors (Uvalda, Peoria, Havana

and Randolph Tributary), two laterals (Sand Creek and Highline), and several wetlands, as well as numerous smaller natural drainage conduits and manmade ditches. Six collection basins (Basins A, B, C, D, E, and former Basin F) are located in the portion of the Refuge that originally drained directly into the South Platte River.

The First Creek drainage basin (Figure 1.8) is long and narrow, with much of its area located upstream of the Refuge. Most of the basin is undeveloped. Within the Refuge, the creek flows northwesterly for about 5.5 miles in a relatively straight channel, with a slope of about 0.5 percent. Headcutting of the streambed is occurring in some areas due to manmade channel straightening. Surface flow is intermittent and averages approximately 900 acre-feet per year. Some parts of the creek flow most of the time and some rarely. Continuous surface flow occurs after major storm events. First Creek fluctuates between gaining water from ground water and losing water to ground water. For First Creek, however, ground water is the major source of water supply (Stollar and Associates 1990). Until recently, the Highline Canal has also been a source of supply to First Creek, as are several other ditches and channels on the Refuge.

Other small drainage basins within the Refuge include: the Second Creek drainage basin, which crosses the Refuge at its very northeast corner; and the southwestern and northwestern corners of the Refuge, which drain directly into the South Platte River. The Second Creek basin is mostly undeveloped. The creek is intermittent and has a well-defined channel.

The southwestern corner encompasses most of Stapleton Airport north of Interstate 70, all of Section 9 and portions of Sections 3 and 4 of the Refuge. Due to the sandy soils and sparse development, there is little, if any, surface runoff from this basin.

The northwestern drainage basin does not contain a distinct channel and is characterized by a large number of natural depressions, including Basins A-F. This basin on the Refuge is largely undeveloped, and confined by the Burlington Northern railroad embankment. No surface water discharges from this basin.

Upper Derby Lake, which can receive inflow from the Highline Canal and the Uvalda Interceptor, covers 83 acres at its full storage capacity of 460 acre-feet of water. Upper Derby Lake (Figure 1.9) is currently empty pending cleanup. Lower Derby Lake can receive inflow directly from the same sources or from Upper Derby; its normal pool storage volume is 550 acre-feet with a surface area of 73 acres.

Lake Ladora receives water primarily from Lower Derby Lake and secondarily from Havana Pond. The western tier wells also deliver water to Lake Ladora. These wells are located on the western side of the Refuge within the 815 acres of the Arsenal to be auctioned. A permanent easement would grant continued use of these wells as a supplemental water supply for Lake Ladora. Its storage capacity is 400 acre-feet, with a surface area of 48 acres. Lake Mary is located directly west of Lake Ladora. It receives a regulated water supply from wells, Lake Ladora, and a potable water storage tank. Lake surface area is 9 acres at a normal pool storage volume of 60 acre-feet. These lakes were all constructed for various purposes. Rod and Gun Club Pond was excavated in a natural topographic depression south of Lower Derby Lake (Stollar and Associates 1990). The pond receives runoff within its small basin and overflow from Lower Derby Lake and the Uvalda Interceptor. The pond covers an area of about 4.9

Figure 1.9 Upper Derby Lake (foreground) is currently empty, while Lower Derby (background) is filled.

acres when full and has a volume of about 15 acre-feet. There is a large marshy area around the pond.

Six basins used for the retention of process water, waste water, or storm runoff were constructed during operation of the Arsenal. These basins are natural topographic depressions that have been supplemented by berms and other structures. Basin A is the largest of these collection basins (240 acres). It was used for many years to store liquid process wastes. Most runoff collects in low areas and causes local ponding. Basin F, which was a primary disposal site for liquid and chemical wastes for many years, has been recontoured and no longer captures surface runoff.

Surface and ground water flows are connected at the Refuge. Within the First Creek drainage, surface water typically discharges to ground water at the south boundary, while at the north boundary and beyond, ground water discharges to First Creek. In general, ground water discharges to the lakes at their east to southeast sides and is recharged by the lakes to the north and northwest sides. Ground water is the main water source for Rod and Gun Club Pond. A net discharge of ground water to surface water occurs at Lake Ladora, and Lake Mary to Upper Derby Lake when dry. A net loss to ground water occurs in First Creek, Lower Derby Lake, Upper Derby Lake (when filled), Havana Pond, and the Uvalda Interceptor (Stollar and Associates 1990).

Ground Water Hydrology

The Refuge is within the Denver ground water basin. Surficial stream and wind deposited soil contain water, as do several bedrock aquifers. Unconsolidated deposits cover nearly all of the Refuge and are underlain by the sedimentary Denver formation. Shallow ground water flow occurs primarily in the unconsolidated deposits, but also in the weathered outer layer of the Denver formation. The thickness of the shallow aquifer varies from less than 20 feet under the disposal basins and South Plants area (where a bedrock mound rises close to the surface) to 70 feet in bedrock valleys in which unconsolidated materials have been deposited. Water levels range from less than 5 feet below ground surface in the area of the lakes, Basin A, and First Creek to more than 60 feet on the west side of the Refuge. Ground water level fluctuations are generally less than 2 feet. Ground water flows to the north and northwest.

Previous human activities and cleanup operations have altered the water table and flow direction in local areas. These changes include the

boundary containment and treatment systems, recharge from surface water impoundments, and depression due to well pumping. A ground water mound underlying South Plants creates flow in every direction away from the area. Ground water flows to the west beneath at least two of the lakes. The shallow aquifer is recharged from precipitation and surface water and discharges to surface water (principally to the South Platte River). It is also recharged from and discharges to the Denver Formation aquifer.

The Denver Formation aquifer is separated from the shallow alluvial flow system by relatively impermeable shale or claystone. The Denver Formation, 200 to 500 feet thick under the Refuge, contains water-bearing layers of sandstone and siltstone in poorly defined, irregular, interconnected beds that range in thickness from a few inches to 50 feet. Ground water flow in the Denver Formation is toward the northwest. A small amount of recharge occurs from the overly unconfined aquifer and from bedrock outcrops, which occur in only a few locations. Discharge from the Denver Formation occurs by lateral flow into the unconfined aquifer and by leakage to the underlying Arapahoe bedrock aquifer.

Surface Water Quality

Both off-site and on-site sources of contamination have adversely affected the surface water quality on the Refuge. Chemical constituents can be introduced into a channel or lake in either dissolved and/or particulate form via runoff, discharge from poor quality ground water or windblown deposition of particulates directly into the water. Inorganic constituents may be naturally occurring or from manmade sources, while organic constituents are from manmade sources, such as runoff from developed areas or past industrial manufacturing of chemical compounds at the Arsenal.

In the Irondale Gulch basin south of the South Plants area, surface water is the principal migration pathway for pesticides and other organic compounds, as well as arsenic, mercury, cyanide, and trace metals. Some organic compounds were also detected in ditches entering the Refuge from residential and industrial areas to the south and in ditches originating in the South Plants area. Other compounds are likely to have both off-site and on-site sources, while some are likely to be only from past activities at the Arsenal. Compounds detected in ditch sediments were similar to those in surface water, except that heavier trace metals were found.

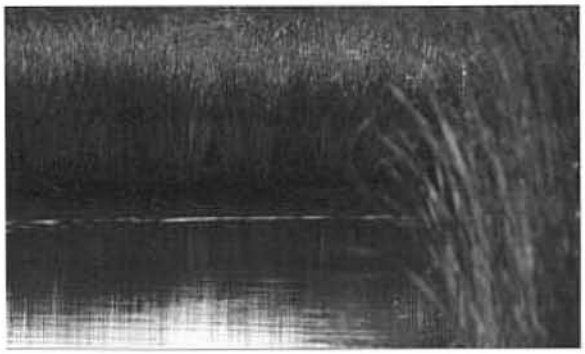


Figure 1.10 Water quality of the major lakes and ponds is typically quite high, with only isolated organic and trace inorganic compounds detected in the water and lake bottom sediments.

In contrast to stormwater flowing onto the Refuge, water in Refuge lakes and ditches in the Irondale Gulch basin generally have low concentrations of organic and inorganic compounds. The water quality of the major lakes and ponds on the Refuge is typically quite high, with only isolated organic and trace inorganic detections in the water and lake bottom sediments (Figure 1.10). It may be that dilution, settling, and infiltration of

constituents are responsible for the relative absence of pollutants downstream of the stormwater inflows to the Refuge. The high alkalinity of the surface water also may act to effectively remove toxic heavy metals.

Classes of compounds detected in surface water in the South Plants area include many types of organic compounds, some of which are pesticides and nerve-gas related compounds. Trace metals detected in this area are generally higher in concentration than near the southern boundary, indicating an on-site source. Surface water is a significant transport mechanism for contaminants in this area.

Lands east of First Creek on the Refuge exhibit minimal contamination of surface water. First Creek, however, has detectable levels of organic compounds throughout its length on the Refuge and north of the Refuge. It also has elevated concentrations of calcium, magnesium, potassium, sodium, chloride, fluoride, sulfate, nitrate, and arsenic. Sources of arsenic may include the Refuge sewage treatment plant and off-site sources. Organic compounds and metals also have been detected in stream bottom sediments. Sediment contamination does not appear to be directly related to surface water contamination. Some organic compounds are entering First Creek from sources upstream of the Refuge; however, some were also manufactured at the Arsenal.

Surface water samples collected from Basin A have consistently contained organic compounds, pesticides, and arsenic. Elevated concentrations of sodium, fluoride, mercury, calcium, and cadmium have also been detected. Sediments in Basin A also are contaminated with organic compounds and heavier trace metals. The South Plants area is the principal source of contamination to this as chemical wastes were discharged into Basin A. Surface water flowing north from the South Plants area contains high concentrations of many organic compounds and arsenic. Trace metals detected in the water and sediments in Basin A are higher in concentration than at the south boundary of the Refuge, indicating Arsenal activities were the likely source. Water in the collection basins generally does not exit the Refuge as surface flow.

In the Sand Creek basin outside the Refuge, one pesticide compound occasionally has been detected in surface water. No other organic or inorganic compounds have been detected within the basin.

Ground Water Quality

The largest areas of contaminated ground water are in the north, central, and western parts of the Refuge and occur as spatially distinct contaminant plumes. The plumes contain one or more contaminants migrating together through the shallow aquifer. Migration has resulted in the merging of contaminant plumes from individual source areas.

A zone of high level contamination exists within the shallow ground water flow system from the South Plants area through Basins A, C, and F to the north boundary containment system. High concentrations also occur from South Plants north to Basin A and south towards Lower Derby Lake. Other contaminated areas include the North Plants area and the western part of the Refuge. These plumes contain elevated concentrations of various organic compounds, such as pesticides and hydrocarbons, as well as inorganics such as arsenic, mercury, trace metals, chloride, and fluoride.

One plume extends from the South Plants tank farm to Lake Ladora and Lower Derby Lake. This plume is driven by a ground water mound under

South Plants and is inhibited from migrating by maintaining the lakes at the approximate level of the local water table. Control of these lake levels also drives other ground water contaminant plumes toward the boundary containment systems for treatment.

Distinct contaminant plumes have not been identified in the bedrock aquifers at the Refuge, but detections in bedrock water indicate that vertical migration pathways exist between shallow ground water and deeper water. Sources of ground water contamination include contaminated surface water and waste water, chemical sewer leakage and contributions from solid waste burial sites. At the north and northwest boundaries of the Refuge, contaminated shallow ground water is being removed, treated, and returned to the flow system downgradient of the boundaries. Ground water intercept-and-treat systems also are located at Basin A, Basin F, and at the Rail Classification Yard and Motor Pool within the Refuge.

Climate and Air Quality

Climate at the Refuge is considered semi-arid, with low relative humidity, intense sunshine, and wide variations in seasonal and daily temperatures. The average high temperature in January is 43°F and the average low is 16°F. Highest temperatures occur in July with an average high of 88°F and average minimum temperatures of 59°F. Precipitation generally ranges from 12 to 16 inches annually, with 80 percent occurring between April and September. May is the wettest month and averages 2.5 inches. January is the driest month with an average of 0.5 inches.

Winds follow a daily pattern of flowing from the south at night and from the north during the day. Wind speeds at the Refuge average 8.7 miles per hour. Strong winds are common throughout the year, but March and April are the windiest months with the greatest potential for dust storms (Woodward Clyde 1992).

The Denver metropolitan area experiences chronic carbon monoxide, ozone, and particulate matter air pollution as well as visibility problems. Major sources of pollutants are thought to come from motor vehicles, industry, wood burning, and agricultural operations. Climatic and topographic conditions also contribute to air quality problems in the region. Denver's high elevation and abundance of cloud free days are conducive to production of ozone. Temperature inversions prevent atmospheric mixing and results in the accumulation of pollutants. Stable atmospheric conditions that are favorable for accumulation of pollutants occur throughout the year, but primarily in the winter. The Refuge is located in a non-attainment area for ozone, carbon monoxide, and extremely fine particulates (PM-10). Non-attainment indicates that the state standards for pollutants are not being met.

Air quality on the Refuge has been monitored since 1988 to determine ambient air quality levels and potential air pollution from cleanup activities (Woodward Clyde 1992). Monitoring of criteria pollutants–sulfur dioxide, nitrogen dioxide, carbon monoxide, and ozone–indicates air quality at the Refuge is generally better than most Denver area sites. Through 1991, there had been no violation of applicable air quality standards at the Refuge. The plume of urban air pollutants occurs primarily within the South Platte River drainage basin (City of Denver 1988). The Refuge is located on the periphery of the most polluted area. Periods of increased air pollutants at the Refuge are generally attributable to Denver metropolitan sources.

There are two primary sources of total suspended particles (fine dust particles): particulates from the Denver metro area and remedial cleanup actions that generate dust (Woodward Clyde 1992). The contribution from remediation activities is generally localized and short-term. Particulate levels on the northern and eastern boundaries of the Refuge are well below Denver's and similar to rural conditions. The concentration of PM-10 particulates (extremely fine dust particles) at the Refuge are related to dry windy conditions, and from sources in metro Denver. Current remediation and construction activities at the Refuge do not contribute substantially to PM-10 concentrations.

Air quality monitoring for metals, organic compounds, and pesticides also has been conducted at the Refuge (Woodward Clyde 1992). Maximum metal concentrations typically occur during windy periods when particulate concentrations are high. Remediation activities are believed to contribute to metal concentrations. The presence of organic compounds at the Refuge appears to be related mostly to off-site sources, although remediation activities also may be a source. The primary source of pesticides is believed to be agricultural sources north of the Refuge, although cleanup activities also appear to have contributed to pesticide concentrations.

Noise

The Refuge is located on the northeastern edge of the Denver metropolitan area. Noise levels at the Refuge vary widely with location. Noise on the western and southern perimeter of the Refuge is dominated by sounds from commercial development, traffic, and residential areas. Historically, Stapleton Airport generated very high noise levels in the southern and western portion of the Refuge from adjacent take-off runways. Relocation of the airport to the new Denver International Airport (DIA) east of the Refuge has reduced noise levels greatly in the western portions of the Refuge. Noise contours of up to 60 decibels from one DIA runway extends into a small portion of the eastern side of the Refuge (City of Denver 1988). Noise levels on the eastern side of the Refuge have increased with local and DIA vehicle traffic on Buckley Road and Peña Boulevard. The northern boundary of the Refuge is primarily agricultural land, with traffic from 96th Avenue being the primary noise source.

Noise levels within the interior of the Refuge are very similar to rural conditions, except for aircraft noise. Traffic within the Refuge is restricted, and there is limited public vehicle access. Remediation activities that involve the use of heavy equipment results in elevated noise levels during periods of operation. Noise sources within the Refuge generally are concentrated to specific areas of activity at buildings, cleanup operations, and along roadways. Many areas within the Refuge have very low background noise levels with a minimum of human activities or disturbance.

BIOLOGICAL ENVIRONMENT

Vegetation

Most of the vegetation on the Refuge (Map 1.5) has been altered by human activities. Agricultural practices, industrial activities, cleanup operations, and current wildlife management operations all have played a role in creating the existing compo-

sition of Refuge vegetation. There are, however, small areas of remnant native vegetation.

The Refuge occurs within the western edge of the High Plains that extend through the midwest U.S. Prior to settlement, the area was covered by warm-season, shortgrass prairie vegetation. Blue grama and buffalo grass were dominant perennial grasses in the predevelopment ecosystem. These species were well adapted to the semi-arid environment and periods of drought. In moister sites, green needle grass, side-oats grama, little bluestem, and Sandberg bluegrass were likely common. Sandy soils developed in wind blown sediments and historically supported sand sagebrush, needle-and-thread grass, sand dropseed, prairie sandreed, sand bluestem, switchgrass, and Indian ricegrass. Bottomlands often supported stands of switchgrass and big bluestem. Perennial forbs common prior to development varied with soil and topographic position, and included American vetch, prairie clover, silvery lupine, prairie cone flower, prairie aster, and evening primrose. Annual native forbs may have included plantain, prairie pepper grass, western ragweed, and narrowleaf goosefoot (Morrison-Knudsen 1989a).

Before establishment of the Rocky Mountain Arsenal in 1942, much of the native vegetation had been removed. Historical data from 1937 indicates non-irrigated dryland farms covered much of the Refuge area (Morrison-Knudsen 1989a). Irrigated cropland occurred on approximately 2,000 acres in the northern and western sections of the Refuge. Although native grassland and shrubland occurred in scattered locations throughout the Refuge in 1937, most of the native vegetation had been disturbed before industrial activities.

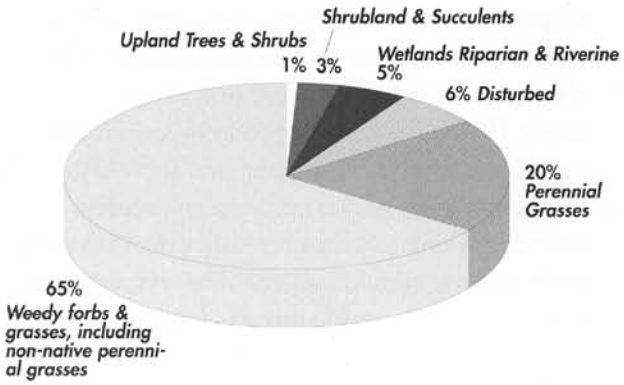


Figure 1.17 Current vegetation types at the Rocky Mountain Arsenal National Wildlife Refuge.

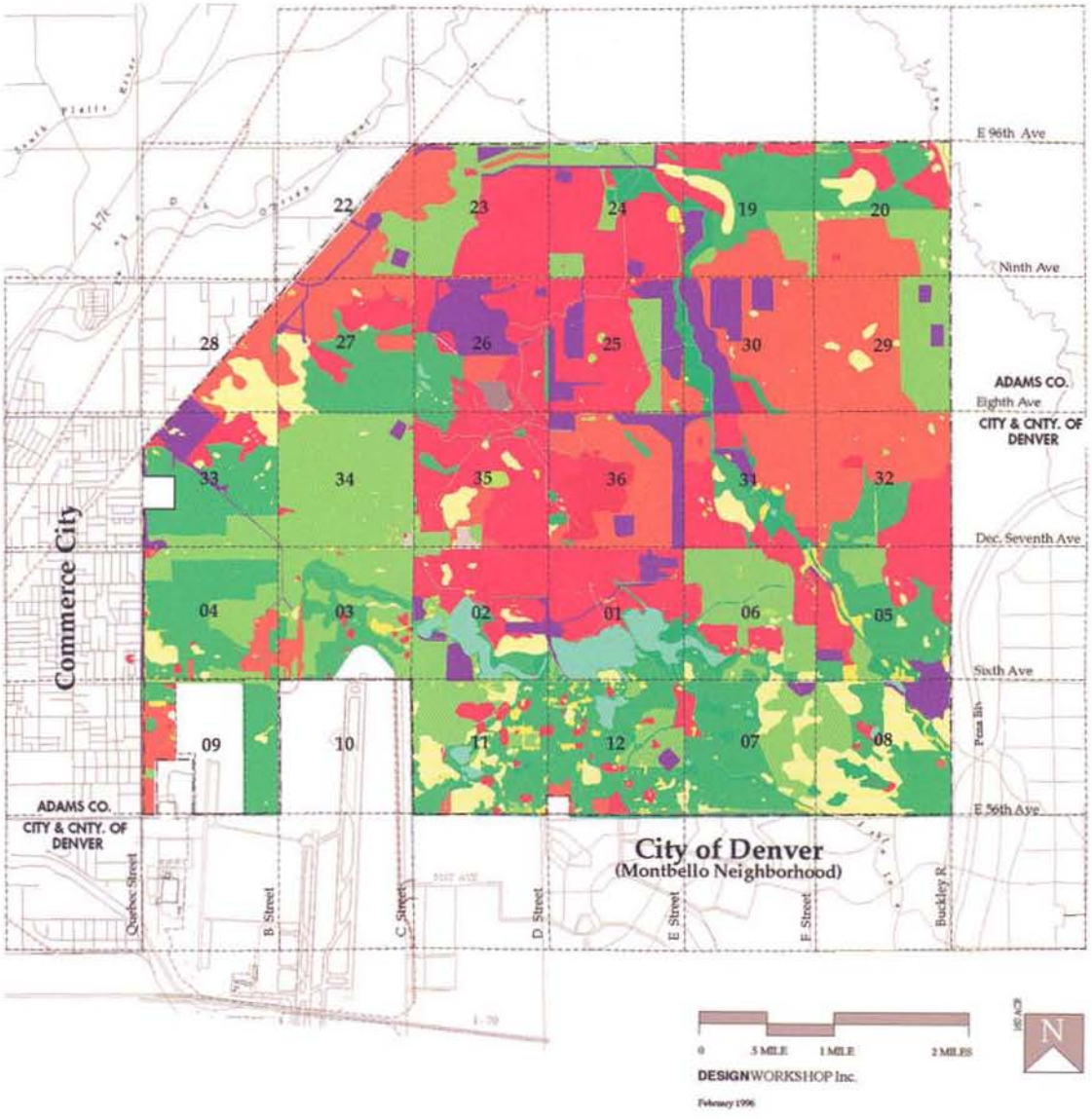
Historically, native trees were found primarily along drainages, with additional plantings of non-native and native trees around homesteads. Riparian trees before settlement included plains cottonwood, peachleaf willow, and occasional boxelders and hackberries. The wettest sites were dominated by cattails and bulrushes. Understory vegetation in the riparian plant communities contained choke cherry, golden currant, wild plum, hawthorn, yellow Indian grass, and slender wheatgrass. Native shrubs historically occurring on the Refuge were fringed sage, sand sage, rabbitbrush, broom snakeweed, and winterfat. Saline bottomland areas contained alkali sacaton, inland salt grass, and western wheatgrass (Morrison Knudsen 1989a).

There are six primary vegetation types currently found on the Refuge (Figures 1.11 - 1.16). They are weedy forbs and grasses; native perennial grasses; wetlands, riparian and riverine; shrubland and succulents; upland trees and shrubs; and remnant vegetation. Their percentages of cover are shown in Figure 1.17.

VEGETATION
(Map 1.5)

- Unclassified
- Research
- Bare
- Alfalfa/Sweetclover
- Cereal Rye
- Cobble Soil Veg
- Seeded Area
- Lawn Area
- Tree Grove
- Wetlands
- Locust Thicket
- Crested Wheatgrass
- Shrublands/Succulents
- Native Perennial Grasses
- Cheatgrass/Weedy Forb
- Weedy Forb
- Water
- Railroads
- Streams
- Section Lines
- Refuge Boundary

Source:
Interpreted from Vegetation Classification from 1:2400 Aerial photographs dated 1989-1992 and Morrison Knudsen



VEGETATION DISTRIBUTION
(Map 1.6)

- Weedy Forbs & Grasses
- Native Perennial Grasses
- Major Disturbed Areas
- Lacustrine
- Wetlands
- Riparian / Riverine
- Shrubland/Succulents
- Upland Trees
- Streams
- Section Lines
- Refuge Boundary

Source:
Interpreted from Vegetation Classification from 1:2400 Aerial photographs dated 1989-1992, Morrison Knudsen Corp.

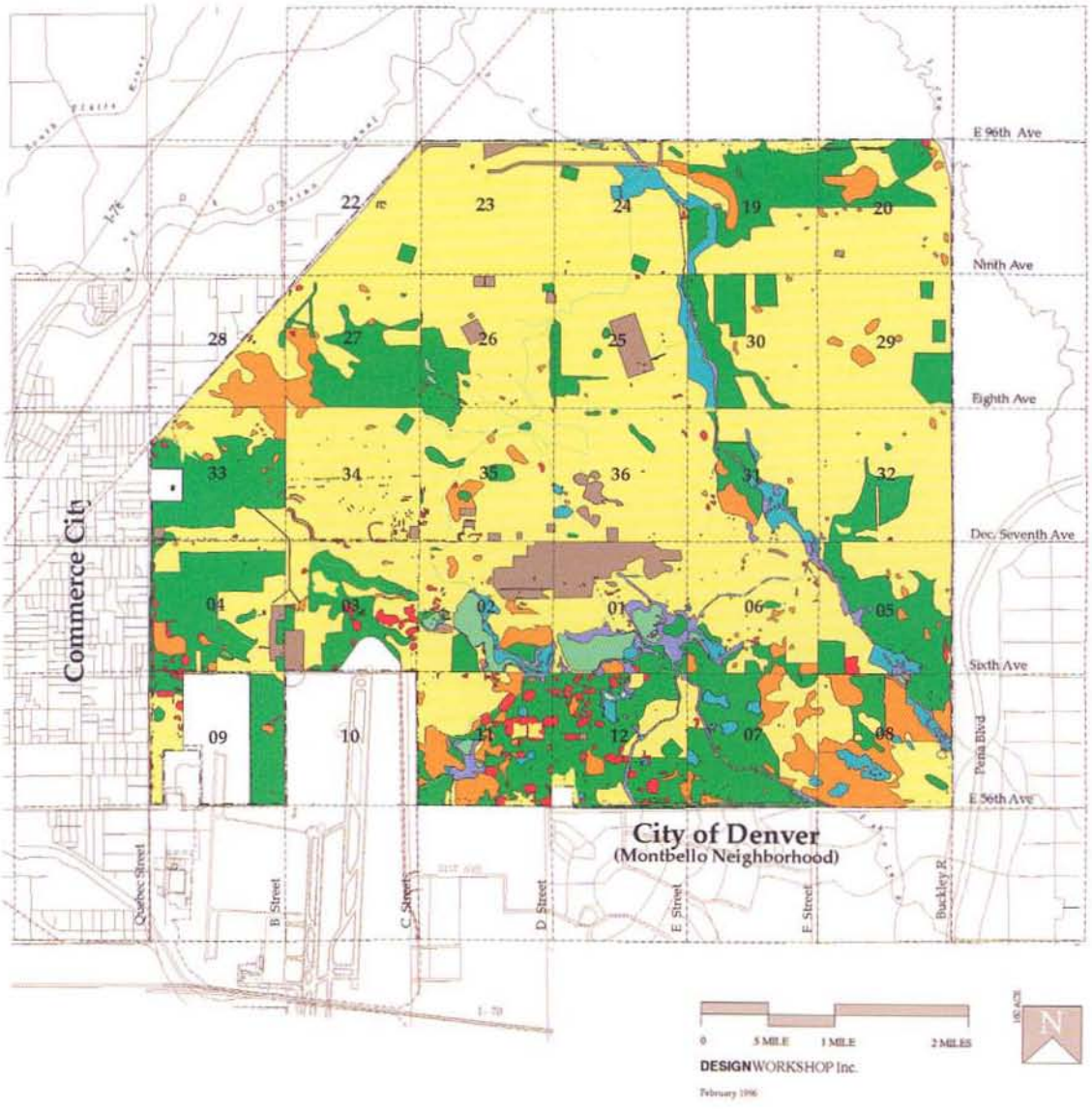


Figure **1.11** Perennial Grasses

Figure **1.12** Shrublands and succulents

Figure **1.13** Remnant Vegetation Areas

Figure **1.14** Wetland, Riparian, and Riverine Plant Communities

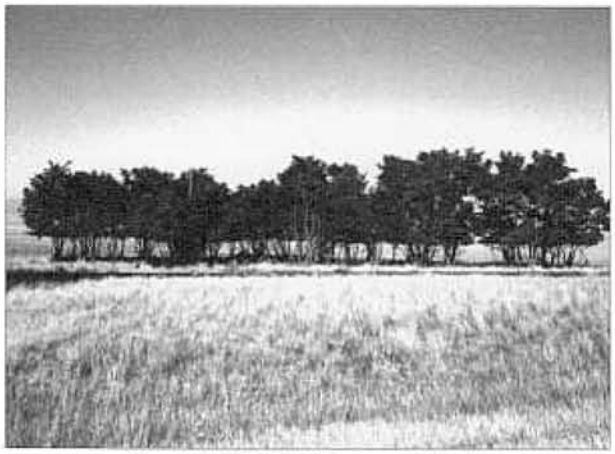


Figure **1.15** Upland Trees and Shrubs

Figure **1.16** Weedy Forbs and Grasses

Weedy Forbs and Grasses

The weedy forb and grass vegetation type is the most widespread. Morrison-Knudsen (1989a) mapped four different types of weedy vegetation:

Weedy Forbs.

The weedy forb type is the most common vegetation type on the northern two-thirds of the Refuge. This vegetation type was established following land disturbing activities, and may be perpetuated by prairie dogs that selectively graze perennial grasses (Morrison-Knudsen 1989a). This type is dominated by annual and biennial forbs and is found on 16 percent of the Refuge. Common species include cheatgrass, summer cypress (kochia), field bindweed, prickly lettuce, and tansy mustard. Areas mapped as weedy forb include a few native forbs and grasses such as scarlet globemallow, sunflower, and red three-awn. There are very few woody or succulent plants found in this vegetation type.

Cheatgrass and Weedy Forb.

This is the most extensive vegetation type, with about 20 percent of the Refuge supporting a mixture of cheatgrass and weedy forbs. Cheatgrass represents about two-thirds of the plant cover in this type. Principal weedy forbs include field bindweed, musk thistle, and prickly lettuce. Cheatgrass has become established throughout the Refuge.

Cheatgrass/Perennial Grass.

This type represents a mixture of annual and perennial grasses and occurred on 10 percent of the Refuge by 1989. Cheatgrass was the dominant vegetation cover (58 percent), followed by perennial grasses (28 percent). Common native perennial grasses included sand dropseed, red three-awn, and needle-and-thread grass. This type represents areas where native grasses have not been completely replaced by weedy species. These areas may be in successional transition to native perennial grasses (Morrison-Knudsen 1989a).

Crested Wheatgrass.

Crested wheatgrass is not considered a weedy species. It is an introduced species imported from Eurasia for erosion control. This species was planted in various locations on the Refuge throughout the years to reclaim disturbed areas. Currently, crested wheatgrass covers 19 percent of the Refuge. This species often occurs in relatively pure stands, but other species found in this unit include cheatgrass, sand dropseed, and field bindweed. Yucca and prickly pear cactus also occur to a limited extent in this type. Stands of crested wheatgrass typically are replaced by native perennial grasses over time (Morrison-Knudsen 1989a).

Perennial Grasses

Native perennial grasses are scattered throughout the Refuge. About 20 percent of the Refuge is covered by this type in stands from less than a tenth of an acre to about 500 acres. Native grass cover averaged 57 percent in 1989, with weedy vegetation (mostly cheatgrass) providing the rest of the cover. Perennial grasslands are remnants of the original grasslands that have survived or escaped disturbance from farming, grazing, and industrial activities.

Composition of the native grassland communities varies with soil, topographic position, and previous disturbance. Blue grama and buffalo grass occur on loamy soils in the northern and west-central portions of the Refuge. On coarser

textured soils of this type, needle-and-thread grass, sand dropseed, and red three-awn are present. Western wheatgrass occurs on finer textured soils in east-central and northern areas. Sandy wind deposited soils support stands dominated by sand dropseed, and needle-and-thread grass, although prairie sandreed, sand bluestem, and Indian ricegrass also are present.

Bottomlands along First Creek support several native perennial grasses including western wheatgrass, slender wheatgrass, and Canada wild rye. Numerous weedy species are also found in these moist locations. There are several small cobbly areas on hills in the central and northern areas of the Refuge that support stands of native grasses such as side-oats grama, ring muhly, and Sandberg bluegrass.

Woody and succulent plants also occur in varying densities in perennial grasslands. Prickly pear cactus was the most common followed by bushy eriogonum.

Shrubland and Succulents

Several shrub or succulent dominated communities are found on the Refuge. These communities occur primarily in association with various grassland types. Shrubland and succulents represent about 3 percent of the vegetation types on the Refuge.

Sand Sagebrush.

Sand sagebrush occurs on sandy upland sites in the southern portion of the Refuge. Needle-and-thread grass and prairie sandreed are the most common native grasses in this type, while cheatgrass is the most abundant weedy grass. Areas of sand sagebrush possibly escaped plowing due to the unsuitability of the soils for farming.

Rubber Rabbitbrush.

Rabbitbrush occurs on scattered upland hills in the eastern and southern parts of the Refuge. Only about 0.3 percent of the Refuge is covered in this vegetation type. Associated herbaceous vegetation is primarily cheatgrass and several perennial grass species, including sand dropseed and red three-awn. It is likely these areas were established as a result of overgrazing.

Yucca Grassland.

Yuccas do not occur as a community by themselves, but in association with mixed grassland vegetation. This type is found in the northwestern and south-central areas of the Refuge. Common associated vegetation includes cheatgrass, needle-and-thread grass, red three-awn, sand dropseed, and blue grama. Yuccas are most common on sandy shallow soils along low ridges.

Locust Thickets.

New Mexico locust thickets are found on about 0.5 percent of the Refuge and are most common in the southern portion. Locusts form dense thickets with 88 percent cover and an understory of cheatgrass. Locust stands probably were planted as windbreaks or for game cover.

Wetland, Riparian and Riverine Plant Communities

Riparian plant communities occur on approximately 5 percent of the Refuge. Streams and bottomland areas where moister conditions exist provide habitat capable of sustaining varied plant communities.

Cottonwood-Willows.

Plains cottonwood and peachleaf willow are the principal tree species occurring along

drainages, canals and reservoirs. This community was found on the Refuge prior to settlement, but has expanded due to additional water features. This vegetation type is most developed along the First Creek drainage. Understory species are currently dominated by smooth brome, with a subdominant presence of cheatgrass, slender wheatgrass, Canada wild rye, and Kentucky bluegrass.

Bottomland Meadow.

Bottomland meadows are found in moist soils near drainages, reservoirs and canals. Species composition varies widely between locations, with weedy forbs the most common. Representative species include barnyard grass, lady's thumb, horseweed, prickly lettuce, and showy milkweed. Canada thistle, a noxious weed, is present at nearly all sites. Disturbance to these areas eliminated native grasslands, which likely were dominated by big bluestem, and slender and western wheatgrass.

Cattail Marsh.

Cattail areas typically occur in almost pure stands in the wettest locations along streams, ditches and reservoirs. An increase in water features on the Refuge likely has increased the presence of this vegetation type.

Upland Trees and Shrubs

There are a variety of ornamental trees and shrubs scattered throughout the Refuge. The majority of these are found in the southern half, where it was planted near homesteads and as windbreaks. Common species include Siberian and American elm, Russian olive, Rocky Mountain juniper, green ash, and various fruit trees.

Remnant Vegetation Areas

Several plant communities of special interest were identified in investigations conducted in association with cleanup operations (Morrison-Knudsen 1989a). These areas of remnant native vegetation are considered important due to their excellent condition, unique characteristics, or rarity. Areas of highest priority for protection and preservation include:

- Sand prairie grassland–This plant community is rare regionally and statewide. Sand bluestem, prairie sandreed, and bush morning-glory are the key species distinguishing this site.
- Shortgrass prairie grassland–This 200-acre native prairie is dominated by blue grama, needle-and-thread grass, and buffalo grass. This site provides a seed source for revegetation of other sites and important wildlife habitat.
- Sand sagebrush shrubland–Several areas of sand sagebrush are found in the central and southeast parts of the Refuge. Other vegetation found in this type includes ball and hedgehog cactus, blue grama, and prairie sandreed.
- Gravel breaks–Remnants of a South Platte River terrace such as those found on Rattlesnake Hill support species found at no other location on the Refuge. Vegetation on these cobbly sites includes Fendler three-awn, side-oats grama, Sandberg bluegrass, yellow violet, salt and pepper, and broom snakeweed.
- Mature cottonwoods–The large mature cottonwoods found along First Creek provide excellent nesting and roosting habitat for raptors and a variety of migratory birds, and serve as cover for deer and most other mammals.

Figure 1.18 Before settlement, the plains ecosystem provided habitat for a variety of species such as fox (above) and badger (below) that are now rarely seen.

Wildlife and Fisheries

The Refuge supports a variety of wildlife and fish species common to the presettlement plains ecosystem (Figure 1.18), as well as several introduced or exotic species that were not historically present. There are also several species that are native to the plains ecosystem that no longer occur on the Refuge. Several of these species are being considered for reintroduction.

Wildlife Populations

There are a number of wildlife species that are more common on the Refuge than other regional habitats. The most abundant include mule and white-tailed deer, coyotes, prairie dogs, bald eagles, ferruginous hawks, and burrowing owls. Deer populations have increased due to a variety of factors including the perimeter fence, the abundance of weedy forbs, suitable cover, relatively low human disturbance, and the absence of hunting. Ferruginous hawks and bald eagles benefit from the large population of prairie dogs and favorable habitat. Coyotes also benefit from numerous prairie dogs and other small mammals. Burrowing owls take advantage of prairie dog burrows for nesting. Ring-necked pheasants have thrived in grassland habitats in the absence of hunting, although pheasant populations often experience population fluctuations periodically. Western meadow larks, grasshopper sparrows, vesper sparrows, and horned larks also are more common on the Refuge than similar off-site habitat.

Important areas of habitat for selected species as may be seen on Map 1.7 Wildlife Habitat-Winter and Map 1.8 Wildlife Habitat-Spring, Summer, Fall.

Before settlement, the plains ecosystem provided habitat for a variety of species including bison, pronghorn antelope, prairie dogs, coyotes, foxes, badgers, and rabbits. It also provided habitat for a variety of small mammals, birds, reptiles, and amphibians. Conversion of the native grasslands to agricultural lands and subsequent industrial development followed by invasion of non-native plant species has resulted in a substantial shift in the composition of wildlife species, numbers and distribution.

Following cleanup, the Refuge will be the largest contiguous block of undeveloped land within the Denver metropolitan area. The Refuge currently supports a significant concentration of

prairie dogs, bald eagles, burrowing owls, and other raptors (hawks, falcons, owls, and eagles) along the Front Range. In addition, the Refuge provides a significant source of habitat for a substantial population of deer, migratory birds, and small mammals.

The importance of the Refuge to the region, particularly for migratory bird species, will continue to increase with development along the Front Range in the Denver metropolitan area. The Refuge's large, 27-square mile area supports species and communities associated with the once expansive plains grasslands that have been long in decline due to agricultural and urban development (Map 1.6 Vegetation Distribution). Many of the remaining areas of native grassland or undeveloped land have been fragmented by cropland, roads, housing, and commercial development. The diversity of habitat found on the Refuge provides a unique setting for maintaining, and establishing wildlife native to the region.

Figure 1.19 Great Blue heron are among the many bird species attracted to the Refuge.

Mammals

Deer are the most noticeable wildlife found on the Refuge. Two deer species are present–mule deer and white-tailed deer. Mule deer are the most common with a current population estimated at 530 animals. These deer are found throughout the Refuge. Mule deer populations have increased rapidly from a density of 8 per square mile in 1986 and 1987, to a 1995 population of 20 per square mile. The current density is higher than typical for most prairie habitats, and is due primarily to Refuge fencing in 1990. White-tailed deer are found typically in riparian and wooded areas with greater cover, such as along First Creek and the South Lakes area. Their current population is estimated at 200, up from the 1986-87 census of 56 (Morrison-Knudsen 1989b).

Other mammals also are found on the Refuge. Desert cottontail rabbits, the most abundant rabbits, usually are found in association with prairie dogs. Eastern cottontails generally are found in riparian areas or thickets. Black-tailed jack rabbits are common in the southwest portion of the Refuge (Jones et al. 1994). Plains pocket gophers are found throughout most of the Refuge, although they typically avoid prairie dog towns and areas of crested wheatgrass. The thirteen-lined ground squirrel is the most common ground squirrel. The spotted ground squirrel occurs where sandy soils exist in the western portion of the Refuge. A few fox squirrels inhabit woody riparian areas and upland tree groves. Muskrats are found at all lakes and ponds. No beavers have been found on the Refuge, although there is some evidence indicating beaver were once present.

Other small mammals found on the Refuge include deer mice, western harvest mice, prairie vole, silky pocket mice, and plains pocket mice (Boone and Preston 1994). The northern grasshopper mouse prefers native grasslands and yucca stands. Ord's kangaroo rat can be found in yucca dominated plant communities. Prairie and meadow voles favor areas with developed grass

and forb cover, and are an important part of the prey base.

Birds

Birds found on the Refuge include year-round residents, nesting species, and seasonal migrants. The most conspicuous of the grassland songbirds are the horned lark, western meadow lark, grasshopper sparrow, and lark bunting (Preston et al. 1994). Horned larks prefer areas of sparse vegetation such as prairie dog towns, while the western meadow lark is found in taller herbaceous vegetation. Various sparrows, such as the vesper sparrow, Cassin's sparrow, Brewer's sparrow, and lark sparrow, nest in grassland habitat (Preston et al. 1994). Grassland migrant species include various swifts, swallows, and sparrows.

Figure 1.20 Burrowing owls are the most numerous of the owls found at the Refuge.

Deciduous trees near buildings or old homesteads provide nest sites for northern flickers, western kingbirds, black-billed magpies, American robins, common grackles, European starlings, northern orioles, yellow warblers, and a variety of other species. Riparian woodlands that contain denser and more varied plant communities also support a similar composition of tree nesting birds. Riparian areas also attract spring migrants such as red-headed woodpeckers, dusky and willow flycatchers, and various thrushes, sparrows, and warblers. Cattail marshes bordering lakes, ponds, ditches, and streams provide valuable nesting habitat for red-winged blackbirds and common yellowthroats. Important migratory bird nesting habitat is concentrated along First Creek, area lakes, and in areas of wooded and shrubby vegetation.

Lakes, ponds, and streams on the Refuge provide a variety of habitat for waterfowl and shorebirds. The Refuge supports more waterbirds than historically occurred, since most of the lakes, ponds and associated wetlands were created following settlement. Canada geese are probably the most common waterbird found on the lakes. A variety of ducks are found on Refuge lakes during the spring and fall including mallards, northern pintails, gadwalls, American wigeons, teals, and many other species. Diving ducks that frequent lakes include canvasbacks, redheads, common goldeneyes, and buffleheads. Lake Ladora currently supports the highest waterfowl use.

Great blue herons are most frequently found near aquatic sites (Figure 1.19). Black-crowned night herons are also active around lakes and wetland sites. There are a number of shorebirds common at lake shores during the spring and fall including killdeer, American avocet, willet, greater yellowlegs, several sandpipers, and numerous others (Morrison-Knudsen 1989b). Herring and ring-billed gulls are the most common gulls found on the Refuge. American white pelicans have been observed on all Refuge lakes.

Ring-necked pheasants, a non-native species, were introduced to the Refuge for hunting during the 1960s and are still abundant. Mourning doves are common seasonally.

There are 16 species of raptors known to use the Refuge. Ferruginous hawks are winter

Figure 1.21 Yellow bellied Racer is one of the species of snakes found at the Refuge along with frogs, toads, and salamanders.

migrants that hunt in the open grassland habitats on the Refuge. Cooper's and sharp-shinned hawks are seasonal migrants that favor wooded areas, but no nests have been found to date. The Refuge also provides suitable habitat for American kestrels and prairie falcons that feed on small mammals and insects. Red-tailed hawks, Swainson's hawks, and northern harriers are seasonally common and all nest on the Refuge. Rough-legged hawks are found in open grassland habitat during the winter months.

There are five owl species found on the Refuge, the most numerous of which is the burrowing owl. Burrowing owls make use of abandoned prairie dog burrows for nesting (Figure 1.20). Great horned owls and long-eared owls also nest on the Refuge. Although uncommon, eastern screech owls use wooded habitat, and short-eared owls have been observed during migration.

Bald eagles winter on the Refuge primarily from November to March. Bald eagles roost in the large cottonwood trees on First Creek and feed primarily on prairie dogs and jack rabbits (USFWS 1992). The Service has established a bald eagle management area to restrict access to important eagle habitat during winter use periods.

Reptiles and Amphibians

Bullsnakes are the most common reptiles found on the Refuge (Figure 1.21). Relatively uncommon, the western hognose is found in sandy areas. Garter snakes can be found near water. Prairie rattlesnakes are present and very common. Only a few lizard species have been observed including lesser earless lizard, short-horned lizard, and many-lined skink.

The most abundant amphibian is the striped chorus frog, which breeds in shallow wet areas. The northern leopard frog and bullfrog occur primarily at Refuge lakes. Toads known to exist in the vicinity of water sources include the Plains spadefoot toad and Woodhouse's toad. Tiger salamander larvae are found in most wetland areas across the Refuge, whereas adults use mammal burrows.

Fish

Ladora, Mary, and Lower Derby lakes provide a source of water that supports viable fish populations. Bluegill, channel catfish, northern pike, and largemouth bass are the principal species. The Service currently manages these lakes for a catch and release fishery program. First Creek and other small ponds contain small fish populations such as fathead minnows. Mosquito fish are stocked annually in wetlands in the southern area of the Refuge to assist in control of mosquito larvae.

Threatened, Endangered, and Candidate Species

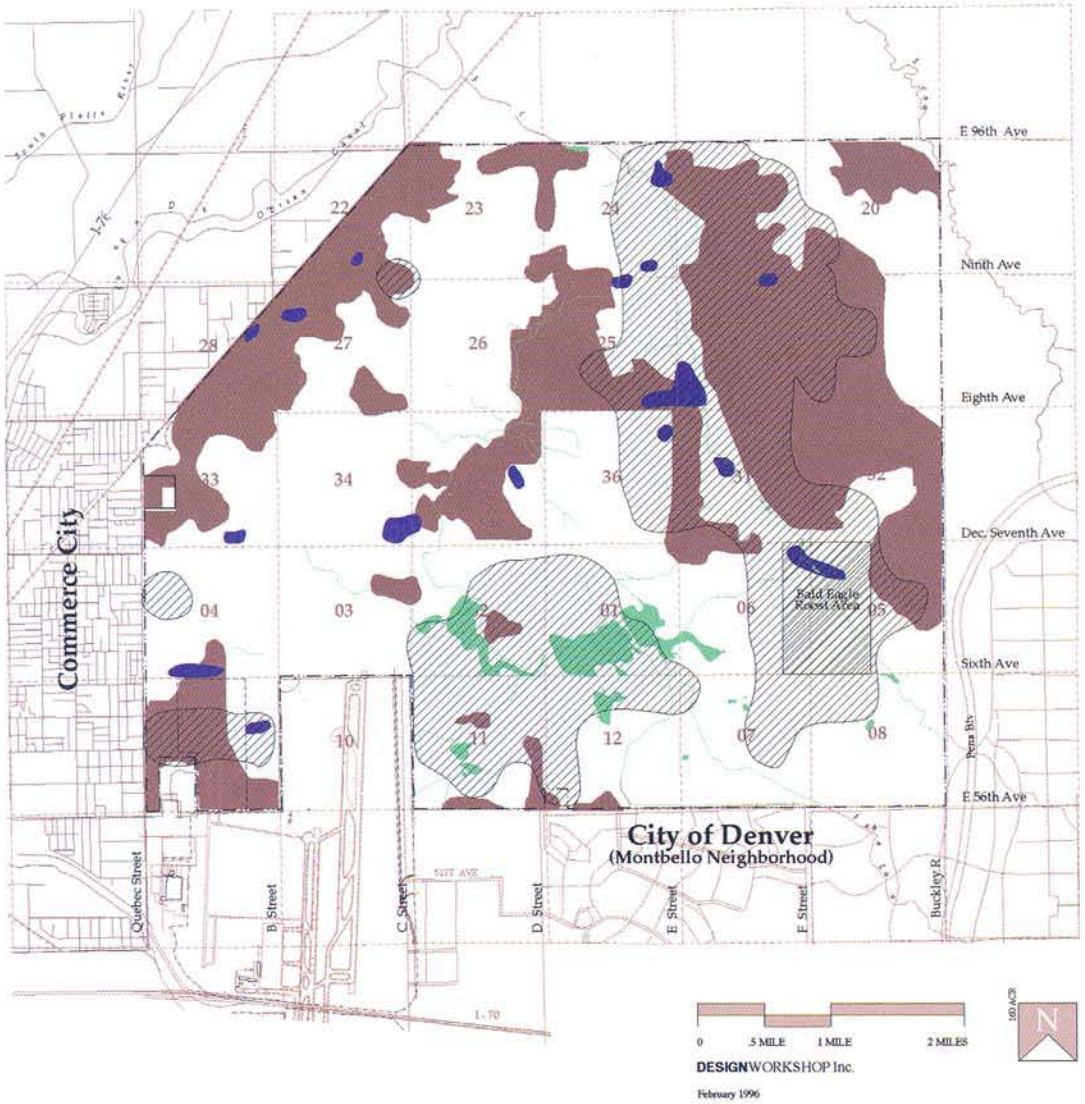
The Refuge provides habitat for several federally listed threatened, endangered and candidate plant and animal species. Candidate species are

SELECTED WILDLIFE HABITATS — WINTER *(Map 1.7)*

- Prairie Dog Colonies
- Ferruginous Hawk Winter Roost Sites
- Principal Roosting and Loafing Eagle Habitat
- Lakes

- Streams
- Section Lines
- Refuge Boundary

Source: U.S. Fish & Wildlife Service and Rocky Mountain Arsenal National Wildlife Area surveys
Note: The entire Refuge provides important foraging habitat for bald eagles and habitat for many other wildlife species and is important both on a local and regional basis.



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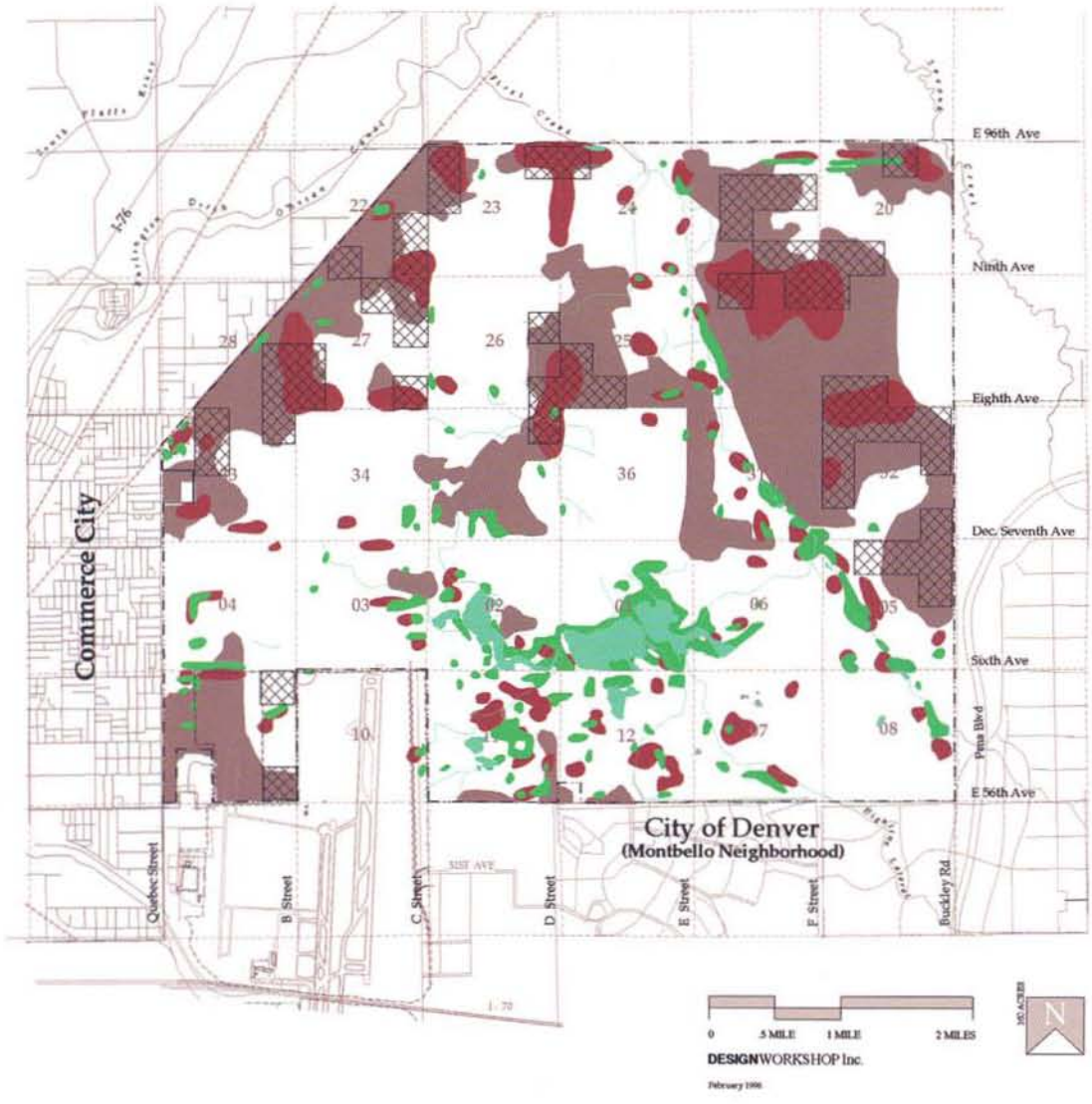
SELECTED WILDLIFE HABITATS — SPRING, SUMMER, FALL *(Map 1.8)*

- Prairie Dog Colonies
- Migratory Bird Nesting Habitat
- Raptor Nest Areas
- Known Burrowing Owl Nest Areas
- Lakes

- Streams
- Section Lines
- Refuge Boundary

Source: U.S. Fish & Wildlife Service and Rocky Mountain Arsenal National Wildlife Area surveys
Note: The entire Refuge provides important habitat to many wildlife species and is important both on a local and regional basis.



those for which insufficient information is currently available for listing as threatened or endangered. Some species inhabit the Refuge on a regular or seasonal basis while others are migrants that are infrequently sighted on the Refuge.

Bald Eagle

The bald eagle was recently downlisted from endangered to threatened status in the majority of the contiguous U.S., including Colorado, due to nationwide recovery efforts. The decline of the bald eagle was attributed primarily to the use of organochlorine pesticides, that caused egg shell thinning and subsequent nesting failure. Additional factors such as loss of habitat, habitat electrocution, powerline collisions, and other human disturbances also contributed to the decrease in eagle populations.

A winter bald eagle communal roost was first discovered at the Refuge in 1986. Bald eagles annually use the cottonwood trees along First Creek between October and April as a winter communal roost. Bald eagles at the Refuge prey on prairie dogs and other small mammals. The Service has implemented measures to restore prairie dog populations from a sylvatic plague outbreak that decimated populations in 1988. A 7000 acre Bald Eagle Management Area was also established on the Refuge to protect high eagle use areas during critical times of the year. An Eagle Watch blind was established on the east side of the Refuge to allow public viewing of the eagles on their evening roost without disturbing them.

American peregrine falcon

The American peregrine falcon is listed as an endangered species throughout its range. Pesticide use is thought to have led to the decline of this species. Peregrines typically nest on ledges close to water near readily available sources of avian prey. The closest suitable nesting habitat for peregrines near the Refuge is located along the Front Range foothills, 25 miles to the west. Peregrines have also been introduced in the downtown Denver area in efforts to establish an urban population. Peregrines have been observed at the Refuge on several occasions.

Eskimo curlew

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. It could potentially occur on the Refuge, however habitat to the north along the South Platte River is likely to be more suitable.

The Ute ladies'-tresses orchid

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

Water use on the Refuge will result in depletions to the Platte River system. Several threatened and endangered species, such as whooping crane, piping plover, and least tern in central Nebraska, may be affected by reductions in Platte River streamflow.

Candidate Species

The following species are candidates for federal listing:

- Preble's meadow jumping mouse–The Preble's meadow jumping mouse prefers dense willow and grass riparian vegetation. Although this type of habitat is present on the Refuge, no specimens have been recorded.
- Swift fox–The swift fox prefers shortgrass prairie habitat. They prey on a variety of small birds and mammals. Suitable habitat and a potential prey base are found on the Refuge, however it is uncertain whether the swift fox is present.
- Ferruginous hawk–The ferruginous hawk is native to open grassland habitat. Conversion of grasslands to agriculture, loss of nesting sites, and reduction in prey base have led to its decline. A large number of ferruginous hawks are attracted to the Refuge each winter by the abundance of prairie dogs and rabbits.
- Baird's sparrow–Baird's sparrow is a migrant visitor to the native grassland prairie of the Refuge. Its decline is attributed to the loss of open grassland prairie habitat.
- Black tern–The black tern typically nests along lake shores and marshes and feeds on small fish. The Refuge contains suitable habitat for the black tern, but it has only been observed as an uncommon migrant.
- Mountain plover–The mountain plover prefers dry upland plains and prairies. It feeds primarily on grasshoppers. The extensive prairie dog towns at the Refuge provide excellent habitat for the plover. Although the mountain plover has been observed on the Refuge, no nesting activity has been documented.
- White-faced ibis–The white faced ibis, a long-legged, wading bird, is found in association with lakes, rivers and wetlands. The Refuge does not provide optimal nesting or foraging habitat for the ibis, but it is recorded as a casual visitor.
- Regal fritillary butterfly–This species prefers wet or moist meadows. Larvae feed on the leaves of Viola, which are not common on the Refuge. No regal fritillary butterflies have been recorded on the Refuge.
- Colorado butterfly weed–The Colorado butterfly weed prefers moist prairie meadows. The Refuge contains suitable habitat, but there have been no documented occurrences of the butterfly weed.

SOCIAL AND ECONOMIC ENVIRONMENT

Land Use

The Refuge is located in Adams County, Colorado, in the northeastern portion of the six-county Denver metropolitan area. The Refuge's 17,000 acres accounts for about 2 percent of the 764,200 acres in Adams County. (See Map 1.1 Regional context.)

Land use surrounding the Refuge varies considerably. The site of the former Stapleton International Airport adjoins the Refuge on the southwest. The Refuge is adjoined by residential and commercial development on the southeast, agricultural land on the north and east, and industrial development on the southwest, northwest and west. The Burlington Northern Railroad corridor parallels Highway 2 and Interstate 76 along the northwest boundary of the Refuge. This area is characterized mostly by industrial development, and is expected to continue to attract industry.

Adams County consists of 9 cities: Aurora, Bennett, Brighton, Broomfield, Commerce City, Federal Heights, Northglenn, Thornton, and Westminster. Bennett, Commerce City, Federal Heights, Northglenn, and Thornton are located entirely in Adams County. Unincorporated Adams County consists mostly of rural residential land use (52 percent). Other types of development in unincorporated Adams County include single-family and multi-family residential (15 percent), industrial (19 percent), commercial (2 percent), and planned unit developments (12 percent). Large tracts of designated open space in Adams County include Barr Lake State Park and Recreation Area northwest of the Refuge, and Adams County Regional Park north of the Refuge. Other regional recreation areas in the Denver metropolitan area include state parks at Cherry Creek and Chatfield Reservoirs and Roxborough State Park, and the Denver and Boulder Mountain Parks Systems.

Future land use around the Refuge is designated by Adams County, the City and County of Denver, and Commerce City (Map 1.9 Regional Flows). Development of the Gateway area surrounding the Denver International Airport and redevelopment of the former site of Stapleton Airport is under the jurisdiction of the City and County of Denver. Agricultural land north and northwest of the Refuge is designated for residential development, with open space areas designated along First and Second Creeks.

The land adjoining Section 29 east of the Refuge is designated for development of offices and businesses specializing in distribution. South and east of the Peña Boulevard and Buckley Road corridor is part of the planned site of Gateway. Most of this area is designated mixed use, including offices, hotels, and retail uses. Residential development is planned south of Sections 7 and 8 and east of Section 8 beyond Peña Boulevard. The Montbello Neighborhood is located south of the Refuge in the City and County of Denver.

Utility corridors in the Refuge exist for potable and non-potable water, operational and non-operational sewer, electrical, contaminant waste, gas, and fiber optics. Primary utility corridors are located along East 56th Avenue; December Seventh Avenue, especially in the area of South Plants; portions of Ninth Avenue and Highway 2; and portions of Section 25 especially in the area of North Plants. A primary electrical corridor is located along Buckley Road north of Sixth Avenue to 96th Avenue, and along East 96th Avenue from Buckley Road to E Street.

Some areas of the Refuge would be transferred to other owners or converted to other uses. Under the law establishing the Refuge, a strip of land up to 100 feet wide could be used to widen 56th Avenue on the south side, 96th Avenue on the north side, and Colorado Highway 2 on the northwest side of the Refuge. The Refuge boundary on the southwest and west sides would be modified by the sale of 815 acres. The proceeds from the sale of this land, as specified in the Refuge Act, will be used to help build the Visitor Learning Center. The Service will use these opportunities to modify the existing fencing. Fencing would be set back from its current location to accommodate the new Refuge boundary.

Socioeconomics

The socioeconomic study area includes two regions. Adams County, where the Refuge is located, is the primary study area. The Denver metro area is the secondary study area. The Adams County economy is integrated into the larger and more complex Denver metro area economy.

Adams County is one of six counties in the Denver metro area. Population in the metro area was 1,715,300 in 1992. Population is expected to grow to 2,612,200 by 2015. In 1992, Adams County had a total population of 281,700, which ranked fifth in the state. Population in Adams County has shown small annual increases from 1983 to 1992; the total increase for this period was 8 percent. It is expected to grow to 408,400 by 2015.

Adams County includes 9 cities and has a land area of 1,194 square miles. About 78 percent of the population in the county resides in incorporated areas. Development patterns vary significantly across the county. Some areas are highly urbanized or industrialized, while others are commercial, suburban, or agricultural. Population densities also vary. The most concentrated population densities are in Commerce City, Thornton and Northglenn. Population is more dispersed around Bennett and Brighton. Average household size is 2.68 persons. There are about 230 persons per square mile in Adams County.

Commerce City adjoins (or will adjoin) the Refuge on the north, west, and northeast. By agreement with surrounding jurisdictions, the city may expand into areas north and east of the Refuge. Major highways, arterials, and railroads make Commerce City a central transportation and distribution hub. Transportation is the city's growth industry. During the last few years, truck terminals, air freight handlers, mail handlers, and local truckers and distributors have located in Commerce City. It is also home to a high concentration of industry. Even with growth in transportation and industry, nearly half of the business in Commerce City are services and retail trade. The majority of land in Commerce City is used for public roads, infrastructure and industry. Residential uses account for 23 percent and commercial uses account for 5 percent.

Median household income in Commerce City is $22,916, about 70 percent of median household income in Adams County. Unemployment was 6.8 percent in 1994. From 1980 to 1990, population in Commerce City increased 1.4 percent, significantly less than the 7.8 percent increase in Adams County during the same period.

Colorado tourism

A major factor in the Refuge's future attendance will be its attractiveness to Colorado tourists. Colorado has a large and complex tourism industry with significant seasonal fluctuations. There are very little reliable data on Colorado tourism activity, particularly since the demise of the Colorado Tourism Board. In past studies, BBC Research and Consulting has estimated the total number of out-of-state, discretionary tourists at about 7.0 million individuals per year. Approximately 60 percent of these visitors pass through the Denver metropolitan area on their way to mountain resorts and other destinations. Research by the Denver Convention and Visitors Bureau indicates that Denver's local tourist market (visitors with Denver as a destination) is comprised principally of persons visiting friends and relatives and those persons visiting Denver for multiple purposes, such as shopping, medical care, or specific events.

Although Colorado enjoys a sizable tourism industry, and a market predisposed to nature and wildlife attractions, the Refuge still faces difficult challenges in penetrating this market. Most of the Colorado tourism market passes through Denver on its way to the more dramatic natural attractions of the Rocky Mountains. Enticing visitors to

stop at what is largely a plains exhibit, while in sight of the mountains, will be difficult.

Denver also has a well used and strongly supported system of arts and cultural attractions. Attendance at the Denver Natural History Museum and the Denver Zoo, approximately 1.8 and 1.5 million per year respectively, provides some indication of the area's ability to support wildlife or nature-related exhibits and attractions. Currently the Refuge ranks third behind Rocky Mountain National Park and the Denver Zoo as a destination for wildlife viewing. It should be noted that museum attendance figures can be skewed by one time major attractions, such as the King Tut exhibit or similar promotions. Multiple use by members is also a factor that adds uncertainty to attendance figures.

Current Public Use on and near the Refuge

Outdoor activities and the use of natural areas for recreation are important aspects of the quality of life that the Denver metropolitan area offers. Public use programs at the Refuge give the public the chance to learn about its history, wildlife, and cleanup activities. These programs include wildlife tours, environmental education, presentations, special events, the Eagle Watch, interpretive activities, nature walks, and fishing and scout programs. Public participation programs occur on and off the Refuge. In 1994, nearly 49,000 people participated in these programs. A large portion of the public participation programs is devoted to programs involving school children. In 1994, almost 15,000 students participated in environmental education programs on the Refuge.

An average of 4,075 visitors came to the Refuge each month in 1994. About 1,425 of these visitors participated in environmental education. Many of these participants were students and teachers. Another 1,140 visitors participated in wildlife tours and eagle watching. Visitors also participated in interpretive programs and nature walks, presentations, scout programs, and special events.

Current recreational activities on the Refuge include bird watching, eagle watching, and fishing. Annually, 700 permits are issued for catch-and-release fishing. From 1990 to 1994, participation in environmental education programs, interpretive programs, and nature walks increased significantly. Other programs that gained popularity included fishing and presentations.

Currently, there are eight full-time positions associated with public use of the Refuge. These positions are funded by the Army. As the Service assumes full responsibility for the management and operations of the Refuge, it will be required to fund all staffing. Volunteers contribute to the staff requirements necessary to offer current public participation programs. In 1994, volunteers contributed the equivalent of more than three full-time positions. The Rocky Mountain Arsenal Wildlife Society was established in 1995 to assist the Refuge by supplying volunteers and other resources.

The Emerald Strands Plan (Adams County, et. al. 1990) is a cooperative park, open space, and trail Plan for the area surrounding the new Denver International Airport. The plan focuses on future development in order to provide links with other metropolitan-area trails and open spaces and creates a system allowing people to move about the area on a series of trail loops designed for pedestrians, bicyclists, and equestrians.

Open space corridors and trails are recommended throughout the area, in response to all stream corridors, which have been identified as

open space. However, not all stream corridors will have trails. Off-street trails have been recommended to provide a link with the Rocky Mountain Arsenal National Wildlife Refuge. Three areas of focus proposed to provide connection with the Arsenal are the Highline Canal and Lateral, First Creek, Second Creek, and a corridor in relation to the proposed E-470.

In addition, Commerce City has studied open space trail connections and has identified several on-street connections to an off-street trail, running parallel to Quebec, adjacent to the Refuge.

In Montbello, perimeter streets now have separated bike paths: Peoria Street, Chambers Road, and 56th Avenue. Montbello has explored developing an on-street bikeway system within the Montbello neighborhood to connect residential small areas, schools, parks, recreation facilities, and off-street bicycle trails. In Green Valley, bike paths are not yet developed. The Highline Canal and First Creek open space are proposed locations for a new off-street bike trails.

Transportation

The main freeways that provide significant regional connections for the Refuge are I-70, I-270, the proposed E-470, and Peña Boulevard. Proposed development on these roads calls for an increased number of lanes and thus increased transportation capacity.

Table 1.2 Attendance at Selected Recreation Opportunities

Recreation Area	1993 Attendance	1994 Attendance	1993-1994 Attendance	Visitation as % of CMSA population *(1)*
Denver Recreation Area Opportunities				
Barr Lake State Park *(2)*	125,773	113,956	-9.40%	5.46%
Chatfield Reservoir *(3)*	na	1,500,000	na	71.80%
Cherry Creek State Park	1,200,000	1,400,000	16.67%	67.02%
Lookout Mountain Nature Center	15,500	na	na	0.74%
Roxborough State Park *(3)*	na	100,000	na	4.79%
National Parks				
Rocky Mountain National Park	3,050,000	3,000,000	-1.50%	na
Grand Teton	2,595,000	2,800,000	7.90%	na
Mesa Verde	535,670	553,520	3.33%	na
Yellowstone	2,330,000	2,480,000	6.44%	na

Source: Site interviews conducted by BBC Research and Consulting.
(1) Based on U.S. Bureau of the Census, 1990 Census of Population and Housing, Supplementary Reports, Metropolitan Areas as defined by Office of Management and Budget, June 30, 1993, as reported in the Statistical Abstract of the United States, 1994.
Reported population for Denver-Boulder-Greeley CMSA
(2) Through June 30 only, for both years
(3) Estimate

• I-70 is located south of the Refuge running east-west through Stapleton. This freeway is an important connector between the plains and the mountains. It is an important regional transportation corridor to Denver International Airport and is slated to increase in size from 6 lanes to 10-12 lanes of traffic. I-270 connects US 85 and I-70 southwest of the Refuge. The freeway directs traffic through Commerce City and is proposed to increase from 6 lanes to 10-12 lanes.

• E-470 is a proposed beltway running along the eastern edge of the metropolitan area from the intersection of I-25 and C-470 in the south to approximately I-25 and 120th Avenue in the north. E-470 is a proposed 6 lane freeway that would serve as a major north/south access road to and from the new airport, connecting I-25, I-76, and I-70 with an interchange at Peña Boulevard.

• The construction of Peña Boulevard between I-70 and the new airport has greatly increased traffic along the Refuge's eastern boundary. An interchange at 56th Avenue has a prominent informational sign advertising the Refuge.

The roads immediately bordering the Refuge are Quebec Street, 96th Avenue, 56th Avenue, and Buckley Road. Each of these, except Buckley Road, are principal arterials that make important connections with Denver International Airport.

• Quebec Street borders the west boundary of the Refuge. Quebec's proposed future development will result in realignment to the east, an increase from 4 lanes of traffic to 6 lanes, and improved interchanges between I-70 and I-270.

• Bordering the northern boundary of the Arsenal is 96th Avenue, which is to be extended east of Buckley Road to an interchange at E-470. The existing 96th west of Buckley will increase from 2 to 4 lanes of traffic.

• 56th Avenue bordering the Refuge's southern boundary has recently been completed from Peña Boulevard to Quebec Street. Plans call for it eventually to be widened to 4 lanes.

• Buckley Road, on the eastern border of the Refuge, is a gravel road that the Service proposes closing from the Eagle Watch north to 96th Avenue.

LANDSCAPE STRUCTURE AND ZONES

A landscape ecological view

If you look in the right direction when landing or taking off from Denver International Airport, you can get a fascinating aerial view of the Refuge (Figure 1.22). Included in that vista are many distinct patterns, some natural and some the work of human hands. Most visible are the stands of large trees, either in lines along First Creek, the lakes, ditches, and canals or in other, more regular shapes where people have planted them. The manufacturing plants, other buildings, utilities, and roads also make strong marks. Other patterns are obvious on the surface of the ground, where vegetation and soils have been disturbed for one purpose or another.

Not only do these patterns reveal many stories about past uses of the site, they also hint at ecological function. Thickets of New Mexico locust and other patches of vegetation, for example, provide important habitat. The large cottonwoods and other vegetation along First Creek provide roosts for bald eagles and function as movement corridors for some birds and small mammals.

Understanding the relationships between landscape forms, like patch and corridors, and eco-

logical functioning helps plan more effectively. For example, knowing that deer or small mammals are using a thicket or a lake edge for cover and feeding means that roads or trails should either be kept out or be very carefully planned.

Regional patterns

Looking at these same landscape patterns as they relate to the larger region, it becomes clear that many of the patterns extend well beyond the Refuge's boundaries (Map 1.9 Regional Flows). First Creek and its considerable riparian vegetation continue from upstream right through the Refuge fence. Areas of grasses or forbs extend off site to the north.

Even with the Refuge's extensive size, it is not an island. It is tied into its region ecologically and many other ways. One of the challenges of planning and managing the Refuge is recognizing and working with these regional connections and relationships. It is a mistake to believe that Refuge boundaries or even a fence separates the Refuge from its environs. (Refuge biologists note that the existing boundary fence stops few species other than deer and people. All others either dig under or fly over the fence.)

Figure **1.22** From the air, there are many fascinating patterns to read on the surface of the Refuge.

Zones

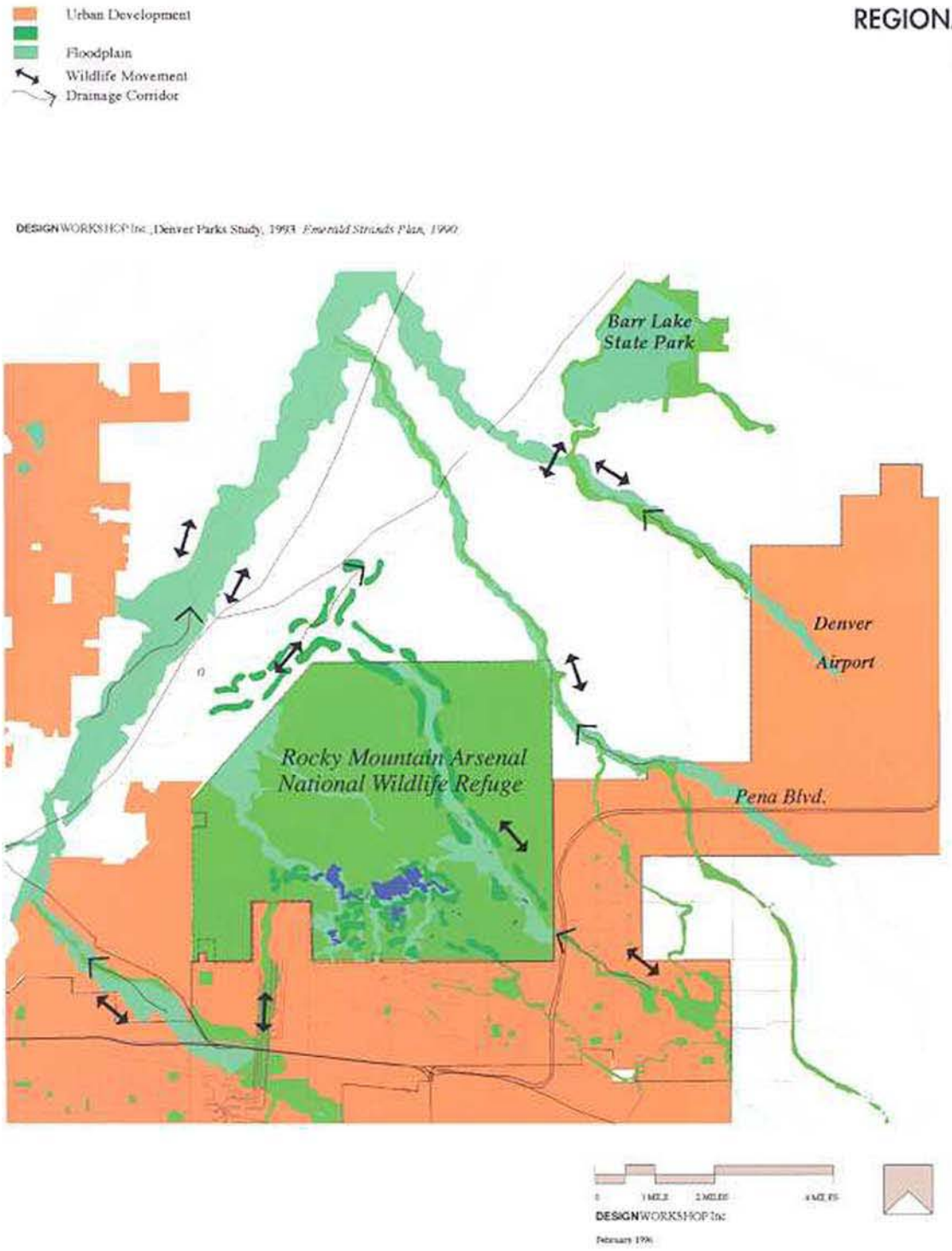
Early in the planning process a zone management concept was identified for the Refuge. The Refuge was divided into three planning and management zones based on a combination of current habitat types, historical disturbance, likely levels of public use, and anticipated cleanup activities (Map 1.10 Planning Zones).

The northern zone has the least trees and shrubs and will see the majority of cleanup activities. Cleanup will alter the area considerably, but will provide an opportunity to re-establish native prairie vegetation that has long been displaced.

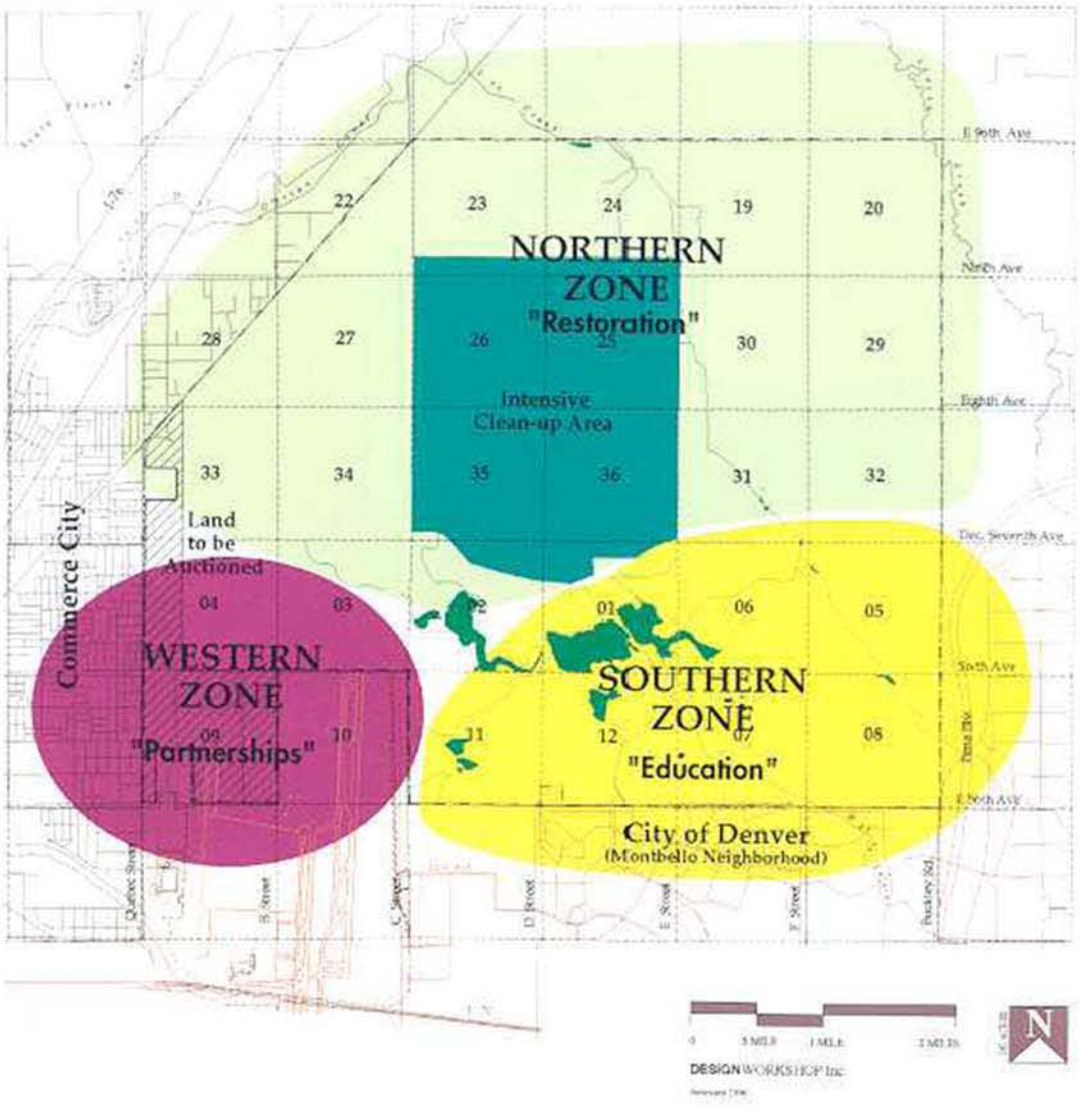
The southern zone has many lakes and ditches and related vegetation. Little cleanup activity will take place here. Because of its rich diversity of habitat, wildlife viewing is particularly rewarding in the southern zone. To be sustained, the southern zone will need greater habitat and wildlife management inputs because it is an artificial, even a cultural, system.

The western zone is a product of economic and political reality. It includes the southwestern corner of the Refuge, adjacent lands that will be auctioned off by the U.S. Government, and the northern end of the former Stapleton International Airport. Because this zone is in the general direction of the center of the metropolitan area, it is a logical gateway to the Refuge. Because these lands are undergoing dramatic transitions in use, the opportunity exists to plan them together to

REGIONAL FLOWS
(Map 1.9)



PLANNING ZONES
(Map 1.10)



achieve a coordinated result. This zone also is an acknowledgement that the Service wants and needs the participation and cooperation of the larger community if the Refuge is to succeed.

Both the perimeter greenbelt (that will surround the Refuge on the outside of the fence) and the western zone have the potential for accommodating higher public use than other parts of the Refuge because habitat is less sensitive in these places. In addition, because of the cleanup work and the distinct differences between the northern and southern portions of the Refuge, potential uses and user groups can be divided between these northern and southern zones.

Visual Resources

The Refuge is located on the edge of a major urban area; with Commerce City to the immediate west, the City of Denver to the south; Denver International Airport and the future Gateway development to the east; and to the north is agricultural land. The most striking views are westward to the Front Range with the Denver skyline in the foreground (Figure 1.23). The site has experienced considerable changes during its conversion from prairie to agriculture prior to the 1940s, and subsequent to that in its role as a military arsenal and a site for the production of agricultural chemicals. As a Superfund cleanup site, it will experience further disruption over the next several decades. The visual resources have been affected by these past uses. Visual resources range from fragments of undisturbed landforms and vegetation cover that have existed since presettlement days, to the creation of storage lakes for irrigation purposes, to regraded areas, to cleanup landfills and capped sites.

The southern zone is the most culturally affected landscape, with lakes, wetlands, canals, ditches and detention basins providing water for woody riparian vegetation, and old homestead sites with remnant upland trees. Roads and tracks that serviced this agricultural landscape remain, along with utility poles, powerlines and railroad lines. This is a highly modified landscape, with little original native vegetation remaining. The overall appearance is of a more intimate, partially treed landscape amid grassland, with a lushness less typical than would be expected in adjacent rural areas.

The northern zone has been less obviously disturbed by agriculture, although it was severely affected as a result of weapons and agricultural chemical manufacturing. This cleanup zone will be most affected by future work. However, it retains an open, prairie-like feel, interrupted by only the occasional grouping of upland trees associated with old homesteads, and by a line of riparian vegetation along First Creek. Its gently undulating nature with the higher ground to the east precludes long views eastward, except at high points, and provides a panorama of the Front Range.

Figure 1.23 From the Refuge there are many opportunities for dramatic views of the Denver skyline with the Front Range as a backdrop.

Some of the manmade structures, such as the Army's headquarters, homesteads, warehouses, bunkers, the perimeter fence, the boundary ground water containment system and some utilities may remain (Figure 1.24). These add to the visual diversity. In addition, many of the manmade topographic features including, road and railroad profiles, cleanup mounds, bunkers, ditches and dikes, and a large number of miscellaneous "gouges" and "lumps" in the landscape will remain.

The dominant landmark from most points within the Refuge is the Front Range. The Denver skyline is silhouetted against that backdrop. A number of silos and stacks in Commerce City are visible from the Refuge. The blue Post Office Bulk Mail Facility dominates the foreground in the southwest corner of the Refuge. From Henderson Hill, it is possible to see Denver International Airport and, from the southeast edge of the Refuge, Peña Boulevard leading to the airport. Both Commerce City and the Montbello neighborhood with their low rooflines are visible when close to the Refuge perimeter.

Figure 1.24 Most of the structures built on the site, such as this water tower, will be removed either because they are contaminated or the earth under them is.

2. VISION AND GOALS

As with all national wildlife refuges that are open to the public, the Rocky Mountain Arsenal National Wildlife Refuge will welcome visitors from every background and interest. Special effort will be made, however, to attract and engage those urban dwellers who might not otherwise visit a wildlife refuge. The goal is to open up the world of nature to persons—particularly those in the immediate neighborhoods of Montbello, Commerce City, and North Aurora—who may have little opportunity to experience nature. Another goal is to help nearby residents feel a sense of ownership and pride for the Refuge.

The mission of the Rocky Mountain Arsenal National Wildlife Refuge is to enhance and sustain fish and wildlife and their habitat and to provide the public with meaningful opportunities to experience nature near an urban area. In addition, the Refuge will provide urban dwellers with the opportunity to see a variety of wildlife close to home.

Special attention will be paid to school children in the region, who may have had little opportunity to understand or experience Colorado's plains environment and heritage. Other groups to be accommodated will include civic organizations, wildlife advocacy groups, and photography clubs (Figure 2.1).

Just as residents of the surrounding neighborhoods will be encouraged to visit and enjoy the Refuge, so will the Refuge staff increasingly participate in the neighborhoods. The latter will be accomplished by taking programs into the neighborhoods and by staff participating in neighborhood organizations and activities.

GOALS AND OBJECTIVES

The process of developing goals and objectives for the Refuge, as well as specifically for the Comprehensive Management Plan as a whole, is a step-down process that goes from the general to the specific. The legislative framework (described in the previous chapter) provides the broadest

Figure 2.1 The Refuge staff will make a special effort to reach urban youth who might otherwise not visit a wildlife refuge.

context for the Refuge. From this framework, six goals were developed to help guide planning and management of the Refuge (Table 2.1). Presented below are supporting principles and objectives for each of the six. Specific Refuge actions and facilities should each be traceable through the various levels of this step-down process. In this way everyday activities can be kept consistent with the Refuge's broader mission.

Table 2.1 Six goals were developed to help guide planning and management of the Refuge.

1. *Manage wildlife and habitat to contribute to ecosystem management using strategies that recognize the Refuge's different resource types and the varying purposes specified in the enabling legislation.*

2. *Interact with communities and organizations through outreach and cooperative agreements to create mutually beneficial partnerships.*

3. *Develop environmental education and outreach programs for urban communities to nurture an appreciation of nature which ultimately results in fostering an environmental consciousness which promotes conservation of our natural resources.*

4. *Provide opportunities for wildlife-oriented recreational activities.*

5. *Utilize the Refuge for research opportunities compatible with Refuge management.*

6. *Develop a program support system to provide facilities, funding, and resources necessary to accomplish Refuge purposes.*

GOAL 1

Manage wildlife and habitat to contribute to ecosystem management using strategies that recognize the Refuge's different resource types and the varying purposes specified in the enabling legislation.

An essential part of this goal is that within the 27-square mile Refuge there are two major planning zones and a third less traditional planning zone. To the north, the land is open grassland and it is in this area that most of the major disturbance related to environmental cleanup will occur. The southern zone has human-created lakes and other areas of introduced water sources and diverse plant and animal species. Some of the objectives in support of this goal relate to both northern and southern zones, while others relate to one or the other. The western zone is a much smaller area and was specifically established to facilitate the development of community partnerships.

Principles for Goal 1

Management principles for the northern and southern zones

- Continue inventories of habitat types and plant and animal species present on the Refuge.
- Preserve, enhance, and augment grasslands for use by songbirds and other grassland-related species.
- Conserve and enhance species listed as threatened or endangered under the Endangered Species Act, species that are candidates for such listing and sensitive or regionally declining species.
- Reintroduce and manage appropriate indigenous species.
- Manage First Creek as an important riparian corridor and restore degraded portions.
- Fulfill international treaty obligations of the United States for the conservation of fish, wildlife, and their habitats.
- Phase the restoration of impacted/degraded habitat and adjust restoration techniques as necessary to achieve desired results.
- Evaluate and monitor the health of fish, wildlife, the success of restoration and remediation efforts, and the overall impact of human activities on wildlife.
- Identify and develop local sources of native grass, shrub, and forb seed.
- Work with the U.S. Army and Shell Oil company (who are responsible for cleanup) to ensure that the process of environmental remediation achieves fish, wildlife, and habitat restoration goals.
- Identify management units within each zone and manage appropriately.

Management principles for the northern zone

- Manage and restore the northern zone of the Refuge as habitat for indigenous species.
- Promote the preservation and establishment of native plants and animal species to encourage self-sustainable systems.
- Preserve, enhance, restore, and augment prairie dog communities.

Management principles for the southern zone

- Manage and improve the southern zone of the Refuge to maintain and enhance diverse habitats for wildlife populations at appropriate densities.
- Preserve, enhance, and augment wetlands for use by waterfowl, fish, and shore birds. (Also applies to First Creek in both zones.)
- Promote the preservation and establishment of native plant species to maintain or enhance habitat values for wildlife.
- Encourage sustainable systems where not in conflict with maintaining existing diversity and abundance of wildlife populations.

Principles for the western zone

- The western zone is the Refuge Gateway and a place for considerable interaction with adjacent communities.
- Environmentally, it is a place to demonstrate how facilities can be sited and maintained in ways that recognize ecological principles.

Objectives for Goal 1

Habitat Management (northern zone)

Covered/capped areas

The Service, U.S. Army, and Shell will revegetate capped/cleanup areas to establish a plant community consisting of 70-100 percent grasses and 0-30 percent forbs and shallow rooted shrubs.

The species composition of the desired plant community will vary with site-specific wildlife management objectives and soil types. For example, if the objective is to exclude most wildlife from a site, such as a landfill, a monoculture of crested wheatgrass or a mixture of crested wheatgrass and pubescent wheatgrass may be selected. On the other hand, if only burrowing animals will be excluded from an area, forbs and shallow-rooted shrubs, such as annual sunflower, blue flax, fringed sage, four-wing saltbush, and rubber rabbitbrush, may be seeded as well to provide cover and forage for other wildlife, such as songbirds and deer.

Revegetation efforts will be initiated the first growing season cover/caps are in place, and will aim to establish the desired plant communities within five years of planting. Additional maintenance after five years may be necessary to control the invasion of undesirable species. This project will retard erosion, discourage use of these areas by certain wildlife, and help to protect human and wildlife health.

Habitat undisturbed by cleanup

The Service will reseed and establish a plant community consisting of 70-90 percent native grasses, 10-30 percent native forbs and shrubs, and plant trees both in existing areas and in

appropriate riparian areas as identified on the Refuge's Restoration Priority Areas map to replace trees lost due to age, disease, lightning, etc. Specific areas may vary in composition mix depending on site-specific soil types and management objectives (e.g., shrubland restoration).

Native grasses typical of sand prairie communities will be seeded on coarser textured soil types (loamy sand/sandy loam); species include blue grama, western wheatgrass, sand dropseed, needle-and-thread, sand bluestem, Indian ricegrass, prairie sandreed, and side-oats grama. Forbs and semi-shrubs typically found in sandy soils include bush morning glory, blue flax, annual sunflower, prickly poppy, evening primrose, and fringed sage, but the actual percentage of these and other species in the seed mix will also depend upon availability and cost. Shrubs such as rubber rabbitbrush, four-wing saltbush, sand sagebrush, or skunkbush sumac may be included in the seed mix depending upon site-specific management objectives.

Finer textured soils (loam/clay loam) would support a short-grass prairie plant community; blue grama, western wheatgrass, and buffalo grass would be co-dominant grass species, while forbs and shrubs would likely include annual sunflower, blue flax, rubber rabbitbrush, and four-wing saltbush.

Restoration plans to date have expressed a desire to establish plant communities within five years of planting. Additional maintenance beyond five years may be necessary to control the invasion of undesirable species.

Habitat Management (southern zone)

Restoration/enhancement areas

The Service and the U.S. Army will restore 1,000-1,500 acres to native grasses, and maintain the remaining habitat in areas as identified on the Service's map of restoration priorities (Map 2.1). Soils in the southern zone generally are coarse textured and would support a typical sand prairie community. Desired native plant species are the same as those described for loamy sand/sandy loam soil types in the northern zone.

The remainder of existing habitat will continue to be dominated by crested wheatgrass, annual weeds, and cheatgrass. The restoration plan identifies the phasing of this project to establish desired plant communities within five years of planting. An additional five years of maintenance may be necessary to control the invasion of undesirable species. This project will restore habitat values lost through cleanup and improve habitat values of weedy areas.

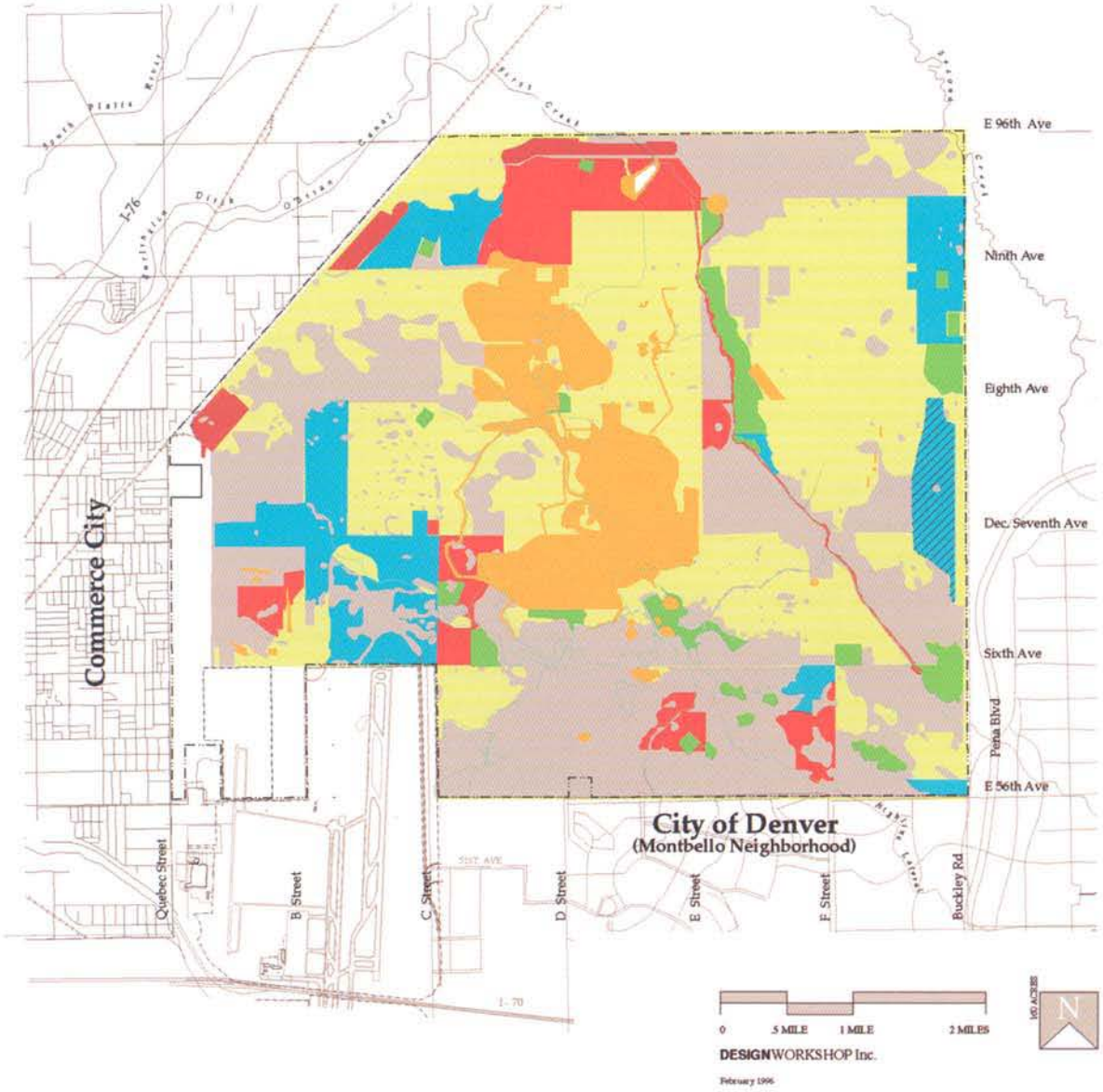
Undisturbed habitat

The Service will maintain 5000 acres of the existing vegetative composition of 70-90 percent grassland and 10-30 percent woody vegetation in areas identified on the Service's Restoration Priority Areas map. Grasslands will continue to be dominated by prairie sandreed, western wheatgrass, blue grama, and buffalo grass with a 10-20 percent complement of native forbs. Woody vegetation will continue to be dominated by cottonwoods, New Mexico locust, white poplar, sumac, and Chinese elm. This maintenance program is on-going and will sustain current habitat values for existing wildlife species through the 15-year planning horizon

HABITAT RESTORATION PRIORITIES *(Map 2.1)*

First Priority–Seeding	1505.93 Acres	Railroads	
First Priority–Shrubs Only	211.64 Acres	Streams	
Second Priority	930.42 Acres	Section Lines	
Third Priority	5691.04 Acres	Refuge Boundary	
Fourth Priority	5313.02 Acres		
Potential Vegetation Maintenance Sites	559.88 Acres		
Unclassified	1216.38 Acres		
Remediation Zone	1599.63 Acres		
Interseeding Only	218.76 Acres		

Source:
Morrison Knudsen Corporation, classification boundaries determined by U.S. Fish & Wildlife Service. Updated November 1995.



First Creek Restoration

The Service will restore and improve First Creek (approximately 1000 acres) according to the First Creek restoration plan, including: restore appropriate portions of the old stream channel; install drop structures to prevent further erosion; enlarge/improve Bald Eagle Shallows, if required, by the Urban Drainage and Flood Control District Master Plan (when completed); restore and create wetlands in the First Creek corridor; and restore riparian vegetation and replace upland trees. This task will be initiated within five years and completed within 15 years. It will reduce channel headcutting and soil erosion; protect and replace eagle roost trees; minimize downstream flooding; improve water quality; improve riparian habitat values and replace dead upland trees in the northern zone with trees in riparian areas.

Identify and Develop Seed Sources for Revegetation

The Service will develop an on-site seed collection program; establish a nursery for the propagation of woody species and for seed cleaning and storage; and develop off-site sources of local provenance. This on-going program will develop the use of local genotypes for revegetation projects and reduce the cost of seed acquisitions.

Manage Prairie Dog Communities

The Service will strive to maintain 3,500 to 5,000 acres of prairie dog colonies to provide and sustain an important year-round regional prey base and habitat for raptors and other wildlife species. Management of these colonies will include: efforts to control plague and minimize public health risks; control prairie dog use of capped areas and landfills; maintain isolated colonies in selected areas to serve as population reservoirs in the event of plague episodes; control the introduction/colonization of prairie dogs into selected habitat restoration areas to allow revegetation establishment; and relocate prairie dogs in appropriate areas by trapping.

Deer Management

The Service's deer management program will contain deer herds within the Refuge boundary through the maintenance of the perimeter fence to minimize deer/vehicle collisions and determine the ultimate carrying capacity of white-tailed and mule deer on the Refuge. The Service will use a variety of management techniques to control numbers including culling/hunting and contraception. Additionally, the Service will determine strategies to maintain a healthy deer population. These efforts are necessary because deer populations have the potential for rapid growth, and large deer populations can have severe impacts on other animal communities which depend on healthy vegetation for food and cover.

Maintain and Enhance Aquatic Communities - Lakes and Wetlands

The Service, U.S. Army, and Shell Oil Company will continue to maintain the existing lakes and wetlands and/or create new wetlands resulting from cleanup borrow pits. The Service, Army, Denver Water Board, and the Urban Drainage and Flood Control will cooperatively create new/enlarged stormwater detention and water quality ponds on First Creek at Bald Eagle Shallows and along 56th Avenue within the next 15 years. These lakes and wetlands will provide habitat for abundant and diverse terrestrial and aquatic organisms, manage stormwater, and provide environmental education opportunities. The detention basins will help to remove debris, sedi-

ment, and contaminants from urban runoff where it enters the Refuge.

Maintain Lakes and Wetlands Water Levels

The Service, Army, and Shell will maintain existing lake and wetland water levels. Maintaining lake levels will help to stabilize contaminant plumes and reduce stream channel/habitat degradation on the Refuge by controlling floods, and benefit Refuge fishery resources.

Reintroduction of Bison

Pending approval within the Service, the Service may introduce a herd of 10 to 100 bison in the northern zone within 5 years after cleanup completion. At one time bison were present in the ecosystem, and this species provides a necessary grazing/trampling component in sustaining a short-grass prairie. Additionally, bison would be a major attraction in the urban setting of Denver and would facilitate educating visitors/students in plains ecology and ecosystem management.

Reintroduction of Pronghorn Antelope

The Service may reintroduce a herd of 15 to 30 pronghorn antelope which would roam Refuge-wide, within 5 years after cleanup completion. Pronghorn antelope were also an historic component of the grassland ecosystem. Reintroduction of this species would increase wildlife diversity, facilitate educating visitors/students in plains ecology/ecosystem management and provide a major attraction in this urban setting.

Reintroduction of Greater Prairie Chickens

The Service may reintroduce a self-sustaining population of prairie chickens within 5 years after cleanup completion. Leks (grounds for breeding courtship) would be artificially developed and enhanced where necessary. The prairie chickens would increase wildlife diversity on the Refuge and would facilitate educating visitors in plains ecology/ecosystem management.

Reintroduction of Plains Sharp-tailed Grouse

The Service may reintroduce a self-sustaining population of sharp-tailed grouse within 5 years after cleanup completion. Leks would be artificially developed and enhanced where necessary. The sharp-tailed grouse would increase wildlife diversity and would facilitate educating people in plains ecology/ecosystem management.

GOAL 2

Interact with communities and organizations through outreach and cooperative agreements to create mutually beneficial partnerships.

Principles for Goal 2

- Communicate with and engage communities, neighborhoods, and constituencies in the development and implementation of the

Refuge Comprehensive Management Plan.

- Explore and develop creative partnership opportunities to fund joint facilities and programs and diversify funding sources.
- As part of an ecosystem management approach, develop cooperative agreements with adjacent property owners to manage landscape connections.
- Maintain the boundary fence, but soften its visual impact on adjacent neighborhoods and communities and provide public visual access from overlooks and the perimeter trail.
- Target adjacent communities to participate in Refuge activities and programs so that they develop a sense of ownership, stewardship, and volunteerism which ultimately will help support the Refuge.
- Work with federal, state, and local governments and private interests to protect and enhance the Refuge watershed.
- Inform the public that proposed public uses and activities will occur in areas which pose no human health risks.

Objectives for Goal 2

Cooperative Agreements and Joint Ventures

The Service will develop cooperative agreements/joint ventures with federal, state, and local officials (particularly Commerce City and the City and County of Denver), educational institutions, and civic and business leaders to develop the western zone and perimeter trail and to build constituencies to help raise funds for Refuge support. This effort will begin now and extend beyond cleanup.

Volunteerism and the Rocky Mountain Arsenal Wildlife Society

The Service will increase levels of volunteerism proportionate to increased levels of public attendance and will work to support the Rocky Mountain Arsenal National Wildlife Society, which is charged with building constituencies for the Refuge and to communicate the benefits of an urban refuge to the community. These efforts will support the Refuge's public use staff and help engender a sense of ownership of the Refuge.

Buffer Zone and Landscape Connections

The Service will coordinate planning efforts with Commerce City, Stapleton Redevelopment, Denver International Airport, State Trails Program, Colorado Division of Wildlife, Colorado Department of Natural Resources, Urban Drainage and Flood Control District, Barr Lake State Park, Denver Regional Council of Governments (DRCOG),City and County of Denver, Adams County, and adjacent landowners to manage and promote landscape connections, stormwater management, transportation connections and adjacent development during and beyond cleanup. These actions will help to create a buffer zone between the Refuge boundary and surrounding development, and create connections between the Refuge and other wildlife habitats.

These are in recognition that the Refuge needs to be managed as part of a larger ecosystem that extends beyond its boundaries and to minimize negative impacts of adjacent development on the Refuge. The creation of such synergistic partnerships will be essential in achieving the Refuge goals.

Perimeter Trail

The Service, in cooperation with other jurisdictions and partners, will develop portions of a perimeter trail and water quality detention area along 56th Avenue by the year 2000, the remainder of which will be completed within 5 years after cleanup. The Service will work with other jurisdictions to raise funds and submit for grant money from the Great Outdoors Colorado Fund, ISTEA (Intermodal Surface Transportation Efficiency Act); and private interests.

The perimeter trail and the strip of land it sits within will aid in buffering the impacts between the Refuge boundary and surrounding development, thus minimizing the negative impacts of adjacent land uses on the Refuge, while promoting wildlife oriented recreation activities through connections with regional greenways.

Public Safety

The Service will continue to demonstrate the safety of public activities through exhibits, fact sheets, outreach, and educational activities. It will develop a Station Health and Safety plan which specifically addresses the needs of visitors.

GOAL 3

Develop environmental education and outreach programs for urban communities to nurture an appreciation of nature which ultimately results in fostering an environmental consciousness which promotes conservation of our natural resources.

MATHEW EVANS/DESIGN WORKSHOP

Principles for Goal 3

Environmental education and interpretation principles

- Create on- and off-site programs and facilities that:
  - build new constituencies for wildlife and habitat conservation,
  - foster an informed citizenry,
  - communicate urban wildlife and habitat issues, and
  - explain the evolution of the Refuge's landscape and its cultural and natural history.
- Target urban dwellers as participants and visitors, especially those who might not otherwise visit a refuge.
- Provide visitors with ideas that they can apply to their own lives which result in environmen-

tally responsible behavior.
- Identify audiences and establish programs specific to the needs of these audiences.
- Use the Arsenal's history, site cleanup, and habitat restoration of the Refuge for environmental education and interpretation opportunities.
- Ensure the compatibility of educational/interpretive activities with the Refuge's purposes, funding, and other legal mandates.

Environmental Education Principles:
- Communicate with other regional and state environmental educators and combine resources where possible.
- Use the Refuge to demonstrate how human influences have resulted in a diversity of habitats, which in turn resulted in a diversity of wildlife.
- Promote instructor-led field trips and provide related instructor training.
- Develop partnerships with local school and youth groups.

Interpretation principles:
- Develop and promote self-guided interpretive activities.
- Interpretive programs and displays should convey the story of natural and managed ecosystems and the cultural and historical evolution of the Refuge and its surroundings.

Objectives for Goal 3

Community Relations Plan

The Service will develop a community relations plan, updated every 5 years, outlining how the Service can best use its current financial resources and staff to improve communications with neighboring communities, identify potential partnerships, and build a framework for future community activities at the Refuge. These efforts are needed for the Service to build a strong image within the community as a leader in environmental stewardship.

Business Outreach Plan

The Service will develop a business outreach plan within 5 years to position the Refuge as an asset to Denver's cultural and economic climate. The business community is viewed as an influential audience and can play a key role in making the Refuge successful.

Public Needs Assessment

The Service will conduct a public needs assessment annually to determine the types of activities and programs current and future visitors would be interested in, and assess the quality of existing programs. This assessment will ensure that programs and their messages are modified to meet public needs.

Special Events

The Service will develop partnerships with other institutions and organizations to provide a minimum of 12 special events per year. These will provide opportunities for public participation in Refuge activities.

Public Outreach

The Service will develop a full range of professional quality but cost effective publications/collateral materials, and a variety of outreach tools in order to generate interest in the Refuge, interpret various aspects of the Refuge and provide an

events calendar. The success of these efforts will be reviewed annually.

Public Use Programs

The Service will develop public use programs which enable people to understand the Refuge's diverse history and the current wildlife and habitat management philosophy. The emphasis of public use will be geared toward environmental education.

The Service will develop formal environmental education programs for schools which will be curriculum-based; organized by appropriate grade level; involve teachers in curriculum development and piloting; relevant to Colorado State Content Standards; coordinated with and designed to complement other State-wide environmental education programs; correlated with Refuge management goals; provide opportunities for hands-on student involvement; result in measurable outcomes; include pre-and post activities, and/or multiple contacts between learner and instructor; designed to be led by teachers, volunteers, youth group leaders, and Refuge staff; enhanced by teacher assistance through training workshops and in-service programs; and accommodate the needs of various school/youth groups and their leaders.

The success of these programs will be reviewed annually with outside educators providing feedback.

GOAL 4

Provide opportunities for wildlife-oriented recreational activities.

Principles for Goal 4

- Ensure the compatibility of all wildlife-oriented recreational activities with the Refuge's purpose, funding, and other legal mandates.
- Provide opportunities for the public to engage in wildlife-oriented activities, such as fishing, photography, and bird watching.
- Enter into partnerships with other institutions to enhance wildlife-oriented recreational opportunities offered to the public, particularly the perimeter trail and the western zone.
- Establish trails and observation points for wildlife watching opportunities.

Objectives for Goal 4

The Service will work with adjacent jurisdictions to develop the perimeter trail as part of a regional trail system within 5 years of completion of cleanup; provide a seasonal-use bike trail along the southern tram route after completion of cleanup; manage the fishing program to maxi-

mize fishing opportunities for not more than 700 people per year; and develop partnerships with other institutions and organizations to provide wildlife-oriented recreation program(s) on an annual basis.

GOAL 5

Utilize the Refuge for research opportunities compatible with Refuge management.

Principles for Goal 5

- Wildlife and habitat research should be focused on species currently or historically found on the Refuge or within proximity to the Refuge.
- Research should contribute to the science of prairie restoration and management.
- Research should examine urban wildlife/human interactions research.
- Biomonitoring of contaminated sites or areas adjacent to contaminated area should continue to be a primary emphasis of research.

Objectives for Goal 5

Wildlife-oriented Research

The Service will continue biomonitoring programs; complete deer population control studies; encourage research with other institutions that is compatible with Refuge goals; use volunteers for data gathering; and maintain relationships with universities, museums, Colorado Division of Wildlife and other state and federal agencies. All research activities will fulfill the requirements of the Refuge Act and provide data necessary for proper management of Refuge habitat and wildlife. The research studies will be reviewed annually with outside representatives to evaluate the effectiveness of Refuge research.

Historical and Archaeological Research

Instigate immediately an artifact protection program in coordination with the National Park Service. Using remaining artifacts and other interpretive media to incorporate history and archeology into the Refuge's interpretive and environmental education programs within the next five years. In cooperation with outside researchers, incorporate archeological digs into environmental education programs.

GOAL 6

Develop a program support system to provide facilities, funding, and resources necessary to accomplish Refuge purposes.

Principles for Goal 6

- Develop diversified funding sources.
- Establish a priority system to implement Refuge objectives.
- Cluster facilities to minimize the overall impact of development, and restrict these to a small portion of the Refuge. Reuse existing facilities where practicable.

Objectives for Goal 6

The Service will raise monies through the formation of partnerships with local governments, corporations, institutions and many other entities; through the formation of a foundation by 2001; and by the establishment of an entry/user fee for the tram route. These efforts will enable the Refuge to become more independent of federal budget constraints; will allow for private funding of off-Refuge facilities' construction and maintenance; and will provide subsidies for environmental education programs.

PUBLIC USE PLAN

The public's future use of the Refuge has been given careful consideration. Public use is mandated by the Act of Congress that created the Refuge, but also mandated is the protection of the Refuge's resources. In order to understand the implications of public use and to plan for it, a separate Public Use Plan (1996) was created. The major points of that plan are presented here.

The following are the general groups of likely Refuge visitors.

- Urban youth: Refuge staff have made a special commitment, because of the urban location of the Refuge, to engage and educate those youth and other urban dwellers who may not otherwise ever visit a Refuge.
- First time/short term (visitor): These visitors have never been to the Refuge before, may stay a short time, and may never return. On average, they are more likely to go to the visitor center and perhaps ride on the tram, but their (one to two hour) visit may be all they are interested in.
- Tourists (visitor): Denver residents welcome entertainment opportunities for their visiting friends and relatives who have to be taken some place. (See Figure 2.2.) Hosts want the visitor to think highly of Denver and enjoy themselves. The host becomes a repeat user by bringing visitors. Some visitors who have lay-overs at Denver International Airport may visit the Refuge, and an exhibit booth at Denver International Airport would encourage these visits. The sign along Peña Boulevard will be an excellent advertisement for the Refuge, for both visitors and residents.
- School programs developed for each environmental education area on-site will target

Figure 2.2 Visitors have an opportunity to observe and photograph wildlife

specific grade levels (i.e., wetlands (grades 3-6), Lakes (K-2), Rattlesnake Hill (7-12). This will provide opportunities for repeat visits.

- School children (may be visitor or user): Individual students may or may not become repeat visitors, but the schools/teachers readily do. Because environmental education objectives will be specific to each grade level, a teacher at that level is likely to bring a class each year. School children in neighboring schools likely have more extensive involvement through partnerships (12 or more visits annually). (See Figure 2.3.)

Figure 2.3 Volunteers and students can help restore the prairie on which wildlife is dependent

- Long term (user): These visitors have returned to the Refuge and, on average, will participate in activities about three to four times a year. Increasing their involvement at the Refuge is easier than other groups because they already relate to the Refuge. These are likely candidates for Wildlife Society membership. Members of environmental/ conservation organizations, like Denver Audubon Society, are likely candidates to become long-term users.
- Perimeter greenbelt users (visitors): These are primarily recreationists along the trails and nature observers at the overlooks and viewing areas. The latter are more likely to become users than the former.

Uses and Visitation

The public use program is designed to accommodate a broad range of compatible uses and is best explained in terms of the zone concept. The zone concept was developed to create management zones for both habitat/wildlife and public use. The zones include a number of common activities, but where certain public uses are considered incompatible with habitat and wildlife requirements, uses will be restricted.

The likely users of the Refuge are shown in Table 2.2.

Based on visitor levels at related facilities, both in Denver and around the country, and based on the perceived demand for the kinds of experiences the Refuge will offer once cleanup is complete, visitation is projected to be 90,000-150,000 visits, including 40,000 environmental education participants. When the site is fully developed, the Refuge programs will be able to handle 350,000 visitors,

Table 2.2 Anticipated users of the Rocky Mountain Arsenal National Wildlife Refuge, by management zone.

NORTHERN ZONE	SOUTHERN ZONE	WESTERN ZONE
EDUCATIONAL USERS		
Elementary school students/groups	*Elementary school students/groups*	*Elementary school students/groups*
Secondary school students/groups	*Secondary school students/groups*	*Secondary school students/groups*
College/graduate students/groups	*College/graduate students/groups*	*College/graduate students/groups*
Adult students/education groups	*Adult students/education groups*	*Adult students/education groups*
Professional educators	*Professional educators*	*Professional educators*
Professional education groups	*Professional education groups*	*Professional education groups*
General public	*General public*	*General public*
ENVIRONMENTAL INTEREST USERS		
Conservation groups	*Conservation groups*	*Conservation groups*
RESEARCHERS (NON-USFWS)		
Wildlife researchers	*Wildlife researchers*	*Wildlife researchers*
Ecologists	*Ecologists*	*Ecologists*
Botanists	*Botanists*	*Botanists*
Agronomists	*Agronomists*	*Agronomists*
Historians	*Historians*	*Historians*
Archaeologists	*Archaeologists*	*Archaeologists*
Reclamation specialists	*Reclamation specialists*	*Reclamation specialists*
	Fishery biologists	
	Limnologists	*Limnologists*
GENERAL INTEREST USERS		
Local individuals	*Local individuals*	*Local individuals*
Local families	*Local families*	*Local families*
Organized groups	*Organized groups/special events*	*Organized groups/special events*
Destination tourists	*Destination tourists*	*Destination tourists*
Drop-in tourists	*Drop-in tourists*	*Drop-in tourists*
Air travel stop-over visitors	*Air travel stop-over visitors*	*Air travel stop-over visitors*
RESOURCE MANAGEMENT STAFF		
Staff	*Staff*	*Staff*
Volunteers	*Volunteers*	*Volunteers*
Partners	*Partners*	*Partners*
Other resource managers	*Other resource managers*	*Other resource managers*
Trainees	*Trainees*	*Trainees*
OTHER RECREATION USERS		
Wildlife watchers	*Wildlife watchers*	*Wildlife watchers*
Bird watchers	*Bird watchers*	*Bird watchers*
Hikers	*Hikers*	*Hikers*
Cyclists — supervised	*Cyclists — supervised*	*Cyclists*
Photographers	*Photographers*	*Photographers*
Non-consumptive hunters	*Non-consumptive hunters*	
	Anglers	*Joggers*

Table 2.3 **The Refuge's public use storyline has five major themes.**

A. History: *The history of the Refuge – the historical interaction between land, people, and technology – offers many lessons for taking responsibility for this and other places.*

B. Wildlife: *Wildlife improves everyone's quality of life*

C. Ecosystem Connections: *Nature consists of dynamic and interrelated systems*

D. Consequences and Responsibilities: *Understanding and working with natural processes is more responsible and efficient in the long run*

E. Stewardship: *The U.S. Fish and Wildlife Service, in serving as the Refuge's stewards must carefully manage the resources of the refuge and its visitors*

including 60,000 environmental education participants.

The actual numbers that are realized depend on a very large, unknown factor: the extent of development in the western zone. If substantial partnerships develop in that zone that result in the creation of "attractions," the upper end of the estimate could easily be reached.

Visitation for the Refuge proper (i.e., the southern and northern zones) should be viewed in a different way. Because the Refuge's resources are here, visitation should be carefully monitored to avoid degrading these resources. It may be possible to attract more visitors to these areas than is desirable for the resources.

In order to meet the demand for environmental education, seven environmental education staff will be needed. This includes an environmental education marketing staff member, three program staff, an environmental education development staff member, a volunteer coordinator, and an environmental education supervisor.

Storyline

As a means of ensuring that the messages imparted to the public (through education and interpretive programs, as well as all other communication) is focused and appropriate for the Refuge, a storyline was developed that identifies the specific themes and messages that will be given at the Refuge. In addition, the kinds of experiences visitors will likely have, the sites where these messages are best given, and the kinds of media to be used are all presented.

There are five overarching themes that comprise the storyline. (See Table 2.3.)

Fundamental to all of these messages and themes is that they are integral to Refuge management. Thus, the story being communicated to the public is firmly grounded in what is being done to restore and care for the Refuge.

This also suggests that the places where stories are told (or educational activities carried out) are resource-oriented and may be permanent or temporary. The emphasis is on the dynamic nature of the Refuge and biological systems in general, and is in sharp contrast to conventional static exhibits. Seasonal changes will influence the relevance of the messages. The necessity and implications of resource management will be taught, whether it be reclamation associated with cleanup

Figure 2.4 Trails will allow visitors to experience the Refuge at their own pace.

operations or plague control in prairie dog communities. Neither public use programs nor resource management activities should operate in isolation since environmental education and interpretation programs must stress the relevance of the Refuge, its wildlife and habitat, to the visitor.

The five storyline messages, related subthemes, visitor experiences, correlated management activities and other information is given in Appendix C.

Visitor Experiences

The following are a series of scenarios developed to describe the full range of visitor experiences which will be available at the Refuge.

First-Time Refuge Visitor

- First-time visitors arrive at the Visitor Learning Center by public or private transportation, enter the building to discover a reception area that orients them both to the Center complex and to the Refuge. They discover they have many choices to consider. They can:
- Spend time reviewing exhibits in the Center or watch a film about the Refuge,
- Buy tickets for an interpretative tram ride through a large part of the Refuge,
- Buy a ticket for the universally accessible, "Express Tram" and get on and off at any of the designated stops,
- Sign up for an interpretive program (that may leave by tram, foot, or bicycle),
- Walk around an interpretive trail just out the door of the Center or hike a longer trail to other locations on the Refuge, (See Figure 2.4.)
- Enroll in a class or lecture series that meets at the Center,
- Use the library at the environmental education Center,
- Visit the Eagle Repository and view its exhibits.

Figure 2.5 Universal access will be available to all Refuge activities.

Fishing

- Visitor Learning Center: Visitors who are enrolled in the catch and release fishing program come to the Visitor Center by public or private transportation and take the tram to and from the fishing lakes. The tram could either be the interpretive, guided tour or the "express" tram which just picks up and drops off people along the tram route. The tram has an outside rack for holding fishing equipment (much as ski trams hold skis).
- Private buses/vans: For a few special programs, such as for disabled adults and children, there may be direct access to the lakes, instead of tram use. (See Figure 2.5.)

Figure 2.6 Along the Refuge trails, visitors can observe and photograph nature.

Nature/History Observation/Photography (self-directed)

- Visitor Learning Center: Visitors come to the Visitor Learning Center by public or private transportation, board the tram and get off at any stop, where they may follow the trails and observe and photograph nature (Figure 2.6).

Eagle Watch (Winter)

- Visitor Learning Center: Visitors arrive at the Visitor Learning Center by either bus or private transportation, and take the tram tour. This could either be the interpretive, guided tour, or the "express" tram which just acts to pick up and drop off people along the tram route. There would be less formal opportunities for interpretation of sights on the express tram. This route remains within the Refuge fence and stops at the Eagle Watch as part of the tour.
- Tram Ride: On the way to the Eagle Watch, the lakes, wetlands, drainage and irrigation ditches, and First Creek are passed. On the guided tour, these habitats would be described as being important roosting sites for bald eagles and nesting sites for other birds. (See Figure 2.7.)
- Arrival by Private Vehicle: When the Eagle Watch viewing area is open, private groups could arrive directly by private vehicles via Buckley Road.
- Current Eagle Watch Programs: On arriving and having been oriented, people would engage in current Eagle Watch interpretive and environmental education programs.
- A loop trail close to the Eagle Watch would interpret the prairie dog ecosystem of which Bald Eagles are a part. (See Figure 2.8.)

Figure 2.7 Some of the best wildlife viewing is available from the tram – a mobile "blind."

Figure 2.8 Spontaneous wildlife viewing will be possible along the trails.

Environmental Education

- Field Programs: Children arrive by bus at the Visitor Learning Center. After receiving an orientation by staff and viewing exhibits, the children are taken by tram to one of the satellite envi-

ronmental education/interpretive areas with an introductory interpretive talk given on the way. Depending on the site, equipment may or may not be located at the environmental education/interpretive area. Several of these areas which are part of the same theme (e.g., water resources – irrigation, wastewater treatment and wetlands) would be interconnected with trails for an integrated environmental education experience. (See Figure 2.9.) A tram ride back to the Visitor Learning Center could culminate in work in the Environmental Education Center for more detailed examination of what was studied at the environmental education/interpretive area(s). Schools can enroll their children in a regularly meeting educational program (including ones that pair them with scientists).

Figure 2.9 Environmental education requires hands-on field work.

- Volunteer Programs: As part of the environmental education program there would be opportunities for environmental education through volunteer activities. Monitoring wildlife, seed collecting, seeding, tree and shrub planting, and trash collecting could all become opportunities for combining field activities with environmental education. These groups would arrive at the Visitor Learning Center, be oriented and then be taken to wherever on the Refuge the activity is to take place. Environmental education lessons are learned as part of the process, and then further developed back at the environmental education center. (See Figure 2.10.)
- Adult environmental education Programs: These could include teacher training and an elder hostel program.
- Indoor Experience: In addition to using the area adjacent to the Visitor Learning Center as an extension of outdoor programs, particularly in inclement weather, indoor exhibits and lab programs could be used for environmental education.
- To reduce the need for Service personnel to be with each school group, training courses for educators (recertification credit) would allow teachers to structure and run their own visits.

Special Events

- At the Eagle Watch: In some instances there would be special eagle watch days. Although it is preferable to have people arrive at the Visitor Learning Center, there may be a need to have people have the option to drive directly out to the Eagle Watch via Buckley Road. Refer to the Eagle Watch scenario for the rest of the visitor's experience.
- At the Visitor Learning Center (See Figure 2.11): People would arrive by private vehicle,

Figure 2.10 Student groups can participate in Refuge management, learning through action.

Figure 2.12 Perimeter overlook and interpretive area

public transport, or in the case of well attended events where the paved parking lot and overflow parking area are inadequate, an off-site parking area, such as Stapleton would be used with shuttle buses taking people to the Visitor Learning Center. People could either pass through the Visitor Learning Center straight to the special event area or choose to look at the exhibits first. The outdoor events area and amphitheater would be within walking distance of the Visitor Learning Center. This would be the main gathering area for special events. In certain circumstances it would be necessary to shuttle people out to an area, such as the lakes or Eagle Watch, if it were to be the focus of the special event. People would also have the opportunity to get involved with other normal Refuge activities – tours, hiking, interpretive trails etc.

Perimeter Recreation

- Overlook Areas: There are anticipated to be two perimeter overlook parking areas accessible from outside the Refuge. One would be along 56th Avenue near Havana Pond, and another one located along 96th Avenue near Henderson Hill. The overlooks would include limited parking areas which would occur on Refuge property, outside the perimeter fence, and would be interpretive in nature, and act as trail heads for the perimeter trail and for regional trails which access the perimeter trail. In addition, there would be one viewing area from the trail along 56th Ave. There would be no parking areas associated with this viewing area, and access would be from the trail. This site would be used to interpret the importance of water quality and the role of wetlands. All the overlooks and viewing areas would be located on the Refuge but outside the perimeter fence.
- The regional trail system would access the perimeter trail at First and Second Creek, the Highline Canal, Stapleton, and at various points from the Montbello and Commerce City neighborhoods. Uses of the perimeter trail would include cycling, jogging, walking, rollerblading, and associated wildlife watching. This would require that the trails be capable of handling both foot traffic and wheeled traffic. Seating areas would occur at interpretive stops and overlook areas. (See Figure 2.12.)

Bicyclists - On Refuge

- Arrival: Bicyclists would arrive, either along regional trails, from the local neighborhoods, or by public or private transport. All access would occur at the Visitor Learning Center.
- Self-Guided Biking: This would be confined to the tram route along a designated lane on the side of the road. Cyclists would only be

allowed on paved roads, and signage at trail heads would emphasize this. This use would likely be seasonal in nature.

- Guided Biking Tours: These would occur at specific times during the day and would be confined to the tram route along a designated lane on the side of the road. (See Figure 2.13.)

Figure 2.13 Bicycling on the Refuge will be possible on the Southern tram route

LANDSCAPE AND BUILDING PHILOSOPHY: SUSTAINABILITY

During public meetings concern was expressed that new development at the Refuge be carried out in a sustainable way. Specifically, it was mentioned that because of the severe chemical contamination at the Arsenal, the Refuge should be managed, to the degree possible, free of chemicals. As the Refuge's storyline evolved, a management approach that emphasizes sustainability became all the more appropriate.

Sustainability is not an easy concept to define, let alone implement. For discussion purposes here, landscape and building sustainability are discussed separately.

Defining landscape sustainability

The characteristics of a sustainable landscape have been defined by Robert Thayer (1994) as:

- Use primarily renewable, horizontal energy at rates which can be regenerated without ecological destabilization.
- Maximize the recycling of resources, nutrients, and by-products and produce minimum "waste," or conversion of materials to non-usable locations or forms.
- Maintain local structure and function, and not reduce the diversity or stability of the surrounding ecosystem.
- Preserve and serve local human (and wildlife) communities rather than change or destroy them.

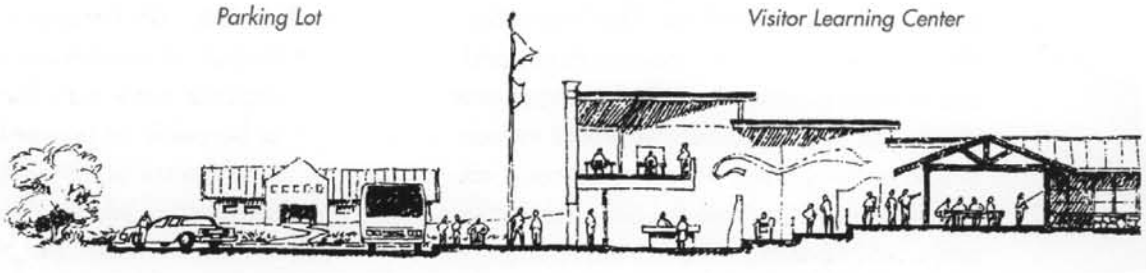


Figure 2.11 The Visitor Learning Center and the Refuge's Gateway will have much to offer visitors.

- Incorporate technologies that support these goals. In the sustainable landscape, technology is secondary and subservient, not primary and dominating.

These characteristics should be evidenced in the ways that the Refuge's landscape is developed and managed.

The regional landscape types should be expressed visually, physically and dynamically. This means, for example, that where shortgrass prairie is the dominant vegetation type, trees should be confined to riparian areas, and an open landscape should predominate. The prairie should be sustained through grazing, and, if possible, fire.

Landscape type is affected by aspect, topography, soils, drainage, climate, habitat management, and human intervention.

- Revegetation planning has identified a number of different plant communities, and combining these community types with soil and drainage characteristics has resulted in identifiable seed and plant mixes for different areas. The Refuge should aim to become self-sufficient in seed and plant materials so that they are of a local provenance and acclimated to local conditions. Aspect, topography and microclimate will, over time, influence the development of the restored landscapes. The aim is to restore the Refuge to as close to a self-sustaining state as possible, with the associated benefits of creating plant and habitat diversity, and visual appropriateness. The following have been identified as distinct native plant communities on the Refuge:
  - Shortgrass prairie
  - Sandhills prairie
  - Riparian vegetation
  - Wetland vegetation
  - Cobble soil vegetation
  - Shrublands and succulents

The revegetation plan, in combination with the zone management plan, will combine natural factors with human historical artifacts and influences to produce a landscape which is diverse, provides rich habitat, recognizes natural systems and yet preserves memories of people's historical affects on the land. Thus, within one area, which overall may be managed as shortgrass prairie may also be overlaid artificial riparian and wetland systems, a capped contamination mound and upland trees associated with old homesteads. The shortgrass prairie should require little human intervention, yet all of the latter features will require management to retain them.

The larger context beyond the Refuge boundary should be recognized. Buffer areas will be increasingly important in order to retain visual and physical continuity with surrounding areas. The prairie relies upon large open vistas as part

Outside Exhibit Area *Tram to Refuge*

of its identity. Habitat should not end at artificial political boundaries.

Vegetation Management

Where native plant communities exist or become established, management should aim to mimic natural systems as closely as possible. In the prairie landscape this means grazing and fire. During establishment of restored areas, mowing and herbicides may need to be employed. However, in keeping with lessons learned from the history of the Arsenal, the use of potentially polluting management strategies should be avoided. (See Figure 2.14.)

Figure 2.14 Restoration of the prairie will be a lengthy, slow process

Where plant communities have developed through human intervention, such as wetland mitigation sites, new communities should be established only where most sustainable. New wetlands should be restricted to re-establishment of historic ones, trees should be planted in riparian areas, and the form that tree and shrub plantings take should be as natural as possible, and sensitive to landform, soil type, moisture, and aspect.

Human Intervention

New construction and disturbance which results in vegetation destruction, soil compaction, erosion and silt laden runoff should be minimized. Some of the techniques employed should include:

- Restrict construction damage to delineated areas;
- Define construction roads, and confine to existing or proposed permanent roadways;
- Windrow stripped soil to preserve its biological health; and
- Implement erosion control plans.

Employ construction and design techniques which result in minimum impact on the land, and maximize benefits:

- Design only surface drainage systems;
- Harvest runoff from impermeable surfaces to avoid erosion and irrigate vegetation, or create special habitats;
- Allow runoff from buildings and parking areas to disperse and infiltrate in accepted ways to deal with non-point source pollution; and
- Design plantings to provide windbreaks, reduce heating and cooling buildings, and to harvest.

The following generalized criteria should be considered for each project at the Refuge. The visual experience of the Refuge landscape and its wildlife and supporting facilities should include components of sufficient interest to invite people to visit and return for further exploration several times. Whenever possible, trails should provide short, long, enclosed, and open views.

Opportunities for viewing wildlife with minimum disturbances should be utilized, taking advantage of topography, vegetation, and other natural features. The emphasis should be on design which reflects stewardship of the land, including project locations, structures, materials use, and respect for historical (natural and artificial) artifacts.

Construction techniques should minimize disturbance of the land, and materials choice combined with maintenance practices should limit post-construction impacts. Both the natural and artificial elements associated with the project can potentially be interpreted.

Cleanup

Environmental cleanup will affect large areas of the Refuge. The result will be a loss of habitat and topsoil in many areas, the creation of capped mounds and landfills with engineered profiles which will limit vegetation establishment, and artificial landforms.

In the long-term the aim should be to minimize loss of habitat, integrate the landfills and capped areas into the landscape, and retain physical aspects of the cleanup areas which will serve as interpretive prompts for visitors in the future. The cleanup areas by their nature will never be able to function as natural systems, and a conscious attempt should be made to balance the need for them to serve the Refuge's wildlife needs with their role as reminder's of the history of the place.

Introduced Materials in the Landscape

Roads, trails, signage, fencing, gates, and other remote structures should be vernacular (i.e., common to this region) in form and use of materials. The vernacular can include any aspects of the historical past including the native Americans, settlers and weapons and chemical production facilities.

Sustainable design concepts as described for new buildings should also be used to guide design of introduced elements in the landscape.

NEW BUILDINGS PHILOSOHY

Defining Factors

Recognize the relationship between the building and its site, including:

- The sun
- Prevailing winds
- Topography
- Contextual features – buildings and infrastructure, if new buildings are located at the Refuge perimeter.

Recognize the history of the Refuge through:

- Building form
- Building materials
- Building layout, and the relationships between groups of buildings

Buildings should not only express a sense of place and its history, but should function well and be environmentally responsible. Buildings also should provide examples of how, through expressing unseen phenomena, visitors can understand human impacts on the landscape and how, through good design, these impacts can be minimized.

Sustainable design elements should be explained to the visitor. Energy use can be interpreted. Habitat damage and creation as a result of development should be defined and interpreted. Artists can be used to reinterpret and present what might otherwise not be interesting so that a fresh understanding of these places can be gained through the combination of the pragmatic with the poetic.

Relationship Between Program Elements and their Enclosure

Determine whether the building should have an inward or an outward focus. Determine whether there should be separation or connection between building elements

Sustainable Design Practices

Many clues can be taken from homestead siting and design. Windbreaks provided shelter from wind, snow and sun. Aspect could take advantage of passive solar gain. Proximity to water provided access for irrigation and domestic water needs. Wastewater can be used, through its treatment, to create wetlands and thus habitat.

New buildings can also take advantage of many of these natural amenities. Building materials should be chosen with these criteria in mind:

- Low embodied energy
- Recycled and recyclable components
- Non-toxic components
- Local origin
- Energy efficient electrical/mechanical systems i.e., heating, lighting, plumbing
- Maintenance considerations

3. DEVELOPMENT PLAN

For most refuges, a development plan is created which indicates where on the Refuge facilities are to be built and then funds—mostly federal—are sought to implement that plan. In this as in so many other ways, the Rocky Mountain Arsenal National Wildlife Refuge will be unique. All of the Refuge's major facilities are proposed for an area off the Refuge—in the western zone. These facilities will be built and run in cooperation with other agencies and companies. The Visitor Learning Center, for example, may have an exhibit hall that is created and operated by an organization other than the U.S. Fish and Wildlife Service, perhaps a museum. Commerce City has taken the lead in planning part of the western zone, with the cooperation and appreciation of the Service. An adjacent section has been planned by the Stapleton Redevelopment Foundation in ways that are compatible with the Refuge.

The kind of cooperation that will make such facilities possible, will also mean that they can be managed creatively and responsively by and for the community. The Refuge will be an integral

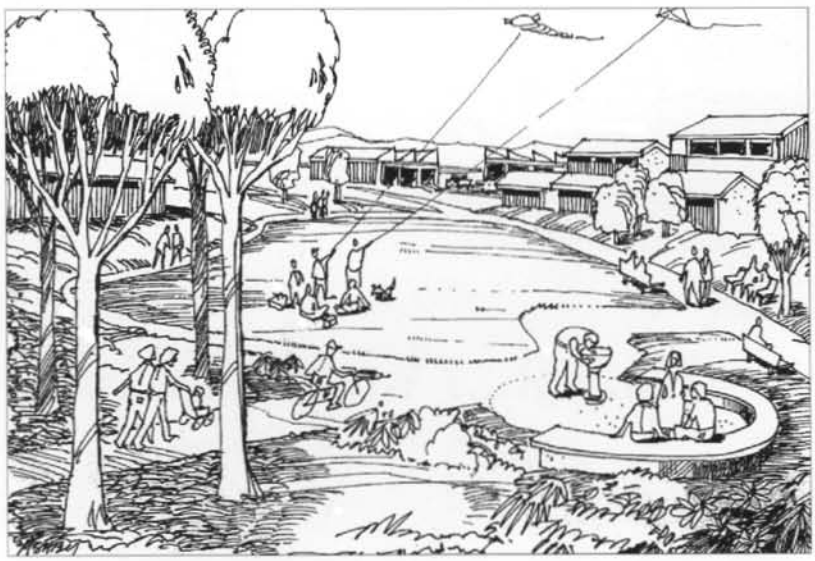
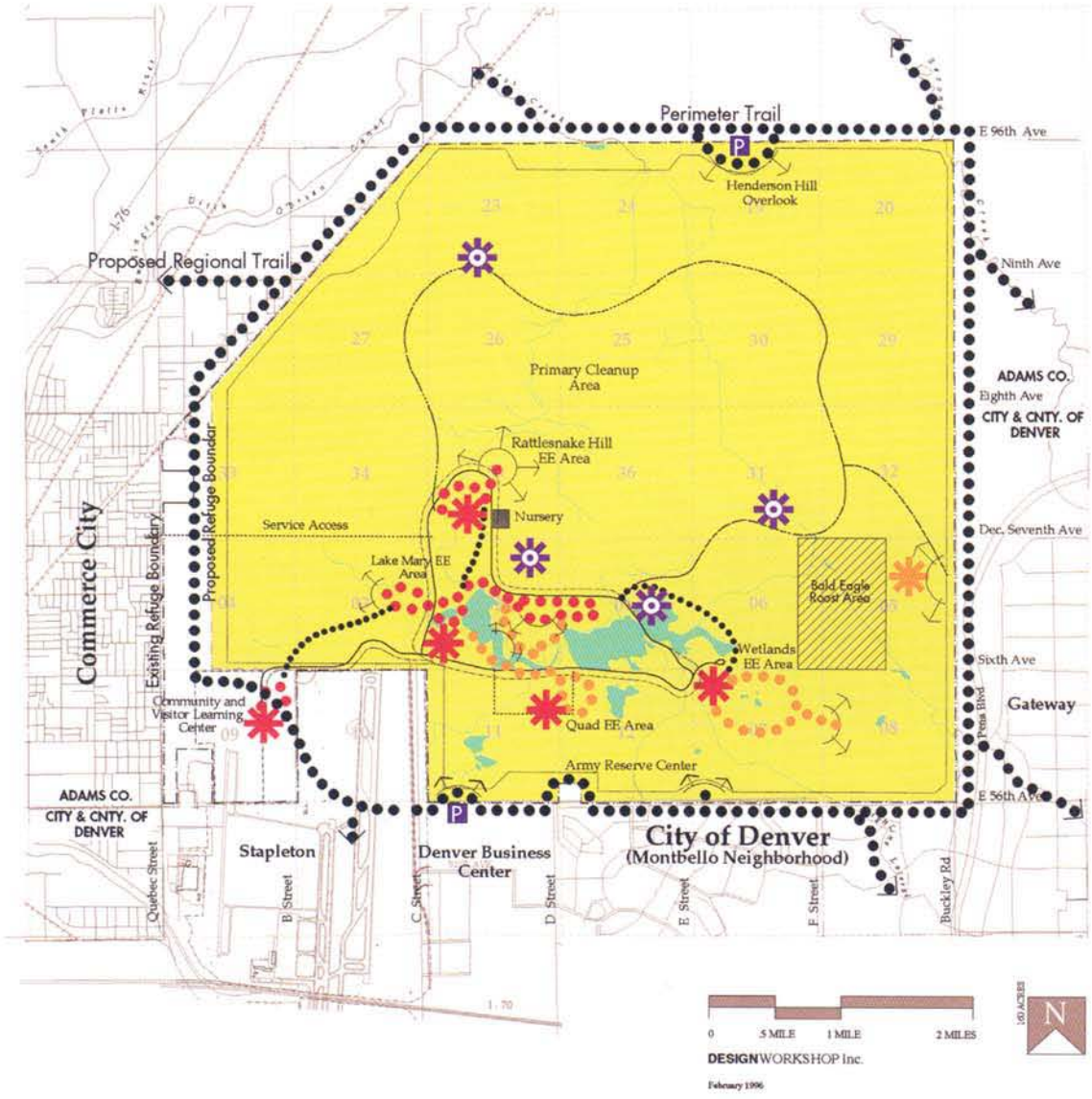


Figure 3.1 The Refuge's western zone will be home to the Visitor Learning Center, and the place where many activities and programs will be concentrated.

DEVELOPMENT PLAN
(Map 3.1)



part of the community, not a separate, visit-it-now-and-then amenity. Not only will the Visitor Center be located in the community, it will function as a community center, rather than an isolated, narrowly focused facility.

It is the fiscal reality of the times that the federal government alone cannot come up with the money to build all of the needed Refuge facilities. If, to some degree, the Refuge is created and sustained by the community it sits within, then there isn't just one agency "owner," but literally thousands of stakeholders.

When fully developed the Refuge will feature a Gateway in its western—off-Refuge—zone that is home to the Visitor Learning Center Complex. This complex includes facilities run cooperatively by the Service and its partners. The campus of buildings here will include orientation and exhibit spaces, the Environmental Education Center, the Environmental Education Research Laboratory, Refuge Administrative offices, restaurants, a bookstore, and other compatible commercial and non-profit businesses.

OVERVIEW

This chapter describes the facilities to be built at the Refuge. (See Map 3.1 Development Plan.)

The Gateway will be the place for the hustle and bustle of large crowds, whose main goals can be achieved here away from the Refuge's resources (Figure 3.1). For some visitors and some visits to the Refuge, visitors may go no farther into the Refuge.

The western zone in which the Gateway sits is a large area that includes much more than just the Visitor Learning Center Complex. It also contains extensive open space, some of which is devoted to types of active recreation that would not be compatible if they occurred on the Refuge itself. Also in the Gateway area, will be a wide range of businesses and other organizations with goals consistent with the Refuge's. The Gateway has been envisioned as a green industry campus where there is extensive public/private interaction and cooperation. Land uses on the part of the Gateway that is or was part of the Arsenal are restricted by federal legislation. For example, no residential or agricultural uses are permitted.

The western zone is envisioned as a cooperative zone where partnerships and collaboration with the Service are encouraged.

Within the Refuge proper, there will be a tram that transports visitors throughout the southern zone and into parts of the northern zone. No private cars will be allowed on the Refuge. The tram route, and other aspects of public use, will be adjusted seasonally in response to the changing habitat needs of sensitive wildlife species.

In the southern zone, there are trails for general public use and environmental education. Also developed in support of education are environmental education and interpretive areas, some of which include outdoor classroom facilities. Bicyclists will be allowed to use the southern tram route at specified times.

The northern zone is intentionally a quieter, less visited place. Except for around Rattlesnake Hill, there are no trails and the only access for the public is on the tram, which runs less frequently here than on the southern route.

On the eastern boundary of the Refuge is the Eagle Watch. While the bald eagles are in residence along First Creek, the public has access to the Eagle Watch along Buckley Road.

Table 3.1 Projected costs of developing the Refuge.

Refuge Restoration	
Prairie	
Prairie Restoration	$23,636,000
Wetlands & Creek	
First Creek Restoration	$1,874,796
Bald Eagle Shallow	$62,700
Demolition	
Bldg. Demolition/Site Clearing	$2,247,300
Demolition Roads & Bridges	$3,150,840
Visitor Learning Center Complex	
Visitor Center	$13,497,536
Environmental Education	
Environmental Education Center	$1,699,954
Environmental Ed. Research Lab	$178,200
Remote Information Station	$86,130
(3) Outdoor Classrooms	$965,259
Temporary Mobile EE Station	$341,550
Administration	
Administrative Offices	$4,484,329
Retrofitted Facilities	
Research Lab	
Research Facilities	$1,035,045
Maintenance	
Maintenance Facility	$1,498,365
Prairie Plant Nursery	$626,340
Site Amenities	
Trails & Environmental Ed/Interpretive Areas	
Visitor Center Trail EE/Interp. Area	$387,689
Visitor Center Connector Trail	$79,284
Officer's Row Trail EE/Interp. Area	$69,628
Lake Mary Trail EE/Interp. Area	$142,127
Lake Overlook Trail	$135,415
Quad Connector Trail	$53,383
Quad Trail EE/Interp. Area	$72,329
Wetlands Trail EE/Interp. Area	$264,627
Wetlands Connector Trail	$89,249
Bldg. 111 Connector Trail	$29,700
Rattlesnake Hill Trail EE/Interp. Area	$741,544
Eagle Watch Trail EE/Interp. Area	$133,912
Roads	
Southern Tram Route	$1,424,308
Northern Tram Route	$2,177,821
Entry Road @ Gateway	$412,251
Quad Loop Road	$103,499
Internal Perimeter Road	$1,607,079
Outdoor Areas	
Visitor Parking at Visitor Center	$1,583,331
Visitor Parking at Eagle Watch	$50,861
Major Events Area	$69,498
Picnic Area	$12,712
Utilities	
Utility Distribution	$217,582
Perimeter Boundary	
Perimeter Trail & Boundary Barrier	$6,019,292
Signage	
Road Signage	$73,524
TOTAL	**$65,242,173**

Restoration of the Refuge's habitats and the demolition of some facilities will be undertaken as part of the U.S. Army's remediation over the next several decades. First Creek (Figure 3.2) will be restored according to an already developed plan (MacLaughlin 1994).

BUDGET

The costs to accomplish Refuge development are summarized in Table 3.1 by major project. Total project cost for all phases of development is estimated at $65,242,173. Some of these projects—such as habitat restoration—will likely be accomplished concurrently with environmental cleanup and their costs borne by those responsible for that cleanup. Another source of funds—specifically for the creation of the Visitor Learning Center—will come from the sale of 815 acres as required by the Refuge Act. Beyond those sources of funding, there may be some modest annual funding from the federal government for capital improvements. To realize the Refuge's development plan, those monies will have to be leveraged. Partnerships will continually be a way of life for the Refuge.

DEVELOPMENT

The previous discussion gives a broad overview of the development plan and funding needs for the Refuge. More detail about the specific projects that make up the development plan is given below. Developing the Refuge will take place in three general phases related to environmental

Figure 3.2 An approved plan already exists for the restoration of First Creek.

cleanup, details of which were still being worked out as the Comprehensive Management Plan was being completed. Projects are presented here by phases.

Phase I Development

The first phase of development, from 1996-2000, will focus on planning, design, and general site preparation. Some of this work, or preparation for it, is already underway. Experiments with prairie restoration techniques, for example, have been under way for several years. Design of the Rattlesnake Hill trail and environmental education area has proceeded concurrently with the completion of the Comprehensive Management Plan. By the end of Phase I, the Service expects to accommodate 60,000 visitors.

Prairie Restoration

In the process of environmental cleanup, the core of the Refuge will be heavily disturbed as contaminated buildings and soils are consolidated into landfills and covered. These areas will be reseeded and planted in order to re-establish native plant cover wherever practicable. However, some areas may be seeded with non-native species to discourage prairie dogs. Additional areas will be disturbed in the process of gathering fill material for use in the landfills. These areas will also be revegetated as part of cleanup. Still other areas not affected by cleanup will be disturbed for habitat improvement as a mitigation for other habitat loss due to cleanup. Revegetation has been divided into priority areas to coincide with phasing of cleanup and availability of funds.

Most likely there will be three types of cleanup areas, each requiring different restoration techniques: Landfill and capped areas with biota barriers and a four-foot soil cover; excavated areas with a one- to three-foot soil cover placed over the excavation; excavated and borrow areas with no replacement soil.

Most habitat restoration related to cleanup will occur in the northern zone where the objective is to recreate a landscape that visually and ecologically similar to presettlement conditions and is largely self-sustaining (Figure 3.3). Special management intervention will be necessary, however,

Figure 3.3 In the northern zone, the plains ecosystem will be restored to the degree possible.

because the herds of bison that played such a vital part of native prairie ecosystems are no longer present. Artificial maintenance using controlled burns and mowing may be necessary to sustain the prairie.

Seed mixes have been developed and tested by the Service for specific conditions on the Refuge. These mixes are based on surveys of the Refuge's soils, soil moisture, and remnant prairie,

As elms and other exotic trees die, replanting should be with native species and should take place in riparian areas and swales. This approach will sustain the structure that is being provided by the exotics for wildlife, but will do it in an area and with species that are more visually and ecologically consistent with a naturally occurring high plains ecosystem.

Where appropriate, native prairie should also be established in the southern zone. Exotic vegetation in the southern zone will be managed differently than in the northern zone. Because most of the trees and shrubs of the southern zone are introduced species and because much of the wildlife habitat value there is due to the zone's culturally manipulated landscape, management will be directed toward sustaining this cultural landscape, including its introduced plant species. Therefore, a more relaxed attitude will prevail toward exotic species. The goal will be to sustain the habitat diversity that exists in the southern zone. As exotic trees and shrubs die, the first replacement to be considered will be native plants that can provide the same type of structure as what has existed. Non-natives species that have already been planted on the Refuge will also be considered in this zone, especially in preserving windbreaks or other cultural plantings. Only native species, however, will be planted along riparian areas of the southern zone.

Figure 3.4 Most existing buildings on the Refuge will be demolished.

Building Demolition

For the most part, buildings with the greatest historical significance are contaminated or sit on contaminated soil and must be demolished. The U.S Army and the Service has identified those buildings that are not contaminated and have potential use or interpretive value. Approximately 75 buildings that are not contaminated or have no future use will be demolished (Figure 3.4). These buildings have little cultural/historic significance. Responsible disposal of material will be in keeping with the land stewardship values promoted by the Refuge.

The buildings currently used by the Service will eventually be demolished when new facilities are built. Many of these buildings are ill suited for the kinds of future uses required at the Refuge and have prohibitive maintenance costs associated with them.

Grading and revegetation will return the building sites to a condition prescribed in the revegetation plan.

Road Demolition

Road closures will result in the demolition of about 30 miles of existing roads, seven bridges, and ten culverts. Regrading and revegetation will return the roadways to their pre-construction profiles. Some existing roads such as the mainte-

nance road off 72nd Avenue will be retained. Road demolition will be phased with cleanup operations and the construction of the tram routes.

Materials taken from closed roads may be used as fill in cleanup operations. As roads are demolished and reclaimed, additional habitat will be created on the Refuge.

In the northern zone, in particular, the goal is to remove evidence of roads and other disturbance to the greatest degree possible so that the view can approximate pre-settlement times.

In some parts of the southern zone, the new tram route will correspond to the alignment of the existing, historic grid road network. This will be done to help emphasize and explain the historical use of the land. This will be particularly true when the existing roads have associated with them significant vegetation, such as windbreaks.

Remote Information Facilities

Informational signage and limited exhibits at locations, including Denver International Airport, will help direct visitors to the Refuge and its facilities. These exhibits will be semi-portable—either in the form of a free-standing kiosk or a wall-mounted display.

Though an "information station" may be accompanied by a Refuge representative, the design should be equally effective without the presence of such staff. To the degree possible, the facility should project an image consistent with the aesthetic of both the Refuge facilities and the specific location of the "information station."

Materials should reflect a sensitivity to conservation of natural resources and environmental air quality.

Figure 3.5 Outdoor classrooms, at locations such as the wetland environmental education area, will accommodate groups of up to sixty students.

Outdoor Classroom

These "living classrooms" will accommodate groups of sixty students at specific Refuge sites (Rattlesnake Hill, Lakes, Wetlands) chosen to best fulfill the goals of the environmental education program (Figure 3.5). These facilities are comprised of 1000-square foot, primitive shelters over a hard surface, with tables and benches to accommodate students. Also included will be 100 square feet of enclosed storage for education materials and moveable furniture. An accessible, porous-surface trail will connect a parking area and restrooms with the shelter.

The outdoor classrooms facilitate education within natural settings. Because the Refuge itself represents the most significant educational resource, the most effective education at the Refuge occurs in the field. Programs will actively engage students in exploring and resolving issues that affect the dynamics of nature.

Classroom structures should project an image and identity of their particular place and purposes. Further, the design and function of the facility

should exemplify conservation and stewardship of natural resources.

Temporary, Mobile Environmental Education Facility

The mobile classroom will be a fully equipped vehicle that can be located temporarily at places on the Refuge where specific management activities provide environmental opportunities. In addition, the vehicle will be able to go off-Refuge to schools. Because restoration and management activities will always be changing over time, the opportunity to have a mobile environmental education and interpretive facility will provide flexibility in responding to these changing situations. Some schools have inadequate facilities for environmental education and the mobile facility will also help with these situations.

When used on the Refuge, the mobile classroom will be accessed by bus or tram. It will include seating for students, storage for educational materials, and a retractable shelter. Both interpretive and environmental education programs will be conducted using the resources of this facility. Students may use the vehicle as a temporary classroom, and will also be supplied from it with equipment necessary to conduct their studies. Examples of when this facility could be useful include areas of habitat restoration that might be particularly interesting to study for a year or two, but not beyond that. Sites of some research projects might similarly be of interest.

Road Signage

Signage is required to direct visitors to the Refuge and to advertise its presence. On-refuge signage is required to control tram, bus, and bicycle traffic. Regulatory signs will be needed to explain the rules and regulations.

Signs will include those at the main entrance, the entrance to the Visitor Learning Center Complex, along the maintenance road, highway signs along Peña Boulevard, I-70, State Highway 2 and 56th Avenue announcing the Refuge to visitors; and roadway traffic control signs and regulatory signs along the tram route and entry road.

Signage on Refuge property will meet the requirements of the Service sign graphics standards. Where permitted, materials will be natural, such as wood and stone, and of a color compatible with the landscape. Highway signs will comply with the Colorado Department of Transportation.

Southern Tram Route

This tram route is a loop through the southern half of the Refuge (Figure 3.6). It starts at the Visitor Learning Center in section 9 and runs by

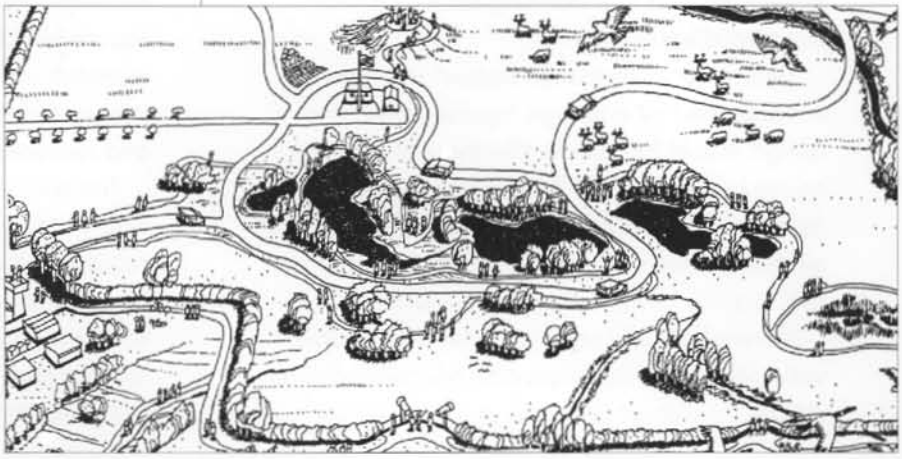


Figure 3.6 The southern tram route provides access from the Visitor Learning Center to lakes and associated trails of the southern half of the Refuge.

Figure 3.7 The tram will be the means by which most visitors reach designations within the Refuge.

all of the main trails and environmental education facilities on the Refuge, encircling the lakes. The tram route is designed to limit vehicular access to the Refuge to trams and buses for public use, and will be the main road for Service vehicles. The tram route will accommodate a bicycle lane, and will allow for spontaneous stops by buses, trams and bicyclists to view wildlife and other things with interpretive potential (Figure 3.7). Tram stops at specific trailheads will allow visitors flexibility in their itineraries.

Regular tram schedules will be combined with special tours and environmental education group visits. Trams will start from the Visitor Learning Center and follow the tram route onto the Refuge to the 5.5 mile-long loop. A gravel loop drive through the Quad area will be used seasonally as part of the tour, and will allow access for students to this environmental education area.

On the Refuge, bicycles will be confined to the wide shoulder along the tram route, and times of access and numbers of cyclists will be controlled. Parking at environmental education trailheads will be for buses with environmental education student groups, and other special groups.

Rattlesnake Hill Environmental Education Area

From Rattlesnake Hill one can get an expansive overview of the whole Refuge and its context, including the plains, downtown Denver, and the mountains beyond. This small hill is located in section 35 to the north of the Army headquarters. It will be served by the southern tram route via a loop which will drop-off visitors to the south of the hill, or by trail. The trail is part of a larger trail system connected to the lakes.

The hill is a significant resource in its own right, being a remnant of a South Platte River terrace, with the cobble soils supporting unique vegetation.

As designed, this site will present an opportunity for visitors to get an overview of the history, cleanup, and natural resources of the Refuge. Visitors will arrive by tram, bus, or by the connector trail which comes from the lakes to the south. There will be restroom facilities and a place to gather close to the drop-off area, an outdoor classroom, and a trailhead for the trail to the top of Rattlesnake Hill.

The plant nursery, greenhouse, and seed cleaning and storage facility will be located adjacent to the parking area and open to the public and environmental education groups. The maintenance and research facility in this same area will provide opportunities for interpretation and an explanation of their role in the management of the Refuge. The trail to the top of the hill will be used to interpret the history and current activities on the Refuge.

Visitors will have the opportunity to see some of the remnant historical artifacts which were interpreted in the Visitor Learning Center. The panorama of the Refuge allows for the interpretation of the zone management plan adopted by the Service.

Prairie Nursery

The nursery will be a 10-acre site adjacent to the existing maintenance facility. It will be used for the propagation of prairie plant material for habitat restoration (Figure 3.8). Accessible by the public from the Rattlesnake Hill Trail, it will also serve as an interpretation and environmental education area, where visitors can learn about prairie restoration and environmental cleanup.

Plant material will be carefully collected from prairie remnants with a genotype indigenous to the Refuge. This will help supply the Refuge with ecologically appropriate seed and plants needed for restoration.

Buildings will include approximately 5000 square feet of seed cleaning and storage area, a lathe- house, a 600-square foot headhouse, and a 1440-square foot greenhouse. The seed cleaning and storage area will also accommodate storage of vehicles and other equipment.

Visiting this facility will help visitors understand the care that is required to restore prairie and help emphasize that the Refuge's management activities demonstrate the land and wildlife stewardship which its public programs talk about.

Figure 3.8 Prairie restoration will be supported by a prairie plant nursery.

Wetlands Trail and Environmental Education Area

This trail and environmental education area is located in section 7, east of the Highline Canal Lateral. Four wetlands are in section 7. They will be served by a tram/bus drop-off loop off the southern tram route. The area can be reached by foot from the lakes overlook trail via the seasonal wetlands connector trail. The wetlands are artificial, having been created to mitigate for wetland loss as a result of cleanup.

The wetlands are a habitat distinct from most of the rest of the prairie grasslands. Only guided public access will be allowed in the winter months. Some of the wetlands hold water only seasonally, and they all are supplied with supplemental water from the Highline Canal Lateral. They provide habitat for waterfowl and serve as a water source for the wildlife on the Refuge. They also provide an opportunity for students to view wildlife and carry out closeup studies of aquatic invertebrates and littoral and aquatic vegetation. Hands-on, interactive experiences will be emphasized. Overlooks will allow visitors to view waterfowl.

The Highline Canal Lateral is an historic part of the Refuge. In the past it supplied water for agriculture and weapons and chemical production. It is currently used to help maintain both the wetlands and the Refuge's lake levels so that wildlife dependent on the lakes can continue to thrive.

The wetlands site will have a series or loop trails of varying lengths. The trails are accessed from a tram turnaround/drop-off and parking area for one bus and five cars. The trailhead will have signage and two handicap-accessible toilets accessed by a hard surface trail. The trails will likely be of crushed stone. The facilities will accommodate groups of up to sixty students,

divided into groups of ten. There will be a permanent outdoor classroom with seating, tables, storage for teaching materials, and shelter sufficient for sixty students (Figure 3.9). There will be a minimum of three interpretive stops for use by up to ten students, including access to one of the wetlands via a dock, a viewing blind at the high point of the trail and access to the Highline Lateral.

A 2.5 mile-long loop trail of crushed stone will go as far east as a high point west of F Street above the easternmost wetland. A spotting scope will provide enhanced wildlife viewing. Because of the seasonal use of this area by sensitive wildlife, visitors will have to be carefully managed. During some times of the year there will be no unescorted public access. Access to the water's edge should be safe and easy for environmental education activities while reducing impacts on the wetland and wildlife (Figure 3.10).

Perimeter Barrier

The existing perimeter fence will be set back along the southern, western, and northern boundary as a result of easements and land sales described in the Refuge Act. This provides the opportunity to mitigate the visual impact of the fence. The fence must be capable of preventing the movement of deer off the Refuge and reducing the trespassing and poaching, but still can be much softer than the current one.

Figure 3.10 Access to the water's edge should be controlled to reduce impacts to wetland wildlife.

During cleanup, sources of borrow material may be needed. By taking soil from along the perimeter area and using it for fill, swales could be created which could help to camouflage the perimeter fence. The boundary will be modified in conjunction with an off-refuge boundary trail system which will provide continuous connections for existing and proposed trails. This will include interpretive stops and two overlooks for off-refuge wildlife viewing.

The modified boundary will be less visually intrusive and a friendlier barrier than that which now exists.

The perimeter trail, just outside the fence, will provide a place for activities such as rollerblading, which are incompatible with Refuge purposes. These trails will also provide continuity for the envisioned regional trail systems.

The overlooks and interpretive stops will provide year-round wildlife viewing and are ways of engaging the interest of members of the surrounding community.

Figure 3.9 An environmental education trail loop includes a permanent outdoor classroom with seating, tables, storage for teaching materials, and shelter sufficient for sixty students.

The interpretive stops and overlooks will maximize viewing wildlife with minimum disturbance by taking advantage of topography, vegetation, and other natural features. The emphasis will be placed on design reflecting stewardship of the land in terms of trail, barrier, and overlook location, materials use, and respect for historical (natural and artificial) artifacts. Construction techniques should minimize disturbance of the land, and materials choice combined with maintenance practices should limit post-construction impacts. Both the natural and artificial elements associated with the barrier and trail have the opportunity to be interpreted.

Phase II Development

The second phase of development, which will run from the year 2000 to the end of environmental cleanup, will include the Refuge's major facilities. By the end of Phase II, the Service expects to accommodate 90,000-150,000 visitors.

Most of the Refuge's major facilities will be contained within a complex of buildings or a single building in the western zone. This Visitor Learning Center Complex will include the Visitor Learning Center, Environmental Education Center, Environmental Education Laboratory, and Refuge Administrative offices.

Visitor Learning Center

The Visitor Learning Center is in the Refuge Gateway, section 9 (Figure 3.11). Visitors will arrive by way of Quebec Street or 56th Avenue by private or public transportation. The center will be adjacent to the perimeter greenbelt trail which will be part of a regional trail system. The center is situated outside the proposed Refuge boundary, and access onto the Refuge from the center will be by tram, bus, bicycle, or pedestrian trail through a single entry point. It will be in close proximity to the Environmental Education Center, the other main component of the Visitor Learning Center.

The Center forms a direct link between the adjacent community and the Refuge. It will serve as a catalyst for compatible development of other institutions and facilities in the Gateway area. By locating what will become the most visited facility off the Refuge, the impacts on the Refuge habitat and wildlife will be reduced. It is primarily a public facility of 25,000 square feet in size, shared with 19,000 square feet of Refuge administrative space, which includes the public use staff. It will serve as a transfer point for visitors entering the Refuge with adjacent parking for private vehicles. It will house exhibit galleries for interpretive exhibits, a 200 seat theater/auditorium, a multipurpose room, a lunch room, an information desk, and a retail bookstore. Additional amenities such as restrooms, telephones, and vending areas will also be provided.

The Center will orient visitors to both the off-Refuge and on-Refuge public use facilities. The

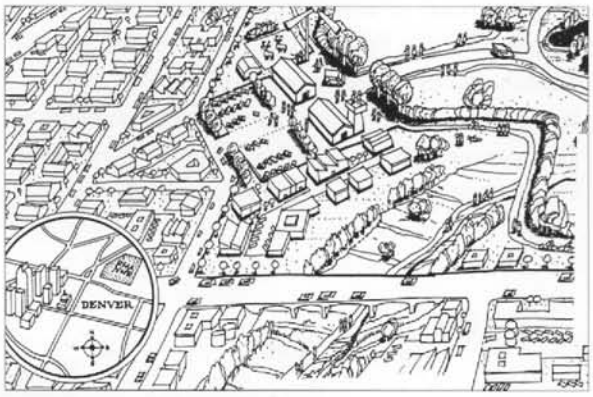


Figure 3.11 The Visitor Learning Center, Environmental Education Center, Environmental Education Laboratory, and Refuge Administrative offices will all be part of a complex in the Refuge Gateway, the western zone.

exhibits and bookstore will provide interpretation of the Refuge's history and natural resources Figure 3.12). In addition, the Center will act as a community resource for meetings and events. It will be the starting point for tram, bicycle, and hiking tours of the Refuge, and as such will act as the gateway into the Refuge. As the entry into the Refuge, user fees will be collected here.

Environmental Education Center

The Environmental Education Center is part of the Visitor Learning Center and will be the main environmental education facility at the Refuge. It will consist of 4,250 square feet of space, including staff offices, a demonstration research laboratory, classrooms, and storage space. For short visits, times when there are unsuitable weather conditions, and when permanent, well-equipped classroom facilities are required, the Environmental Education Center will be used. There will be access from the Environmental Education Center to the Visitor Center to share the multi-purpose room and resource center. The Environmental Education Center also services the outdoor classrooms and the temporary mobile environmental education classroom. Materials and data gathered both at the adjacent Visitor Center environmental education and interpretive area and from the Refuge can be studied here. Students can access the Refuge from the Center by bus or tram.

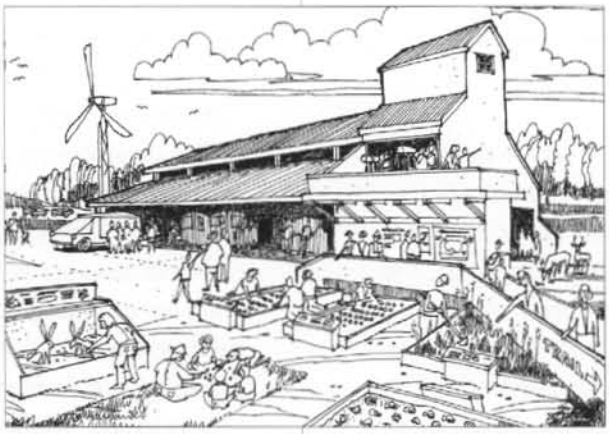


Figure 3.12 The Visitor Learning Center shall provide visitor orientation and visitor interpretation while acting as a community resource for meetings and events.

Environmental Education Laboratory

The Environmental Education Laboratory will be housed within the Environmental Education Center. It will consist of 4,250 square feet of space, including staff spaces, a demonstration research laboratory, classrooms, and storage space. The laboratory is part of the main indoor environmental education facility at the Refuge. It will be used by Service biologists for ongoing research which can be used to demonstrate how wildlife is monitored and studied and thus how the Refuge is managed (Figure 3.13). Students will be able to observe this work without interrupting the biologists.

The Lakes Environmental Education Area

Lake Mary is at the lower end of the lake system. It is currently in use as the main environmental education area on the Refuge, partly because it is adjacent to the current Visitor Center. It will form the hub of future environmental education and interpretive programs, providing access to a number of loop trails and trails to the Quad and Rattlesnake Hill environmental education areas (Figure 3.14). It can be reached either from the Visitor Learning Center by the connector trail via Officers Row, or from stops on the southern tram route. Being the least polluted of the lakes, it can be used for the study of aquatic habitat, wildlife, and fishing. Revegetation plots and a planned introduced prairie dog village will offer examples of components of the prairie ecosystem.

Figure 3.13 The Environmental Education Center will provide facilities for environmental education programs and will complement the remote education areas.

One of the few remaining intact homesteads still stands in the area, which, in combination with the lakes built to store irrigation water, can be used to illustrate the Refuge's agrarian past. The Lakes environmental education area is also a departure point for the catch-and-release fishing program at Lakes Ladora and Lower Derby. The lakes also played an important role in weapons and chemical production, and the subsequent pollution is the consequence of that past. The area is already used for environmental education and has a number of trails which will require some augmentation for long-term use. An amphitheater and boardwalk are recent additions to the area.

There will be an outdoor classroom with a storage area for environmental education materials, seating and shelter. Restrooms will be located close to the tram stop. Programs will include study of aquatic habitat and wildlife, fishing, prairie plant species, prairie dog ecosystem, agricultural and industrial/weapons production history, and water issues on the Refuge.

Administrative Offices

The facilities for the Refuge management staff will be located in close proximity to the Visitor Learning Center. Staff offices, conference rooms, a resource center, a volunteer's center, and reception and lobby areas, including space for traveling exhibits will require about 12,000 feet of space. Support facilities shall include workroom, communications room, locker rooms, restrooms and showers, storage, and access to a shared lunchroom (see Visitor Learning Center). Mechanical, electrical, and telecommunication spaces will be included.

Research Facility

The main Refuge research facility will be located in the existing Army facility in the Building 111 complex in section 35. An on-site research laboratory is required at the Refuge because of the need for on-going bio-monitoring and additional wildlife research. Sharing an existing facility with the Army is a convenient solution to this need.

In addition, it will be possible for environmental education groups to see on-going research on the Refuge. The research laboratory can be used as a demonstration of some of the management activities needed to run the Refuge. This includes demonstrating the need for bio-monitoring associated with Refuge contamination, and wildlife population health and dynamics.

Figure 3.14 The Lakes Area will provide access to a number of loop trails.

Visitor Learning Center Trail and Environmental Education Area

This trail leaves the Visitor Learning and Environmental Education Center and winds through the demonstration and display facilities. The trail is off-Refuge in section 9, part of the Gateway development. This area will be the most heavily used outdoor facility associated with the Refuge. It is appropriate that it will be located outside the new Refuge boundary where potential negative impacts on the Refuge's resources are avoided. Major events will be held here, and activities determined to be incompatible with the Refuge, such as picnicking, can occur in this area.

Figure 3.15 Where possible, topography and vegetation will be used to shield viewers from wildlife. In some cases, structures will be built.

Short-term visitors will be able to gain an insight into the nature of the Refuge in this education area, without having to take a tram or trail onto the Refuge. Students will be able to participate in hands-on environmental educational experiences, using the Environmental Education Center as the base for their activities. The public will be able to observe environmental education in action. The Visitor Learning Center facilities and the infrastructure which supports them will be interpreted. These facilities will illustrate the main tenets of the Refuge messages, demonstrating how careful planning can minimize the impact of development on the land and thus on wildlife (Figure 3.15). These facilities may incorporate alternative energy sources, a wetland wastewater treatment plant, backyard habitat demonstration areas and a recycling center.

Visitor Center Connector Trail

The accessible trail takes visitors by foot from the Visitor Learning Center through the Refuge entrance to the Officers' Row Trail. This provides an alternative to the tram as a means of accessing the Refuge. At the Visitor Learning Center, a trailhead will provide information regarding the Refuge. The trail will offer wildlife viewing opportunities and will include interpretive signs. The length of the trail will be determined by the final location of the Visitor Learning Center in the western Zone, but the trail from the Refuge boundary to Officers' Row will be approximately one mile in length. The trail will be eight feet wide crushed stone. Visitors using the trail can leave the Refuge the same way, or catch a tram.

Some visitors may wish to access the Refuge by foot, and the trail will allow greater freedom than the tram schedule. The visual experience of the Refuge landscape and its wildlife and supporting facilities should have an attraction component that entices people to visit and return several times. The visitor will walk from the artificial landscape in the western zone into the more natural landscape of the Refuge. The trail and associated facilities should be visually compatible with the land-

scape. The trail should provide short, long, enclosed, and open views.

Entry Road

The 1.5 mile-long entry road connects the Visitor Learning Center with the southern tram route. The road is predominantly off-Refuge

Figure 3.16 The entry road will travel through the open landscape of the western zone.

(Figure 3.16) and will be an 18-foot wide asphalt curbless road, with a four-foot wide attached asphalt bike path. The road will predominantly be used by the Refuge tram, school buses, and Service vehicles. The road will be connected to the public road system adjacent to the Visitor Learning Center but will not be accessible by private vehicles. There will be a turnaround with bus parking at the Visitor Learning Center. At the Refuge boundary, there will be a gateway and a cattle-guard which can be locked in the evenings. The nature of the road will be in keeping with the on-Refuge tram route to act as a precursor to the Refuge proper.

With the new Visitor Learning Center planned off-Refuge, there is a need for a connector road to provide access to the internal tram routes, both for visitor access and for the Service personnel.

The visual experience of the Refuge landscape and its wildlife and supporting facilities should have an attraction component that entices people to visit and return several times. The entry road should be visually compatible with the landscape (Figure 3.17) and while off-Refuge create an appropriate experiential introduction to the Refuge. The road should provide short, long, enclosed and open views.

Visitor Learning Center Parking

The parking lots will be adjacent to the environmental education and Visitor Learning Center. The lots will include a drop off area for cars and buses. The main lot will be hard surfaced and will have parking spaces for 125 cars, 10 recreational vehicles, and four buses. When fully developed, the lot will have parking spaces for 550 cars, 20 recreational vehicles and eight buses. Special events overflow parking on a grassy area needs to accommodate additional traffic of between 720 cars for current, and 2,500 cars for fully developed conditions. The lots will conform to Americans with Disabilities Act (ADA) requirements. Paved sidewalks will connect the lot with the arrival plaza at the Visitor Learning Center.

Attendance figures for the Refuge when fully developed anticipate peak weekend visitation of 1,130 vehicles with special events days drawing up to 6,325 vehicles. Current attendance sees 250 and 1,690 vehicles respectively. This requires a range of parking lot size for non-special event traffic of between one for the current usage, and an additional five acres for the fully developed Refuge. Overflow traffic for special events would have to be in the range of six acres for the current usage, an additional 20 acres for the fully developed Refuge.

The visual experience of the Refuge landscape and its wildlife and supporting facilities should have an attraction component that entices people to visit and return several times. The entry road should be visually compatible with the landscape and while off-Refuge create an appropriate experiential introduction to the Refuge. The road should provide short, long, enclosed, and open views.

Events Area

Adjacent to the Visitor Learning Center, the Events area can only be accessed through the Center. The Events Area is designed to accommodate large numbers of people for special events. This concentration of people will not assemble on the Refuge, and will be dispersed by the time they enter the Refuge, thus reducing their impact on the Refuge's habitat and wildlife. Events such as bald eagle and prairie days will see large numbers of people visiting the Refuge. The events area will consist of a partially covered outdoor amphitheater with seating for 50 people and a grass area for an additional 100 people. Large groups participating in environmental education programs will be able to use this as an outdoor classroom, and will have access to the adjacent outdoor environmental education area.

Officers Row Trail

Officers Row Trail loops through what was once U.S. Army officers housing at the Arsenal. Formal rows of trees survive here which were planted by the Army.

The trail will be connected to both to the Visitor Learning Center Connector Trail and the lakes environmental education area. It will be a six-foot wide crushed stone, universally accessible trail.

Existing woody vegetation will provide a shady place for visitors and school groups of up to sixty children. The trail emerges from the vegetation at the west end of the loop and provides views of Denver and the Front Range and across Irondale Gulch. School groups will start at the outdoor classroom at the Lakes Area, which will provide toilet and classroom storage facilities. There will be two interpretive stops along the trail.

Officers Row Trail offers opportunities for teaching why much of the exotic woody vegetation on the Refuge exists today. It helps illustrate aspects of the Refuge's recent history and provides opportunities for teaching about complex water and drainage issues.

The trees provide habitat for a range of wildlife and a nearby prairie dog town is a convenient demonstration of a major part of the Refuge's ecosystem. The trail is part of a complex of trails associated with the Lakes Area and allows for absorption of a large number of visitors and school groups in this area.

Building 111 Connector Trail

This trail already exists as a six-foot wide crushed stone path connecting the existing Visitor Center with Building 111. It includes an internal loop and bridge over the Sand Creek Lateral. A trailhead at both ends and interpretive signs will be added. An existing homestead at the trailhead could be interpreted as part of the Refuge's history.

The existing trail should be augmented with signage for the unfamiliar visitor. The most intact example of a remaining homestead on the Refuge is along the trail and should be interpreted.

Lake Overlook Trail

This trail consists of both a year-round and a seasonal trail. The year-round trail loops to the north of Lakes Ladora and Lower Derby on a bench above the lakes (3.17). The seasonally open loop follows the Sand Creek Lateral below the bench close to the northern edge of Lake Ladora and returns to join the year round trail. To the north of the trails is South Plants, to the south are the lakes and drainageway with their aquatic and littoral environments. A spotting scope pro-

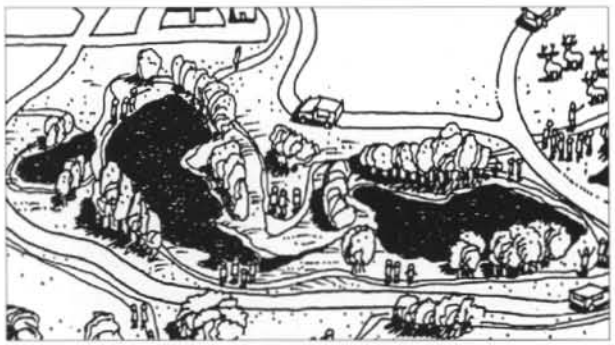


Figure 3.17 The Lake Overlook Trail loops to the north of Lakes Ladora and Lower Derby on a bench above the lakes.

vides enhanced wildlife viewing at a high point on the bench, and seating along the trail provide areas for more prolonged contemplation.

The trail above Lake Ladora will be used to teach visitors about shore birds, water fowl and bald eagles. The history of the Refuge, both agricultural and industrial, can be illustrated in this location.

Quad Connector Trail

The Quad Connector Trail is an extension of the existing trail which connects Lake Mary with the existing anglers' toilets. The trail is currently an accessible six-foot wide crushed stone path, with interpretive signs along its length. It will only be open seasonally and may be gated to control visitors. A new spur out onto the point at Lake Ladora in combination with a blind will provide visitors with the opportunity to watch shore birds and waterfowl (Figure 3.14). It will also be designed as an access point for wading anglers. To the south of the anglers' toilets, the trail will continue to connect with the Quad Trail.

This trail is nearly complete but will be supplemented to enhance current wildlife viewing opportunities, reduce bank erosion by anglers, and connect with a larger trail system and with the anglers' toilets.

The visitor will walk adjacent to a lake dominated landscape. The trail and associated facilities should be visually compatible with the landscape. The trail should provide short, long, enclosed and open views.

Quad Trail and Environmental Education/ Interpretation Area

The Quad is located in section 11, to the south of the lakes. It will be accessed by bus or tram off the southern tram route. A stabilized gravel loop road will provide access along existing track alignments. A turnaround will allow students to disembark. Access by foot can be achieved via the Quad connector trail from the south side of Lake Ladora. Old aerial photographs show this area to have had a particularly high density of homesteads. These have resulted in the remnant tracks, rows of cottonwood and poplar trees and the colonies of New Mexico locust thickets which make this area rich in wildlife - particularly deer who prefer the vegetative cover during over the open grasslands on hot summer days.

The Rod and Gun Club Pond to the east can be overlooked from a loop trail. This pond is only seasonally inundated, but is wet for most of the

year. The combination of fragments of cultural landscape with the rich wildlife make this a valuable educational resource. The area is already used for environmental education and has a number of tracks and trails which will require little augmenting for long-term use. The area will only be available for seasonal use, with access by the public and environmental education groups confined to the spring, summer, and autumn months. The trail system will be able to accommodate up to forty students at one time, broken out into groups of ten or fewer. Studies will include an understanding of settler history, wildlife, and vegetation. There will also be opportunities to better understand the role of the Service in the management of the Refuge habitat and wildlife.

Wetlands Connector Trail

This 1.5-mile long trail is a seasonal connection from the Lake Overlook Trail with the Wetlands Trail following the northern edge of Lower and Upper Derby Lakes. The six-foot wide crushed stone trail crosses two drainage ditches. Because of the vegetative cover, and proximity to wetlands and the lakes, this trail provides high quality wildlife viewing opportunities. Low public use combined with interpretive signs and blinds along the trail offer the greatest opportunity to appreciate wildlife.

This connector trail provides visitors with the opportunity to take extensive hikes through some of the most varied habitat on the Refuge, including historic landscapes, lakelands, and mitigation wetlands.

Eagle Watch Trail

The existing Eagle Watch facility consists of a gravel parking area, a hard surface trail to a large blind with spotting scopes, and remote cameras for eagle viewing (Figure 3.16). The trail should be expanded to include part of the prairie dog community, and will be a hard-surfaced, six-foot wide trail to accommodate heavy visitor use and snow plowing operations. The barn on the east side of Buckley Road has the potential to be an interpretive area.

The bald eagle is at one end of a complex food web with the prairie dog being the highest profile "engine" which drives that ecosystem. As part of the interpretation of the bald eagle, the expansion of the trail system into the prairie dog communities will offer opportunities to interpret prairie dog habitat, communities and management.

Eagle Watch Visitor Parking

The parking lot at the Eagle Watch will be expanded to accommodate fifty cars, three recreational vehicles, and two buses (Figure 3.18). The lot will include a turnaround and drop-off and all vehicular surfaces will be gravel. The lots will conform to ADA requirements. A gate which can be used seasonally will be located at Buckley Road off 56th Avenue.

With the anticipated increase in visitation at the Refuge and the development of a spur off the northern tram loop there will be a need for enlarging the existing parking lot

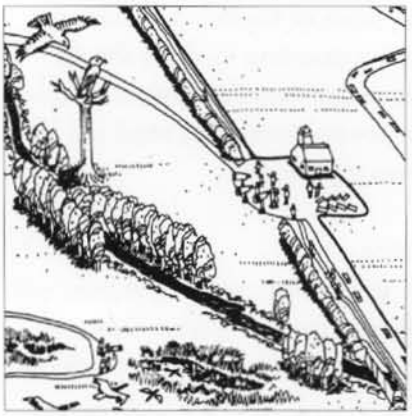


Figure 3.18 The existing Eagle Watch facility consists of a gravel parking area, a hard surface trail to a large blind with spotting scopes, and remote cameras for eagle viewing.

and providing a tram/bus turnaround. The gate at Buckley Road will provide visitors with only seasonal access to the Eagle Watch.

The lot will be oriented to avoid interrupting the visual and physical connection out over the Refuge. The design will minimize the lots' scale and plantings will break up the mass of hard surfaces and vehicles. Stormwater runoff will be handled as surface drainage and allowed to infiltrate into the surrounding landscape. The design will accommodate trams and buses from the tram route and off of Buckley Road and the perimeter trail.

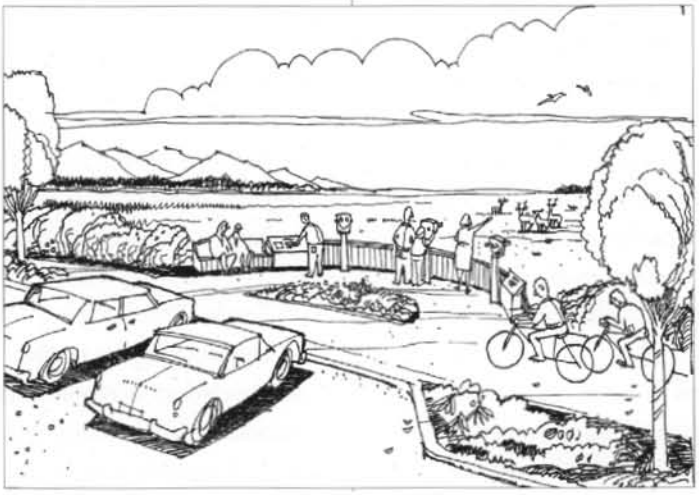


Figure 3.19 Overlooks and interpretive stops provide visual access to the Refuge without diurnal and seasonal restrictions.

Quad Loop Road

An existing two-track road will be upgraded to a stabilized gravel road to accommodate trams and buses for access by tours and school groups.

The Quad is an important seasonal environmental education area, and a special landscape which can be appreciated as part of the tram tour.

The visual experience of the Refuge landscape and its wildlife and supporting facilities should have an attraction component that entices people to visit and return several times. The road will follow the existing two track road.

Utility Distribution

New electrical, gas, sewer, and phone lines will be run underground to the new Visitor Center, administration and environmental education facilities. These utilities will be part of the Commerce City system. With current preliminary location information for these facilities, the lines will need to be approximately 0.5 miles long. All stormwater runoff on-site will be detained to maintain historic flows off-site. No additional stormwater drainage systems will be necessary.

New facilities require new utilities. Existing Refuge utility systems will be maintained by the Army for their own requirements, but are more remote from the proposed new facilities than are city utilities.

Where possible, self-sustaining utility systems will be installed, such as supplementary use of solar power, wind power, and wetland wastewater treatment. Long-term cost benefits will determine appropriateness. Conventional utilities will be buried. Alternative systems will be designed to be interpreted as part of the Refuge. All utility installations will be designed to meet or exceed appropriate engineering standards.

Perimeter Greenbelt Trail

The perimeter trail follows the Refuge boundary with the exception of where it crosses the Stapleton redevelopment and passes by the Visitor Learning Center at the Refuge Gateway. It can be accessed anywhere along its route, particularly at the two overlooks where limited parking is available and from regional trails which connect to it. It can also be accessed by people using the parking lot at the Visitor Learning Center. The perime-

ter trail is an opportunity to allow the public visual access to the Refuge while minimizing disturbance to wildlife and habitat. The trail permits the continuation of regional trails without them crossing the Refuge.

The trail accommodates activities which are not compatible with the Refuge management objectives, such as rollerblading, jogging, and walking with dogs, to occur close to the Refuge. As adjacent activities permit, the perimeter fence can be moved, its visual impact lessened, and interpretive opportunities taken to help to knit the Refuge with its neighbors. The hard surfaced trail will be 25-miles long, and eight-feet wide. It will be multi-purpose for use by human powered wheeled vehicles, joggers, and walkers. The perimeter trail will connect to and act as a continuation of a regional trail system. An overlook and one viewing area are planned along the southern boundary (Figure 3.19). A second overlook is located at Henderson Hill. All of these areas will include interpretive signage, and the overlooks will have some parking. Seasonal access can be gained to the Eagle Watch off the perimeter trail. Visitors can use the trail to reach the Visitor Learning Center.

Bald Eagle Shallows

With the opening of Denver International Airport, there has been increased residential and commercial development adjacent to the Refuge.With the additional impervious surfaces of such development (e.g., streets and parking lots), stormwater runoff will increase the frequency and volume of flows onto the Refuge will rise. (This is particularly important on First Creek because increased flows could contribute to headcutting and further destabilize the cottonwoods that serve as bald eagle roosts.)

In anticipation of these flows, Bald Eagle Shallows along First Creek would be enlarged and a new outlet structure will be installed as part of a basin-wide stormwater detention plan.

Special care will be taken in enlarging the pond to minimize destruction of adjacent sandhills prairie.

Phase III

The final phase of Refuge development will extend from the end of cleanup on. By the end of Phase III, the Refuge could accommodate up to 360,000 visitors with its projected staff and programs.

First Creek Restoration

Restoration will return the creek to its historic channel geometry and length with minimal habitat disturbance (Figures 3.20, 3.21). In the short term, headcutting and channel entrenchment will be curtailed. The eagle roost area will be maintained as it currently exists. Appropriate vegetation communities will be planted to enhance the creek elsewhere. Historic wetlands will be restored along the creek channel. In the northern zone, in particular, the aim will be to create as nearly self-sustaining plant communities as possible.

Channel stabilization is required particularly around eagle roost trees. Returning the channel to its old alignment and reinstating historic wetlands will improve habitat value and reduce downstream flooding risks.

Disturbance of existing habitats and wildlife will be minimized geographically and temporally. Techniques will be employed to ensure that the new stream alignment and wetlands will be self-sustaining and part of a dynamic riparian system

Figure 3.20 First Creek's historic channel geometry and length will be restored.

Northern Tram Route

This tram route loops through the northern half of the Refuge. It forms the upper half of a figure eight above the southern tram route. A spur will serve the Eagle Watch on the eastern boundary of the Refuge. The tram route is designed to limit vehicular access to the Refuge to trams and buses for public use, and will be the main road for service vehicles. The tram route is designed to allow for spontaneous stops to view wildlife and other things of interpretive potential. Regular tram schedules will be combined with special tours and environmental education group visits. Visitors will start from the Visitor Learning Center and reach the northern tram route via the southern loop. The nine-mile long northern route will also provide internal access to the seasonal Eagle Watch. The route passes through the cleanup and prairie restoration zone. The landscape and its history and wildlife will be interpreted by a guide on the tram. The tram route will act as the main access road for Service vehicles.

Maintenance Facility

Most Refuge maintenance activities will be supported by the existing Army maintenance facility,

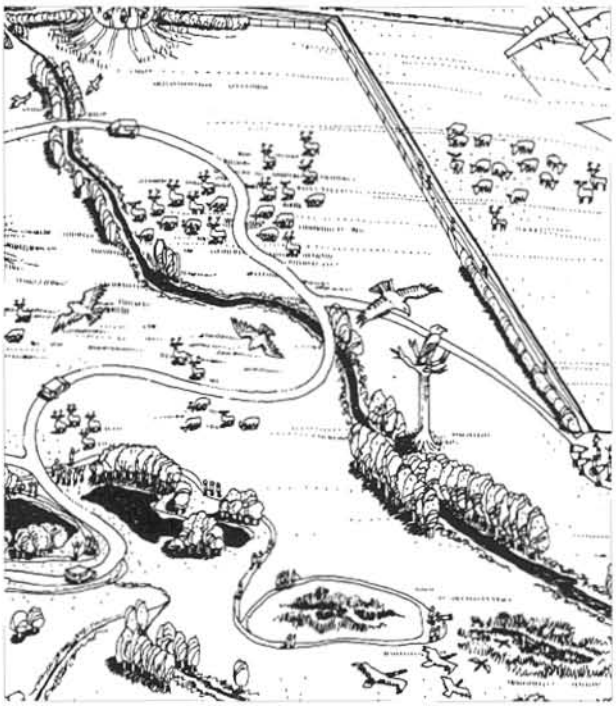


Figure 3.21 The large cottonwood trees growing along First Creek provide winter roost for bald eagles.

where there are offices, lockers, showers, restrooms, vehicle repair equipment, and some storage for parts and vehicles. Additional maintenance facilities will be required to support the Refuge.

Internal Perimeter road

An eight-foot wide, class-five gravel maintenance road will be built along the internal boundary of the Refuge. This road will provide maintenance access for the entire perimeter of the Refuge. The road will be carefully routed to avoid sensitive habitat.

Small bridges will be needed for crossing creeks and canals. The design of culverts, bridges, and "Texas Crossings" will be in keeping with Refuge design guidelines.

Picnic Area

The picnic area is accessible from the Visitor Learning Center. An open area paved with crushed stone will contain twelve picnic tables and benches and three trash receptacles. Here, off-Refuge, both school groups on extended field trips and the general public will have a place to eat snacks and lunches.

The picnic area will be visually compatible with the landscape. It will be oriented to take in views of the contextual landscape of the Refuge and provide shade and shelter from the wind.

Species Reintroduction

In the public meetings interest was expressed in reintroducing wildlife species that historically have been associated with prairie grassland communities but are now missing from the Refuge. A variety of candidate species were identified for reintroduction. The Service will consider four species for reintroduction: bison, pronghorn antelope, prairie chicken, and plains sharp-tailed grouse. These species will contribute to the identity of the Refuge, and assist in maintaining the grassland community structure. Each of these species is discussed briefly here.

Before any reintroductions occur, a reintroduction plan for each species will be developed which includes:

- A feasibility study,
- Translocation procedures, and
- A post-release monitoring program.

The Service has completed preliminary feasibility studies for the bison, plains sharp-tailed grouse and pronghorn antelope (U.S. Fish and Wildlife Service 1995). Studies for the greater prairie chicken have not yet been completed.

Species reintroductions will occur only after cleanup is complete, and probably after portions of the grasslands have been restored. Reintroductions will be based on biological conditions, public interest, available habitat, and funding. Ultimately, reintroduction will be the decision of the Refuge Manager. Necessary environmental analysis will be completed when appropriate.

Bison

A small herd of bison may be reintroduced in the northern zone. Bison would be instrumental in educating Refuge visitors about the relationships within prairie grassland communities (Figure 3.22). The Refuge could sustain a herd of 50 to 100 animals. Bison would not be introduced until sufficient acreage of suitable grassland habitat is established. The herd would be managed in a shifting grazing pattern over about 14 square miles of the northern zone. Periodic removal of older males would be necessary to control herd size. A primary management consideration would be maintaining the adequacy of the exterior fence to contain the bison. Additional exterior and interior fencing may be necessary to control bison

Figure 3.22 Bison may be reintroduced to the Refuge in small numbers once environmental cleanup is complete.

Figure 3.23 Also being considered for reintroduction are Plains Sharp-tailed grouse (shown here) and greater prairie chicken.

movement. Permanent watering facilities will be established.

Pronghorn Antelope

Pronghorn antelope could be reintroduced throughout the Refuge. The Refuge could support a herd of 15 to 30 animals. Management concerns include population control and biological diversity. Fencing and cattle guards may be necessary to control distribution. Some culling, either through hunting or other means, may be necessary to control the antelope population.

Plains Sharp-tailed Grouse and Greater Prairie Chicken

The other two species under consideration, the plains sharp-tailed grouse and greater prairie chicken, are less familiar to the public (Figure 3.23). The two species are similar. The males of both species have elaborate mating rituals in the spring to attract females and establish dominance.

The plains sharp-tailed grouse's historical habitat was a mixed shrub-grassland along the foothills and riparian areas throughout northeastern Colorado. The conversion of native grassland to cropland, livestock grazing, suburban development, and wildfire suppression have reduced its original range. Historically, the greater prairie chicken was less prevalent in the region. Its habitat consists of sand sage, and sand sage-bluestem grassland. Establishment of the plains sharp-tailed grouse and greater prairie chicken on the Refuge is contingent on restoration of suitable stands of native mixed grass, sand-sage and shortgrass prairies. Both these species will be considered for reintroduction after cleanup is complete and revegetation efforts are underway.

4. ENVIRONMENTAL CONSEQUENCES

Discussed below are some of the potential impacts of implementing the development plan. For a complete presentation of impacts see the Final Environmental Impact Statement for the Rocky Mountain Arsenal National Wildlife Refuge (USFWS 1996).

PHYSICAL ENVIRONMENT

Geology and Soils

Implementation of the Comprehensive Management Plan would result in several actions. Restoration activities on First Creek would result in temporary disturbance to the stream channel and banks. Excavation for channel realignment, bank stabilization and revegetation would result in erosion and soil loss during construction. Improvements to First Creek are expected to provide long-term benefits. Stabilized channels and banks and increased diversity of vegetation would improve the quality of habitat for wildlife, and protect soil and water resources from excessive erosion and sedimentation.

Construction of the visitor center, administrative offices, the education center, parking lots, and other facilities would require soil excavation and grading. It is anticipated that topsoil would be removed and stockpiled before construction for subsequent use in revegetation. Temporary increases in soil erosion from disturbed soils is possible during construction. Stormwater flow from buildings and parking areas might contribute very small amounts of sediment. The use of best management practices to control erosion and runoff would minimize potential impacts.

Construction of support facilities, such as roads, interpretive and environmental education areas, and perimeter development, would result in localized disturbance to soil resources. Revegetation of disturbed sites and implementation of erosion and drainage control measures would minimize soil erosion. Unpaved foot trails are often a source of erosion in heavily used recreation areas. Proper trail construction and maintenance would be necessary to prevent

Figure 4.1 Cleanup is currently underway at the Refuge.

excessive soil loss, particularly on steeper slopes, around lake shores, and other sites susceptible to erosion.

Resource development would occur primarily in the south central portion of the Refuge. Trail construction would occur principally on the Bresser soil series, which is a medium to coarse textured soil with low to moderate erosion hazard. The revegetation potential for this soil is moderate to high and should assist in stabilizing the site following construction. Some trails may cross areas of the Truckton soil series, a sandy soil susceptible to wind erosion. Trail stabilization with aggregates or pavement may be necessary at some locations.

The northern tram route, interpretive and environmental education areas, and perimeter developments occur on several soil types. Most of the planned developments disturb relatively small areas and would not significantly impact soil resources. Periodic monitoring, especially at popular locations or sensitive sites, would minimize visitor-related impacts to soil resources.

Remediation activities to clean up contaminated areas on the Refuge (Figure 4.1) will require disturbance to soils. The excavation, remediation, and capping of contaminated soils is expected to affect sections in the central portion of the Refuge. The location and extent of disturbance has not been finalized. There is potential for wind and water erosion during cleanup and revegetation, although it is likely that extensive erosion control measures would be used to prevent soil losses. The area of disturbance is not known at this time.

Other reasonably foreseeable activities involve off-site developments that would not impact Refuge soil resources directly. Increases in stormwater runoff potentially could cause erosion in First Creek and other drainages.

Climate and Air Quality

Implementing the plan would result in insignificant changes to regional air quality. Ground-disturbing activities associated with facility, trail, or tram construction would have minor potential for generating suspended particulates from soil susceptible to wind erosion. Any effects would be minimal and short-term with revegetation of disturbed areas.

Prescribed burning is a management tool that is being considered for use in maintaining the long-term health of the grassland ecosystem. The periodic use of fire would cause a localized increase in particulates and a reduction in visibility. (See Figure 4.2.) Controlled fires would be conducted

Figure 4.2 The Refuge is in close proximity to a large urban area and controlled fires will have to be carried out with great care.

only under optimum weather conditions to minimize air quality degradation and possible effects at Denver International Airport (DIA). Annual prescribed burning plans would be developed with public involvement and adherence to state air quality regulations and DIA requirements. Impacts to air quality from prairie maintenance would be temporary and unlikely to cause significant air quality impacts.

Soil disturbance from tram road construction, trails, buildings, and other facilities could increase dust due to wind erosion. Best management plans would be used to minimize potential impacts. The increase in vehicles traveling to the Refuge would be relatively small in comparison to current average traffic volumes. Additional traffic would introduce air pollutants from vehicle emissions including carbon monoxide, nitrogen oxide, and sulfur dioxide. During peak weekdays, traffic to the Refuge is estimated at only 150 vehicles per day compared to current traffic volumes on Quebec Street of 35,000 vehicles per day. The small additional increase in vehicle traffic to the Refuge is not anticipated to significantly affect air quality in the area.

Excavation and incineration of contaminated soils during cleanup may introduce contaminates into the air including suspended particulates, metals, organic compounds, and pesticides. Air quality impacts from remediation activities will be temporary.

Off-site development surrounding the Refuge, such as redevelopment of Stapleton Airport, Gateway near Denver International Airport, and growth and development in Commerce City, are likely to influence local air quality. Increasing commercial, industrial, and residential growth is anticipated to increase traffic on the roads surrounding the Refuge. The incremental increase in air pollutants from off-site vehicle emissions would be considerably greater than the amount generated by additional vehicle traffic to the Refuge.

Water Resources

The Service would like to maintain and manage existing Refuge lakes and wetlands, partially fill Upper Derby Lake (after contaminated sediments have been removed), and maintain a small base flow in First Creek. The First Creek channel would be improved by returning it, as much as possible, to its presettlement condition by increasing channel stability and restoring meanders to control erosion (Figure 4.3). In addition, the creek would be designed to handle increased flows associated with upstream development of the First Creek watershed. The restoration of the First Creek channel may increase erosion and sedimentation in the short term, but these would decrease from existing conditions over the long term.

The Refuge may have a surplus of water, at least after storm events, due to development in watersheds upstream. Stormwater detention and conveyance facilities would be constructed or modified to handle the increased runoff onto the

Figure 4.3 First Creek has been channelized and dammed since this area was settled.

Refuge in accordance with an intergovernmental agreement between affected jurisdictions. Trash racks and/or settling ponds could be constructed to remove debris, suspended sediment, and floatables from ditches and streams entering the Refuge. These structures could be located in the perimeter buffer zone for easier access and maintenance. The Refuge might create an interpretive and environmental education area to create public awareness of urban pollution problems.

Impacts to surface and ground water flows and water quality would probably be insignificant for each of the action alternatives. Increases in surface flows, which might also affect ground water flows, would be expected due to off-site development. On-site changes would not result in significant changes in surface flows. Similarly, increased off-site runoff of poor quality water could affect water quality at the Refuge. Refuge development, which might contribute very small amounts of nonpoint source pollution, would not significantly affect surface or ground water quality. The relationship between surface water management and ground water flow would be closely monitored by the U.S. Army to ensure that contaminant plumes continue toward the boundary containment and treatment systems. Restoration of First Creek could affect contaminant control due to changes in surface water flow. Channel improvements in First Creek would reduce flow rates and possible flooding. The creation of new wetlands along First Creek or in other areas could improve water quality.

Water resources would be managed to maintain wildlife habitat and recreational and educational opportunities for the public. Implementing the plan could possibly result in minor impacts to surface and ground water. Construction of new facilities and other ground disturbing activities could increase sedimentation to surface water temporarily. New trail construction and increased trail usage along some of the lakes and in the southeast wetlands area could increase sedimentation to surface water. Implementation of best management practices to control runoff and erosion would minimize these impacts. Most roads within the Refuge would be reclaimed and revegetated; those remaining would be for staff use. This would reduce erosion and sedimentation to surface water. Impacts to water resources would not be significant.

Reasonably foreseeable activities

Reasonably foreseeable activities could have minor to major effects within the Refuge on surface and ground water flows and water quality. These include Stapleton redevelopment, development of the Gateway area southeast of the Refuge, and Commerce City and Adams County developments. Other reasonably foreseeable activities that are not likely to affect surface or ground water at the Refuge are "The Emerald Strands" plan, part of the *Airport Environs Plan* to link the Refuge to Barr Lake State Park, and other area parks and open space. It is likely that all off-site residential, commercial, and industrial development located upstream from the Refuge would increase runoff to the Refuge, which could alter current water management practices, cause local flooding, erosion, and damage infrastructure. The potential impact could be serious, since ground water flow direction could be altered, thus diverting contaminant plumes away from containment and treatment systems, resulting in flows that also could exceed treatment system capacity. The Army and Shell Oil Company would be responsible for managing impacts caused by changes in ground

water flows. Proposed Irondale Gulch stormwater management structures along 56th Avenue could intercept increased urban runoff and improve both quality and quantity aspects of Irondale water entering the Refuge.

Stapleton Redevelopment

The redevelopment of the former Stapleton International Airport (Figure 4.4) south of the Refuge could affect some surface water flows on the Refuge. Flows in the Havana interceptor from Montbello runoff currently discharge to Havana pond on the Refuge. However, much of the flow may be used to supply surface water features on the Stapleton property leaving only a small amount to fill Havana pond.

Figure 4.4 The redevelopment of the former Stapleton International Airport, south of the Refuge could affect some surface water flows on the Refuge.

Gateway Development

The Gateway Development area in the City of Denver would be located largely within the Irondale Gulch, First Creek, and Second Creek drainage basins upstream and southeast of the Refuge. Additional development also would occur along the Highline Canal and elsewhere within the Irondale Gulch basin. Several thousand acres of undeveloped land would become residential, commercial, and industrial areas likely to yield much greater peak flows during precipitation events and base flows from irrigation of lawns and parks.

Full urbanization of the First Creek watershed upstream of the Refuge would increase the annual base flow of the creek by an estimated 261 percent, from 720 acre-feet to 2,600 acre-feet (McLaughlin Water Engineers 1994). The largest flow increases typically would be in the summer months when high intensity storm events occur. Future alterations in the First Creek channel would have to be completed to accommodate increased runoff from off-site. Plans include the possible construction of a detention reservoir upstream from the Bald Eagle Roost Exclusion Area to control peak flows and erosion through the roost area.

Since First Creek loses water due to infiltration, ground water flow would also increase in the First Creek basin within the Refuge. The increased flows of both surface and ground water would likely change water quality constituents and concentrations within the basin. Greater amounts of contaminated runoff from developed areas upstream might be carried onto the Refuge. If the Highline Canal were to capture runoff from newly developed areas adjacent to it, the increased flow in the Highline Canal could benefit the Refuge, which often does not get much of its water supply from this source. However, this is not a primary conduit for storm runoff, and would contain higher levels of contaminants than water diverted from the South Platte. Increased flows in Second Creek would have little or no impact on the Refuge, since less than 1,000 feet of the creek crosses the Refuge at its very northeast corner.

Commerce City Development

The Refuge Act of 1992 mandates that approximately 815 acres on the western boundary of the

Refuge be sold. The most likely effect of development on water resources would be increased runoff and sedimentation. Future development in this area may include the visitor center and primary parking area for the Refuge, and likely would increase runoff to the South Platte. Soil erosion and sedimentation during construction should cause only insignificant, short-term impacts to water quality. Commerce City also has plans to develop lands that are in the Second Creek drainage basin east of the Refuge; this probably would have little effect on the Refuge since only 0.6 square mile (3 percent) of the drainage is within the northeast corner of the Refuge.

Adams County Development

Adams County development plans that could impact the hydrology of the Refuge are the same areas described under the *Commerce City Development* section. Impacts, such as increased runoff, could occur to the Sand Creek and Second Creek drainages.

Noise

Noise levels on the Refuge would vary somewhat from existing conditions with the implementation of the plan. Prairie maintenance activities would require the periodic use of farm equipment. Restoration of First Creek also would require the use of heavy equipment and machinery during construction and revegetation. The reclamation of existing roads on the Refuge also would result in a temporary increase in noise levels. Construction of buildings, the tram road, trails, and other facilities would generate localized short-term noise above background levels. Completion of cleanup activities, closure of most internal roads, and a decrease in vehicle traffic would result in an overall long-term reduction of noise levels.

A variety of features including trails, a tram route, interpretive and environmental education areas and buildings will be constructed. These are temporary increases in noise that would be spread over a period of time, and would be scheduled to minimize the potential impact to wildlife and visitors. Following construction of primary facilities, noise on the Refuge would be generated primarily from the tram and visitors. Noise levels on the Refuge should be low in relation to surrounding urban areas.

Cleanup operations are expected to require the use of heavy machinery for excavation of contaminated areas and demolition of buildings. There would be a temporary increase in noise while these activities are in progress. Increasing development around the Refuge may increase off-site noise contributions from traffic, industrial facilities, and residential and commercial development.

Biological Environment

Refuge management of specific habitats, biological communities, and individual species would not cause significant adverse environmental impacts. The proposed biological components of the Comprehensive Management Plan are designed to produce long-term benefits to the Refuge. Biological components consist of a variety of management activities that address management of habitat, individual species, the reintroduction of native species not presently found at the Refuge, and the management of human activities and biological resources.

These activities would affect and alter the current and post-cleanup landscape of the Refuge. Most actions would have net environmental bene-

fits. When an existing landscape is altered and managed to benefit and perpetuate preferred biological communities, the alteration often comes at the expense of some biological resources. Additionally, some proposed actions could create potential resource conflicts.

The Comprehensive Management Plan has specific biological components:

- Grassland management;
- Tree replacement and relocation;
- Management of Upper Derby Lake;
- Restoration of First Creek;
- Management of special species (deer, prairie dogs, ferruginous hawks, burrowing owls, migratory birds, and bald eagles); and
- Reintroduction of species native to the short-grass prairie, but not currently occurring on the Refuge (pronghorn antelope, bison, plains sharp-tailed grouse, and greater prairie chicken).

Figure 4.5 A deer population that exceeds the Refuge's carrying capacity could degrade the Refuge for other species.

Significant effects to the biological environment include those beneficial or adverse effects anticipated to have regional, statewide, or national significance, substantially affect federally-listed species or management of the Refuge, or both. None of the biological components (listed above) would have significant adverse effects.

The management and reintroduction of certain species would likely have the following significant beneficial effects on the biological environment:

- The bald eagle is a federally-listed species, and the maintenance of a regionally important wintering habitat for the bald eagle could be a significant factor in this species' recovery.
- Prairie dog colonies are declining along the Front Range and over their entire range; this is a keystone species essential to other species such as eagles, burrowing owls, and other raptors, which are also in decline.
- Management of deer populations is significant for the Refuge; a deer population that exceeds the Refuge's carrying capacity could significantly degrade habitat for other species. (See Figure 4.5)
- Introduction of plains sharp-tailed grouse and the establishment of a self-sustaining population is of statewide significance as this species is a Colorado state listed endangered species.

In addition to these significant effects, the biological components of the Comprehensive Management Plan would have the following, less significant adverse and beneficial effects on the biological environment.

Grassland Management

The Army's restoration of degraded and weedy non-native grasslands to native grasslands during cleanup would result in a beneficial increase in native plant communities. Establishment of native prairie may reduce the existing plant and animal species diversity of the Refuge and preferentially provide habitat for species dependent on native grassland habitats. Over the short term, grassland restoration could temporarily increase the weed cover of restored sites until desirable native species eventually dominate. The conversion of existing weedy communities to native grasslands

also would reduce weedy habitats at the Refuge that help to support some species such as gold finches, juncos and many other species.

The restored grassland communities and existing native remnant grasslands would be managed primarily to benefit wildlife use by small mammals, prairie dogs, burrowing owls, raptors, and reintroduced native species. The Service would use grazing by wildlife as an important management tool for native grasslands. Other potential management methods include burning, biological, mechanical, and chemical controls. Burning may affect some biological resources in the short term. However, native wildlife have evolved with fire, and should respond favorably over the long term to burns that increase herbaceous plant production and reduce non-native species. Selective use of herbicides or pesticides could add minor amounts of toxic compound residues to vegetation, soils, and organisms, which could affect non-target species.

Tree Replacement and Relocation

Trees associated with old homesteads on the Refuge provide important wildlife habitat. The Service's goal is to maintain the habitat structure provided by trees. In the northern zone, dead trees would be left in place and new trees established along First Creek as an element of the First Creek restoration plan. In the southern zone, the goal would be to maintain a mix and distribution of vegetation similar to existing vegetation. Tree replacement would focus on the use of native species; however, in some instances, non-native species also may be established.

Tree replacement would result in long-term benefits to wildlife that rely on them for habitat (e.g., raptors, cavity-nesting wildlife and deer). The tree replacement program also would result in an increase in native trees. In the northern zone, the replacement of trees in the First Creek riparian corridor eventually would result in a more natural appearing plains riparian woodland. However, the shift in the distribution from homesteads to First Creek would result in the eventual loss of habitat where the trees now occur except in a few sites where homestead trees would be replaced. In the southern zone, tree replacement would be conducted to maintain the current diverse habitat structure.

Figure 4.6 Geese and other waterfowl use the lakes extensively.

Management of Upper Derby Lake

The Army plans to restore Upper Derby Lake during cleanup as a functioning shallow lake that would provide habitat for shorebirds and waterfowl. (See Figure 4.6.) The restoration of Upper Derby Lake would increase the amount of aquatic and waterfowl habitat at the Refuge about 40 percent. Upper Derby Lake would not be open to public fishing.

Restoration of First Creek

The restoration of First Creek, an intermittent stream and its associated wetlands and riparian areas, is an objective common to all action alternatives. Conceptual restoration plans (McLaughlin Water Engineers 1994) call for the restoration of the historical channel shape and length, while maintaining and enhancing existing habitat. The protection and maintenance of roost trees along

Figure 4.7 First Creek is a sensitive and important wildlife corridor.

First Creek is a critical component of the restoration plan. (See Figure 4.7). Over the long term, the restoration of First Creek and its associated habitats would result in a beneficial increase in habitat diversity, including an increase in wetland and aquatic habitats in the northern zone. There may be adverse impacts associated with restoration activities including temporary increases in cover by weedy species due to disturbance, and an increase in the consumption of water from First Creek due to the establishment of additional wetlands and riparian vegetation (e.g., cottonwoods and willows), which in turn could have minor effects on downstream plant and animal communities.

Management of Special Species

Management of habitat within the Refuge would focus on several species, which due to either their legal status (federal listing under the Endangered Species Act), importance to a multitude of other species (keystone species), or because of their high profile and interest to the public, deserve special management considerations. Management of these species would remain constant for all action alternatives. These special species include white-tailed and mule deer, prairie dogs, and bald eagles. Many other important species, such as burrowing owls, migratory birds, ferruginous hawks, and other threatened, endangered or candidate species, would benefit by managing and improving habitat at the Refuge.

Deer. The Refuge currently supports about 730 deer (530 mule deer and 200 white-tailed deer). Deer populations have increased dramatically over the last eight years due to fencing, minimal predation, good habitat, mild winters, and no hunting. (See Figure 4.8.) The Service would manage the deer population at or below the carrying capacity of the Refuge. This would require a variety of population control measures including female sterilization or contraception, hunting and culling of the herd. Additionally, it may be necessary to periodically introduce deer from outside the Refuge to increase genetic diversity. Over the short term, there likely would be reductions of suitable deer habitat due to cleanup. Long-term deer population goals would range from 325 to 550. Managing the deer population for a suitable carrying capacity would have the following long-term benefits:

- Maintenance of a healthy deer herd,
- Minimization of adverse effects to vegetation and habitat that support other species, and
- Maintenance of viewing opportunities for Refuge visitors.

Figure 4.8 Because of the protection the Refuge offers, there are some magnificant wildlife viewing opportunities.

Certain deer population management techniques may be unpopular with segments of the public. Additionally, in the near term, a reduced deer population may reduce public viewing opportunities. However, over the long term,

a healthy deer population maintained at sustainable levels would offer Refuge visitors good deer viewing opportunities and promote other wildlife viewing.

Prairie Dogs. Prairie dogs are a keystone species and an essential prey base for raptors and coyotes. In addition, their burrows and associated habitat structure provide habitat for a variety of birds, mammals and herptiles. Currently, there are approximately 100 acres of active prairie dog colonies within the Refuge due to a 1995 plague event. The Service has set a target of managing 3,500 to 5,000 acres of prairie dog habitat for the Refuge. Management of prairie dog populations would include:

- Efforts to control sylvatic plague, a leading cause of prairie dog population fluctuations.
- Management of several small (50 acres or less), isolated prairie dog colonies as well as larger colonies. The smaller colonies could be used to repopulate plague-stricken colonies.
- A live trapping and relocation program to control prairie dog distribution and minimize colonization of areas beyond the Refuge, burrowing into capped cleanup areas, and disturbance to recently restored grasslands.

Successful implementation of the Service's prairie dog management plan would result in the following long-term benefits:

- Maintenance of a prairie dog population that would support a variety of other dependent species,
- Reduction in the fluctuations of prairie dog populations and secondary effects of such fluctuations on other species,
- Minimization of the spread of plague, and
- A potential reduction in nuisance prairie dog conflicts with Refuge neighbors.

Sylvatic plague is a disease transmissible to humans by infected fleas or direct contamination from infected animals. Efforts to minimize human contact with the plague would include:

- Public education,
- Use of designated trails,
- Dusting colonies in visitor use areas with an insecticide powder to control fleas, and
- Temporary closure of public access to areas with plague-infected prairie dogs.

The prairie dog population would be somewhat self-regulating due to periodic plague epizootics. Once cleanup has been completed, chemical lethal control of the prairie dog population would occur only as a last resort. Most wildlife and habitat management is adaptive (i.e., revisions are made to habitat and species management considering successes and failures). The following potential adverse effects could occur if components of the prairie dog management plan cannot be successfully implemented or fail to meet desired objectives:

- If plague cannot be controlled, and large fluctuations in prairie dog numbers occur, then the use of the Refuge by migratory raptor species (e.g., hawks and eagles) would likely decline during periods of low prairie dog numbers.
- If prairie dogs cannot be successfully contained within the Refuge, infected prairie dogs may spread the plague beyond the Refuge.
- If prairie dogs cannot be successfully contained within the Refuge, they may be considered a nuisance by neighbors.
- If prairie dogs cannot be controlled or excluded from newly restored grasslands, until such areas are vigorous enough to sustain prairie dog grazing, potential restoration areas could be lost or significantly set back in their succession toward sustainable native grasslands.

Bald Eagles. Bald eagles roost and feed on the Refuge from approximately November through March each year. The number of roosting eagles can vary significantly during the winter and between years. However, the Refuge is considered to consistently have the largest population of roosting bald eagles along the Front Range. It is believed that the eagles are attracted to the large population of prairie dogs for prey, in combination with suitable nearby roost sites with minimal disturbance and development. A 7,000-acre bald eagle management area has been established to protect and buffer important hunting and roosting habitat for the eagles. Bald eagles are known to use habitat throughout the entire Refuge. The First Creek roost observation blind (Eagle Watch Area) has been a popular public education program at the Refuge.

Figure 4.9 Special events provide visitors with unique opportunities to learn more about the Refuge

As desirable winter habitat for the bald eagle continues to decline in the region, management of bald eagle habitat at the Refuge would become increasingly important. The protection and enhancement of winter habitat for the bald eagle at the Refuge could contribute to its recovery. Protection of the bald eagle management area may have minor effects to public uses such as the seasonal exclusion of Refuge visitors from important eagle habitats. However, public use programs are adapted so that people may still visit and view bald eagles and other winter wildlife. Current bald eagle management allows for both protection of eagle habitat, and visitor observation via tour buses and at viewing blinds. (See Figure 4.9)

Reintroduction of Native Species

The comprehensive management plan includes the potential reintroduction of species that do not currently occur on the Refuge but were once components of the plains ecosystem. The four species considered for reintroduction are:

- Bison,
- Pronghorn antelope,
- Greater prairie chicken, and
- Plains sharp-tailed grouse.

The following adverse effects may be associated with the reintroduction of bison and pronghorn antelope:

- Populations may require artificial control.
- There are safety concerns for Refuge visitors and neighbors.

Pronghorn antelope are notorious fence walkers and may escape from the Refuge at gates. Perimeter fencing as well as internal fencing would need to be strong enough to control bison; such fencing may be an aesthetic distraction to Refuge visitors.

- Bison and pronghorn antelope would compete with other wildlife grazers.
- Exclusion fencing of the First Creek riparian and wetland habitats may be required.
- Bison may damage signs, trees and shrubs by their daily activities (e.g., rubbing, horning and wallowing).
- Deer and pronghorn antelope are more susceptible to predation if enclosed within bison fence systems.

Establishment of bison and pronghorn antelope would provide a visual attraction to Refuge visi-

tors. The reintroduction of these native species provides an educational opportunity to demonstrate and explain the prairie ecosystem. Bison and pronghorn would also supply an additional tool for management of restored shortgrass prairie.

The reintroduction and management of greater prairie chicken and plains sharp-tailed grouse is expected to increase wildlife viewing and interpretive opportunities and would increase biological diversity. The plains sharp-tailed grouse is a Colorado state-listed endangered species, with only one known self-sustaining population in Colorado. The establishment of a protected self-sustaining population of plains sharp-tailed grouse at the Refuge would be a beneficial effect of statewide significance.

Figure 4.10 The Eagle Watch allows observation of bald eagles with minimal disturbance.

Increased development of the Refuge to accommodate public access and increases in visitor use could adversely affect portions of the biological environment.

Public education and access to wildlife habitat is a major component of the Refuge's program. Access facilities can be located and constructed and the public managed in ways that minimize adverse impacts to the biological environment. For example, seasonal and temporary interpretive and environmental education sites would restrict visitor access at times and locations that avoid or minimize impacts to wildlife.

Presently, visitation at the Refuge is primarily limited to the lakes area and eagle watch, with about 35,000 to 45,000 visitors annually. (See Figure 4.10.) The Comprehensive Management Plan anticipates an increase in annual visitation to 100,000 to 150,000 visitors, and concentrates public use and access primarily around the lakes area in the southern zone. Most of the southern zone occurs within the bald eagle management area and much of the lakes area occurs within high use principal bald eagle habitat.

All the tram loops occur within or pass through portions of the bald eagle management area and the northern loop would pass through the prairie dog management area in Sections 29, 30 and 32, as well as known burrowing owl locations.

A one- to three-fold increase in visitor use, relative to present conditions, that concentrates visitors in the lakes area may increase eagle use of off-Refuge habitat. Service-controlled use of trails, interpretive and environmental education areas, and tram routes would control visitor access in the Bald Eagle Management Area to minimize potential conflicts. It is not anticipated that there would be a substantial shift in bald eagle use on the Refuge. Eagle use would be monitored closely to minimize any potential impacts.

Portions of some of the proposed trails and overlooks are located near important biological resources (e.g., migratory bird nesting habitat, raptor nest locations, or remnant native vegetation). Direct impacts to important biological resources due to construction of public access facilities would be insignificant because these areas would be avoided.

The disruption and division of once continuous habitat into smaller units is called "habitat fragmentation." The public facilities combined with public use, particularly the proposed trails and

tram in the southern zone and lakes area, would divide habitat into smaller units. Visitor education, trail signage and seasonal closure of trails would help to minimize impacts to wildlife. The closure and reclamation of most of the roads on the Refuge would reduce existing habitat fragmentation.

Visitor activities can adversely disrupt wildlife habits and movements. Some species, such as mule deer, become habituated to the presence of humans, while others avoid or minimize contact. Some displacement of wildlife is likely in areas of greatest visitation, particularly in the southern zone. The plan would maintain extensive habitat in the northern zone, which would have only limited public access and only minimal disturbance to wildlife.

Cumulative effects result from the incremental impact of the Comprehensive Management Plan when added to other past, present and reasonably foreseeable future actions. Management of the Refuge for wildlife would result in significant beneficial effects to the biological environment when considering past, present and reasonably foreseeable future actions. Past actions on the Refuge and surrounding area include use of the Refuge for the manufacture of toxic chemical compounds and the subsequent contamination of portions of the Refuge. In addition, the southern part of the Refuge was influenced by activities at Stapleton Airport.

Implementation of the Comprehensive Management Plan would occur in phases, with the majority of development occurring after Refuge cleanup. Portions of the Refuge, particularly in the northern zone, may be disturbed during cleanup activities. The Service would work cooperatively with the parties responsible for cleanup to revegetate disturbed areas. Revegetation of the sites would benefit the Refuge by providing habitat and minimizing erosion of disturbed areas. Provided that wildlife can be excluded from capped toxic material, the presence of properly contained toxic material would not adversely affect wildlife resources or public use of the Refuge. Cleanup activities may result in short-term habitat losses and changes in the present landscape, but contained contaminants would provide a significant net environmental benefit over the long term.

The Refuge occurs at what has historically been the edge of the urban Denver metro area. Residential and commercial development occurs on the east, west, and southern perimeters of the Refuge, with agricultural lands on the north and east sides. In the future, much of the currently undeveloped lands around the Refuge may be developed, especially due to the proximity to Denver International Airport. Increased development around the Refuge could affect the biological environment of the Refuge in the following ways:

- Increased runoff from surrounding urban lands would carry additional pollutants to the Refuge (e.g., nutrients, pesticides, sediments, and oil).
- Additional urban and industrial development around the Refuge would reduce wildlife habitat available to species that move between the Refuge and nearby habitats.
- Development around the Refuge could isolate the Refuge from nearby important wildlife habitats (e.g., South Platte River and Barr Lake).

Development plans for surrounding areas include potential open space, parks, and corridors, which may lessen the effects of the future development. Many of these developments could link trails and open space with the Refuge.

The future development of lands around the Refuge would increase the value of the Refuge as a regionally important wildlife habitat. The 27-square mile Refuge eventually would be the single largest area of undeveloped land in the Denver metro area.

Threatened and Endangered Species

The significance of an impact to a threatened or endangered (T&E) species depends on several factors: duration of the impact, effect on a species population or food source, modification of habitat, and most importantly, the affects on the continued existence of the species. Impacts to candidate species for federal listing also are addressed. An impact to a candidate species is considered significant if the action might cause the species to move toward federal T&E listing.

The Army will continue to manage the Arsenal until the Environmental Protection Agency certifies that cleanup is complete. The Army then will transfer most of the land area to the Service. In addition, following cleanup, the Army will transfer responsibility for lakes and wetlands to the Service. The timing for the transfer is unknown since the length of time for cleanup is undetermined. Until then, the Army will need water for fire control, irrigation of newly restored grasslands, dust suppression, containment and remediation of contaminants, and maintenance of existing lakes and wetlands.

The Army's contract with Denver Water for water from the Highline Canal extends until 2042 and may be renewed at that time. However, the Army is searching for a more reliable water supply from surface water, ground water, treated wastewater, or a combination of sources. The Army currently is considering various alternatives to supply the water. If the Army's selected alternative requires water derived from the South Platte River, the Army will initiate Section 7 consultation with the U.S. Fish and Wildlife Service concerning threatened or endangered species in the Platte River system.

Bald Eagle

The plan incorporates several development and use features within the Bald Eagle Management Area (BEMA). The tram routes would extend into the BEMA, as would an optional route to the Eagle Watch Area. Several trails and interpretive and environmental education areas in the southern portion of the Refuge occur within the BEMA. The Eagle Watch Area on the east side of the Refuge would also be maintained. Most of the physical structures, improvements, or activities within the BEMA would be designated for seasonal use when eagles are not present. The northern tram route would run periodically and is not expected to affect bald eagles. Currently-operating bus tours at the Refuge and visitor activities near the lakes have not significantly affected bald eagle use in these areas. Additional visitor use, noise and activities on the Refuge may result in a shift in eagle habitat use; however, measurable change in bald eagle habitat use is not expected. Intrusions into bald eagle use areas would be closely monitored to minimize potential impacts. No significant adverse impacts to bald eagles are anticipated with the Comprehensive Management Plan.

The maintenance of the Refuge as a regionally important habitat for the bald eagle could be a

significant factor in this species recovery. Management activities that protect and support prairie dog populations also would have a significant beneficial impact on bald eagles. Restoration activities along First Creek would occur during the summer when eagles are not present, and would protect and enhance roost habitat.

Peregrine Falcon

Peregrine falcons are only occasionally sighted on the Refuge. Restoration and enhancement of First Creek and other areas of wetland habitat would improve the quality of songbird habitat, the primary prey for peregrine falcon. Due to the limited occurrence of peregrines on the Refuge, it is unlikely they would be affected adversely by the Comprehensive Management Plan. Long-term protection of lands at the Refuge constitutes a positive impact for this species.

Ute Ladies'-tresses Orchid

No Ute ladies'-tresses orchids have been found on the Refuge. No adverse impacts to the orchid are expected from activities planned.

Plains Sharp-tailed Grouse

There are currently no plains sharp-tailed grouse on the Refuge, but the Refuge would contain habitat suitable for their reintroduction. Establishment of a population of plains sharp-tailed grouse on the Refuge would be a significant benefit to its recovery.

Greater Prairie Chicken

This species is not presently found on the Refuge, but is being considered for reintroduction. Proposed habitat improvements would be beneficial to the establishment of this species.

Preble's Meadow Jumping Mouse

This species has not been observed on the Refuge. Restoration of First Creek could temporarily disturb potential jumping mouse habitat. Significant adverse impacts could likely be avoided. First Creek restoration could provide improved habitat for establishing a population of Preble's meadow jumping mouse.

Swift Fox

The presence of this species on the Refuge has not been confirmed. The maintenance of native vegetation on the Refuge would be beneficial to the swift fox if it is present or reintroduced.

Figure 4.11
Ferruginous Hawks depend upon prairie dogs as one of their main food sources.

Ferruginous Hawks

Several ferruginous hawk winter roosts are found within the vicinity of the proposed northern tram route. (See Figure 4.11.) Ferruginous hawks also hunt in the prairie dog towns bisected by the tram road. Displacement or shifting of ferruginous hawk use areas may occur from tram operation in this area. Maintenance of the prairie ecosystem and prairie dog towns would be an important beneficial effect. Development of the plan is not expected to impact ferruginous hawks adversely.

Baird's Sparrow

This species, which favors shortgrass prairie, is an occasional migrant to the Refuge. Maintenance of native grasslands should greatly improve the quality of habitat for this species.

Black Tern

Black terns are occasional migrants to Refuge lakes and wetland areas. Habitat improvements along First Creek and management of Upper Derby Lake for shorebirds would increase the available habitat for black terns. The plan would not adversely affect this species.

Mountain Plover

This species has been observed at the Refuge, but no nesting activity has been noted. Maintenance of grasslands and proactive management of prairie dog complexes would be a significant improvement in mountain plover habitat.

White-faced Ibis

The management of Upper Derby Lake for shorebirds and waterfowl would provide a beneficial increase in suitable habitat for this species. Overall, there would be a beneficial impact to this species.

Regal Fritillary Butterfly

This species has not been documented on the Refuge. Maintenance of native vegetation is likely to improve habitat suitability for the species.

Colorado Butterflyweed

No occurrence of this species has been documented on the Refuge. The restoration of First Creek and other wetland enhancement activities could affect potential butterflyweed habitat. Discovered stands likely could be avoided. There would be no adverse impacts to this species.

Developments and activities off the Refuge may potentially affect threatened and endangered wildlife populations on the Refuge. In general, development such as the Gateway area, Commerce City, Adams County and E-470 road construction, would reduce the amount of habitat available for use by threatened and endangered species or their prey. This would likely increase the value of the Refuge to these species.

Regional bald eagle use occurs on approximately 140 square miles surrounding the Refuge (USFWS, et. al. 1992). Bald eagles use the Refuge for winter roosting, and Barr Lake, northeast of the Refuge, for nesting. Winter use of the Refuge by eagles has fluctuated, possibly from loss of prey base in surrounding lands. The management of the bald eagle winter roost and prey population habitat on the Refuge may become more important as surrounding lands are disturbed. Cleanup and remediation activities on the Refuge could potentially disturb bald eagle use. Cooperative agreements between the U.S. Army and the Service have developed long-range management plans for protection of bald eagles and other wildlife (USFWS 1992).

Other candidate species and state threatened species may rely on the Refuge to provide habitat due to potential habitat losses from surrounding developments. Species that are most likely to increase their reliance on the Refuge include ferruginous hawks, Baird's sparrow, mountain plover and, if reintroduced, the greater prairie chicken.

Social and Economic Environment

Visitor Projections

Current annual visitation is 40,000 persons. The Refuge could accommodate 60,000 visitors by the year 2000 (Phase I) as additional environmental and interpretive sites are developed.

By the end of cleanup, with the development associated with Phase II, visitation could grow to 100,000-150,000, of which 40,000-50,000 would be participants in environmental education programs. (See Table 4.1.)

Five to ten years beyond the completion of environmental cleanup (Phase III), the Service could accommodate 360,000 visitors per year on the Refuge itself. Approximately 60,000 of these visitors would be participating in environmental education programs.

Most of the land in the western zone, where the Visitor Learning Center will be located, will not be owned by the Service. Its level and rate of development cannot be determined by the Service. (The Service seeks to work in partnerships with Commerce City, Denver, and businesses in developing the western zone.) Visitation to the Visitor Learning Center could reasonably be 512,000 persons per year. That figure could range widely depending on the scope of development in the western zone.

Table 4.1 Annual and daily visitation forecasts (upper range of visitation, Phase II).

Period	Plan Forecast (Phase II)	Current
Total Annual	150,000	45,000
Average Daily		
Weekday	260	80
Weekend	790	240
Peak Daily		
Weekday	650	200
Weekend†	1,960	590
Special Events		
Daily	9,800	4,000

† Peak months have historically been December through February for bald eagle viewing.

Land Use

Development of the plan will not have an adverse impact on land use surrounding the Refuge.

A higher concentration of commercial land use, especially businesses that provide goods and services, like gasoline and convenience items, may develop near the entrances to the Refuge. Access points to the Refuge would include the visitor center and Eagle Watch. Commercial development probably would occur off Quebec Street or 56th Avenue near the visitor center, and off Peña Boulevard near the Eagle Watch. Land use in the southwest corner of the Refuge would be partially devoted to primary facilities.

About 815 acres would be eliminated from the Refuge as mandated by the Refuge Act. This land in the southwest corner of the Refuge and along the western edge would be auctioned by the General Services Administration to the highest bidder. Future land use on the Refuge currently is not known. However, no residential development will be allowed.

Social and Economic Conditions

Community

The character and population of the community surrounding the Refuge would not change significantly. The proposed management emphasis of the Refuge would be the conservation and enhancement of wildlife and natural resources, and opportunities for compatible public use, research, and education. No residential, commercial, or industrial development would occur on the Refuge. There is potential for a small amount of commercial development as an indirect result of the Refuge. This development would be concentrated in services. Effects to community services and infrastructure would be insignificant.

The Refuge would not have significant effects on the local population. No residential development would occur on the Refuge. Plans for lands around the Refuge, including Gateway, Stapleton, Adams County, and New Lands in Commerce City, have been developed. The Refuge could make these areas more desirable places to live, and indirectly attract additional residential development in combination with other factors. The establishment of the Refuge and cleanup of the Arsenal also may alter the public's perception of the Refuge. The public may associate this area more with natural resources, wildlife, and outdoor recreation, and less with environmental degradation and the associated cleanup.

Employment and Income

Staffing levels at the Refuge would increase to 75. Currently, there are 51 positions allotted for the operation and management of the Refuge. A total of 32 positions are filled and 19 are vacant. Based on current salaries for vacant and filled positions, approximately $2.8 million would be needed for the 75 staff positions.

Average salaries for positions at the Refuge may decrease compared to current levels when the Refuge is fully developed and established. Additional temporary employment would be associated with the construction of Refuge facilities, including the visitor center.

Local employment in Commerce City and Adams County may change as a result of the Refuge. However these changes are not expected to be significant. Employment in the Denver metro area would be affected slightly from employment created at the Refuge. For each job at the Refuge, a maximum of 0.5 indirect jobs would be created in the Denver metro area (Colorado Division of Local Governments 1995).

Employment and income impacts would have very minor effects on employment opportunities and income in the Denver metro area. The effects would be positive.

Increased indirect income also would occur with Refuge development. Indirect income results when dollars from the initial purchase of goods and services are spent again. For example, for every paycheck dollar spent on local gasoline or groceries, a portion is spent again by the receiver for other goods and services. It is unlikely that a significant portion of the income earned by employees at the Refuge would be spent on goods and services in Adams County. While much of it would be spent in the Denver area economy, the net effect would be very small.

Visitors to the Refuge may impact existing retail corridors slightly and increase commercial development near the Refuge. Refuge visitors would travel through existing or future retail corridors and may alter their spending patterns slightly.

With the development of the new Denver International Airport and the closing and proposed redevelopment of Stapleton Airport, several plans for the area surrounding the Refuge have been created. These plans and others include aspects of residential, commercial, and open space development.

Sites of residential communities planned for the area include Gateway, Stapleton, and Commerce City New Lands. Open Space and trails are planned in and around these communities. More opportunities for public use in and around the Refuge would mean an increased quality of life for residents of the surrounding communities, both existing and planned. The Refuge and its facilities could become a center of community recreation, and thus provide an important link for coordinating community programs and recreational opportunities.

The establishment of the Refuge and cleanup of the Arsenal also may alter the public's perception of the northern metro area communities, including Commerce City. The public may come to associate this area with natural resources, wildlife and outdoor recreation.

Once the communities planned for Gateway, Stapleton, and Commerce City New Lands are developed, more of the indirect jobs and income created by the Refuge may remain in these communities rather than being more widely distributed in the entire Denver metro area. Currently, there are few retail corridors near the Refuge. As the planned mixed use and commercial areas develop, visitors to the Refuge may stimulate additional growth in these corridors. Commercial development near the proposed Refuge entrances, especially the proposed entrance off Peña Boulevard, where commercial development already is planned, may increase with development.

The indirect employment that the Refuge would generate would be a portion of an overall increase in employment in the northern metro area. This area may become an employment center with the concentration of the Refuge, DIA, Stapleton, and Gateway.

Environmental Justice

This section provides an analysis of the effects of implementing the plan on minority populations and low-income populations.

The Refuge would be an urban Refuge, with potential users coming primarily from the Denver metro area. Portions of the Denver metro area consist of minority and low-income populations. The public use proposed would have a beneficial effect on minority and low-income populations. The Service would seek partnerships with area schools to provide free environmental education. The Service also proposes periodic "free days" where the admission fee would not be charged. These free days would provide an additional opportunity for low-income populations to visit the Refuge. The perimeter trail would provide increased recreational opportunity to any minority and low-income populations in the area surrounding the Refuge.

The increased traffic would have an adverse effect on any minority and low-income populations in the area surrounding the Refuge. The effects would not be significant, however.

Recreation

Many types of recreational opportunities would exist at the Refuge. Interpretive and environmental education areas, presentations, and special events allow the public to learn more about the Refuge, its wildlife, natural resources, history, and

Figure 4.12 Catch-and-release fishing can be enjoyed by all age groups.

cleanup. Eagle watching, bird watching, and wildlife tours provide the public with a better understanding of wildlife.

Considering current visitation and participation in public programs, many programs seem to be gaining popularity, especially participation in environmental education, interpretive programs, and nature walks. Participation in fishing, presentations, eagle watching, and special events has increased markedly. (See Figure 4.12.) It is expected that the popularity of these programs would continue, and growth in participation would level out as the Refuge is developed and becomes an established outdoor recreation site. Expected visitation levels would be higher than current levels and, therefore, would provide more opportunities for the public to participate in these and other programs.

An environmental education facility would be built near the visitor center or combined with it. Specific interpretive and environmental education areas would be designated at various sites.

Refuge populations of bald eagles, waterfowl, deer, and other wildlife species would enhance public opportunities for wildlife observation, environmental education, and interpretation. The plan will offer the public more opportunities to participate in Refuge programs. More visitors and opportunities for public use would mean an increased quality of life for residents of the surrounding communities (both existing and planned), and for Refuge visitors from the Denver metro area.

The visitor center and other primary structures will benefit the public recreational experience by providing facilities for environmental education and interpretive programs. There would be an increased availability of environmental education programs for local and regional schools and the public. The placement of such facilities in the area would enhance interpretation of other local features and provide an important link for coordinating community programs and recreational opportunities. The recreational and environmental education opportunities of the region would be enhanced by the Refuge. The perimeter regional trail around the Refuge would connect with many of the natural resource amenities of northeast metro Denver.

Other outdoor recreation sites that may offer similar opportunities to the Refuge include Barr Lake State Park and Recreation Area, Cherry Creek and Chatfield Reservoirs, Roxborough Park, and the Boulder Mountain Parks System. These areas may lose some of their total annual visitors to the Refuge. On the other hand, areas located near the Refuge, like Barr Lake, may attract more visitors due to an increased awareness of recreational opportunities in the area.

The Refuge would provide greater access and connection to regional trails, open space, and outdoor recreational opportunities. The development of recreational and educational facilities at the Refuge would enhance interpretation of other local features and provide an important link for coordinating community programs and recreational

opportunities. It also may stimulate greater awareness of recreational opportunities in Adams County and use of open space and outdoor recreation facilities. Populations of wildlife might increase in response to an increase in land area and corridors, and enhance public opportunities for wildlife observation, environmental education, and interpretation. Linking on-site open space to regional, community, and neighborhood open space and parks systems and trails would contribute to the structure and organization of land use and development, provide more pedestrian and bicycle links, and create a greater amenity.

Cultural Resources

Historic properties on the Refuge may be subject to direct and indirect impacts as a result of implementation of the Comprehensive Management Plan. Direct impacts are primarily the effects related to project construction, operation and maintenance. Indirect impacts are usually attributable to factors such as better access, increased traffic and visual intrusions. Better access and increased traffic can lead to increased vandalism, while visual intrusions may impair the ability to see and interpret a historic property in its original setting.

Implementation of the plan is not expected to significantly affect cultural resources. The specific location of facilities and improvements have not been determined and the status and location of historic sites is still under investigation.

No cumulative effects are expected to cultural resources from foreseeable off-Refuge development. Cleanup operations on the Refuge could potentially affect several cultural resource sites.

Table 4.2 Traffic volume forecasts to the Refuge with development (Phase II).

Average Weekday Traffic	
Auto	60
Bus	4
Average Weekend Traffic	
Auto	330
Peak Weekday Traffic	
Auto	140
Bus	10
Peak Weekend Traffic	
Auto	830
Special Event Traffic	
Auto	4,110

Transportation

Estimates of vehicle traffic to the Refuge were based on current visitation patterns as well as several assumptions on future visitor use. (See Table 4.2.) It was assumed that on weekends, essentially all visitors would arrive by automobile, but that during the week, half of the visitors are school children who would arrive by bus. The average occupancy of autos is assumed to be 2.37, the average family size for the Denver area. It is also anticipated that the average visitor stay would be one-half day. Primary access to the Refuge would be through the Visitor Learning Center. Visitors would park their automobiles here and either walk or ride trams into the Refuge.

Based on projected visitation of 150,000 by the end of Phase II, traffic volumes would be projected at 60 cars and four buses on an average weekday. Weekend traffic is estimated at 330 vehicles per day, which is about three times the current weekend traffic. Peak visitor month traffic volumes for the weekend is estimated at 830 vehicles. Special event traffic volume is estimated at 4,110 vehicles.

Future traffic levels (year 2015) were estimated by increasing current (1995) volumes by 2 percent per year, the general rate of growth in the Denver metro area. Current average weekday volumes on Quebec Street, the primary road accessing the Refuge, is approximately 35,000 vehicles per day. The maximum weekday volume forecasted for the Refuge would be 140 vehicles per day. This moderate increase in traffic volume may be difficult to distinguish from background traffic volumes and would not be considered significant.

Winter peak event Saturday volumes including Refuge traffic have been forecasted (year 2015) for nearby roadways. As with weekday volumes, the traffic generated by the Refuge on peak event Saturdays would be relatively small in relation to the normal volumes. The peak season Saturday volumes that include the Refuge are less than the normal weekday volumes. This is because both Saturday and Sunday normally have less traffic than during the week. Traffic safety would not be reduced if adequate turn lanes are provided at the main entrance to the visitor center. Special events may require additional traffic control to facilitate traffic flow.

If the Visitor Learning Center or other features of the western zone become major attractions, this would affect traffic projections significantly.

Development of lands surrounding the Refuge for residential, commercial and industrial activities is expected to increase the amount of traffic on roads adjacent to the Refuge. The closure of Stapleton Airport has reduced traffic on Quebec Street, but redevelopment of these lands may increase future traffic volumes. In addition, development of the 815-acre parcel of land to be sold along the west side of the Refuge would generate traffic along Quebec. Gateway development on lands to the south and east of the Refuge would increase traffic volumes along Buckley Road, Peña Boulevard, and proposed E-470. Cleanup operations would continue to generate traffic from Army personnel, equipment operators, and contractors for the next ten years or more. Traffic from cleanup operations would occur both on and off the Refuge. Following cleanup, on-Refuge traffic would decrease significantly.

Visual Resources

The Visitor Center off the Refuge to the southwest would reduce the visual impact of the new primary facilities. They would be absorbed into the adjacent urban fabric of that area. It is anticipated that the existing on-site maintenance and research facilities would be reused by the Service. Other improvements to the Refuge would result in satellite interpretive and environmental education areas with outdoor classroom structures and associated loop trails, interpretive trails, and a tram route; the trails would consist of crushed stone and the tram route would be paved. It is anticipated that all of the existing roads would eventually be removed, with the exception of the two track perimeter road inside the fence, several internal two-track roads, and a paved service road for management access.

The trails would be designed to avoid sensitive wildlife areas and would be integrated into natur-

al land forms. The satellite interpretive and environmental education areas would be constructed of native materials and designed to blend into the surrounding landscape. Because of the more vegetated nature of the southern portion of the Refuge, and its greater wealth of natural resources, most of the facilities for public use would be located there. Public access to the Refuge would be controlled and confined to the tram route and designated trails. The visual intrusiveness of these facilities would be in direct proportion to their quantity, since their nature would remain unchanged between alternatives.

Resource Commitments

Federal funding for staff and operations would be an irretrievable commitment of resources. These resources would not be available for other federal programs or projects.

The transfer of land from the Department of Defense to the Service (Department of Interior) would be retained as "public lands" and would be unavailable for private use or development, with the exception of about 815 acres of land, which would be sold under all alternatives. These changes would be an irretrievable commitment of resources.

Short-term Uses of the Environment and Maintenance of Long-term Productivity

Historical uses of the Refuge, including early settlement, the manufacture of munitions and toxic chemicals, and cleanup of soil and ground water contamination have affected the long-term productivity of the ecological environment of the Refuge. These activities have altered the natural environment. Short-term uses of the refuge associated with implementing the Comprehensive Management Plan include the construction of facilities and modifications and enhancement of the natural environment. The effects of implementing the Comprehensive Management Plan would contribute to the maintenance and enhancement of long-term productivity of the Refuge environment.

Unavoidable Adverse Environmental Effects

Adverse environmental effects that would be associated with implementation of the Comprehensive Management Plan are short-term and minimal. During construction of additional facilities on the Refuge, wildlife would be disturbed and temporarily displaced. Facilities construction, enhancement of First Creek, and wetlands development would result in minor, short-term disturbance of soils and erosion. The long-term effects of implementing the Comprehensive Management Plan would be beneficial to the biological community and the diversity and productivity of the Refuge ecosystem.

How the Refuge will relate to its surroundings

Stapleton Redevelopment

The former site of Stapleton International Airport adjoins the Refuge on the southwest. Plans for Stapleton redevelopment are described in the *Stapleton Development Plan* (February 1995). Stapleton will be redeveloped during the next 30 to 40 years into a mixed-use community capable of supporting 30,000 jobs and 25,000 residents. The plan focuses on the sustainable integration of employment, housing, and public transportation; ties between Stapleton and the surrounding com-

munity; and opportunities for parks, open space, and recreation.

More than one-third of Stapleton (about 1,600 acres) will be managed for parks, open space, and recreation. The open space system will serve a major role in unifying Stapleton, making effective regional connections, and restoring the ecological health of natural systems on and off the site.

The Refuge borders the Stapleton property and connects through it to the Sand Creek waterway. Regional trails are anticipated along Sand Creek, Westerly Creek, and the open space corridor connecting Sand Creek with the Refuge.

DIA Gateway Development

In 1988, Denver annexed about 2,000 acres of land near Denver International Airport (DIA). A comprehensive plan for this land plus an additional 2,500 acres already in Denver was prepared (City and County of Denver 1991). These 4,500 acres, south and east of the Refuge and between DIA and Interstate-70, are known as Gateway. Most of the land presently is used for dryland farming. Gateway is expected to develop over the next 50 years due to its proximity to DIA. About 65,000 people are expected to reside at Gateway at buildout in 2045.

The eastern Refuge boundary will be separated from Gateway by Peña Boulevard. Residential and mixed uses will adjoin the Refuge south of 56th Avenue. A 90-acre urban park will be located south of the Refuge and east of the Montbello neighborhood, and a 180-acre golf-course will be located along First Creek southeast of the Refuge. Drainage from the golf course will flow towards the northwest into a drainage pond on the Refuge. First Creek is significant wildlife habitat and, therefore, the Gateway Plan proposes this area remain undeveloped. Gateway will be linked to the surrounding areas by the Platte River Greenway and Highline Lateral hike and bike trails.

The Gateway Plan emphasizes economically successful development; distinctive, livable neighborhoods; mass transit, pedestrian and bicycle links; open space; and environmental protection.

The Refuge's perimeter greenbelt trail will feed into the Gateway neighborhoods.

New Lands in Commerce City

A series of intergovernmental agreements among Commerce City, Adams County, Aurora, and Brighton divided the land around Denver International Airport and identified 43 square miles as the Commerce City Annexation Area. This area is located north and east of the Refuge and is referred to as *New Lands*. The plan for this area is detailed in the *New Lands Comprehensive Plan* (City of Commerce City 1992).

Existing land use in this area is mostly agricultural with scattered residential properties. Small parcels of commercial and industrial uses are located less than a mile north, northeast, and east of the Refuge. The Burlington Northern Railroad, which runs along the northwest corner of the Refuge, is expected to draw additional industrial development. A storage facility and the Rocky Mountain Speedway adjoin the Refuge on the northeast. Tower Landfill, located about 1 mile east of the Refuge, is within the planning area.

Most of the New Lands in Commerce City are zoned by Adams County. Non-contiguous areas north and east of the Refuge are zoned by Commerce City. Most of the area surrounding the Refuge is zoned agricultural or planned unit development.

The plan proposes various land uses. The area north and east of the Refuge, between Tower Road and State Highway 2, is proposed for residential use. A small parcel adjoining the south half of Section 29 is proposed for office and distribution development. Proposed open space will be in the First Creek and Second Creek flood plains.

Significant transportation routes near the Refuge include I-76 to the northwest, 96th Avenue along the northern boundary, and Buckley and Tower roads to the east. The proposed E-470 highway will be located about 2 to 4 miles northeast of the Refuge. Significant development is expected to occur along the E-470 corridor.

Lands within 100-year flood plains are reserved for trails, parks, recreation areas, parking, and open space. Neighborhood parks are proposed for Sections 13, 17, and 18 north of the Refuge, and Section 21 east of the Refuge. The Parks and Open Space Frame Work Plan (BRW, Inc. April 1992) proposes to incorporate recreational opportunities from the Refuge, Barr Lake, the E-470 Corridor, and the Denver International Airport buffer zones.

Adams County Development

The *Adams County Comprehensive Plan* (1984, Amendments through 1990), includes several county development objectives: strong economic development, locating development on suitable soils, minimizing erosion, and conserving prime agricultural soils and subsurface resources.

The plan describes proposed land use for the areas adjoining the Refuge on the west, northwest, north, and northeast. The area along Quebec Street, from 56th Avenue to State Highway 2, is designated commercial mixed use. The area northwest of State Highway 2 is primarily designated industrial, with some medium density residential and parks, open space, and flood plains. North and northeast of the Refuge along 96th Avenue, from Buckley Road to Peoria Street, is designated suburban residential, and parks, open space, and flood plains. A small portion of land east of the Refuge between 72nd and 88th Avenues is designated commercial mixed use.

Large portions of open space and natural areas (including agricultural lands) are located in Adams County, including the Refuge, an area west of Highway 86 from 88th Avenue to the County's northern boundary, around Barr Lake, and north and east of the DIA. The plan establishes buffer areas of 150 feet around lakes, 20 feet on either side of trails, and 1/2 mile around Barr Lake. Stated objectives in the plan are to protect and enhance Barr Lake, restore wildlife values along the South Platte River valley, and protect critical wildlife habitat.

Emerald Strands

The Emerald Strands (Adams County, et. al.1990) is a network of existing and planned trails and open space from Cherry Creek Reservoir on the south to beyond Barr Lake State Park and Recreation Area on the north, and from the South Platte River on the west to Box Elder Creek on the east. Emerald Strands was developed as part of the *Airport Environs Plan*, which focused on controlling development around the Denver International Airport. The interjurisdictional plan addressed the following issues:

- The continuity of trails across city and county boundaries,
- The joint development of regional parks, and
- Consistent standards for trails and parks.

The Refuge is the largest and most concentrated area of open space in the Emerald Strands. On the south, the Refuge connects to trails and open space along First Creek, Sand Creek, the Highline Lateral, and E-470. On the North the Refuge connects to open space and trails along First and Second Creeks, E-470, I-76, the South Platte River, Barr Lake, Fulton Ditch, and the Brighton Lateral. Recreational opportunities include hiking, biking, fishing, bird watching, and picnicking.

5. PLANNING PROCESS

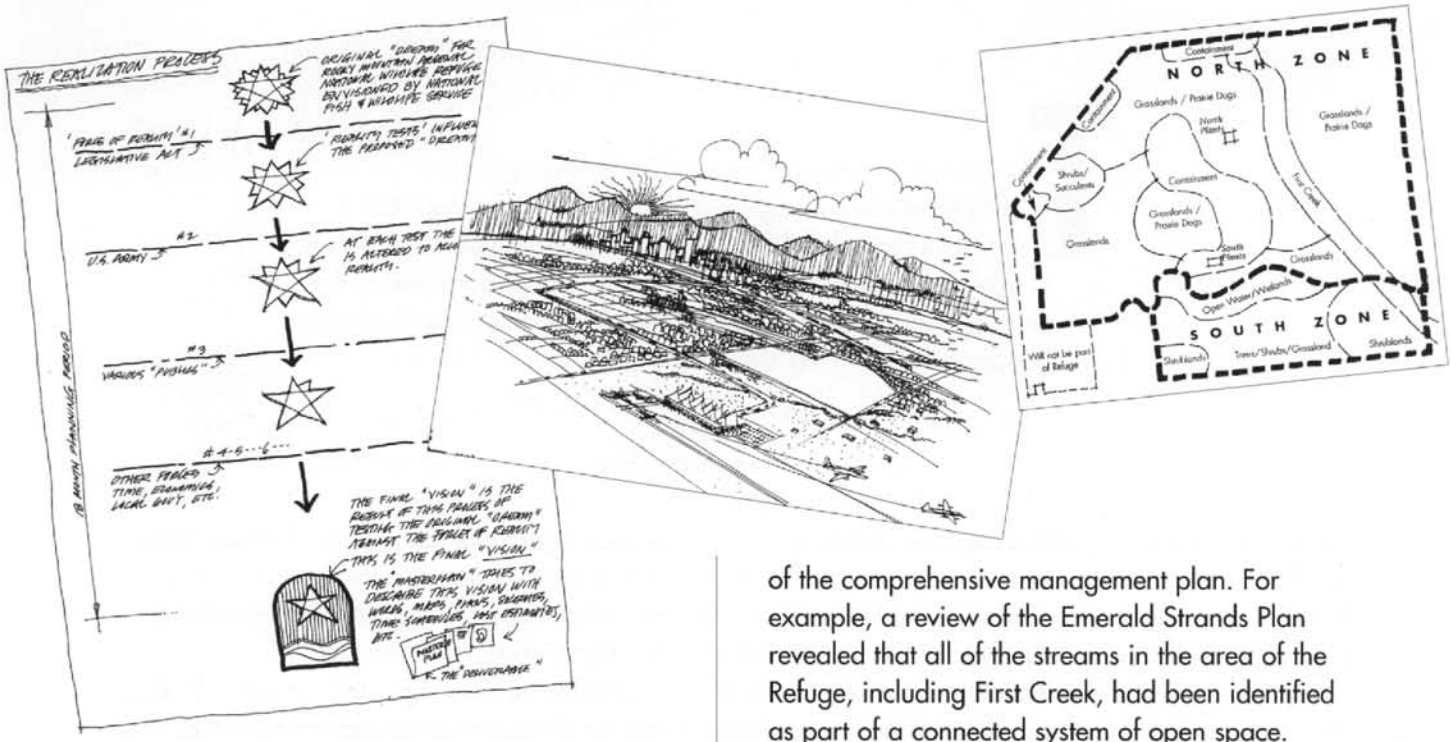
This section summarizes the process of developing the Comprehensive Management Plan for the Rocky Mountain Arsenal National Wildlife Refuge. The purpose of this section is to explain the procedures that were followed for each step of the process. The specific outcomes of the various steps described here are given earlier in this document.

The process included four major steps. First, an inventory and an analysis of relevant data, including maps, were carried out. Second, a program—an overall package of activities and functions—was developed for the Refuge. Third, the program was applied to the site and five alternative plans were created. Fourth, the selected alternative plan was thoroughly documented so that the intent of the plan could be communicated to the public. The process itself was not as linear as this list of steps might suggest. In many cases it was important to revisit earlier decisions as more or better information became available.

Part of the process of creating the final plan included evaluating its environmental impacts. A draft environmental impact statement was created and presented to the public during the development of alternative plans. The final environmental impact statement was carried out during the final phase of the project.

Table 5.1 The Refuge planning process was characterized by four broad phases.

1. *Inventory and analysis*
2. *Program development*
3. *Alternatives plan development*
4. *Preferred plan selection and development*



The diagrams and other illustrations found across the top of the next pages present in graphic format some of the ideas considered during the planning process.

Each component of the planning process is described below.

1. INVENTORY AND ANALYSIS

Orient team to site

The project started with a series of activities, including site tours, that introduced the planning team to the site and the Refuge staff.

Review existing information and maps

All existing relevant information, including reports and maps, were reviewed for comments or recommendations that might relate to the creation of the comprehensive management plan. For example, a review of the Emerald Strands Plan revealed that all of the streams in the area of the Refuge, including First Creek, had been identified as part of a connected system of open space. Many of them were targeted for trails development. This information proved important in developing the Refuge's management plan because a through-trail along First Creek was seen as incompatible with the bald eagles and other species using that corridor. In recognition of the community's stated desire (in the Emerald Strands Plan) for a trail along First Creek, the concept was explored and later adopted to include a perimeter greenbelt around the Refuge thus connecting into the regional trail system.

Information summarized from these diverse sources was reviewed during the development of the Refuge plan.

Create preliminary vision

A two-day workshop was conducted with both Refuge staff and the planning team to record a preliminary vision for what the Refuge might become. In very broad terms, participants discussed and reached consensus on the types of

wildlife management, public programs, and facilities that seemed appropriate at this early stage of the planning process. The workshop helped the planning team frame questions to the public.

A particularly significant concept developed at the workshop was the recognition that the 27-square mile Arsenal has several very different landscape types: a northern zone characterized by grasslands and prairie dog colonies, a southern zone with extensive introduced vegetation and water bodies, and a corridor along First Creek. These zones, along with one that was added later in the project to include gateway lands just off the Refuge, reflect ecological conditions that are quite different across the Refuge. This "zones concept" was used in developing management objectives that respond to these ecological differences.

Organize and conduct focus groups

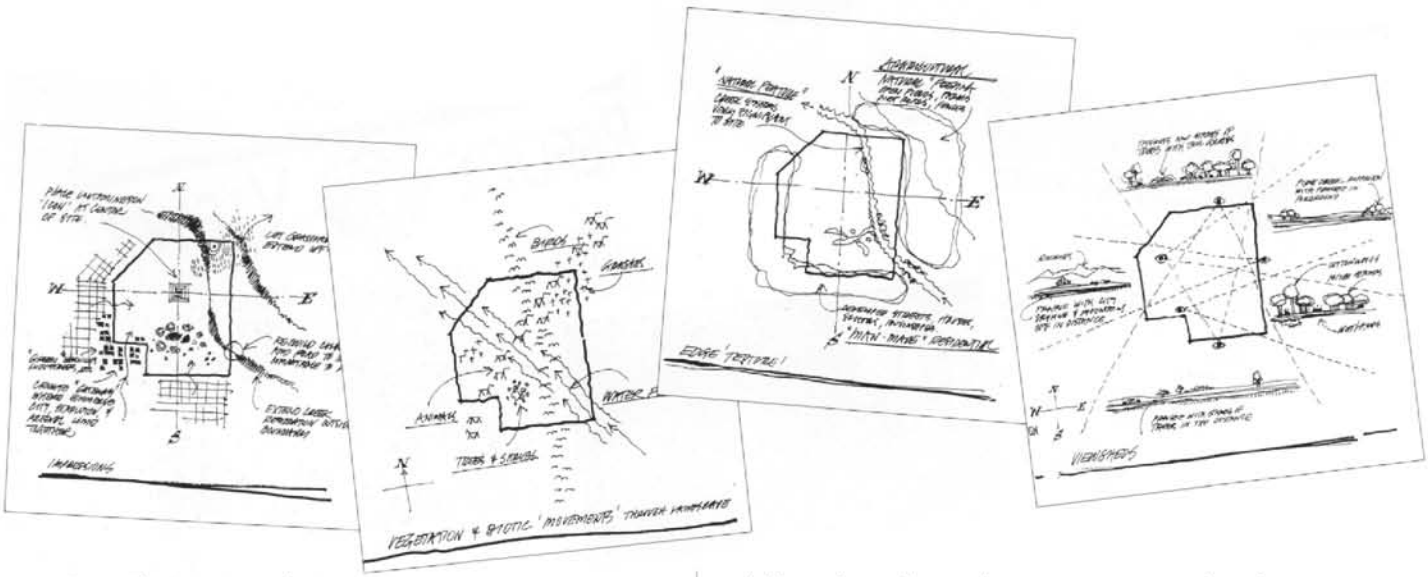
Eight focus groups were created with the following principal memberships: neighbors, civic and business leaders, environmental education, environmental organizations, recreation, public agencies, tourism, and the scientific community.

These groups met twice during the project to provide input into the process, particularly as it related to the topic of specific concern to each group. Meetings were timed so that they came before major public presentations as a way of getting timely feedback in anticipation of those larger meetings.

The first meetings were held in June 1994 to identify important issues and concerns that would have to be addressed in creating the comprehensive management plan. From these meetings—and continuing on throughout the project—the planning team detected no great controversy about the development of the Refuge. The focus group participants helped identify issues needing to be dealt with and helped the planning team understand better how to interact with the surrounding neighborhoods and the larger community.

A second round of meetings was held in January and February 1995 to review the alternative plans that had, by then, been developed. Insightful questions and comments at these meetings helped the planning team revise its presentation strategy before the public presentation of the alternative plans.

The focus groups were very helpful in the development of the final plan. Because each group was made up of people with similar interests, discussions at meetings were often more in-depth than at the public meetings.



Compile issues and concerns

From discussions with the general public, focus groups, and personnel from the U.S. Fish and Wildlife Service and other agencies, the planning team compiled a list of issues and concerns that helped in developing goals and objectives for the Refuge.

These issues and concerns included the following questions:

- What should be the balance of uses at the Refuge?
- What should be the level of access available to people?
- How much wildlife movement should be allowed beyond the site?
- Which species, if any, should be reintroduced?
- What is the nature of the western zone and what kinds of activities should be encouraged there?
- To what degree can existing infrastructure be reused?
- How do you tell the whole history of the site, including contamination?

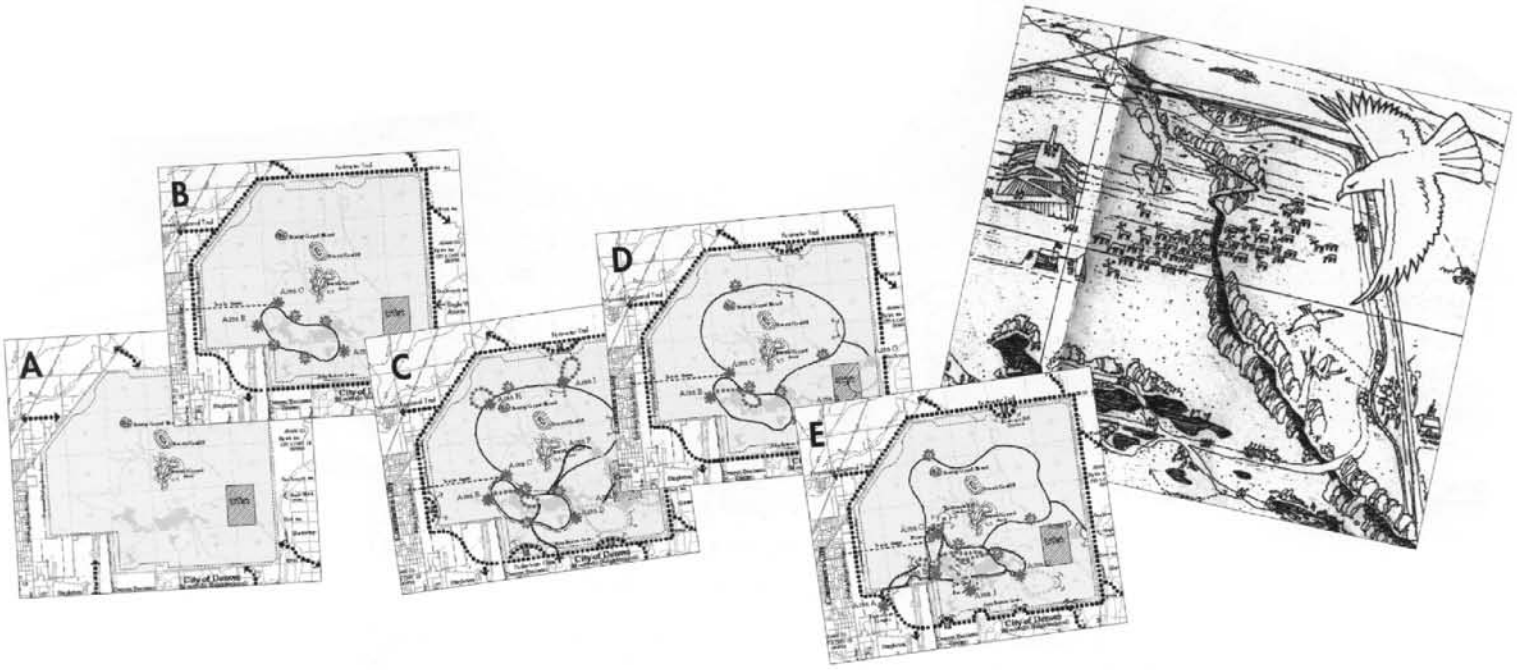
Develop preliminary goals and objectives

Goals and objectives were developed based on the issues and concerns identified earlier and on the mandates set out by the legislation establishing the Refuge. These were presented to the public for comment and later revised.

Conduct public meetings

Public scoping meetings held in September 1995 gave the community the opportunity to comment on the direction of the development of the Refuge's plan. These meetings were held in three different communities to make it more convenient for the public to attend. A notice of the meeting appeared in the Federal Register. Invitations were sent to approximately 25,000 people, including each postal address in the surrounding communities of Commerce City and Denver's Montbello neighborhood. Advertisements announcing the meetings appeared in the local newspapers and the two dailies. Flyers were distributed to key locations.

A video tape developed by the U.S. Fish and Wildlife Service specifically for these meetings was used to introduce the public to the Refuge and its planning process. A preliminary vision of the Refuge was presented as was a three- landscape-zone way of looking at the site. Attendees were then divided into smaller discussion groups and asked to respond to three main questions: What should be the primary mission of the Refuge? What kinds of activities should be



allowed or not allowed at the Refuge? What advice would you like to give the U.S. Fish and Wildlife Service in creating the Refuge plan?

Each group then made a brief report back to the full meeting. An opportunity was provided for formal comment and then the meeting was adjourned.

Comments from the meetings and those that were received through the mail (a public comment period ran for an additional 30 days after the meetings) were used to revise the preliminary vision and help develop alternative plans for the Refuge. Comments were summarized in a scoping report.

Public review of alternative plans

Preliminary alternative Refuge plans were presented to the public in a second series of public meetings in February 1995 at Adams City High School in Commerce City, Montbello High School in Denver, and at the Denver Botanic Gardens. These meetings were not a requirement of the process stipulated in the National Environmental Policy Act. They were added to the process to provide greater public involvement in planning the Refuge.

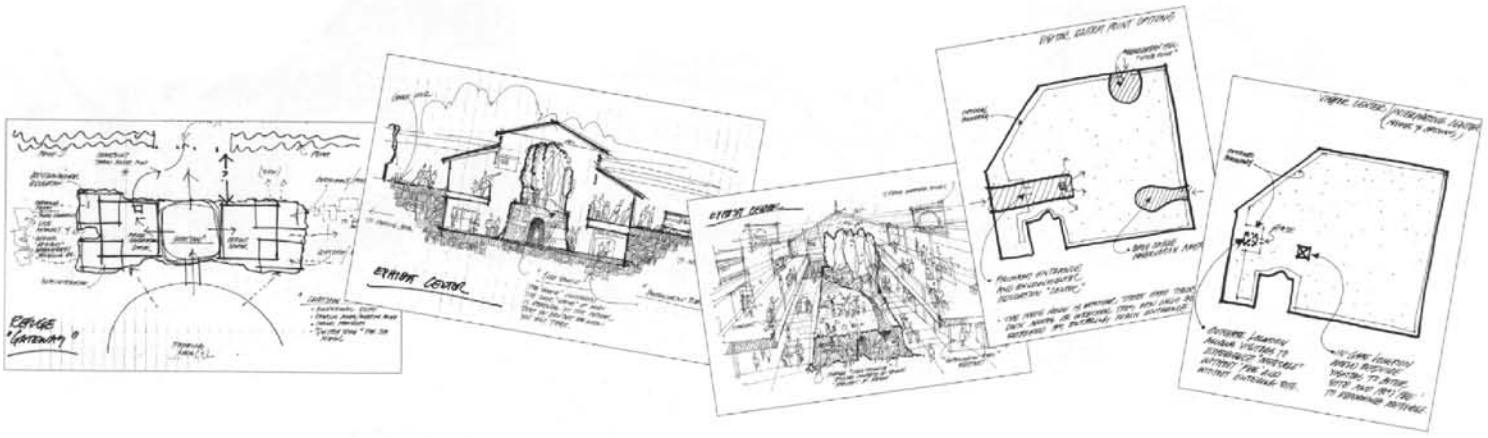
Once again the meetings were held in three different locations as a convenience to the public. Approximately 10,000 copies of a newsletter were sent out as an invitation to the meetings. Advertisements announcing the meetings appeared in the local newspapers and the two dailies. Flyers were distributed to key locations.

After a brief introduction from the Project Leader, a video was shown which presented the activities to date and explained several important aspects of the planning process. An overview was given of the preliminary alternative plans, then those in attendance were divided into smaller discussion groups so they could ask further questions and make comments on the preliminary plans. Each group reported back to the larger group.

Comments from these meetings, those sent in, and those from the focus groups helped the planning team revise the alternative plans and develop a preferred alternative.

Public review of the draft environmental impact statement

The draft environmental impact statement, which analyzes the environmental effects of the alternative plans, was presented to the public at a meeting in Denver on June 27, 1995. (Advertisements alerting the public to the meeting were placed in local newspapers and flyers were



circulated. Forty thousand copies of a newsletter were sent out with information about the meeting.)

Particular detail was given on the Service's preferred alternative. A formal comment period came at the close of the meeting and written comments were taken through August 15. With a few minor exceptions, comments strongly favored the preferred alternative.

Conduct Agency meetings

Two special meetings were held with representatives from federal, state, and local agencies interested in the creation of the Refuge. These meetings provided opportunities for the representatives to voice concerns from their agencies as well as ask questions about the project.

2. PROGRAM DEVELOPMENT

Identify public needs (uses, market demand)

The kinds of uses that the public would likely want to see at the Refuge—from the more obvious such as nature watching to the less traditional, like bicycling— were drawn from a range of sources, including a survey conducted by the Service. Each use had to meet the legislated purposes of the Refuge to be allowed within the Refuge.

A number of uses not typically allowed on refuges, such as inline skating and jogging, will be allowed in the Refuge greenbelt, which is along the perimeter of the entire Refuge, but not within the fence enclosing the majority of the Refuge.

Identify biological needs

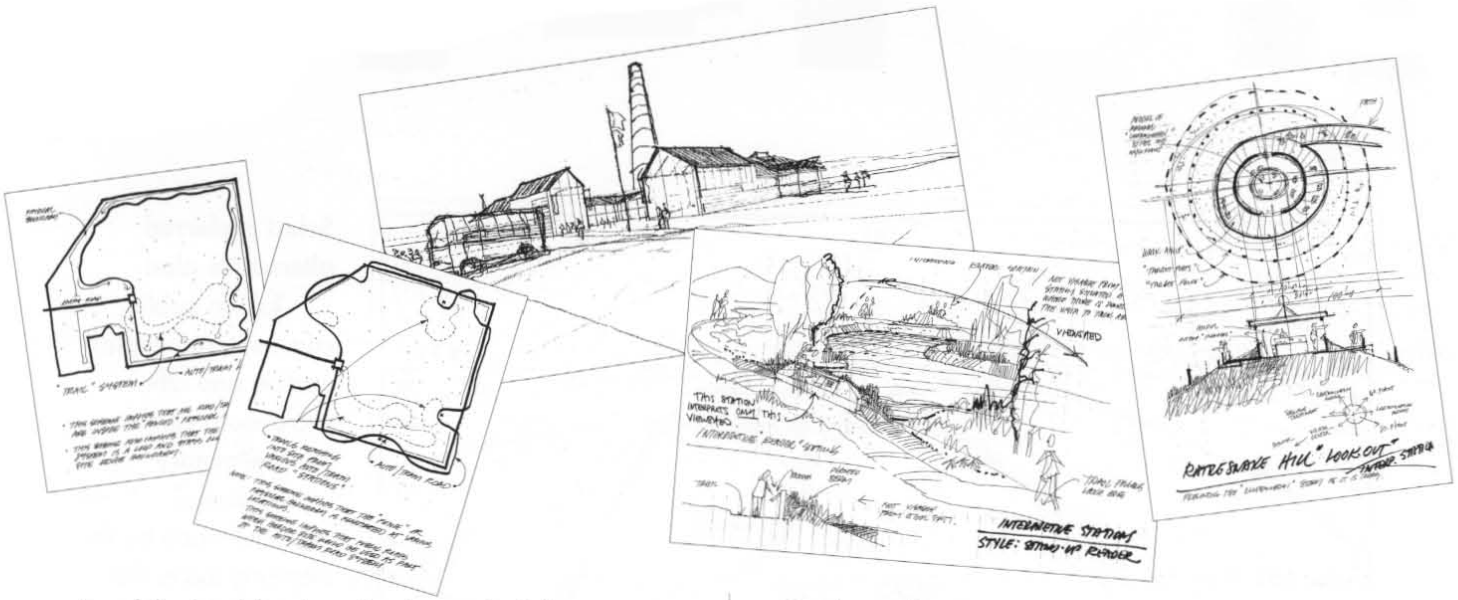
A workshop was held with Service personnel to identify and record the biological communities of the Refuge and their needs. These biological needs were considered with the public needs to identify a program of uses and facilities for the Refuge.

Analyze compatibility of uses with Refuge purposes

Each of the public uses of the Refuge was evaluated preliminarily for its compatibility with the purposes for which the Refuge was established. Some uses were found to be compatible because they would be separated in time or space from a purpose they might otherwise disrupt. For example, bicycling is allowed only on the southern tram route and only when the bald eagles are not in residence at the Refuge.

A more formal compatibility analysis is currently underway.

As part of this process, a suitability mapping exercise was conducted that looked at the suitabil-



ity of the land for three land uses: buildings, roads, and trails.

Assess impacts (preliminary)

A preliminary assessment of impacts was carried out for the uses proposed for the Refuge. This was an early way to identify potential conflicts between the Refuge's resources and the uses being considered.

Develop preliminary and final program

The planning team developed a draft preliminary program for the uses that were being considered for the Refuge. This was based on the facility requirements for similar uses at other refuges. A workshop was then held with Service personnel to review and revise that document and create a preliminary program, which showed, among other things, approximate requirements for each element (both biological, as well as public use) of the plan.

The preliminary program was revised as the final plan was selected and its uses and facilities refined. A detailed analysis of each major facility was carried out as part of the process of creating a budget and a phasing plan for the final plan. These are described in project worksheets.

Send newsletters

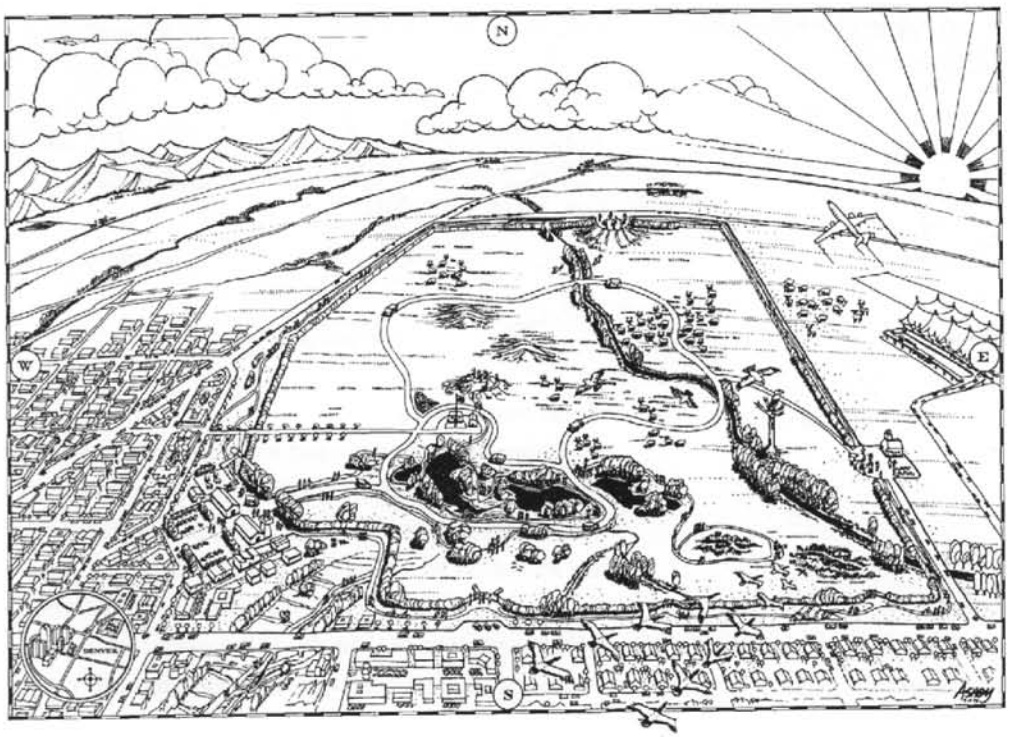
Newsletters were used to communicate project progress to the public and to invite them to upcoming public meetings. The first newsletter was an invitation to attend the scoping meetings in September 1994. The second newsletter (Winter 1995) reported the results of the public scoping meetings, outlined the preliminary alternative plans, and invited the public to workshops to review the alternatives. The third newsletter (Spring 1995) discussed the results of the previous public meeting, described the alternative preferred by the Service, and invited the public to a presentation of the draft environmental impact statement and the preferred alternative.

A poster was also created at the end of the project to communicate the major characteristics of the final plan.

3. ALTERNATIVES ANALYSIS

Develop alternative plans

A range of comments was heard at each of the early public meetings about the levels of access that the public should have on the Refuge. Some people spoke in favor of high levels of pub-



lic access, allowing people to use most of the Refuge. Others favored heavy restrictions on what people would be allowed to do and where they would be allowed to go. Still others felt some intermediate level of access was appropriate. Because of the range of opinion, the planning team felt the level of public access would be a good characteristic to vary among the alternatives.

Three major alternative plans were created with high, moderate, and low public access. A fourth alternative plan—no action—was considered as a requirement of the National Environmental Policy Act.

Refine alternatives

The alternatives were revised based on comments made at the public workshops and those sent to the Project Leader.

Select preferred alternative plan

Taking public comment into consideration and other evaluations (such as the preliminary assessment of impacts) made by the planning team, the Service selected as the preferred alternative the plan with moderate public access.

Prepare draft environmental impact statement

The Service and the planning team prepared an Environmental Impact Statement (EIS) to document the possible environmental effects of the alternative management plans on the natural, social and economic environment. The EIS is intended to comply with the provisions of the National Environmental Policy Act and the Service's policy on new Refuge development. The analysis of environmental impacts associated with implementation of the management plan is addressed at the conceptual planning level. (See the Draft and Final EIS for details of the processes that lead to those documents.)

Draft preliminary Comprehensive Management Plan

Worksheets

Project worksheets were completed for each

project to be undertaken as part of the comprehensive management plan. These sheets include a preliminary cost estimate to carry out the project and describe the characteristics of each project.

Refine budget

The cost estimates from the project worksheets were combined to create an overall budget for the project. The budget was refined by making adjustments to the project worksheets.

Phasing

A phasing scheme was developed for the comprehensive management plan because the plan will be realized over a period of years. Each phase has associated with it specific projects and project costs.

4. PREFERRED PLAN SELECTION AND DEVELOPMENT

Finalize goals and objectives

The process of finalizing the comprehensive management plan and creating the final documents that describe it included revisiting the preliminary goals and objectives. They were revised and finalized based on comments that had been offered by the public and in an effort to make the objectives more measurable.

Prepare public use plan

Concurrent with the development of the comprehensive management plan, a companion document was created outlining public use for the Refuge. This public use plan, which describes the Refuge's range of environmental education and interpretation and wildlife-oriented recreation, was developed from the earlier assessment of anticipated user needs and market demand for such services.

Prepare final environmental impact statement

After reviewing comments received from the public and from other agencies on the draft EIS, the final EIS was prepared.

Draft record of decision

On December 8, 1995 the Acting Regional Director for Region 6 issued a record of decision designating the Service's preferred plan as the final plan for the Refuge.

Issue comprehensive management plan and summary poster

This comprehensive management plan was published along with a summary poster to notify the public that the Refuge's management plan had been completed.

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Public Law 102-402
102d Congress

An Act

To direct the Secretary of the Army to transfer jurisdiction over the Rocky Mountain Arsenal, Colorado, to the Secretary of the Interior.

Oct. 9, 1992
[H.R. 1435]

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

Rocky Mountain Arsenal National Wildlife Refuge Act of 1992. Real property. 16 USC 668dd note.

SECTION 1. SHORT TITLE AND DEFINITIONS.

(a) SHORT TITLE.—This Act may be cited as the "Rocky Mountain Arsenal National Wildlife Refuge Act of 1992".

(b) DEFINITIONS.—For purposes of this Act:

(1) The term "Arsenal" means the Rocky Mountain Arsenal in the State of Colorado.

(2) The term "refuge" means the Rocky Mountain Arsenal National Wildlife Refuge established pursuant to section 4(a).

(3) The term "hazardous substance" has the meaning given such term by section 101(14) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (42 U.S.C. 9601(14)).

(4) The term "pollutant or contaminant" has the meaning given such term by section 101(33) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (42 U.S.C. 9601(14)).

(5) The term "response action" has the meaning given the term "response" by section 101(25) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (42 U.S.C. 9601(25)).

(6) The term "person" has the meaning given that term by section 101(21) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (42 U.S.C. 9601(21)).

SEC. 2. TRANSFER OF MANAGEMENT RESPONSIBILITIES AND JURISDICTION OVER THE ROCKY MOUNTAIN ARSENAL.

(a) TRANSFER OF MANAGEMENT RESPONSIBILITIES.—(1) Not later than October 1, 1992, the Secretary of the Army and the Secretary of the Interior shall enter into a memorandum of understanding under which—

(A) the Secretary of the Army shall transfer to the Secretary of the Interior, without reimbursement, all responsibility to manage for wildlife and public use purposes the real property comprising the Rocky Mountain Arsenal in the State of Colorado, except the property and facilities required to be retained under subsection (c) or designated for disposal under section 5; and

(B) the Secretary of the Interior shall manage that real property as if it were a unit of the National Wildlife Refuge System established for the purposes provided in section 4.

(2) The management of the property by the Secretary of the Interior shall be subject to (A) any response action at the Arsenal

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carried out by or under the authority of the Secretary of the Army under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (42 U.S.C. 9601 et seq.) and other applicable provisions of law, and (B) any action required under any other statute to remediate petroleum products or their derivatives (including motor oil and aviation fuel) carried out by or under the authority of the Secretary of the Army. In the case of any conflict between management of the property by the Secretary of the Interior and any such response action or other action, the response action or other action shall take priority.

(b) TRANSFER OF JURISDICTION.—(1) Upon receipt of the certification described in paragraph (2), the Secretary of the Army shall transfer to the Secretary of the Interior jurisdiction over the real property comprising the Arsenal, except the property and facilities required to be retained under subsection (c) or designated for disposal under section 5. The transfer shall be made without cost to the Secretary of the Interior and shall include such improvements on the property as the Secretary of the Interior may request in writing for refuge management purposes.

(2) The transfer of real property under paragraph (1) may occur only after the Administrator of the Environmental Protection Agency certifies to the Secretary of the Army that response action required at the Arsenal and any action required under any other statute to remediate petroleum products or their derivatives (including motor oil and aviation fuel) at the Arsenal have been completed, except operation and maintenance associated with those actions.

(3) The exact acreage and legal description of the real property subject to transfer under paragraph (1) shall be determined by a survey mutually satisfactory to the Secretary of the Army and the Secretary of the Interior. The Secretary of the Army shall bear any costs related to the survey.

(c) PROPERTY AND FACILITIES EXCLUDED FROM TRANSFERS.—

(1) PROPERTY USED FOR ENVIRONMENTAL CLEANUP PURPOSES.—The Secretary of the Army shall retain jurisdiction, authority, and control over all real property at the Arsenal to be used for water treatment; the treatment, storage, or disposal of hazardous substances, pollutants, or contaminants; or other purposes related to response action at the Arsenal and any action required under any other statute to remediate petroleum products or their derivatives (including motor oil and aviation fuel) at the Arsenal. The Secretary of the Army shall consult with the Secretary of the Interior regarding the identification and management of all real property retained under this paragraph and ensure that activities carried out on that property are—

(A) consistent with the purposes for which the refuge is to be established under section 4(c), to the extent practicable; and

(B) consistent with the provisions of sections 2(a)(2) and 4(e).

(2) PROPERTY USED FOR LEASE OF PUBLIC FACILITIES.—(A) The Secretary of the Army shall retain jurisdiction, authority, and control over the following real property at the Arsenal:

(i) Approximately 12.08 acres containing the South Adams County Water Treatment Plant and described in Department of the Army lease No. DACA 45–1–87–6121.

(ii) Approximately 63.04 acres containing a United States Postal Service facility and described in Department of the Army lease No. DACA 45–4–71–6185.

(B) Nothing in this Act shall affect the validity or continued operation of leases of the Department of the Army in existence on the date of the enactment of this Act and involving the property described in subparagraph (A).

SEC. 3. CONTINUATION OF RESPONSIBILITY AND LIABILITY OF THE SECRETARY OF THE ARMY FOR ENVIRONMENTAL CLEANUP.

(a) RESPONSIBILITY.—Notwithstanding the memorandum of understanding required under section 2(a), the Secretary of the Army shall, with respect to the real property at the Arsenal that is subject to the memorandum, continue to carry out (1) response action at that property under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (42 U.S.C. 9601 et seq.) and other applicable provisions of law, and (2) any action required under any other statute to remediate petroleum products or their derivatives (including motor oil and aviation fuel). The management by the Secretary of the Interior of such real property shall be subject to any such response action or other action at the property being carried out by or under the authority of the Secretary of the Army under such provisions of law.

(b) LIABILITY.—(1) Nothing in this Act shall relieve, and no action may be taken under this Act to relieve, the Secretary of the Army or any other person from any obligation or other liability at the Arsenal under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (42 U.S.C. 9601 et seq.) and other applicable provisions of law.

(2) After the transfer of jurisdiction under section 2(b), the Secretary of the Army shall retain any obligation or other liability at the Arsenal under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (42 U.S.C. 9601 et seq.) and other applicable provisions of law and shall be accorded all easements and access as may be reasonably required to carry out such obligation or other liability.

(c) DEGREE OF CLEANUP.—Nothing in this Act shall be construed to restrict or lessen the degree of cleanup at the Arsenal required to be carried out under applicable provisions of law.

(d) PAYMENT OF RESPONSE ACTION COSTS.—Any Federal department or agency that had or has operations at the Arsenal resulting in the release or threatened release of hazardous substances, pollutants, or contaminants shall pay the cost of related response actions or related actions under other statutes to remediate petroleum products or their derivatives, including motor oil and aviation fuel.

(e) CONSULTATION.—In carrying out response actions at the Arsenal, the Secretary of the Army shall consult with the Secretary of the Interior to ensure that such actions are carried out in a manner—

(1) to the extent practicable, consistent with the purposes set forth in section 4(c) for which the refuge will be established after the certification required under section 2(b)(2); and

(2) consistent with the provisions of sections 2(a)(2) and 4(e).

(f) EXISTING LAW.—The Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.), the Migratory Bird Treaty Act

(16 U.S.C. 703 et seq.), and the Bald Eagle Protection Act (16 U.S.C. 668 et seq.) shall apply to all actions at the Arsenal.

(g) RESPONSE ACTIONS.—(1) The future establishment of the refuge shall not restrict or lessen in any way any response action or degree of cleanup under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 or other applicable provisions of law, or any response action required under any other statute to remediate petroleum products or their derivatives (including motor oil and aviation fuel), required to be carried out by or under the authority of the Secretary of the Army at the Arsenal and surrounding areas, including (but not limited to)—

(A) the substance or performance of the remedial investigation and feasibility study or endangerment assessments;

(B) the contents and conclusions of the remedial investigation and feasibility study or the endangerment assessment reports; or

(C) the selection and implementation of response action and any action required under any other statute to remediate petroleum products or their derivatives (including motor oil and aviation fuel) for the Arsenal and surrounding areas.

(2) All response action and action required under any other statute to remediate petroleum products or their derivatives (including motor oil and aviation fuel) carried out at the Arsenal shall attain a degree of cleanup of hazardous substances, pollutants, and contaminants that, at a minimum, is sufficient to fully meet the purposes set forth in section 4(c) for which the refuge will be established and to permit access to all real property comprising the refuge by refuge personnel, wildlife researchers, and visitors.

SEC. 4. ESTABLISHMENT OF THE ROCKY MOUNTAIN ARSENAL NATIONAL WILDLIFE REFUGE.

(a) ESTABLISHMENT.—Not later than 30 days after the transfer of jurisdiction under section 2(b), the Secretary of the Interior shall establish a national wildlife refuge that shall be known as the Rocky Mountain Arsenal National Wildlife Refuge and consist of the real property required to be transferred under such section. The Secretary of the Interior shall publish a notice of the establishment of the refuge in the Federal Register.

Federal Register, publication.

(b) ADMINISTRATION.—

(1) IN GENERAL.—The Secretary of the Interior shall manage the refuge in accordance with the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 668dd et seq.) and other applicable law.

(2) CONSULTATION.—In developing plans for the management of fish and wildlife at and public use of the refuge, the Secretary of the Interior shall—

(A) consult with the Colorado Department of Natural Resources and local governments adjacent to the refuge; and

(B) provide an opportunity for public comment on such plans.

(3) The Secretary of the Interior and the Administrator of the Federal Aviation Administration shall confer from time to time as necessary to coordinate the management of the refuge with the operations of the Denver International Airport.

(c) PURPOSES OF THE REFUGE.—The refuge is established for the following purposes:

(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 or endangered under the Endangered Species Act and species that are candidates for such listing.

(3) To provide maximum fish and wildlife oriented 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.

(d) LIMITATIONS.—

(1) PROHIBITION AGAINST ANNEXATION.—Notwithstanding section 4(a)(2) of the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 668dd(a)(2)), the Secretary of the Interior shall not allow the annexation of lands within the refuge by any unit of general local government.

(2) PROHIBITION AGAINST THROUGH ROADS.—Public roads may not be constructed through the refuge.

SEC. 5. DISPOSAL OF CERTAIN REAL PROPERTY AT THE ARSENAL FOR COMMERCIAL, HIGHWAY, OR OTHER PUBLIC USE.

(a) PROPERTY DESIGNATED FOR DISPOSAL UNDER THIS SECTION.—The following areas of real property at the Arsenal are designated for disposal under this section for commercial, highway, or other public use purposes:

(1) An area of real property consisting of approximately 815 acres located at the Arsenal, the approximate legal description of which is section 9, T3S–R67W, the W2W2 of section 4 and the W4E2W2 of section 4, T3S–R67W, and the SW4SW4 of section 33, the W4E2W2 of section 33, and the W2NW4 of section 33, T2S–R67W; except that the area designated shall not include the approximately 63.04 acres containing a United States Postal Service facility and described in Department of the Army lease No. DACA 45–4–71–6185 and the water wells located in buildings 385, 386, and 387 at the Arsenal and associated facilities and easements necessary to operate and maintain the water wells, which shall be treated in the manner provided in section 2.

(2) To permit the widening of existing roads, an area of real property of not more than 100 feet inside the boundary of the Arsenal on—

(A) the Northwest side of the Arsenal adjacent to Colorado Highway #2;

(B) the Northern side of the Arsenal adjacent to 96th Avenue; and

(C) the Southern side of the Arsenal adjacent to 56th Avenue.

(b) TRANSFER FOR HIGHWAY PURPOSES.—The Secretary of the Army shall convey those parcels of real property described in subsection (a)(2) to the State or the appropriate unit of general local government at no cost to allow for the improvement of public roads in existence on the date of the enactment of this Act or for the provision of alternative means of transportation.

(c) TRANSFER FOR SALE.—(1) The Secretary of the Army shall transfer to the Administrator of the General Services Administration those parcels of the area of real property described in subsection (a)(1). The transferred property shall be sold in advertised sales as surplus property under the provisions of the Federal Property and Administrative Services Act of 1949 (40 U.S.C. 471 et seq.), except that the provisions of such Act relating to reduced- or no-cost transfers to other governmental entities shall not apply to this property.

(2) Any amounts realized by the United States upon the sale of property as described in paragraph (1) shall be transferred to the Director of the United States Fish and Wildlife Service to be used, to the extent provided for in appropriation Acts, to supplement the funds otherwise available for construction of a visitor and education center at the refuge.

(d) LIMITATIONS.—

(1) PERPETUAL RESTRICTIONS.—(A) The disposal of real property under this section shall be subject to perpetual restrictions that are attached to any deed to such property and that prohibit—

(i) the use of the property for residential or industrial purposes;

(ii) the use of ground water located under, or surface water located on, the property as a source of potable water;

(iii) hunting and fishing on the property, excluding hunting and fishing for nonconsumptive use subject to appropriate restrictions; and

(iv) agricultural use of the property, including all farming activities such as the raising of livestock, crops, or vegetables, but excluding agricultural practices used in response action or used for erosion control.

(B) Nothing in subparagraph (A) shall be construed to restrict or lessen the degree of cleanup required to be carried out under applicable provisions of law at the property designated for disposal under this section.

(2) DISPOSAL IN ACCORDANCE WITH CERCLA.—The disposal of real property under this section shall be carried out in compliance with section 120(h) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (42 U.S.C. 9620(h)) and other applicable provisions of law.

Approved October 9, 1992.

LEGISLATIVE HISTORY—H.R. 1435:

HOUSE REPORTS: No. 102-463, Pt. 1 (Comm. on Armed Services) and Pt. 2 (Comm. on Merchant Marine and Fisheries).
CONGRESSIONAL RECORD, Vol. 138 (1992):
July 7, considered and passed House.
Sept. 18, considered and passed Senate, amended.
Sept. 25, House concurred in Senate amendments.
WEEKLY COMPILATION OF PRESIDENTIAL DOCUMENTS, Vol. 28 (1992):
Oct. 9, Presidential statement.

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APPENDIX B. DEVELOPMENT PLAN PHASING

The Refuge's development plan will be realized in three broad phases. The following lists the projects that will make up each of these phases.

Phase 1: Pre-Development/Site Preparation, 1996-2000

- Restore prairie, first phase.
- Demolish unnecessary buildings and cleanup site, first phase.
- Demolish unnecessary roads and bridges, first phase.
- Construct remote information stations.
- Construct outdoor classroom.
- Create temporary mobile classroom for environmental education.
- Construct the prairie plant nursery.
- Construct the Wetlands environmental education area
- Construct the Rattlesnake Hill environmental education area.
- Construct the southern tram route.
- Construct the perimeter barrier.
- Construct the first phase of the perimeter greenbelt trail, including the Havana Ponds Overlook.
- Install the first phase of the interpretive, regulatory and road signage.

Phase II: Major Development, 2000-End of cleanup

- Construct Bald Eagle Shallows
- Restore the prairie, phase 2
- Demolish additional unnecessary buildings and clean site.
- Demolish additional unnecessary roads and bridges.
- Construct Visitor Learning Center (Visitor Center & Environmental Education Center).
- Construct the Lakes interpretive and environmental education area.
- Construct Administrative Offices.
- Retrofit research facilities.
- Retrofit the maintenance facility.
- Construct visitor learning center interpretive and environmental education area.
- Construct Officer's Row trail and environmental education area.
- Construct Lake overlook trail.
- Construct Quad connector trail.
- Construct Quad trail and environmental education area.
- Construct Wetlands connector trail.
- Construct Building 111 connector trail enhancements.
- Construct Eagle Watch trail and environmental education area.
- Construct entry road at Gateway.
- Construct Quad loop road.
- Construct first phase of the internal perimeter road.
- Construct the first phase of the Visitor Learning Center parking lot.
- Construct visitor parking at the Eagle Watch.
- Construct the major events area.
- Complete utility distribution.
- Complete the second phase of the perimeter greenbelt trail.
- Complete the second phase of the interpretive, regulatory and road signage.

Phase III: Future Development, From end of cleanup

- Complete the final phase of prairie restoration.
- Restore First Creek.
- Complete the northern tram route.
- Complete the final phase of the internal perimeter road.
- Construct the second phase of the Visitor Learning Center parking lot.
- Complete the final phase of the perimeter greenbelt trail.
- Complete the final phase of the interpretive, regulatory and road signage.

APPENDIX C. ENVIRONMENTAL EDUCATION AND INTERPRETATION STORYLINE

Theme A: History

The history of the Refuge—the historical interaction between land, people, and technology—offers many lessons for taking responsibility for this and other places.

Subtheme: **People are dependent on the environment.** This site has served people throughout time. Its history demonstrates how people are connected to the land and how they have changed the landscape

Prehistory/Native American Message:	**Settlement Message:**	**Industrial Message**:
The plains Indians had a closeness to the land, yet they made changes to the landscape although minimal in nature (i.e. fire management/remains).	The settlers changed the land by introducing agricultural practices. They broke the soil, introduced water, and planted trees and shrubs. The times were hard for the settlers and they had many harsh experiences with nature and the elements. Their impact on the land was high but local in effect (farming, grazing, water) ◦The settlers had to move off the land when the Army took over. Many were not happy but were willing to do their part for the war effort.	• Arsenal established to support national interests in war time (WWII, Korean Conflict, rocket fuel which led to weapons productions at N. & S. plants, prisoner of war camp) • Arsenal facilities leased to private industry for pesticide production. • By-product of the Arsenal and Chemical Co. activities created long-term pollution. • Impact was high and regional in effect (wildlife deaths, contaminated water, earthquakes) • Nerve/mustard gas was a deterrent that never had to be used.
Visitor Experience: • The big picture of this segment of history will be told in a Visitor Learning Center setting. • Archaeological dig utilized by school kids as part of an Environmental education Experience. • Tram Route(northern) will show what part of the prairie may have looked like at one time. • Special events like Prairie Days can relive this era. • Vantage points can give visitors the experience of the vastness of land at one time.	**Visitor Experience:** • The big picture will be told in the Visitor Learning Center. setting. • Tour (southern) will show and explain the agricultural effects that this era had on the land (water, disturbed areas) • Events such as Prairie Day can relive "back on the farm".	**Visitor Experience**: • Overview of era told in Visitor Learning Center setting. • Come out with a sense of fear with understanding of effects of nerve gas and other chemical weapons. • See where production and disposal took place along the tram route (Southern, Northern) and vantage points. • School programs will be linked to student's study of WWII-consequences
Correlated Management/ Research/Facilities/Activities: • Maintain historical sites and artifacts	**Correlated Management/ Research/Facilities/Activities:** • Reclamation & revegetation • Seed & plant nursery • Habitat mitigation • Maintain habitat quality and quantity even if non-sustaining methods and non-indigenous species/materials are used.	**Correlated Management/ Research/Facilities/Activities:** • Judicious use of pesticides and inorganic fertilizers. • Water detention, detritus and pollutant filtration. • Waste water wetland treatment demonstration area. • Biomonitoring - sentinel species. • Program Manager for the Rocky Mountain Arsenal's project technical assistance.
Place: • Visitor Learning Centerexhibit halls • Northern Tour route • Henderson Hill • Archaeological Dig (ENVIRONMENTAL EDUCATION)	**Place:** • Visitor Learning Center • Southern/northern tour Route • Historic Farm Site • Events Area (lakes area) • Prairie Area (as it used to be) • Quad	**Place:** • Visitor Learning Center • Rattlesnake Hill • Boundary Treatment • The Lakes (small part) • Northern tour route • Outreach sites
Media: • Exhibit panels at Visitor Learning Center • Video • History tour • Interp. panel at Henderson Hill • Interp. Brochure • Event/Reenactment (Prairie Days)	**Media:** • Interp. sign-time line • Video • Diorama exhibits • Exterior farm exhibit that people could walk through • Other exhibits • Brochure	**Media:** • Video • Models/photo dioramas at Rattlesnake Hill and Visitor Learning Center • Brochures • History tours

APPENDIX C, CONT.

Theme B: Wildlife
Wildlife improves everyone's quality of life.

Subtheme: Wildlife and open space is the main draw that brings people to the Refuge. Once here, people can enjoy their experience that wildlife and open space offer and learn how they can benefit wildlife in an urban environment.

Wildlife viewing is enjoyable	**The value of RMA as open space**	**Create wildlife habitat at home**
Message: • Participating in a variety of wildlife-oriented activities is fun and relaxing and provides some respite from living in an urban area. • Many people value the fact that they know wildlife still exists and thrives so close to home (intrinsic value of knowing its there).	**Message:** • The refuge offers people the opportunity to see a great diversity of wildlife in a relatively large urban space area. • People need open space/wild areas where they can get out and experience nature.	**Message:** • People can learn how to create wildlife habitat at home and thus benefit wildlife. • People need to understand the problems of planting ornamental exotics such as purple loosestrife in their backyards.
Visitor Experience: • People will receive orientation of where go to see wildlife at Visitor Learning Center. • Tram tours will provide good opportunities to see and learn about wildlife and their habitat requirements. • Special presentations (bird tours, wildlife walks) offer more specialized experiences. • Recreational opportunities (bike, fish, self-guided hikes, nature photography, art) allows people to experience wildlife on their own, opportunities for learning. • As a watchable program site	**Visitor Experience:** • People will be oriented to the Refuge and where they can go to at the Visitor Learning Center through orientation desk, inside/outside exhibits. °Visitors will see how big the Refuge is in comparison to other open space areas in the metro area. • Guided tram tours (northern/southern) allow for people to see a lot of open space. • Self guided opportunities will allow people to enjoy the open space at their own pace. • Special presentations-wildflower walks • The perimeter trail will allow for people to participate in a variety of recreational pursuits (biking, walking, jogging, in-line skating) on the Refuge edge and still be able to have numerous opportunities to view wildlife. -Perimeter overlooks allow people to view into a large area of open space at the edge of the Refuge from their own vehicles. -Special presentations/events offer more specialized experiences.	**Visitor Experience:** • Outdoor exhibits at Visitor Learning Center complex will demonstrate native prairie/xeriscaping techniques. • Special classes will be offered in landscaping for wildlife which would take place in the Environmental Education classrooms and out in the field. • Guided tram tours (northern prairie) offer experience of seeing restored prairie. • Guided tours through the nursery for seeing native plants being propagated from seed. • Environmental education classes will collect seeds to grow in school and replant at the Refuge.
Correlated Management/ Research/Facilities/Activities: • Lake Mary pond study • Biomonitoring	**Correlated Management/ Research/Facilities/Activities:**	**Correlated Management/ Research/Facilities/Activities:** • Reclamation & revegetation. • Seed & plant nursery • Habitat mitigation • Manage vegetation to reduce the need for irrigation, except at the initial stages of revegetation.
Place: • Visitor Learning Center • Tour Routes-all • Trails, observation overlooks including perimeter trail • Eagle Watch viewing area • Lakes, Wetlands, Havana Pond • Parking Overlooks	**Place**: • Visitor Learning Center • Tour Routes-all • Trails, observation overlooks, including perimeter trail • Eagle Watch viewing area • Parking overlooks • Lakes, Wetlands, Havana Pond • Outreach sites-schools	**Place:** • Visitor Learning Center Exhibit area • Visitor Learning Center classrooms • Tour Route-Northern • Nursery • Rattlesnake Hill • Active site restoration areas

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Media: • Exhibits-live and stuffed • Events and special tours • Signage (tactile) • Viewing scopes • Wildlife viewing structures (nature sound opportunities, parabolic disc) • Remote video camera • Models (feet, beaks) • Publications • Nature gift shop • Floating dock • Sculpture • Outdoor exhibits (prairie dogs, nightlife) • Video	**Media:** • Exhibits • Events and special tours • Publications • Signage • Viewing scopes • Wildlife viewing structures, etc. • Refuge education kit	**Media:** • Exhibits • Classrooms • Events and special tours • Publications • Seed packets • Signage

Theme C: Ecosystem Connections
Nature consists of dynamic and interrelated systems.

Subtheme: Although it is an urban open-space island in some respects, the Refuge is part of a bigger ecosystem which requires special management practices to maintain the vitality and diversity of the wildlife species present.

Pre-Settlement Shortgrass prairie Message: • Historically, short-grass prairie were the dominant plant community here. The conditions which create prairie include extreme heat, dry conditions, mixed with extreme cold temps., wind and soils. The prairie ecosystem supports diverse wildlife (raptors and prairie dogs). The decline of one species will have an impact on other populations. Grazing (by native ungulates and rodents) and fire (natural and anthropogenic) are important components of maintaining this ecosystem. Water is life in the arid west. Where was water found and how did it affect wildlife distribution? The benefits of indigenous species are not just to support wildlife.	**How settlement changed Prairie ecosystem Message:** The settlement era changed the prairie ecosystem resulting in changes for wildlife. The diversity of wildlife is directly related to the water resources found here as a result of building irrigation ditches and lakes. The upland tree habitat is another example related to water resources. The quality of the grassland community has changed which has changed the quality of the habitat. Prairie Grassland is the most threatened type of habitat in N. America. The restoration efforts are expensive and time consuming. Many of the species here now have relatively poor root systems and would not hold up well in another dust bowl situation.	**Wildlife Management objectives Message:** The Refuge need to be managed for both wildlife and people. An open space island requires some special management practices in order to maintain genetic diversity and variation. With the exception of deer (antelope and bison if reintroduced), most other wildlife are able to move off the Refuge. Fluctuating wildlife populations are the norm, but habitat preservation is vital to preserving species. The Refuge is a migratory stopover for many bird species and will become even more important as more habitat is lost through development on the front range.

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Visitor Experience: • The big picture is gained through the Visitor Learning Center complex from exhibits (indoor and outdoor), videos, classes in environmental education center. • Native prairie exhibits offer the chance to see short-grass prairie • Visitors/environmental education classes will be able to view revegetated areas along the tram route (northern) • Visitors can see native seedlings being propagated at the Nursery • Participation in special events like *Prairie Days and Bald Eagle Days* • Special outreach presentations by staff personnel • Guided tours of the northern portion of refuge with views of the prairie, prairie dog towns, and prairie wildlife • *Visitors will be able to tour through a* prairie dog burrow exhibit • Environmental education programs compare conditions in grassland communities with those in other plant communities and promote value of grasslands • Prescribed burns can be used to demonstrate role of fire in resettlement times • Visitor will see how plants and wildlife have adapted to living in arid environment from tour route	**Visitor Experience:** • The big picture is gained through the Visitor Learning Center. Complex from exhibits, classes, videos • Guided tram tours will point out grassland areas that have been restored and areas that have not which will enable the visitor to better understand how the ecosystem changed • Guided tram tour of both the northern/southern zone and vantage points/dioramas demonstrate the effect of bringing water onto the site and the diversity of wildlife species as *a result of bringing in water* • Trails will take visitors through various habitats/areas demonstrating landscape changes • Perimeter detention ponds demonstrate effect of urban runoff onto the Refuge • Special outreach programs will be conducted by staff • Visitors will see native seedling being propagated at the Nursery • Visitors/environmental education classes will be able to participate in revegetation work • Environmental education programs compare wildlife diversity among differing habitats. • Visitors will see the effects of fire suppression on the plant communities	**Visitor Experience:** • The big picture is gained through the Visitor Learning Center complex from exhibits, classes, videos, orientation desk, etc. • Environmental Educationclasses will be able to join wildlife managers in research such as deer counts, creel census, etc. • Visitors/Environmental Educationclasses will be able to see wildlife managers performing biomonitoring duties • Visitors/Environmental Educationclasses will be able to watch *wildlife management activities going on* in research lab • Guided tours show/tell how wildlife is influenced by man's presence, the encroachment of development, and the importance of water/upland trees are to migrating birds, and how the Refuge is an open-space island • Visitors will be able to view eagles roosting from Eagle watch and understand the importance of first Creek as a riparian corridor • Visitors will experience what life is like in a prairie dog burrow • Trails will offer vantage points into mitigated wetlands, water detention ponds etc. • Outreach programs will be conducted by staff personnel • Prescribes burn areas will demonstrate importance of fire to maintaining the ecosystem.
Correlated Management/ Research/Facilities/Activities: • Reclamation & revegetation. • Seed & plant nursery • Grazing and the use of fire as management tools.	**Correlated Management/ Research/Facilities/Activities:** • Reclamation & revegetation. • Seed & plant nursery • Habitat mitigation • Maintain habitat quality and quantity even if non-sustaining methods and non-indigenous species/materials are used. • Management of Endangered, Threatened & Candidate species. • Monitoring population trends. • Wildlife population control - culling, introductions / translocations. • Manage vegetation to reduce the *need for irrigation, except at the initial* stages of revegetation.	**Correlated Management/ Research/Facilities/Activities:** • Form partnerships with adjacent landowners to manage habitat & wildlife beyond the refuge boundaries. • Aim to participate in planning for physically connecting the refuge with adjacent open space - Stapleton, Barr Lake, Sand Creek, S. Platte. • Encourage groups such as *trails and* greenways organizations to forge connections to the refuge boundaries. Become active in realizing the Emerald Strands plan (a regional trails plan) and help influence its quality as wildlife *habitat throughout that plan area.*
Place: • Visitor Learning Center, outdoors, classrooms • Guided tours (northern) • *Eagle Watch* • Prairie dog exhibit area • Nursery • Rattlesnake Hill • Quad • Outreach sites • Events areas	**Place:** • Visitor Learning Center, outdoors, classrooms • Guided tours (southern emphasis) • *Lakes, Wetlands* • Trails • Perimeter viewing areas • Havana Pond • Detention Ponds • Outreach sites • Events areas	**Place:** • Visitor Learning Center exhibits, classrooms, research lab • Research lab (Bldg. 111) • *Nursery* • Northern/Southern tram routes • Lakes/wetlands/quad • Eagle Watch • Trails-interp. facility • Havana Pond • Perimeter Overlooks • Detention Ponds • Outreach Sites (special emphasis) • Events areas • Restoration areas including any prescribed burn areas

Media:	Media:	Media:
• Exhibits-indoor/outdoor • Prairie dog burrow exhibit • Prairie root exhibit • Interp. facilities • Eagle Watch • Guided Tours • Special Events • Scopes • Models • Tactile signage	• Exhibits-indoor/outdoor • Prairie dog burrow exhibit • Guided/self-guided hikes with interp. facilities (signs, info) • Special events • Scopes • Models, dioramas • Tactile signage	• Exhibits • Publications • Guided/self guided hikes with interp facilities (signs, info) • Wildlife viewing structures • Scopes • Models • Tactile signage

Theme D: Consequences and Responsibilities
Understanding and working with natural process is more responsible and efficient in the long run.

Overall Subtheme: People's actions are not just local in effect. People's lifestyle choices can either hurt or help the environment. The costs of cleanup and restoration are borne by the people.

Consequences Subtheme: The post-1942 activities that occurred at the Arsenal had both positive and negative consequences for the local people and the nation.

Consequences of War Message:	Consequences of Chemical Manufacturing Message:	Consequence of Cleanup Message:
• The total cost of the war/cold war era was tremendous. Across the country, we have many of these facilities. We are now deciding to what degree we can afford to clean them all up. • There was a tremendous human effort that went into the war, and the arsenal played a major role locally in this effort. It brought women in the work force, provided economic benefits, and employed thousands of people • What went on here had a great impact on the communities-employment, displacing people, sense of fear of chemicals • The war unified the country toward the mission of war • There are tremendous costs associated with dismantling this place	• It caused long-term soil pollution and affected wildlife health • It caused long-term water pollution and contaminated the groundwater in the region (people on bottled water, affected crops) and impacted wildlife • It will never be the same again • Pesticides created a boom in farming • Large scale waterfowl die-offs occurred	• The total costs to clean up this site over period of time (Superfund, CERCLA, RCRA) • The pollution cannot be completely cleaned up to everyone's satisfaction due to current technology and the costs involved • It caused a lot of turmoil for the public industry including fear and lack of trust • The consequences of this being a Superfund site including the restrictions on hunting, the 815 acres It is being protected as a wildlife refuge and not developed • The ground water treatment systems have to be maintained indefinitely (lake levels)

Responsibility Subtheme: We have responsibility to turn the Arsenal into a National Wildlife Refuge for both people and wildlife

War Responsibilities:	Chemical/By-products Responsibilities:	Cleanup Responsibilities:
• The site is being converted from a military site into a National Wildlife Refuge. Production ceased in 1982 when demilitarization and cleanup became the focus • Project Eagle got rid of the nerve gas • The army did take action to begin cleaning it up • There's much recycling of parts (copper, SQI facility, steel)	• The site became a priority to begin cleaning it up (Superfund, CERCLA) • If we produce chemicals for war/pesticides in the future, we must ensure we understand the consequences and know how to contain/destroy the by-products	• The Arsenal is on the forefront of a massive and complex cleanup • People have a continual responsibility to get involved in what government and private industry are doing in our communities • It takes the whole community to clean it up • It's being cleaned up with the future Refuge in mind • Biomonitoring will go on for a long time • The land is being restored back to prairie and natural habitat

Visitor Experience: • Visitors will experience what the war years were like here in the Visitor Learning Center setting (visual reality exhibit) • Visitors should come out with a sense of fear and the power of the place (i.e. seeing a canister of nerve gas that will kill thousands/millions of people) from both the Visitor Learning Center experience and going out onto the site • The feeling for the vastness of the site and the need for buffers can be had from vantage points • Vantage points can be used to demonstrate how the Arsenal was once located away from the community and now the community surrounds it • Visitor's will be able to see what was here through dioramas and remaining artifacts from vantage points • Visitor's will experience what military life was like from remnant places like Officer's Row, Rod and Gun Club, etc.	**Visitor Experience:** • Visitor's will get the big picture of the positive and negative consequences of pesticide and chemical use in the Visitor Learning Center setting • Vantage point overlooking basins using videos or dioramas can show how pesticides/chemicals were disposed of into the basins • Guided tram tours can stop at point along the route where through icons or panels, visitor's get a sense of how the site was polluted	**Visitor Experience:** Visitors will experience the safety aspects of cleanup in the Visitor Learning Center setting (i.e. be able to slip into the front half of a white suite and mask) • Visitor's will be able to see ongoing research in the lab • Visitor's will see how the ground water is being treated along the tram route at the groundwater treatment facilities • Interpretive sites along the guided tours will give the visitor vantage points of the cleanup
Correlated Management/ Research/Facilities/Activities: • Maintain historical sites and artifacts	**Correlated Management/ Research/Facilities/Activities:** • Water detention, detritus and pollutant filtration. • Wastewater wetland treatment demonstration area. • Judicious use of pesticides and inorganic fertilizers. • Maintain historical sites and artifacts	**Correlated Management/ Research/Facilities/Activities:** • Biomonitoring - sentinel species. • PMRMA project technical assistance. • Reclamation & revegetation. • Seed & plant nursery • Habitat mitigation
Place: • Visitor Learning Center • Rattlesnake Hill • Henderson Hill Overlook • Northern Tram Route • Perimeter Trail	**Place:** • Visitor Learning Center • Rattlesnake Hill • Northern Tram Route • Southern Tram Route	**Place:** • Visitor Learning Center • Rattlesnake Hill • Henderson Hill • Perimeter Trail • Tram Route (northern)
Media: • Exhibits • Dioramas • Models • Brochures • Videos • Artifacts • Sculptures • Panels (signs) • Guided tours	**Media:** • Exhibits • Dioramas • Models • Brochures • Videos • Artifacts • Sculptures • Panels (signs) • Guided tours	**Media:** • Exhibits • Groundwater treatment facilities • Dioramas • Models • Brochures • Videos • Artifacts • Sculptures • Panels (signs) • Guided tours

Theme E: Stewardship
The USFWS, in serving as the Refuge's stewards must carefully manage the resources of the refuge and its visitors

Subtheme: The USFWS is mandated to manage the Refuge for wildlife and people

Mission of the USFWS Message: • The Refuge is part of a national system of lands managed for wildlife purposes by the USFWS • Environmental Educationis a primary focus of public use at the Refuge	**Part of the Community Message:** • Outreach programs, volunteer, and "Friends" activities and the development of a regional trail system around the Refuge help to blur the edge between the surrounding neighborhoods and the Refuge Gateway is a demonstration of community projects that work	**Take Responsibility Message:** • People have to realize that they need to take responsibility for their own action on the land • People must realize how what they do at home impacts the Refuge (what they dump down their drains) • The Refuge will demonstrate good stewardship practices in how it handles energy and waste disposal systems • The Gateway partnerships will be geared toward science and technology and will demonstrate sound

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Visitor Experience: • Visitors will see that there are solutions to the problems, and that people are part of it both at the Visitor Learning Center Setting and out in the Refuge • Visitor's will experience being out with biologists and other USFWS personnel and getting to know the agency • Environmental Educationprograms will provide hands on experience • People can learn more about the USFWS by becoming a volunteer -Outreach programs will make the USFWS more visible in the public eye	**Visitor Experience:** -The Gateway and learning center will reflect the community spirit -Environmental Educationprograms will involve the community -People can gain experience by being a volunteer -Outreach programs will be geared to serving the community needs	**Visitor Experience:** -Big picture in the Visitor Learning Center setting that there is a solution and it's up to people to make it happen -People will experience the importance of the grassland/prairie dog ecosystem -People will experience how water quality is affected by their actions at home along the perimeter -People will see how development affects both quality and quantity of water -People will see recycling/sound conservation practices going on both in the gateway and out in the Refuge -People can gain experience by being a volunteer
Correlated Management/ Research/Facilities/Activities: • Demonstrate how the FWS maintains international treaties and manages migratory wildlife • Integrate hands-on environmental education with all aspects of Refuge research and management.	**Correlated Management/ Research/Facilities/Activities:** • Promote the recognition and management of ecological rather than political or legal units, such as watersheds • Form partnerships with adjacent landowners to manage habitat & wildlife beyond the refuge boundaries. • Encourage groups such as trails and greenways organizations to forge connections to the refuge boundaries. Become active in realizing the Emerald Strands plan (a regional trails plan) and help influence its quality as wildlife habitat throughout that plan area. • Aim to participate in planning for physically connecting the refuge with adjacent open space - Stapleton, Barr Lake, Sand Creek, S. Platte.	**Correlated Management/ Research/Facilities/Activities:** • Water detention, detritus and pollutant filtration. • Wastewater wetland treatment demonstration area. • Judicious use of pesticides and inorganic fertilizers. • Minimize the adverse affects of the human impacts by using appropriate technologies to treat wastewater, cool and heat buildings, provide transportation, recycle materials and utilize grey water. • Aim to integrate concepts such as the embodied energy of building materials into facilities development programs. • Manage vegetation to reduce the need for irrigation, except at the initial stages of revegetation.
Place: • Visitor Learning Center (Western Zone) • Ongoing research/restoration sites on the Refuge • Outreach Sites • Environmental Educationsites- wetlands, lakes, quad, temporary sites • Research lab • Nursery • Maintenance/Administrative facilities • Eagle Watch	**Place:** • Visitor Learning Center (Western Zone) • Outreach Sites • Environmental Educationsites- wetlands, lakes, quad, etc. • Perimeter Trail-detention ponds • Havana Pond • Bald Eagle Shallows	**Place:** • Visitor Learning Center (Western Zone) • Outreach Sites • Environmental Educationsites- wetlands, lakes, quad, etc. • Perimeter trail-detention ponds • Perimeter groundwater treatment sites • Guided tour • Eagle Watch • Havana Pond • Bald Eagle Shallows
Media: • Exhibits • USFWS facilities • Publications • Video • Restoration/research sites • Volunteer program • Special events • Teacher education kits	**Media:** • Newsletter/publications • Volunteer program • Teacher education kits • Interp. facilities (signs, etc.) • Special events	**Media:** • Publications/newsletters • Community projects • Special event (on/off refuge) • Volunteer program • "Friends" program • Teacher education kits • Interp. facilities

APPENDIX D: ROCKY MOUNTAIN ARSENAL NATIONAL WILDLIFE REFUGE PLANNING TEAM AND PROJECT PARTICIPANTS

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APPENDIX E: RELATED DOCUMENTS

The Comprehensive Management Plan provides a summary of the most important aspects of bringing the Refuge into being. More detail may be found in the following reports, all of which may be reviewed at the Refuge (303-289-0232).

Final Environmental Impact Statement. 148 pages (plus appendices) describing the alternative refuge plans developed during the planning process and the potential environmental impacts of implementing each plan. Also provides a detailed discussion of the characteristics of the Refuge's environment.

Public Use Plan. Describes a framework for public use of the Refuge in educational, interpretive, and recreational programs and activities. Also details the Refuge storyline.

Final Refuge Program. Gives a detailed analysis of each major facilitiy that is part of the Refuge plan.

Project Worksheets. Profiles the character, techniques, and costs of each major project associated with the Refuge plan.

Map Atlas. Contains 20 inventory and analysis maps from the planning process.

Printing - Moser Printing Inc., Englewood, Colorado