RECLAMATION

Managing Water in the West

Brantley and Avalon Dams
Integrated Vegetation Management Plan

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MISSION STATEMENTS

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

The mission of the Bureau of Reclamation (BOR) is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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Management Units

Carlsbad Project

The Carlsbad Project is in southeastern New Mexico near Ft. Sumner and Carlsbad. The Carlsbad Project stores water in Santa Rosa (a Corps of Engineers Dam), Sumner, Brantley, and Avalon Dams to provide water for about 25,000 acres within the Carlsbad Irrigation District. Project features include Sumner Dam and Lake Sumner (formerly Alamogordo Dam and Reservoir), McMillan Dam (breached in 1991 and replaced with Brantley Dam), Avalon Dam, and a drainage and distribution system to irrigate 25,055 acres of land in the Carlsbad area.

Located in the Chihuahuan Desert, the Carlsbad Project area exhibits mostly sun-drenched days during the 212-day growing season. The water supply for the Project comes from the Pecos and Black Rivers. The Carlsbad Project was one of the earliest Reclamation projects and is significant as a surviving example of mixed 19th and 20th century technology. Many features of this project are listed on the National Register of Historic Places.

The Project provides for regulation and storage of irrigation and flood water in Lake Sumner, and Avalon Reservoir, with diversion of water from Avalon Reservoir into a canal system to irrigate project lands on both sides of the Pecos River near Carlsbad.

Brantley Dam and Reservoir

Brantley Dam is on the Pecos River about 13 miles upstream from the city of Carlsbad, New Mexico. It is about 10 miles upstream from the Avalon Dam. These dams are part of the Carlsbad Project.

The Brantley Project area extends about 16.5 miles above the dam site. The Pecos River watershed is in a semi-arid region. Average annual precipitation in the Pecos River Basin varies from about 10 inches near Pecos, Texas, to greater than 33 inches in the higher mountain elevations of northern New Mexico.

The main purpose of this dam is to replace McMillan Dam, which was declared unsafe. Dam safety evaluations in 1964 of McMillan and Avalon Dams showed that a large flood could exceed the existing spillway capacity of McMillan Dam and overtop the structure. Brantley was designed and construction relocations started in 1983. Additional benefits include irrigation, flood control, fish and wildlife enhancement, and recreation.

Brantley Dam is comprised of several dams:

- The main dam is a concrete gravity section 730 feet long and 143.5 feet high above the streambed with a roadway elevation at 3,308.5 feet above mean sea level. The main dam contains the outlet works and the spillway.
- The east wing dam is an earth and rockfill section 730 feet long with a maximum height of 150 feet where it crosses the Pecos River. The crest width is 24 feet, and the crest elevation is 3,308 feet above mean sea level.
- The west wing dam is an earth and rockfill section 8,020 feet long with a maximum height of 120 feet where it ties to the main dam. The crest width is 24 feet, and the crest elevation is 3,308 feet above mean sea level.

The outlet works consist of two four-foot-square conduits controlled by tandem hydraulic slide gates. The invert elevation is 3,210.7 feet mean sea level with a design capacity of 1,450 cubic feet per second at reservoir elevation 3,259.5 feet mean sea level and a maximum capacity of 1,800 cubic feet per second at water surface elevation 3,283 (the top of the flood control pool).

The spillway is part of the central section of the main dam. It has six gated bays, each 50 feet wide. Six radial arm gates (tainter gates) control spillway discharge. Each radial arm gate is 50 feet wide by 25.24 feet high. Crest elevation is 3,259.5 feet mean sea level. At the maximum water surface elevation of 3,303.5, the spillway capacity is about 357,000 cubic feet per second.

A low flow outlet works is to the left of the spillway on the downstream side of the dam. This structure ensures a minimum flow of 20 cubic feet per second in the portion of the river between the dam and the junction with the spillway channel. The structure consists of a 36-inch diameter concrete pipe between the stilling basin and the old Pecos River channel.

Carlsbad Irrigation District operates and maintains Brantley Dam for irrigation releases.

Avalon Dam and Reservoir

In addition to forming a small storage and regulating reservoir, Avalon Dam serves as the diversion dam for the project by diverting water into the Main Canal. The dam is located on the Pecos River five miles north of Carlsbad, New Mexico. The dam is a zoned earthfill structure that was constructed by private interests in 1888. The dam washed out in 1893 and, after reconstruction, was washed out again in 1904 by the Pecos River flood. The Reclamation Service rebuilt the dam in 1907. The height of the dam was increased in 1912, and again in 1936. The dam now has a structural height of 60 feet and a volume of 202,000 cubic yards. This is an earthfilled structure 1,360 feet long and 53 feet high. There are three spillways and an outlet works. The original reservoir storage capacity was 7,000 acre-feet; a 1996 resurvey showed a capacity of 4,466 acre-feet at the top of conservation pool.

Purpose and Need

The purpose of this plan is to outline the objectives, management alternatives, short- and long-term Integrated Vegetation Management (IVM) strategies, control techniques, mitigations and best management practices (BMPs), and monitoring and follow-up actions to remove undesirable plant species.

Dam Faces and Structures: Management of vegetation on the faces of the dams is necessary for the following reasons:

1) To allow for proper surveillance and inspection of the structures and adjacent areas for seepage, cracking, sinkholes, settlement, deflection, and other signs of distress

2) To allow adequate access for normal and emergency Operation and Maintenance (O&M) activities

3) To prevent damage to the structures due to root growth, such as shortened seepage paths through embankments; voids in embankments from decaying roots from dead or damaged trees; expansion of crack or joints of concrete walls, canal linings, or pipes; and plugging of perforated or open-jointed pipes

4) To discourage animal/rodent activity by eliminating the food source and habitat

5) To allow adequate flow-carrying capacity of water conveyance (e.g., spillway inlet and outlet channels; open canals, laterals, and drains).

- **Riparian Areas on the River and Lakebeds**: The long-term view for management of vegetation in the lakebeds is to reduce the extensive infestations of invasive plant species and re-establish native vegetation like grasses and shrubs.

Objectives and Standards

Objectives

Managers must clearly define the resource objectives they want to achieve before an IVM strategy can be developed. The IVM objectives for Brantley and Avalon Dams and the lakebeds follow:

- **Dam Faces and Structures**: The objective is to remove all trees and shrubs that would interfere with the inspection of the dam faces and structures or compromised the structural integrity of the dam.

- **Riparian Areas on the River and Lakebeds**: The objective for the lakebeds, especially the McMillan Lakebed, is to study and develop methods to remove dense stands of saltcedar and kochia (*Kochia scoparia*) and eventually begin implementation to remove the invasive plants and re-establish native vegetation, especially grasses and shrubs. Another objective will be to initiate control of infestations of other invasive plant species immediately following detection.

Standards

The following IVM standards were established based on the assumptions that they are obtainable and measurable.

1) **Control Effectiveness**

   - **Annual Control Standard**: Annual treatments must show a strong potential for success, i.e., 80 percent or higher control of selected plant species.

   - **Long-term Standards**

     - **Dam Faces and Structures**: After 2 years of annual treatments, only 1 to 4 percent of the original number of undesirable plants will remain or invade the dam faces, which will require minimal follow-up maintenance control on a periodic basis.

     - **Riparian Areas on the River and Lakebeds**:
       - Saltcedar: Over three years, at least 97 percent of the saltcedar population must be removed by aerial spraying to provide effective long-term control.
       - Kochia: Annual control will be required due to re-invasion from the extensive infestations adjacent to the lakebeds. Successful treatment is defined as the area needing control which will not exceed 20 percent of the area treated in the previous year.
       - Other invasive plant species: Following detection and control, the standard is 100 percent removal.
       - Re-vegetation: At least 80 percent of treated sites must be able to be re-vegetated with native plant species. The Department of Interior (DOI) Strategic Plan for 2003 to 2008 includes the goal to "sustain biological communities on DOI managed lands and waters in a manner consistent with obligations regarding the allocations and use of water."

2) **Efficiency**: The standard will be to select control methods that provide the maximum level of control at the least cost.

3) **Environmental Acceptability**: The standard will be to prevent or mitigate any adverse environmental effects associated with implementation of vegetation management methods. Prior to any on-the-ground vegetation management, an environmental analysis must be completed and approved.

4) **Cooperation**: The standard for cooperative agreements is to obtain approval of all involved parties prior to implementing vegetation control treatments.

5) **Mitigations and Best Management Practices (BMPs)**: The standard is to ensure that vegetation control, especially the use of herbicides, is done in a quality manner in compliance with policy and law. Pesticide applicators will be trained to ensure that they understand established mitigations and BMPs.

6) **Monitoring and Records**: The standard is to maintain adequate records to assess the effectiveness of treatments. Project records will include the following elements:

- Date of application
- Undesirable plant species
- Control technique(s) used
- Common name of herbicide(s) used
- Description of formulation or tank mix
- Application method (aerial, backpack, etc.)
- Quantity (ounces/pounds) of herbicide used
- Weather conditions (highest temperature, average wind speed, precipitation, etc.)
- Estimate of acreage treated
- Estimate of annual treatment success

7) **Oversight**: The standard is to ensure that annual oversight and documentation of the IVM program is completed to determine if the management objective was met; treatments complied with standards, mitigations, and BMPs; and actions were in compliance with policies and law.

Identification and Description of Undesirable Plants

1) Saltcedar (*Tamarisk* spp.): Saltcedar is an exotic plant that is in the tamarisk family (Tamaricaceae). It is a deep-rooted deciduous shrub or small tree that can reach up to 25 feet in height. It is highly invasive and forms dense stands that supplant native species. Individual trees can produce up to half a million seeds in a season, which can start in late April and extend until October. In 2004, Saltcedar occupied approximately 6, 172 acres on the Carlsbad Project land around Brantley and Avalon Reservoirs. The stem of saplings is reddish-brown, and the leaves are small and scale-like, on highly branched slender stems. Root growth is predominantly downward with little branching until

plants reach the water table, and root depth can exceed 50 feet. Saltcedar trees readily form sprouts following cutting or burning of the above ground portions of the plant.

2) Honey mesquite (*Proposis glandulosa)*: Honey mesquite is a deep-rooted, thorny shrub or small tree. It is in the pea or legume family (Fabaceae). The species is native to New Mexico. Honey mesquite can develop into a tree 25 feet tall and 30 feet wide, but it often remains a shrub, especially under the stressful conditions that are common in the deserts areas of southern New Mexico. The bright green fernlike leaves are 4 inches long, with small individual leaflets. Among the foliage are thorns, which vary from ¼ to 1 inch long. Honey mesquite is deciduous during the winter. The sweet-smelling flowers are crowded together into fuzzy spikes. They bloom predominantly in April and May. The straw-colored leathery pods are about 5 inches long and the seeds ripen in early July. Birds, small mammals, and cattle readily feed on the seeds. In fact, an acre of mesquite range can produce more pounds of rodents than beef. The seeds also were an important food source for native peoples. Modern-day Southwesterners have a love-hate relationship with mesquite. City dwellers love the flavor that mesquite charcoal gives to their steaks, while ranchers seek to control it to improve rangelands. Since this species will readily sprout from roots, control cannot be achieved by cutting trees or using fire to remove the above ground portions.

3) White thorn (*Acacia constricta*): White thorn is a member of the pea family (Fabaceae), and it is a native species. It is a spreading shrub with medium green, lacy foliage and conspicuous, ½-inch long white spines. At maturity, it can reach 10 feet high and 15 feet wide, but shrubs are more commonly about half that size in southern New Mexico. The compound leaves are usually about an inch long and half as wide. In late spring, this shrub has yellow-orange, ball-shaped, fragrant flowers. Pods of white thorn are reddish brown, curved, about 4 inches long, and constricted between seeds. Its habitat includes washes, gravelly plains, and rocky hillsides, between 1,500 to 6,500 feet in elevation. This shrub is very drought tolerant and it will sprout if the aerial portions are cut or burned.

4) Catclaw acacia (*Acacia greggii*): Again, this native shrub is a member of the pea family (Fabaceae). It is a shrub that grows to about 6 to 7 feet in southern New Mexico and often occurs in thickets along desert washes, flats, and rocky hillsides. The feathery, gray-green foliage is winter-deciduous and the leaves will drop during periods of extreme drought. Scattered along the gray branches, partially hidden by the leaves, are the short, curved spines that give this shrub its common name. Fuzzy, pale yellow flower spikes are about 2 inches long and they perfume the air in the spring. Rust-colored pods are flat to twisted, usually reaching about three inches long. This species grows in hot desert areas and it is very drought tolerant. Cutting or burning of this shrub will stimulate sprouting and result in thickets of this species.

5) Yerba-De-Pasmo (*Baccharis pteronioides*) and willow baccharis (*B. salicina*): Both of these plants are small to medium shrubs that are common in southern New Mexico. They are in the sunflower family (Asteraceae). They are commonly found in dry, hilly country, along roadsides, and on open or overgrazed rangelands. The leaves are small, linear, with toothed or serrated edges. Both species produce light, cream-colored flowers that occur through the growing season. Although it is assumed that these shrubs will produce sprouts if cut, no information was found to confirm this suspicion.

6) Rabbitbrush (*Ericameria* sp.): Several species of rabbitbrush, which are in the sunflower family (Asteraceae), occur in southern New Mexico. They are medium-size, woody shrubs, with light green foliage. They commonly occur along dry stream beds, along the sides of roads, and on dry plains. They have yellow flowers that occur in the fall. This shrub will readily sprout following removal of the aerial portions by cutting or burning.

7) Creosote bush (*Larrea tridentate*): This plant is in the caltrop family (Zygophyllaceae). It is one of the most common shrubs of Southwestern deserts. It grows in loose, well-drained soil on dry plains, mesas, and slopes. It is extremely drought tolerant and will sprout from roots if cut. It has tiny resinous olive-green leaves that occur at the ends of along, twisted, gray stems. The typical shrub is about 6 feet high and 8 feet wide. Small, yellow flowers sprinkle the foliage and occur through the year, although they are most abundant in the spring. It will sprout if cut or burned.

8) Feather dalea (*Dalea Formosa*): This member of the pea family (Fabarceae) is a low, rounded shrub that often grows less than a foot tall and 2 feet wide. It is semi-evergreen, and the leaves are divided into many tiny, light green leaflets. The magenta flowers occur in clusters that seem outsized for the plant, like blossoms on a bonsai plant. The blooming season extends from March to September, with the heaviest flowering in spring. This species is widely distributed in Southwestern deserts. It usually grows on gravelly or rocks slopes, and was found on Brantley Dam.

9) Narrowleaf yucca (*Yucca* sp.): This member of the agave family (Agavaceae) is most abundant on desert plains, hills, and grasslands. The blue-green leaves are about 2 feet long and an inch wide and terminate in a sharp point. A tall, slender flower stalk emerges from the foliage in late spring and eventually opens into a showy cluster of white bell-shaped flowers. The plant can be killed by grubbing if it is cut several inches below the ground level.

10) One-seeded juniper (*Juniperus monosperma*): This small tree is a member of the cypress family (Cupressaceae). It is one of the more widely distributed woody plants in New Mexico, and it is common at the lower elevations of pinyon/juniper woodlands. It also can be found in lower elevation desert sites.

It has shreddy bark on the trunk, and the scale-like leaves have many branches. The soft, bluish berries, which are actually cones, since junipers are conifers, have one seed. This tree is not able to sprout following cutting.

11) Netleaf hackberry (*Celtis reticulate*): Netleaf hackberry, a deciduous tree, is found along watercourses. It is a member of the elm family (Ulmaceae). Distinctive features include the strongly veined pattern on the undersides of leaves, and the warty appearance of the leaves caused by small green galls that disfigure them. The orange fruits also are distinctive. It is not known if this tree will sprout following cutting.

12) Ash (*Fraxinus* sp.): A few scattered ash trees were observed in the riparian zone below Avalon Dam. They are probably velvet ash (*Fraxinus velutina*), although this species will hybridize with green ash (*Fraxinus pennsylvanica*). Ash species are in the olive family (Oleaceae). The trees may be removed by cutting. However, since they are not expected to be invasive, there probably is no need to remove them.

13) Mulberry (*Morus* sp.): A mulberry tree (mulberry family, Moraceae) was found in the riparian zone below Avalon Dam. It may be a native species (Texas mulberry, *Morus micorphylla*) or an exotic species, either red mulberry (*Morus rubra*) or white mulberry (*Morus alba*). Mulberry trees are medium size trees that are deciduous. They have juicy and sweet fruits that attract birds. Again, cutting will effectively control the tree.

14) Prickly pear (*Opuntia* sp.): Prickly pear species are members of the cactus family (Cactaceae). There are four prickly pear species that have yellow flowers that are known to occur in southern New Mexico. This plant can to effectively controlled by grubbing.

15) Buffalo bur (*Solanum rostratum*): This native annual, which is in the nightshade family (Solanaceae), is widely distributed in the West. It is drought resistant, but it is not highly competitive. It grows to 2 feet high, and the leaves are deeply lobed and covered with spines. The stems and fruits also have spines. The 5-lobed, yellow flowers are common throughout the summer. This plant can be abundant on disturbed sites. It is easily controlled by hand grubbing or by herbicides.

16) Kochia (*Kochia scoparia*): This plant is a member of the goosefoot family (Chenopodiaceae). It is an annual broadleaf weed that reproduces only by seed. Kochia can grow up to 10 feet tall under favorable conditions. The leaves are lance-shaped and ½ to 2 inches long. The upper surface of leaves is smooth and the lower surface is usually covered with soft hairs. Flowers are inconspicuous. Flowering and seed production is from July to October. Each plant can produce as many as 15,000 to 25,000 seeds per plant, but most seeds are short-lived and die within the first year. Therefore, most kochia problems result from plants

that set seed the previous year. Kochia germinates in the early spring. Roots can penetrate to a depth of 100 feet or more in the soil; thus, this explains its ability to withstand drought and also explains why kochia is a dominant weed during drought years. This plant is a native of Europe and is found throughout North America. In the West, it is common in cultivated fields, roadsides, waste areas, and riparian sites along the Pecos River, especially sites with bare ground. When the plants are young, livestock will readily feed on it, but mature plants are not as attractive as a food source.

17) Longspine sandbur (*Cenchrus longispinus*): A native of Europe, longspine sandbur is a warm-season grass (grass family, Poaceae). This plant will grow in cultivated fields, pastures, and waste areas, but it favors sandy or well-drained, gravely soils. The mature burs are a nuisance to humans, but they are particularly troublesome to livestock and wildlife. The plant can be controlled by hand pulling, grubbing, or spraying with herbicides.

18) Silverleaf nightshade (*Solanum elaeagnifolium*): A member of the nightshade family (Solanceae), this is a perennial plant that can spread by rhizomes or seeds. It often grows to a foot tall, although this plant can grow to 3 feet tall under favorable conditions. The leaves and stems are covered with dense short hairs that give the foliage a silvery appearance. The leaves are narrow and lance-shaped. Flowers have five petals and are violet to light blue. The fruit is a yellow or dull orange berry, and they look like little tomatoes. This plant is a native to the central United States, but it has spread to New Mexico and has invaded rangelands, roadsides, croplands, and waste areas. Hand-pulling or grubbing of plants is ineffective, and persistence is needed to control it with herbicides.

Strategies

Management actions can be optimized by adopting a systematic approach such as Integrated Vegetation Management (IVM). Successful managers choose a variety of vegetation management options, such as prevention, containment, and control of invasive plants that have proven to be effective, economical, and environmentally acceptable. It must be realized when attempting to manage undesirable plants that sustained control efforts, including follow-up treatments, will be necessary to prevent reinvasion. However, follow-up maintenance treatments will require less effort each year they are implemented. Implementing a well planned strategic IVM approach, following 2 or possibly 3 years of treatment, maintenance treatments will only need to be done infrequently. A necessary component of IVM must be the maintenance or re-establishment of desirable vegetation on sites where control actions have been implemented.

Different strategies will be needed to address undesirable plant problems on the dam faces and structures and the lakebeds.

- **Dam Faces and Structures**: The treatment goal is to remove all trees, shrubs, and other undesirable plants on dam faces, roadsides, and near the spillways or near structures that have the potential to cause damage or interfere with access or inspection operations. After 2 to 3 years of treatment, maintenance treatments will only need to be done infrequently to remove a few plants that invade the dam faces. One-seeded juniper and other trees that do not sprout can be effectively removed by cutting them as close to the ground as possible. Hand-grubbing of narrowleaf yucca and prickly pear cacti will provide effective and economical control of scattered plants. It is especially important to obtain root-kill of trees like saltcedar and honey mesquite, and the various woody shrubs. These trees and shrubs readily sprout; thus, they will need to be treated with herbicides to obtain root-kill. Low-volume oil basal and cut stump methods will need to be used. Foliar applications of herbicides would be the preferred technique to remove plants like buffalo bur, longspine sandbur, and silverleaf nightshade. The initial treatment will require the most work and cost, but subsequent treatments will involve significantly less effort and will only need to done infrequently. Re-vegetation of treatment sites on the dam faces is not needed since the objective is to maintain the dam faces free of trees, shrubs, or other plants.

- **Riparian Areas on the River and Lakebeds**:
  - **Saltcedar**:
    - **Mechanical Removal under the Pecos River Basin Water Salvage Project**: Since the 1960s, BOR has continued an annual program to mechanically treat approximately 33, 000 acres on the Pecos River in New Mexico to keep the sites free of saltcedar. This originally was a federally approved project between New Mexico and Texas. The Secretary of the Interior was to implement a continuing program to reduce the non-beneficial consumptive use of water in the Pecos River Basin, including the removal of saltcedar and other undesirable invasive species. The Texas portion was stopped in 1973 as a result of a lawsuit. Subsequently, the scattered treatment sites on both sides of the river have been maintained from Santa Rosa, New Mexico, to the State line of Texas. Treatment sites are distributed as follows: 40% south of Carlsbad, 40% north of Artesia just north of Roswell at the New Mexico State Game Refuge, and about 20% between Santa Rosa and Ft. Sumner Irrigation District. Under contract RO910 with the Carlsbad Irrigation District (CID), the sites are mechanically cleared of any new saltcedar growth each year, utilizing Reclamation equipment and labor furnished by CID.

- **Mechanical Removal along the Floodway in McMillan Lakebed**: Annually, a strip 6 miles long by 200 to 300 feet in width is mowed once or twice each year to assure passage of flood flows in case such an event might occur.

- **Aerial Application of Herbicide**: Dense stands of saltcedar over large acreages can be effectively controlled through the aerial application of imazapyr or a mixture of imazapyr and glyphosate. For optimal control, applications should be done from late August through September prior to foliar color change when plants are actively growing. These herbicides are slow acting and treated trees should not be removed for a period of 3 years to achieve the desired root kill. It has been found that over 97 percent of trees must be killed in a treatment area to provide long-term control results, and revegetation is usually required to obtain sustainable, long-term results. If there are any nearby or upstream stands of saltcedar, it must be realized that they will often lead to rapid reinvasion of treatment sites, especially if natural regeneration does not occur or artificial plantings do not result in adequate ground cover to offer some competition to the development of saltcedar seedlings.

o **Kochia**:

- **Mechanical Treatment**: To be effective, mechanical treatments have to remove all kochia plants in a project area before they set seed. Since the majority of kochia seeds are not viable for more than one year, preventing seed production by mowing can substantially reduce infestations the following season. The best time to mow plants is before they exceed 2 feet in height to reduce the amount of vegetative matter left on the ground. The combined biomass in treatment areas can present problems by clogging dam and irrigation structures. Cutting the kochia for feed would be another viable option. Kochia has been used as livestock feed during droughts. As a forage crop, kochia is noteworthy because it has good drought tolerance, salinity tolerance, good leafiness, high yields, and it has high protein and carbohydrate content. Kochia can, however, be harmful or toxic to cattle if it comprises more than 50 percent of their diet. Kochia contains toxic substances including saponins, alkaloids, oxalates, and nitrates. Animals that consume large amounts of this plant may exhibit a range of health problems and have lower weight gains. Since each plant can produce up to 25,000 seeds, all plants on selected sites will need to be removed. The initial treatment of the extensive infestations, such as on the McMillan lakebed, would be time-consuming and

costly. In addition, kochia infestations on adjacent sites may need to be controlled to prevent wind dispersal of seeds into the project area. The major difficulty associated with removal of the almost pure stands of kochia would be that there are no other plants present that have the capacity to occupy the treatment site. Bare ground would not be acceptable, especially since it is highly probable that the site would be occupied by another exotic plant species that could be more of a problem than kochia. Also, bare ground would be subject to creating dust storms during windy weather. Therefore, seeding is necessary to occupy the site and prevent invasion by undesirable plants. Without a viable revegetation option, mechanical removal is not a viable IVM option.

- **Application of Herbicides**: Several herbicides will effectively control kochia. Glyphosate, imazapyr, dicamba, pendimethalin, metsulfuron methyl, sulfometuron methyl, and 2,4-D products will work. If desirable grasses are present, selective herbicides like Escort (metsulfuron methyl), 2,4-D, or dicamba (Clarity or Banvel) will remove kochia and have little or no effect on the grasses. Arsenal (imazapyr) or Accord (glyphosate) are broad spectrum herbicides the can be used where bareground control would be acceptable. Glyphoste and 2, -D will likely be the most cost effective products to use. However, when glyphosate is used, ammonia sulfate (17 pounds/100 gallons of spray) must be added to prevent any potential antagonism (i.e., undesirable chemical reaction) with divalent cations in alkaline water common in New Mexico. The herbicides can be applied by on-the-ground power sprayers or by aerial application. Ground sprays work well on relatively flat ground where access is good and the equipment can be operated. Aerial application would be more cost effective for treating large tracts, especially where access may be difficult or impossible. The key to success in applying herbicides is to spray early when the kochia plants are small. This plant is the first to emerge in the spring and it is usually well advanced by the time other broadleaf weeds emerge. Good coverage is also important, and the more persistent products, such as Escort, will provide extended results. However, if there are no desirable plant species present to occupy the site and prevent invasion by undesirable species, the herbicidal option ends up having the same problems as the mechanical techniques. Again, more research is needed to examine revegetation options before the use of herbicides can be recommended.

- **Burning**: On sites where there are dense stands of kochia, fire could be used to remove the build up of dead vegetative material to

avoid the potential problem of clogging irrigation and dam structures. However, since the plants would not burn until they begin to dry out, seed production would already have occurred, and burning would provide acceptable control the following season.

Methods

The following are descriptions of the various methods that can be used to manage undesirable plants.

1) **Individual plant removal**: Hand grubbing of the relatively small number of narrowleaf yucca and prickly pear cacti on the dam faces would be an effective and economical control method. Likewise, excellent control of one-seeded juniper, netleaf hackberry, ash, and mulberry trees in the riparian area below Avalon Dam could be achieved by cutting them down with a chainsaw. Hand-pulling of buffalo bur plants would provide control, but this is only practical if there are just a few plants in a small area. For the other trees and shrubs, especially those that will sprout, individual plant removal would be exceedingly costly to implement (over $1,000 per acre) and mostly ineffective.

2) **Mechanical Control**:

- Saltcedar: For several decades, approximately 33,000 acres have been repeatedly treated to mechanically remove saltcedar under the Pecos River Basin Water Salvage Project. Repeated treatment was necessary because the sites remained mostly free of any vegetation and wind or water dispersal of seeds occurred from nearby stands of saltcedar. Since there is no evidence that the stated objective meets the IVM standards of being measurable and obtainable, continuation of annual treatments should be reassessed. Annual mowing of saltcedar along the McMillan floodway to keep the channel open is an effective option.

- Kochia: Even though kochia can be controlled by mowing or tilling, mechanical control is not a viable IVM option because of the uncertainty of being able to get natural or artificial revegetation with desirable plant species where treatments would be done.

- Preventing the introduction of invasive weeds: To avoid introducing invasive weeds, especially noxious weed species like Russian knapweed, heavy equipment must be cleaned with high-pressure water to remove seeds prior to using the equipment on the Pecos River.

3) **Aerial Application of Herbicides**:

- Saltcedar: Aerial application of imazapyr (Arsenal®) or a mixture of imazapyr and glyphosate (Accord XRT® or a similar product) will provide effective and economical control of dense stands of saltcedar. However, almost all of the trees must be killed (at least 97%) and revegetation is usually required to obtain sustainable, long-term results. Treatment of a portion of the saltcedar infestation would provide only marginal, short-term control results.

- Kochia: Several herbicides could be aerially applied to effectively control the extensive kochia infestations. However, since the standard is to revegetate the treatment sites with at least 80 percent native species, the DOI goal to sustain biological communities could not be met. Therefore, the aerial application of herbicides is not a viable IVM option until proven revegetation methods have been developed.

4) Low-volume oil basal herbicide application:

- Use: Garlon 4® (triclopyr), which is a general use herbicide, is recommended for this method. It will provide acceptable control of woody shrubs and trees, including honey mesquite, white thorn, catclaw acacia, and *Baccharis* species. This approach also can be used to treat netleaf hackberry, ash, or mulberry trees if they sprout following cutting. It is unknown if this method will provide control of creosote bush, but this method will not control rabbitbrush species. This method would provide effective control of shrubs and small trees that have stems with smooth bark and a stem diameter of about an inch at ground level. The estimated cost would be less than $100 per acre, including labor. The best time to do the treatment is late fall to early spring. Application should not be done if the stems are wet or there is a threat of rain.

- Equipment

  - Backpack sprayer: A 4-gallon backpack sprayer is the best equipment to treat individual shrubs or trees in hard to reach sites on the dam. A backpack sprayer with a diaphragm pump is recommended. Sprayers with piston pumps are not recommended due to their tendency to leak. A Swissmex SP1 and a Solo Model 475 are commonly used units that are relatively inexpensive. Chemical Containers, Inc., is a company that can provide assembled backpack units, spray guns and nozzles, and safety equipment (1-800-346-7867 or www.chemicalcontainers.com). A WCCI 210 Trigger Jet spray gun with a TP 1503 or TP 2503 flat fan spray tip will allow applicators to efficiently spray stem of shrubs or trees.

The use of trade or firm names in this plan is provided for information and does not imply endorsement by the Bureau of Reclamation

- Power sprayer: A truck, trailer, or ATV mounted sprayer with spray tank, 25-foot or longer hose, and spray gun can be used to treat shrubs and trees in reach of the road on the dam. A spray gun, such as a Model 30 Gunjet with a TP 1503 or TP 2503 spray tip, or a spray gun with an adjustable nozzle that applies an appropriate volume, will allow for proper application.

- Mixing: A 25 percent mixture of the Garlon 4® (triclopyr) in vegetable oil is recommended. Another product registered for industrial sites, which includes dams and adjoining sites, is Tahoe 4®. Triclopyr is a selective herbicide, which is especially useful for control of trees and woody shrubs. It acts by mimicking the activity of auxin, a natural growth hormone. It also is a systemic material that readily moves through the stems of treated trees or shrubs and then moves throughout the plant to the sites of growth where the herbicidal activity occurs. It has little or no herbicidal activity in soil and the average half-life in soil is 30 days. Triclopyr is categorized as slightly toxic to humans and animals. Herbicides can be obtained from the following companies: Helena Chemical in Artesia, New Mexico (505-365-2148 or www.helenachemical.com); or UAP Timberland in Las Cruces, New Mexico (505-525-8783 or www.upatimberland.com). The recommended oil is Improved JLB OIL Plus®, which is produced by Brewer International (1-800-228-1833 or www.brewerint.com). This product is a blend of vegetable oils plus limonene, which is a bark penetrant. Other oil products, such as Amigo® (twice refined soybean oil), can be substituted, but these products have not been tested and they may not provide the same level of control.

How to obtain a 25% mixture: Add 1 gallon (one part) of herbicide formulation to 3 gallons (three parts) oil.

- Spraying: Spray the herbicide/oil mixture evenly but lightly from the base of the stem(s) up to 12 inches above the ground. For small shrubs (below 2 feet), it is only necessary to spray about 3- to 4 inches above the ground. It is important to cover the entire circumference of the stem(s), but not to cause runoff or puddling. The oil helps the spray mixture to wrap around the stem(s) as it flows downward with gravity. Linonene helps the herbicide to move through the bark. Where there are many stems in a shrub, it usually is necessary to spray from 2 to 3 sides of the clump to ensure that all stems are sufficiently covered. Do not conduct treatments when the stems are wet from rain or snow. Water and oil do not mix, and the control results will not meet

the objective (80% or higher control). It is not necessary to use a marker dye in the spray. Treated plants are easy to detect, even months following spraying.

5) Low-Volume, Cut Stump Method:

- Use: This method involves a combination of mechanical and herbicide treatments to achieve root-kill of saltcedar and honey mesquite trees. The first step is to use a chain saw to cut the stems just above the ground. It is important to have well trained personnel to do the cutting, because chain saw use is inherently dangerous. Also, experienced chain saw operators are much more efficient. Cut surfaces need to be horizontal to the ground to allow the herbicide to soak into the cut surface and not run off. Prior to applying the herbicide mixture, all sawdust needs to be removed for the cut surface. A mixture of 50 percent Garlon 3A and 50 percent water yields adequate control results at the least cost. Garlon 3A is a product with a triethylamine salt of triclopyr that mixes with water. It is legal to use the formulation at full strength, but this is usually not necessary.

- Equipment: A one quart spray bottle is the most efficient and safe equipment to use to treat a relatively small number of cut stems. Spray bottles with chemically resistant Viton seals are recommended. They can be obtained from Chemical Containers, Inc., for about $3.00 per spray bottle.

- Mixing: A 50 percent mixture with an equal part of Garlon 3A and water usually provides acceptable control results. If it is found that this mixture does not provide adequate results, the percent of Garlon 3A can be increased, including a straight (100%) application of the product. To make a quart (32 ounces) of a 50 percent mixture, add one pint (16 ounces) of Garlon 3A to one pint of water.

How to obtain a 50 percent mixture for the cut stump method:
Add one part Garlon 3A to an equal part of water.

- Spraying: Immediately following the cutting of trees, remove the sawdust and spray the entire perimeter of the sapwood (lighter colored wood that conducts water) of the cut surface. The mixture will sink into water conducting tissues and will be moved to the growing center of the roots. On large stems that are 4 inches in diameter or larger, the darker colored heartwood is dead tissue and should not be spayed. For small stems, the practical approach is to just spray the entire cut surface.

6) Foliar spray method:

- Use: A foliar application of glyphosate will provide excellent control of buffalo bur and longspine sandbur, and the method can be used to obtain moderate control of rabbitbrush shrubs and clumps of silverleaf nightshade. Application must be done when the plants are actively growing. However, a foliar application of Tordon 22K® will provide better control of silverleaf nightshade at a lower cost, and a water basal application of Tordon 22K® will provide a high level of control of rabbitbrush shrubs. The difficulty with using Tordon 22K® is that the product is a Restricted-Use herbicide and applicators must be certified to use the product.

- Equipment

  - Backpack sprayer: Again, a backpack sprayer with a diaphragm pump is recommended for treating a relatively small number (less than 100) of individual shrubs. Depending on the ease of application to the foliage, use either a TP 2503, 2504 or TP 4006 flat spray tip.

  - Power Sprayer: A power unit is more efficient when spraying a large number of shrubs when access is good, which is not the case for the Sumner Dam site.

- Mixing: To obtain a 1.5 percent solution, mix 2 ounces of glyphosate (Accord XRT®, Accord Concentrate, or comparable product) per gallon of water. Glyphosate is a non-selective herbicide that controls virtually all annual and perennial plants, although it is generally most phytotoxic to annual grasses. It works by inhibiting amino acid pathways in plants. These amino acid pathways are not found in animals; thus, it has relatively low toxicity to humans and animals. It has no soil activity, and persistence and mobility are low. Also, add 3 ounces of liquid ammonia sulfate to prevent any potential antagonism with divalent cations in alkaline water.

How to mix a 1.5% solution of glyphosate for foliar spraying:
Add 2 ounces of herbicide concentrate, plus 3 ounces
of liquid ammonia sulfate, to a gallon of water.

- Spraying: Wet the foliage from the top of shrubs down, being sure to spray all growing tips. The foliage should be sprayed until the leaves glisten, but not to the point of dripping. Be sure to cover the foliage on all side of the shrubs being treated. Spraying should not be done on windy days to avoid drift. Also, extreme care must be used to avoid getting the spray solution on desirable plants because glyphosate is a broad spectrum herbicide.

7) Low-volume Water Basal Method:

- Use: A basal application of Tordon 22 K® (picloram) in water has shown to be the most cost-effective method to control rabbitbrush species. This approach also will provide excellent control of honey mesquite, white thorn, catclaw acacia, creosote bush, narrowleaf yucca, juniper species, prickly pear, and many other woody shrubs and trees. However, this herbicide is a Restricted-Use product that can only be purchased and applied by a certified applicator.

- Equipment: Again, a backpack sprayer with a diaphragm pump is recommended for treating a relatively small number (less than 100) of individual shrubs. A DE-2 disc or TP-0002 straight stream nozzle is recommended.

- Mixing: Tordon 22K® is a liquid formulation that is mixed with water and a silicone wetting agent. A 15 percent mixture is recommended for shrubs above 3 feet in height and a crown diameter over 3 feet. This mixture can be obtained by adding 20 ounces of the herbicide plus water to make one gallon and 5 milliliters (ml) of a silicone wetting agent. A 10 percent solution will provide effective control of shrubs less than 3 feet high and wide. Instruction for obtaining a 10 percent mixture follow: 13 ounces of herbicide plus water to make one gallon and 5 ml of a silicone wetting agent.

How to mix picloram for a water basal application:
10% mixture: 13 oz of Tordon 22K in a gallon of water plus 5 ml of silicone;
15% mixture: 20 oz of Tordon 22 K in a gallon of water plus 5 ml of silicone.

- Spraying: The spray mixture must be applied as a solid stream around the crown of individual shrubs. The best results can be obtained by applying the spray to the stem of the shrub just above the ground level to allow the liquid to "slip" down the stem below the soil surface. This approach, however, is usually not possible because most shrubs have multiple stems and it is difficult to locate the base of the plant through the stems and foliage. In this instance, the spray is directed at about a 45 degree angle in a circular or oval pattern into the center of the shrub about where the root crown is expected to occur. The key is to get a sufficient volume of the spray solution around the entire circumference of the root crown. For small shrubs, treatment can be accomplished by spraying an oval pattern from one side of the shrub. With larger shrubs, applicators usually will need to spray the circular pattern by walking around the plant so that the spray stream is applied to the entire root crown. The amount of spray solution applied to individual shrubs depends on

their size. As the plant size increases, an increasingly larger volume must be applied to obtain satisfactory results. It has been found that about 4ml of the solution is needed for each foot of crown width. It takes about half a second to spray out 4 ml from a backpack that is at maximum pressure. Thus, it would take about one second to treat a shrub that has a crown diameter of 2 feet.

Mitigations and Best Management Practices (BMPs)

The application of herbicides is tightly controlled by state and federal agencies. The Bureau of Reclamation is required to follow all state and federal laws and regulations applicable to the application of herbicides. The following mitigation measures will be followed when applying herbicides:

1. **Mitigations**

   - All herbicide label requirements will be followed.
   - All BMPs will be followed.
   - Herbicides will not be directly applied to water.
   - Spot applications of triclopyr and glyphosate can be done to the edge of some bodies of water in compliance with label requirements, but spot applications will not be done within 5 feet of water being used for irrigation.
   - Ester formulations of triclopyr (Garlon 4 and Tahoe 4) will not be applied in the summer when high temperatures (over 85° Fahrenheit) can cause volatilization.
   - Applicators will be required to wear long-sleeved shirts and long pants, boots plus socks, and other personal protective equipment (PPE) as required on the label.
   - All requirements in the attached Safety and Spill Plan will be followed (see Appendix A).
   - Herbicides will be secured (lock and key) at all times.
   - Herbicides will be transported according to safety requirements.

2. **Pre-spray BMPs**

   - Comprehensive project files will be maintained.

- Non-herbicidal techniques will be evaluated for use when they are known to provide acceptable control (over 80%) at a reasonable cost.

- Herbicides will only be used when they provide the most effective control relative to cost and do not present unacceptable environmental or safety risk.

- Herbicides will be selected based on their ability to provide the most effective control and least cost.

- Applicators will be required to read and understand the label and Material Data Safety Sheet for all herbicides being used.

- The lowest effective herbicide rate will be used.

- Treatment sites will be checked by qualified personnel to ensure they are not occupied by threatened, endangered, or sensitive species.

3. **Herbicide Spraying BMPs**

- Individuals spraying herbicides will receive safety and application training prior to doing any treatment.

- Spraying will not be done when the average wind speed exceeds 8 miles per hour or as indicated on the label.

- Applications will not be done when there is a threat of rain or snow.

- Treatment areas will be posted with information signs to inform the public that herbicides are being used and the date of application.

- Mixing of herbicides will not be done near water, recreation sites, residences, or areas frequented by the public.

- Daily herbicide treatment records will be kept.

- Applicators will use appropriate PPE.

4. **Herbicide post-spray BMPs**

- Treatment areas will be checked at least once annually to assess efficacy.

- Application records will be maintained in the project file.

- Managerial oversight will be done annually to ensure compliance with all requirements.

Appendix A: Herbicide Safety and Spill Plan

1. Information and equipment

   - All individuals applying herbicides will receive training on safety and application procedures prior to spraying.

   - A copy of herbicide labels and MSDS will be available at all times during project operations, and applicators will be completely familiar with these documents.

   - Required PPE will be worn at all times when herbicides are being mixed and applied.

   - An emergency spill kit, with directions for use, will be present when herbicides are being transported, mixed and applied.

   - Employees will be trained in the use of the spill kit prior to initiation of operations.

   - The spill kit will contain the following equipment:

     - At least three gallons of clean water
     - Hand soap
     - Shovel
     - Broom
     - Ten pounds of absorbent material, such as kitty litter
     - Box of plastic bags
     - Nitrile gloves

2) Procedures for herbicide spill containment

   Information in this section is derived from the EPA document "Applying Pesticides Correctly: A Guide for Private and Commercial Applicators," and the rules and regulations for the New Mexico Pesticide Control Act administered by the New Mexico Department of Agriculture, Pesticide Management Bureau.

   The following information will be reviewed by workers who handle herbicides:

   - Immediately notify the direct supervisor of an incident or spill. Identify the nature of the incident and extent of the spill, including the product and chemical names and the EPA registration number(s).

   - Remove any injured or contaminated person to a safe area. Remove contaminated clothing and follow MSDS guidelines for emergency first

aid procedures regarding exposure. Do not leave an injured person alone. Obtain medical help for any injured employee.

- Contain the spilled herbicide as much as possible on the site. Prevent the herbicide from entering ditches, gullies, wells, or water systems.

- **Small Spills** (Less than 1 gallon of herbicide formulation or less than 10 gallons of herbicide mixture)

    - Qualified employees will be present to confine a spill.

    - Follow MSDS guidelines for emergency first aid procedures in the event of an accidental exposure.

    - Restrict entry to the spill area.

    - Contain the spread of the spill with earthen dikes.

    - Cover the spill with absorbent material.

    - Place contaminated materials into leak-proof container(s) and label.

    - Dispose of contaminated material according to label instructions and State Requirements.

- **Large Spills** (More than 1 gallon of herbicide formulation or more than 10 gallons of herbicide mixture)

    - Keep people away from the spill.

    - Follow MSDS guidelines for emergency first aid procedures in the event of an accidental exposure.

    - Contain the spread of the spill with earthen dikes.

    - Cover the spill with absorbent material.

    - Spread the absorbent material around the perimeter of the spill and sweep toward the center.

    - Call the direct supervisor and the local fire department, and follow their instructions for further actions.

3) Procedures for herbicide mixing, loading and disposal

- Mixing of herbicides and adjuvants will be done at least 100 feet from well heads or surface waters.
- Dilution water will be added to the spray container prior to the addition of the herbicide concentrate.
- Hoses used to add dilution water to spray containers shall be equipped with a device to prevent back-siphoning, or a minimum 2-inch air gap.
- Workers mixing herbicide will wear the maximum PPE required by the label.
- Empty containers will be triple rinsed. Rinsate will be added to the spray mix or disposed of on the application site at a rate that does not exceed amounts addressed on the label.
- Unused herbicide will be stored in a locked facility in accordance with herbicide storage instructions provided by the manufacturer, and in accordance with the New Mexico Department of Agriculture regulations.
- Empty and rinsed herbicide containers will be punctured and disposed in accordance with label instructions.

4) Transportation and Security

- Transport only the quantity of herbicide needed for the day's operation.
- Do not leave vehicles being used to transport pesticides unattended unless the herbicides are secured in a locked area.
- Keep herbicides separated from drivers and passengers when they are being moved from storage sites to field locations
- Do not transport open container with herbicides.
- Make sure all lids or bungs are tight on herbicide containers prior to transport.
- Maintain security of herbicides at field sites.

Appendix B: Pesticide Labels

1) Arsenal® (Imazapyr)
2) Accord XRT® (Glyphosate)
3) Hardball® (2,4-D Acid)
4) Banvel® (Dicamba)
5) Escort® (Metsulfuron methyl)
6) Oust® (Sulfometuron methyl)
7) Pendulum® (Pendimethalin)
8) Tordon 22K®
9) Garlon 4® (Triclopyr, butoxyethyl ester)
10) Garlon 3A® (Triclopyr, triethylamine salt)

Appendix C: Pesticide MSDS Sheets

1) Arsenal® (Imazapyr)
2) Accord XRT® (Glyphosate)
3) Hardball® (2,4-D Acid)
4) Banvel® (Dicamba)
5) Escort® (Metsulfuron methyl)
6) Oust® (Sulfometuron methyl)
7) Pendulum® (Pendimethalin)
8) Tordon 22K®
9) Garlon 4® (Triclopyr, butoxyethyl ester)
11) Garlon 3A® (Triclopyr, triethylamine salt)