2007 Annual Performance Report

1. **State**: California
Grant number: E-2-P-23
Grant name: Threatened and Endangered Plants

Project name: EP03-6: Phoenix Vernal Pools Management Plan

2. **Report Period**: March 29, 2006 to March 29, 2007

Report due date: March 29, 2007 **Report received by USFWS date**_____

3. **Location of work** Sacramento County, Phoenix Field Ecological Reserve, Phoenix Fields Park

4. **Costs:** Please identify sources of federal and no-federal match and indicate amounts budgeted and spend for each. Indicate if match is in-kind. Indicate in the table whether costs are "Actual" or "Estimated".

Fund source	Budgeted	Actual Amount Spent
Federal: USFWS	29,000	
State: California		
Total Federal:	29,000	
Total Match:	9,667	
Total Project:	38,667	

5. **Objectives**: To establish a set of management goals and tasks in a Land Management Plan that will ensure the long-term protection of wildlife and their habitats on site including special plant and animal communities, and where appropriate provide or allow for compatible public uses.

6. **If the work in this grant was part of a larger undertaking with other components and funding, present a brief overview of the larger activity and the role of this project. n/a**

7. **Describe how the objectives were met. See attachment 1 for additional requirements.** Funds were used to contract with ESA to do the data collection, analysis and draft write-up of the LMP. To date ESA has compiled all existing information on the PFER from CDFG, pulled information from CNDDB, met with the contract manager, the members of the Fair Oaks Recreation and Parks District and other contacts involved with the project, conducted field surveys. A copy of the final report is attached.

8. **Discuss differences between work anticipated in grant proposal and grant agreement, and that actually carried out with Federal Aid grant funds; include differences between expected and actual costs.** No differences have occurred to my knowledge and the budget will stay within the expected costs.

9. **List any publications or in-house reports resulting from this work.** N/A

10. **Name, title, phone number, and e-mail address of person compiling this report:**
Sara Holm
Wildlife Biologist
916-358-2881
sholm@dfg.ca.gov

Mary Ann Showers
916-651-6594
mshowers@dfg.ca.gov

PHOENIX VERNAL POOLS

Land Management Plan

Prepared for:
State of California
The Resources Agency
Department of Fish and Game

October 2006

Project Funded Under Federal Section 6 Grant No. E-2-P-23

8950 Cal Center Drive
Building 3, Suite 300
Sacramento, CA 95826
916.564.4500
www.esassoc.com

Los Angeles

Oakland

Orlando

Petaluma

San Francisco

Seattle

Tampa

205442

ESA

TABLE OF CONTENTS

Draft Land Management Plan

List of Figures

Chapter 1
Introduction

CHAPTER 1
Introduction

Acquisition Purpose and History

The legislative purpose of ecological reserves and preserves is to protect threatened or endangered native plants, animals, or specialized habitat types, both terrestrial and aquatic, or large heterogeneous natural marine gene pools for the future use of mankind. The goal of the reserves is to protect species and their habitats in as natural a condition as possible.

The Phoenix Vernal Pools Management Plan encompasses the Phoenix Field Ecological Reserve (PFER) and the Phoenix Park Vernal Pool Preserve (PPVPP), collectively referred to as the Phoenix Vernal Pools (PVP). The primary purpose for acquiring the eight-acre PFER property by the California Department of Fish and Game (CDFG) was to conserve onsite vernal pools which support populations of the extremely rare Sacramento orcutt grass (*Orcuttia viscida*) and the rare pincushion navarretia (*Navarretia myersii* ssp. *myersii*). The PFER parcel was donated to the CDFG in 1979 by the Sacramento Savings and Loan Association at the request of Westwood Homes, Inc., the developer of the adjoining Rollingwood development. The PFER property was established as mitigation for this nearby development and is managed by the CDFG.

The parcel now known as was PPVPP was deeded from the "Phoenix Field Investors," a part of Camray Development and Construction, Inc. It includes a 15-acre area that is managed as a natural area within Phoenix Park as well as public use areas such as baseball diamonds, playing fields, parking lots, roads, and trails. The natural area was designated as a separate management area in order to conserve vernal pool habitat for the Sacramento orcutt grass and to preserve the last remaining vernal pools in the area for community enjoyment and in the public interest. Sacramento orcutt grass is a state and federal listed endangered species under the California and Federal Endangered Species Acts, and is also listed as a Category 1B plant (defined as "Rare, threatened, or endangered in California and elsewhere") by the California Native Plant Society (CNPS). The western spadefoot toad (*Scaphiopus hammondii*), a CDFG and U.S. Fish and Wildlife Service (USFWS) designated species of special concern, has also been reported at the site. Currently, the PPVPP is owned by the Fair Oaks Park District, which has managed the preserve in cooperation with the USFWS, CDFG, CNPS, and National Park Services' (NPS) National Natural Landmark Program (NNLP).

Purpose of This Management Plan

The proposed management plan will establish a set of management goals and tasks that will ensure the long-term protection of wildlife (birds, mammals, reptiles, amphibians, fish, and invertebrates) and their habitats and plants (including special-status vegetation types) and provide for compatible public use where appropriate. The proposed management plan will not only update the PFER management plan (Clemons, 1981) to address current habitat conditions and issues, but it will also use current scientific knowledge to guide the management of the PVP.

Chapter 2
Property Description

CHAPTER 2
Property Description

Geographical Setting

The PVP is located in Fair Oaks, a suburb of Sacramento, approximately 20 miles east of the City of Sacramento and north of Highway 50 (Figure 1). The vernal pools are situated on a high terrace approximately 160 feet above the north bank of the American River. The elevation of the vernal pools ranges from 271 to 280 feet above sea level (Clark et al., 1998). These types of vernal pools are described as northern hardpan vernal pools (Sawyer and Keeler-Wolf, 1995).

Property Boundaries and Adjacent Lands

The PFER is completely surrounded by fenced residential developments and public access is not permitted although trespassing appears to be frequent (J. Gerlach, personal observation) (Figure 2). Access is obtained at the northwest and southwest corners of the property where there are locked gates in the cyclone fence. The PPVPP is a part of Phoenix Park which is managed by the Fair Oaks Recreation and Parks District. It is bounded to the north by Sunset Avenue, on the west side by athletic fields and a parking lot, and on the east and south sides by private residences and public streets (Figure 2).

Climate, Geology, Soils, and Hydrology

In the Mediterranean-type climate of the PVP all precipitation falls as rain (approximately 24 inches annually) with most falling from October through April (Western Regional Climate Center, 2005). Summers are hot and dry with a mean high temperature of 92° F and an extreme high of 115° F. Winters are cool and wet with a mean low temperature of 40° F and an extreme low temperature of 16° F.

The vernal pools formed in the Arroyo Seco Gravels, which are located in an eroded alluvial plain of the ancient American River that was deposited on top of the siltstone of the Fair Oaks formation (Stromberg and Balance Hydrologics, 1989; Smith and Verrill, 1998; California Department of Water Resources, 2004). The Arroyo Seco Gravels are composed of metamorphic and volcanic (andesite) pebbles and cobbles (Trugel, 1993) and the andesite mineral weathers to produce soil water with very high concentrations of silica (B. Hecht, 2006, personal communication). Dissolved silica from the andesite mineral produced the silica cemented hardpan in the soil (Trugel, 1993).

SOURCE: Globe Explorer, 2004; and ESA, 2006

Phoenix Park Biological Services . 205442

Figure 1
Vicinity Map

SOURCE: Globe Explorer, 2004; and ESA, 2006

Phoenix Park Biological Services . 205442

Figure 2
Project Site Map

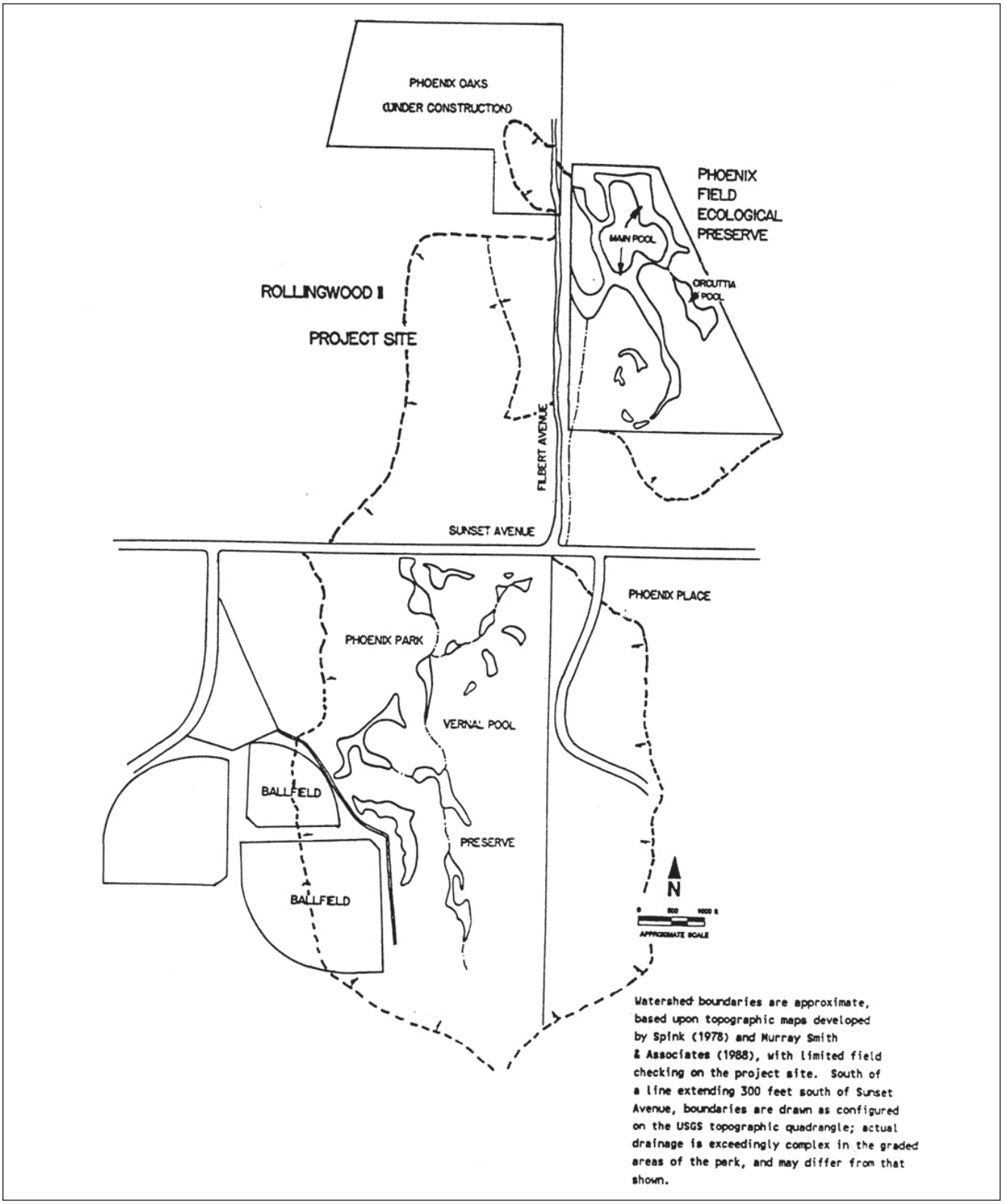
Soils of the PVP vernal pool and swale areas are mapped as Redding gravelly loam which is described as moderately deep and well-drained with a surface layer that is typically 7 inches of gravelly loam and the upper 13 inches of subsoil consists of loam and gravelly loam (Appendix A) (Trugel, 1993). The soil series description states that below the surface layer there is a claypan of gravelly clay and below the claypan is a very gravelly silica cemented hardpan. Both layers are nearly impermeable and during the wet season produce a perched water table which is expressed on the ground surface as vernal pools and swales. Soil profile sampling of the PFER and adjacent areas found a continuous silica cemented hardpan at depths between 12 and 36 inches (J. H. Kleinfelder & Associates, 1976) but the degree of cementation was later found to vary considerably across the site (Stromberg and Balance Hydrologics, 1989). The depth to hardpan was determined to be less than 12 inches in the vernal pools while it varied from 12 to 36 inches in upland areas. The overlying soil was determined to be a relatively permeable sandy loam with almost no slope (J. H. Kleinfelder & Associates, 1976). A subsequent soil core analysis is consistent with those findings but also identified local areas that were underlain by a claypan (Stromberg and Balance Hydrologics, 1989).

The soil of the uplands adjacent to the vernal pools and swales at the PFER is characterized as the Red Bluff 0-5% slopes series but the presence of a hardpan across the site indicates that the soil does not match the soil series description (Appendix A). The soil of the uplands adjacent to the vernal pools and swales at the PPVPP is mapped as the Red Bluff 2-5% slopes series with no hardpan. The surface layer of this series is described as an 8-inch-thick loam, the upper part of the subsoil is a 17-inch-thick clay loam, and below that is a gravely clay that extends to a depth of about 68 inches (Trugel, 1993). No formal soil sampling has been conducted at this site. However, excavation work and posthole boring work at the baseball diamonds found extensive areas of hardpan at a depth of approximately two feet (R. Melton, personal communication).

Prior to the development of the area, the PVP was located on the south side and slightly below the summit of a low knoll which formed a southwest to northeast trending watershed divide (Figure 3) (Stromberg and Balance Hydrologics, 1989). Additionally, all of the vernal pools and swales are contained within a broad swale-like drainage that drains southward into an unnamed creek (Stromberg and Balance Hydrologics, 1989). The eastern and western divides of this drainage system were less than approximately 75 feet from the *Orcuttia* pool on the PFER site and the Baseball Diamond pool on the PPVPP site respectively which indicates that these two pools may have had some qualities of headwater pools. The slopes of the PPVPP are steeper than those of the PFER with local relief of 5 to 12 feet versus the relief of 2 to 3 feet of the PFER. Maps of the surface drainage systems and watersheds of the PFER and adjacent areas indicate that substantial surface flows from areas of vernal pools and paved portions of the former airfield entered the PFER at its northwest corner (Jones and Stokes Associates, 1987; Stromberg and Balance Hydrologics 1989). The area of the offsite watershed was approximately 2.85 acres (Stromberg and Balance Hydrologics 1989). The flow from this watershed entered a large vernal pool on the PFER (Figure 3, Main pool) and flowed

southward in a swale towards the PPVPP. In 1960, a drainage ditch was excavated in the lower end of the Main pool by the mosquito control district (Stromberg and Balance Hydrologics 1989). Before the development to the west of the PFER, significant surface flows drained from the south end of the former airfield to the PPVPP (4.97 acres) (Jones and Stokes Associates 1987; Stromberg and Balance Hydrologics 1989). Currently, the flows from the residences constructed on the site of the former airfield are diverted into a 10-foot-deep storm detention pond on a property owned and maintained by the Fair Oaks Recreation and Parks District. A storm drain outlet from the pond crosses Sunset Avenue and opens into a swale leading to the vernal pool above the bridge at the north border of the PPVPP. However, it appears that outflow from the detention pond is rare or nonexistent and that most of the water is lost to deep percolation as the surface of the pond was approximately 8 feet below the outlet on January 18, 2006 (J. Gerlach, personal observation). In the nine years since the detention pond was constructed, Fair Oaks Recreation and Parks District staff have never observed flow from the detention pond (R. Melton, personal communication). Historic groundwater flows across Sunset Avenue and into the PPVPP are intercepted by the 10- to 18-foot-deep trenches with gravel fill under storm drains that were constructed in 1980 (Stromberg and Balance Hydrologics, 1989).

Both the PFER and the PPVPP are impacted by offsite irrigation which alters the hydrology of the vernal pools. Currently, surface and ground water drainage onto the PFER from the north and east are intercepted by a drain system that runs along the entire northern and eastern boundaries. The east drain was constructed during residential development in the late 1970s (Woyshner and Hecht, 1988) and the north drain was installed in 1998 to intercept summer irrigation that was converting the vernal pools into seasonal wetlands (Horenstein and Roscoe, 1997; Burmester, 2002). The east drain was specified by CDFG to be four to five feet deep with a 4-inch-diameter perforated PVC pipe at the bottom that was to be connected to a storm drain, but neither the PVC pipe nor the storm drain pipe were detected in the two-foot-wide, gravel-filled trench during hydrology-related soil sampling in the east drain (Woyshner and Hecht, 1988; Stromberg and Balance Hydrologics, 1989). Constructed in 1998, the north drain system, which includes a clay berm, was to be connected to the east drain system (Horenstein and Roscoe, 1997; Burmester, 2002). Given the failure to detect either a perforated PVC pipe or a storm drain pipe in either of two soil bore holes in the east drain, it is unclear where intercepted irrigation water exits the north drain system. However, whether connected to a functional storm drain system or not, the north drain does not appear to be a complete solution to the irrigation problem because during a site visit on December 29, 2005, extensive areas of Bermuda grass (*Cynodon dactylon*), a non-native invasive perennial that requires summer soil moisture, were observed in the Main pool and in the upland near the northeastern corner of the PFER.



SOURCE: Laurence P. Stromberg, Ph.D., Consulting Plant Ecologist, (1989); Balance Hydrologics, Inc., (1989);and ESA, 2006

Phoenix Field . 203521

Figure 3
Phoenix Vernal Pools Watershed Map

Excessive summer irrigation from the residences at the northeastern corner of the PFER has been a long-term problem (Holland, 1982). A vegetated swale and sediment detention basin system runs along much of the west border of the PFER to capture runoff from the roofs, yards, and swimming pools of the houses along the western border (Murray Smith & Associates Engineering et al., 1991). The flow in this system runs into a storm drain and does not enter the PPVPP. An irrigated horse pasture at the southeastern corner of the PFER drains northward into a southern arm of the Main pool (J. Gerlach, personal observation).

Long-term irrigation problems also occur on the PPVPP (Burmester, 2003). At the northeastern corner of the site, a swale has been invaded by a dense stand of exotic perennial grasses such as dallisgrass (*Paspalum dilatatum*) (J. Gerlach, 2005, personal observation). This area collects water from a portion of Sunset Avenue and there is a 12-inch flexible pipe of unknown function in the same area. The swale is also adjacent to and downslope from an irrigated landscaped area of small trees and shrubs that include vertical PVC pipes that probably were installed for deep-watering the trees (R. Melton, 2006, personal communication). Because the dallisgrass is growing up to 30 feet away from the swale and at least 2 feet upslope, it is likely that the damage to the site's vegetation is due to summer irrigation from the landscaped areas and not due to increased winter and spring flows.

The parking lot immediately to the northwest of the Baseball Diamond pool drains eastward into a ditch that drains southward into a small detention pond. Until recently, this pond drained to the west, but that drainage outlet was blocked by the construction of a new foot path. On January 24, 2006, the pond held a considerable amount of water and the large amount of algae growing in the pond indicates that there are relatively high nutrient levels in the water (J. Gerlach, personal observation). It appears that groundwater flows from this pond may be moving towards the Baseball Diamond pond.

Two vernal pools at the southwestern corner of the PPVPP have also been converted into seasonal wetlands. The lower end of the upper pool is blocked by a foot path and outflows from the pool must pass under the path through a culvert. This pool also receives summer irrigation from an area of irrigated turf that extends down slope to the edge of the pool. The upper end of the lower pool receives flows from the culvert draining the upper pool as well as from a storm drain culvert from Vega del Rio Drive on the eastern border of the PPVPP which is connected to the pool by a small drainage ditch. The pool is drained by a ditch that leads to a storm drain which runs off the site to the south. On January 18, 2006, there was substantial flow through the culvert from the upper pool and almost no flow from the Vega del Rio Road culvert. This suggests that the vegetation conversion is due to onsite summer irrigation and offsite summer irrigation discharged from the Vega del Rio Drive culvert.

Effective management of both the PFER and the PPVPP will need to consider the sites' historic and current hydrological conditions in the context of the latest research on vernal pool hydrology. Recent studies of the hydrology of hardpan vernal pools have found significant differences in how hardpan vernal pools in different geographical areas function (Hanes and Stromberg, 1998; Williamson et al., 2005; Rains et al., In press). These studies found that the primary factors that control vernal pool hydrology are the depth and continuity of an impermeable soil layer (hardpan, claypan, or bedrock), the soil's hydraulic conductivity (permeability), the depth of the overlying soil, the slope, the extent of the watershed, the ratio of upland area to vernal pool area, climatic factors, and the amount of water evaporated from plant surfaces after precipitation or lost through leaves during the process of photosynthesis (evapotranspiration).

Two conceptual models, "mounding" and "flow-through", have recently been described to characterize the dynamics of hardpan vernal pool hydrology (Williamson et al., 2005). Both models require the presence of a perched water table and groundwater flow above the impermeable soil layer. In mounding type vernal pools, the presence of a discontinuous hardpan causes the vernal pool to lose more water to the watershed than it receives from the watershed. In contrast, flow-through vernal pools receive more water from the watershed than they lose to the watershed. Because of their different relationship with their watersheds, the water levels in mounding vernal pools drop continuously without supplemental precipitation even in the absence of losses due to evaporation or plant evapotranspiration, while the water levels in flow-through vernal pools remain fairly constant or rise after precipitation events due to the net positive influx of perched groundwater from the watershed. Because flow-through vernal pools receive significant contributions of groundwater from the surrounding uplands, management practices that alter plant evapotranspiration may reduce or increase the length of the spring inundation period. For example, grazing practices that shift vegetation dominance from early season forbs to exotic annual grasses have been found to reduce the duration of the spring inundation period by 50 to 80 percent and destroy the habitat suitability of the vernal pools for sensitive species (Marty, 2005; Pyke and Marty, 2005). This is thought to occur due to the greater biomass of water use of exotic annual grasses from February through April.

Because of the low hydraulic conductivity of the Redding soil (0.01 to 1.0 feet per day) (Trugel, 1993), it was formerly thought that only upland areas immediately adjacent to vernal pools contributed significantly to vernal pool hydrology (Hanes et al., 1990). However, a later study found hydraulic conductivities as high as 30 feet per day which suggests that the watershed and vernal pools are intimately connected through soil macropores (earthworm tunnels, rodent burrows, etc.) (Hanes and Stromberg, 1998). During posthole excavations in the baseball fields at the PPVPP large flow rates were observed flowing out of the downslope postholes (R. Melton, personal communication). This observation indicates that the hydraulic conductivity immediately above the hardpan is very high. The topographic position of a vernal pool in its watershed may also affect its ponding duration and seasonal ponding depth variability. Headwater pools in the upper

reaches of the watershed typically experience shorter inundation periods and often fail to pond during moderate drought years, while collector pools in the lower reaches of the watershed pond in most years, are inundated for longer periods of time, and only fail to pond in more severe droughts (Bauder, 2005).

Vernal pool inundation duration and depth at the PFER have been monitored since the mid-1970s but only data from portions of a wet season during a drought year (March 26 to May 29, 1988) and a wet season with late precipitation (October 13, 1988, to April 13, 1989) are available. In neither case were the pools monitored into the spring and summer months when they completely dried. These data and the hydrological models that were developed for the *Orcuttia* and Main vernal pools at the PFER site and the PPVPP site were generated as part of the mitigation process for the Rollingwood II development that was ultimately constructed adjacent to the west side of the PFER (Stromberg and Balance Hydrologics 1989). The Phoenix Oaks development, which eliminated the portion of the watershed lying to the northwest of the PFER, was already under construction at the time of the study. During the mitigation study, groundwater monitoring wells were bored into the Rollingwood II and Phoenix Oaks portions of the watershed, in the west drain, adjacent to the west side of the *Orcuttia* pool, and the outlet of the Main pool along the Filbert access road. Weirs were installed at the Rollingwood II inlet and at the outlet of the Main pool. No weir was installed at the Phoenix Oaks inlet because a siltation basin installed at the start of construction substantially reduced surface flows into the PFER (Stromberg and Balance Hydrologics, 1989). The most significant findings of the mitigation study are:

- The *Orcuttia* pool was well-buffered from the effects of the Rollingwood II development due to its high topographic position and relatively impermeable bottom and sides;

- The loss of the surface runoff from Rollingwood II to the PFER will delay the initial filling of the Main pool by 5 to 8 weeks;

- The subsurface hydraulic gradient (direction of flow) is away from the *Orcuttia* pool to the Main pool;

- During the beginning of the wet season both pools lost water faster than the rate of evapotranspiration from the pool surface indicating flow into the dry soil of the uplands and pool bottoms;

- During the middle of the wet season both pools lost water slower than the rate of evapotranspiration from the pool surface indicating flow into the pools from the soil of the uplands;

- Later in the wet season both pools lost water faster than the rate of evapotranspiration from the pool surface indicating flow into the soil of the uplands and pool bottoms due to high rates of evapotranspiration in the uplands;

- No findings were made regarding impacts on the duration of pool inundation in the late spring and earl summer.

From these findings it was concluded that the loss of surface runoff from the Rollingwood II development had a significant impact on the duration of inundation in the Main pool by delaying pool filling by 5 to 8 weeks. A water supply line was proposed as part of the mitigation requirements to offset these delays through artificial means but it is not clear where or if the line was installed. Because of the inundation requirements of Sacramento orcutt grass (Holland, 1986), the delay in the filling of the Main pool is likely to have a negative impact on *Orcuttia* plants growing in that pool. Also, despite the fact that the hydrological function of *Orcuttia* pool is buffered from the hydrology of the Main pool, because the hydraulic gradient is away from the *Orcuttia* pool reduced pool depths in the Main pool will increase the magnitude of the gradient thus increasing the tendency of the *Orcuttia* pool to drain. The relatively low hydraulic conductivity of the saturated soil was used as the primary factor for concluding that the two pools are not intricately linked. However, the presence of macropores was not considered in the analysis and the flow rate from the *Orcuttia* pool to the Main pool could be much greater than the calculated value, similar to the high flow rate observed by the Fair Oaks Recreation and Parks staff during posthole boring at the PPVPP. Overall, the PFER pools appear to fit the "flow-through" model better than the "mounding model," and evapotranspiration by non-native annual grasses is likely having a significant impact on late season ponding duration. Considering the mapped extent of the historic watershed for the hydrological study and the current diversion structures and developments, approximately 2 acres of watershed have been lost above the PFER Main pool while 19 of 27 acres of watershed have been lost above the PPVPP Baseball Diamond *Orcuttia* pool. These changes have likely converted both pools into headwater pools (Bauder, 2005) with shorter inundation periods and more variable ponding depths. Because of the Baseball Diamond pool's relatively high topographic position, it is not clear how much this loss of flow has impacted its hydrologic regime. Finally, nothing is known about the late season hydrology of these pools except that historic aerial photographs indicate that both the *Orcuttia* and Baseball Diamond pools remain inundated longer than the adjacent pools.

Cultural Features

Existing Structures

Currently, there are no structures on the PFER site. A cyclone fence runs along the western edge of the property and fence posts have been set along the other three sides. An electrical box and cable box adjacent to the northwest corner of the PFER has, according to a resident, shorted and caused at least one fire. Both boxes are now surrounded by

gravel to reduce the fire hazard. Two gaps in the cyclone fence appear to have been cut by fire crews and at least two gates that open directly into the PFER have been constructed in the fences of the private residences. A drain system and weir have been constructed along the western edge of the property to convey runoff from the residences into the storm water sewer system. At least two of those residences are draining their pools and hot tubs into the drainage system (J. Gerlach, 2005, personal observation). The PPVPP is more developed with pervious concrete pathways located a few feet to the west of the vernal pools as well as a couple of bridges that span swales. The perimeter of the vernal pool area is marked by post and cable fencing.

Recreation

There is no public access to the PFER. The PPVPP, however, is open to the public year-round. There are walking trails along the edge of the vernal pool preserve, and a pervious concrete pathway adjacent to the preserve that provides close views of the vernal pools.

Chapter 3
Habitat and Species Descriptions

CHAPTER 3
Habitat and Species Description

Vegetation Communities, Habitats, and Plant Species

Vernal Pools

Vernal pools are seasonally inundated wetlands that form after winter rains. They become inundated because the percolation of rainwater downward through the soil profile is restricted by a relatively impermeable layer such as a silica cemented hardpan (Holland and Jain, 1988; Keeley and Zedler, 1998). This restrictive layer causes a perched water table to form and be expressed in low areas as vernal pools and swales (Hobson and Dahlgren, 1998; Williamson et al., 2005; Rains et al., In press). The Phoenix Vernal Pools are classified as northern hardpan vernal pools (Sawyer and Keeler-Wolf, 1995). Vernal pools are relatively uncommon ecosystems that support a unique array of plant and animal species, many of which are endemic to vernal pools (Keeley and Zedler, 1998). Vernal pool plants and animals are typically adapted to specific niches in the vernal pool system and may be restricted to a certain duration or depth of inundation and soil texture (Holland and Dains,1990; Simovich, 1998). For example, some plants, like Sacramento orcutt grass, only occur in the lowest part of relatively deep pools (Crampton, 1959; Griggs, 1976).

Non-Native Annual Grassland

Vernal pools are often embedded within an upland grassland landscape. The grassland provides habitat that is an important refuge for some species, such as the western spadefoot toad, that use both the vernal pools as well as the adjacent upland habitat. The upland area at PFER is almost entirely open annual grassland except for a few valley oaks (*Quercus lobata*) in the southeastern corner of the site, while at the PPVPP Non-native Annual Grassland also makes up the understory of blue oak woodland. At the PVP the grass species component of the upland grassland is dominated by non-native species such as medusahead (*Taeniatherum caput-medusae*), barb goatgrass (*Aegilops triuncialis*), wild oats (*Avena fatua*), quaking grass (*Briza minor*), Italian ryegrass (*Lolium multiflorum*), soft chess (*Bromus hordeaceus*), and ripgut brome (*Bromus diandrus*) (van Ess, unknown date). Both exotic and native forbs such as broadleaf filaree (*Erodium botrys*), turkey mullein (*Eremocarpus setigerus*), and Green's popcorn flower (*Plagiobothrys greenei*) are present. Additionally, there are a relatively large number of native liliaceous species present in the PVP (Holland,1988).

Blue Oak Woodland

On the PPVPP much of the upland is dominated by blue oak woodland. Blue oaks are slow-growing, long-lived trees that are winter deciduous and drought deciduous as well (Griffin, 1988; CDFG Wildlife and Habitat Analysis Branch, 2003). Blue oak woodland supports a diversity of wildlife, including 10 species of mammals, 29 species of amphibians and reptiles, and 57 species of birds (CDFG Wildlife and Habitat Analysis Branch, 2003). Oak titmouse, acorn woodpecker, red-tailed hawk, scrub jay, mallard, and broad-footed mole are a few of the wildlife observed in the PPVPP blue oak woodland. The blue oaks at the PPVPP dot the upland areas between the vernal pools and provide total or partial shade in the spring and summer, as well as nutrients from shed leaves in the fall and winter. St. Johnswort (*Hyparicum perforatum*), an invasive exotic perennial, is present in the Blue Oak Woodland as a large patch immediately east of the PPVPP parking lot (J. Gerlach, 2005, personal observation).

Animal Species

Vernal Pools

Vernal pool habitat characteristics vary with microclimatic changes such as fluctuations in rainfall and temperatures (Holland and Jain, 1988; Keeley and Zedler, 1998). There are also large annual variations in ponding characteristics and vernal pools that ponded for long periods in one year may not pond at all in the subsequent year. Plant and animal species that live their lives entirely within vernal pool habitat have adapted to the variable and unpredictable nature of vernal pools through an ephemeral life history. For example, tiny crustaceans such as California linderiella (*Linderiella occidentalis*) lay "resting eggs" or cysts that can persist throughout the dry periods in the soil on the bottom of the pools. When the first rains fall, and if the conditions are right, the cysts hatch and the pools are filled with life again. Some animals, such as western spadefoot toad, lay their eggs in vernal pools but spend much of their adult lives in upland burrows. Similarly, many insects, including flies, dragonflies, and beetles have an aquatic juvenile stage. Other casual users of this wetland habitat include tree frogs, shorebirds, wading birds, and waterfowl (CDFG Wildlife and Habitat Analysis Branch, 2003).

Non-Native Annual Grassland

A variety of wildlife may use annual grassland for foraging, especially if the grassland includes or is adjacent to special habitat features such as vernal pool and swale wetlands (Kie, 2005). Reptiles such as western fence lizard and common garter snake breed in grassland habitat. Amphibians such as western spadefoot toad use upland burrows during non-breeding periods. Mammals such as the broad-footed mole, California vole, and California ground squirrel as well as common grassland bird species include the western meadowlark and mourning dove use the non-native annual grassland habitat (Kie, 2005).

Blue Oak Woodland

Although oak-wildlife habitat relationships are not well known, it is possible that the ability of oak woodlands to support such a variety of species is due to the diversity of available niches, including the oak canopy, the trees themselves, the annual grassland understory, occasional shrub, and even the rich leaf litter dropped every winter (Ritter, 1988). Because the blue oak woodland at PPVPP is located adjacent to the vernal pools and its understory is dominated by non-native annual grasses, in many respects its habitat characteristics are similar to those of non-native annual grassland.

Threatened, Rare, Endangered, or Special-Status Species

Vernal Pool Species

Rare species are known to occur at the PVP and their occurrences are all documented in the California Natural Diversity Database (CNDDB) (California Natural Diversity Database, 2006). Two of the seven known occurrences of Sacramento orcutt grass occur at the PVP highlighting the critical importance of PVP to the future viability of this species. Sacramento orcutt grass, which is endemic to Sacramento County, is both Federal and State-listed Endangered, and is considered a 1B species (rare, threatened, or endangered in California or elsewhere) by the California Native Plant Society (CNPS) (California Native Plant Society, 2006). Pincushion navarretia, although not listed, is also a CNPS 1B species and occurs at PFER. Other species unique to vernal pool habitat and which occur at the PVP include western spadefoot toad and the California fairy shrimp, both California Department of Fish and Game (CDFG) species of special concern (California Natural Diversity Database, 2006). All of these species are dependent upon vernal pool habitat, which continues to be in jeopardy throughout California.

Sacramento Orcutt Grass

Sacramento orcutt grass was federal-listed Endangered on March 26, 1997, and state-listed Endangered in July 1979 (U.S. Fish and Wildlife Service, 2006). Its distribution is limited to a 135-square-mile area in eastern Sacramento County, and there are no known occurrences reported outside of this area (U.S. Fish and Wildlife Service, August 6, 2003). This small annual grass in the family Poaceae only grows in the bottoms of large, deep vernal pools found between approximately 100 and 330 feet in elevation. The plants are small (1 to 4 inches in height), are covered by sticky glandular hairs, and produce a spike-like inflorescence from April through July (U.S. Fish and Wildlife Service, 2006).

Of the only seven known occurrences of Sacramento orcutt grass, two are at PFER and PPVPP (U.S. Fish and Wildlife Service, August 6, 2003). The PPVPP population was introduced to a large vernal pool on the preserve circa 1985. The PFER population is a

natural population and the estimated annual number of individuals in the *Orcuttia* pool has varied from 0 in the drought years of 1976 and 1977 to approximately 180,000 in 1994 and 1995 (Roscoe, 1997). Major threats to the Sacramento orcutt grass include loss or degradation of habitat through urban development and encroachment, agriculture, vehicles, non-native invasive species, and overgrazing (California Native Plant Society, 2006; U.S. Fish and Wildlife Service, 2006). The main threats to the PPVPP population are primarily derived from public use in an urban setting. These problems include changes in hydrology and water contamination from run-off, herbicide input, and foot traffic and littering from extensive public use (California Department of Fish and Game, 2004). The population at PFER is threatened by the same issues, with the exception of foot traffic since the reserve is closed to the public. There is, however, an additional problem with the adjacent landowners disposing of refuse and yard waste by dumping it over their fences onto the reserve.

Pincushion Navarretia (*Navarretia myersii* ssp. *myersii*)

Pincushion navarretia is not federal- or state-listed; however it is considered rare, threatened, or endangered in California by CNPS. A rare, endemic, annual herb in the family Polemoniaceae, it is known from only six locations and has been recorded in Amador, Lake, Merced, and Sacramento Counties (California Native Plant Society, 2006). Pincushion navarretia populations are threatened primarily by development of vernal pool habitat. A population of at least 1,000 plants was recorded at PFER in 1994, growing on or close to the side slope of shallow, dry vernal pools (California Native Plant Society, 2006). The main threat to this population at PFER is habitat degradation from surrounding residential development, including irrigation runoff and horticultural plants that have escaped from backyards (California Department of Fish and Game, 2004).

California Linderiella (*Linderiella occidentalis*)

The California linderiella is not currently a listed species, but it is considered a federal species of concern. Also known as the California fairy shrimp, this animal is the most common of the fairy shrimp in the Central Valley. It was proposed for federal listing along with four other sensitive fairy shrimp but was withdrawn when these four were listed. It was common enough to "not likely become either endangered or threatened throughout all or a significant portion of its range in the foreseeable future" and therefore did not qualify for listing under the Endangered Species Act (U.S. Fish and Wildlife Service, 2006).

The California linderiella feeds on algae, bacteria, protozoa, rotifers and bits of detritus, and can be found in a variety of habitat conditions, from large clear vernal pools and lakes to very small turbid pools (U.S. Fish and Wildlife Service, 2006). The California linderiella exists on a variety of land forms, geologic formations, and soil types supporting vernal pools. It is the most heat-tolerant fairy shrimp in California, able to withstand water temperatures up to 85° F. Eggs are deposited in bottom of pools or sink with the gravid females as the pools dry out. The dried eggs or cysts are capable of

withstanding heat, cold, and prolonged desiccation and may lay dormant in the soil for long periods of time. The shrimp hatch when triggered by the filling of the pools and the appropriate environmental cues. On average the California fairy shrimp mature in 45 days and 31 days minimum, and adults may exist from December to early May (U.S. Fish and Wildlife Service, 2006).

The California fairy shrimp occur in several of the vernal pools on both PFER and PPVPP (ESA surveys, 2005). Although the California linderiella is one of the more common species of fairy shrimp, it is still subject to major habitat loss due to conversion of grassland and vernal pool ecosystems to urban or agricultural uses (U.S. Fish and Wildlife Service, 2006). Changes in hydrology, water pollution, invasion of non-native species, and erosion are other factors that threaten the shrimp.

Western Spadefoot Toad

The western spadefoot toad is not listed but is considered a federal species of special concern (United States Fish and Wildlife Service, 2006). This species once ranged from Redding southward to northwestern Baja California, but it has been extirpated from many locations in this range. The western spadefoot toad has been documented (since 1990) in the following counties: Alameda, Butte, Calaveras, Fresno, Kern, Kings, Los Angeles, Madera, Merced, Monterey, Orange, Placer, Riverside, Sacramento, San Benito, San Diego, San Joaquin, San Luis Obispo, Santa Barbara, Stanislaus, Tulare, Ventura, and Yolo (U.S. Fish and Wildlife Service, 2006).

Adult and sub-adult toads remain in underground burrows for most of the year, emerging with the first rains to reproduce (U.S. Fish and Wildlife Service, 2006). The western spadefoot toad breeds and lays eggs in seasonal wetlands such as vernal pools or ephemeral streams from January through May. The eggs are laid in small clusters attached to plant material or submerged rocks. The eggs hatch within a day or up to 6 days from time of deposition, and larval development may be completed from 3 to 11 weeks. The larval development must be completed prior to evaporation of the pools. Prey species include invertebrates for adults, and plankton and algae for tadpoles.

Western spadefoot toad was collected in the PFER in 1992 (Workmann, 1992). Main threats to the western spadefoot toad are habitat loss due to urban development, conversion of grasslands to agricultural use, and introduction of non-native predators (U.S. Fish and Wildlife Service, 2006).

Non-Native Annual Grassland Species

Although reproduction for the western spadefoot toad occurs in vernal pools, upland underground refugia are also a very important component of its life history (U.S. Fish and Wildlife Service, 2006). As noted above, western spadefoot toad remains in underground burrows for several months during the non-breeding season. Adults construct burrows

using the black sharp-edged “spades” on their hind feet or use existing mammal burrows. Juvenile toads may take refuge near breeding ponds in drying mud cracks, under boards or other debris, and even under decomposing cow dung.

Blue Oak Woodland Species

Western Spadefoot Toad

Because of its proximity to the vernal pools and because its understory consists of non-native annual grassland, the species discussion for non-native annual grassland applies to Oak Woodland as well.

Chapter 4
Management Goals and Tasks

CHAPTER 4
Management Goals and Tasks

Definition of Terms Used in This Plan

Biological elements are species, habitats, or communities for which specific management goals have been developed within the plan.

Public use elements are any recreational, educational, scientific, or other use activity appropriate to and compatible with the purposes for which this property was acquired.

Facility maintenance elements are general-purpose elements describing the maintenance and administrative program, which helps maintain orderly and beneficial management of the area.

Biological goals are statements of intended long-range results of management based upon the feasibility of maintaining, enhancing, or restoring species populations and/or habitat (i.e. these goals provide a statement of desired future conditions on the reserve).

Public use goals are statements of the desired type and level of public use compatible with the biological element goals previously specified in the plan.

Tasks are the individual projects or work elements undertaken to implement the goal and are useful in planning operation and maintenance budgets.

Biological Elements: Goals and Tasks

Management goals must include a clearly stated desired future condition and must be set within the constraints of existing conditions on the vernal pool preserves as well as conditions within nearby areas that affect the vernal pool areas themselves. Relevant background information has been provided in previous sections and this section provides statements of desired future conditions or biological goals for each biological element. A non-management or non-intervention option is not feasible for the PVP due to the proximity of residential and developed urban areas. Without management or intervention, the vernal pools will become more degraded and the vegetation of the preserve will be converted to a greater mixture of non-native invasive species that will result in an increased fire hazard. In addition, there is the potential for endangered species to be lost due to habitat degradation.

Phoenix Field Ecological Reserve

Northern Hardpan Vernal Pools

Ensure that vernal pools and swales are protected from direct and indirect negative impacts and ensure that the vernal pools may continue to support sensitive species such as Sacramento orcutt grass, pincushion navarretia, western spadefoot toad, and the California fairy shrimp.

- GOAL: Protect vernal pools from direct disturbance due to trespassing.

  TASK: Install cyclone fencing around the entire perimeter of the PFER and repair gaps in the existing fencing.

  TASK: Erect metal signs stating "Ecological Reserve" at PFER (or otherwise appropriate text) where lacking at access gates along the perimeter fence.

- GOAL: Protect vernal pool and swale hydrology by eliminating non-seasonal or excess sources of water and restore vernal pools and swales that have been altered by non-seasonal or excess sources of water.

  TASK: Identify all sources of non-seasonal or excess sources of water and take action to eliminate their impacts on vernal pools and swales. The impacts due to the irrigation at the northeast corner of PFER and drainage from the irrigated pasture are the two primary problem areas that need to be addressed.

  TASK: Manage the non-native invasive plant species (NIS) grasses of the uplands as described in the Upland Grassland and Oak Woodland management section to minimize their evapotranspiration impacts on vernal pool hydrology by shifting the dominant herbaceous species to earlier flowering species.

  TASK: Locate or establish a water supply to PFER to ensure that artificial supplies of water are available to match the hydrology of the Main pool to that of the *Orcuttia* pool.

- GOAL: Protect vernal pools from invasion by *Glyceria* species and perennial pepperweed (*Lepidium latifolium*).

  TASK: Survey all vernal pools and swales annually during the spring for the presence of mannagrass (*Glyceria* species) and eradicate all plants using mechanical means before they set viable seed. *Glyceria declinata* has been reported in the flora for the PPVPP (Clark et al., 1998; van Ess, unknown date) but was not observed on the site

during a June 2005 survey for NIS (M. Young, personal communication). It is not clear whether the *Glyceria* species invading vernal pools is the introduced *G. declinata* or the native *G. occidentalis* as the species cannot be distinguished using existing floras (Anderton and Barkworth, 2004). However, because the vernal pools are critical habitat for Sacramento orcutt grass, neither *Glyceria* species should be allowed to establish and spread. Photographs of *Glyceria declinata* are included in Appendix C to aid in plant identification.

TASK: Survey all vernal pools and swales annually in June for the presence of perennial pepperweed (see Appendix C for species identification) and eradicate all plants immediately using Aquamaster® herbicide applied using the cut-and-paint technique. Application in the vernal pools and swales will be limited to periods when there is no ponded water in the vernal pools and swales while upland areas can be treated at any time. All perennial pepperweed stems should be cut a few inches above the rosette leaves using hand clippers followed by an immediate application of a 75% v/v solution of Aquamaster® that includes a 10% v/v solution of X-77 Spreader® non-ionic surfactant by painting or wiping the solution onto the cut surfaces and rosette leaves. The debris generated by cutting the plants should be removed from the vernal pools and swales and properly disposed of. The treated areas should be surveyed in the fall and the same treatment should be immediately applied to any remaining live plants. It is absolutely critical that the plants do not set viable seed so if it appears that the treatment cannot be implemented prior to seed set the flowering stems should be cut above the rosette leaves and properly disposed of.

Non-Native Annual Grassland

Manage upland grasslands on the PFER in order to protect vernal pool hydrology, provide suitable non-breeding habitat for the western spadefoot toad, maintain quality habitat for a diversity of native plants and wildlife, and reduce wildfire hazards.

- GOAL: Significantly reduce the density or eliminate NIS in the upland grasslands and shift the vegetation to earlier flowering species that will have less of an impact on vernal pool hydrology. The following upland NIS have been identified as aggressively invasive: barb goatgrass (*Aegilops triuncialis*), medusahead (*Taeniatherum caput-medusae*), and yellow star-thistle (*Centaurea solstitialis*).

  There are various methods for NIS control depending on the species, the extent of the invasion, and site conditions. The following are suggested control options for each NIS.

TASK: Reduce the plant density and thatch layer of barb goatgrass and medusahead invaded areas. Mow all of the upland areas. In order to be effective, mowing must be conducted during a very narrow period of time at the proper stage in the species' life cycle for three consecutive years and the mower blades must be set as high as possible but just below the spikes or seed heads. This height will vary somewhat each year, depending upon spring weather conditions. Setting the mower blade at this height will ensure that later yellow starthistle management action is effective. This technique partially mimics the effects of controlled burns (DiTomaso et al. 2001) and requires that mowing be conducted during the short period after the plants have begun flowering and before they set viable seed. Depending upon the pattern of spring rainfall, this period might start on May 1, if the wet season ends early, or as late as June 30, if the wet season ends late. This treatment will probably need to be reapplied every few years. It is essential that the mower be cleaned prior to the mowing so that no new invasive species are introduced onto the PFER from the PPVPP or other areas. Therefore, all parts of the mower that may harbor seed must be pressure-washed to remove any adhering seed or soil prior to the equipment entering the PFER.

TASK: Reduce the plant density of yellow starthistle.

Mechanical control: Dense patches of yellow starthistle may be reduced by mowing when about 10 percent of the plants are flowering for three consecutive years. The mower blade should be set as close to the ground as possible. Generally, mowing when about 2 percent of the plants are flowering is the typical management recommendation but, given the variability in soil depth and fertility across the site, and given the mowing treatment for barb goatgrass and medusahead, a slightly later mowing will allow more plants to reach the vulnerable growth stage before the mowing and reduce yellow starthistle densities more evenly across the PFER uplands. There is some fire hazard with this technique as the blade may cause sparks that could ignite the dry grasses. Fire-fighting equipment should be present during any dry season mowing. It is essential that the entire mower be cleaned prior to the mowing so that no new invasive species are introduced onto the PFER from the PPVPP or other areas. Therefore, all parts of the mower that may harbor seed must be pressure-washed to remove any adhering seed or soil prior to the equipment entering the PFER. Manual removal using a shovel to cut the stem approximately one inch below the soil surface is an alternative for areas with only a few scattered plants. The shovel technique may be used as a follow-up treatment about three to four weeks after the mowing to manually remove any misses or skips.

Plants eradicated during the follow-up treatment should be removed from the site and properly disposed of to ensure that no viable seeds are produced.

Prescribed burning: Fire is a very effective control tool if used when approximately 2% of the plants are flowering. A prescribed burn in 2002 at the PPVPP significantly reduced the density of yellow starthistle and appeared to benefit native plant species (Clark and Hobbs, 2002). Ideally, this treatment should be implemented after a year or two of mowing treatments to ensure that enough fine early season grass fuel is available to carry the burn to all areas of the uplands and should be conducted in two consecutive years. Additionally, prescribed burning should be part of an integrated program using both prescribed burning and either Milestone® or Transline® herbicide (DiTomaso et al., In press). The recommended integrated program recommends a prescribed burn followed by an herbicide application in the following season. However, a number of native species on the site are susceptible to these herbicides and the cautions specified in the following chemical control section should be observed. Weed whips can be used to create fire breaks around oak trees and near the fence line as necessary.

Chemical control: If individual plants are more numerous than can be effectively eradicated using a shovel, and if mowing or prescribed burning will not be conducted, then individual or small groups of plants may be sprayed with RoundUp Pro® during the plant's bolting and early flowering stages as an alternative control method. More specific herbicides such as Milestone® or Transline® may be considered for larger areas of yellow starthistle but these herbicides will also kill some native species and should not be used more often than one year in five on the site. Care must be taken to ensure that no herbicide overspray or drift is deposited on the vernal pools or swales and that any impacts to native upland plants are minimized. Ideally (except for applications of Milestone® or Transline® that must be applied in late fall or early winter), in order to more easily see and identify individual yellow starthistle plants, herbicide treatments should not begin until at least two weeks after the barb goatgrass and medusahead mowing treatment with an additional shovel treatment follow up about three to four weeks later to manually remove any misses or skips. Plants eradicated during the follow up treatment should be removed from the site and properly disposed of to ensure that no viable seeds are produced.

Phoenix Park Vernal Pool Preserve

Northern Hardpan Vernal Pools

Ensure that vernal pools and swales are protected from direct and indirect negative impacts and ensure that the vernal pools may continue to support sensitive species such as Sacramento orcutt grass, pincushion navarretia, western spadefoot toad, and the California fairy shrimp.

- GOAL: Protect vernal pools from direct disturbance from trespassing public, off-trail bicycling, unleashed dogs, and any unauthorized motorized vehicles.

  TASK: Erect post and cable (or otherwise appropriate) fencing around perimeter of preserve where it is lacking.

  TASK: Erect metal signs stating "Ecological Preserve" (or otherwise appropriate text) where lacking along the perimeter fence.

  TASK: Update large wooden sign at entrance to the vernal pool preserve on the western boundary to reflect preserve's current title, ownership, and specific access restrictions such as "dogs on leash only", "clean up after your dogs" and "stay on path."

- GOAL: Protect vernal pools from degradation due to erosion, sediment deposition, debris deposition, and contaminated or polluted water runoff.

  TASK: Drainage from the detention pond between the parking lot and the Baseball Diamond pool should be reestablished by installing a culvert under the path and directing flows toward the existing baseball field and away from the Baseball Diamond pool.

  TASK: Control maintenance vehicle access to the playground at the south end of the PPVPP to ensure that the buffer area between the baseball fields and the vernal pools is not negatively impacted.

  TASK: Train Fair Oaks Recreation and Parks staff in best management practices for avoiding sediment runoff, fertilizer, herbicide and pesticide runoff, and other pollutant runoff into the vernal pools and swales.

  TASK: Place soil erosion control materials and structures at appropriate locations.

- GOAL: Protect vernal pool and swale hydrology by eliminating non-seasonal or excess sources of water and restore vernal pools and swales that have been altered by non-seasonal or excess sources of water.

  TASK: Identify all sources of non-seasonal or excess sources of water and take action to eliminate their impacts on vernal pools and swales. The sprinkler system for the area of irrigated turf in the southeastern corner of the PPVPP should be redesigned so that the irrigated areas are at least 30 feet from any vernal pool or swale. A French drain should be constructed at the western border of the irrigated turf area to intercept any subsurface movement of ground water from that area and convey it southward to the storm drain at the southern border of the PPVPP. The drainage ditch leading from the storm drain culvert near Vega del Rio Drive on the eastern border of the PPVPP should be realigned so that it turns southward almost immediately and connects to the storm drain at the southern border of the PPVPP without connecting to the vernal pool and swale drainage system. Similarly, all sources of non-seasonal or excess sources of water entering the northeastern corner of the PPVPP should be identified and corrective action taken.

  TASK: Manage the NIS grasses of the uplands as described in the Non-native Annual Grassland and Oak Woodland section below to minimize their evapotranspiration impacts on vernal pool hydrology by shifting the dominant herbaceous species to earlier flowering species.

  TASK: Restore the two vernal pools and their swales at the southern end of the preserve from seasonal wetlands to vernal pools and swales and replant with appropriate native species from the PPVPP. This restoration action will require restoring the natural hydrological regime as described above, NIS control as necessary, and planting with appropriate native species.

- GOAL: Protect vernal pools from invasion by *Glyceria* species and perennial pepperweed (*Lepidium latifolium*).

  TASK: Survey all vernal pools and swales annually during the spring for the presence of mannagrass (*Glyceria* species) and eradicate all plants using mechanical means before they set viable seed. *Glyceria declinata* has been reported in the flora for the PPVPP (Clark et al., 1998; van Ess, unknown date) but was not observed on the site during a June 2005 survey for NIS (M. Young, personal communication). It is not clear whether the *Glyceria* species invading vernal pools is the introduced *G. declinata* or the native *G. occidentalis* as the species cannot be distinguished using existing

floras (Anderton and Barkworth, 2004). However, because the vernal pools are critical habitat for Sacramento orcutt grass, neither *Glyceria* species should be allowed to establish and spread. Photographs of Glyceria declinata are included in Appendix C to aid in plant identification.

TASK: Survey all vernal pools and swales annually in June for the presence of perennial pepperweed (see Appendix C for species identification) and eradicate all plants immediately using Aquamaster® herbicide applied using the cut-and-paint technique. Application in the vernal pools and swales will be limited to periods when there is no ponded water in the vernal pools and swales while upland areas can be treated at any time. All perennial pepperweed stems should be cut a few inches above the rosette leaves using hand clippers followed by an immediate application of a 75% v/v solution of Aquamaster® that includes a 10% v/v solution of X-77 Spreader® non-ionic surfactant by painting or wiping the solution onto the cut surfaces and rosette leaves. The debris generated by cutting the plants should be removed from the vernal pools and swales and properly disposed of. The treated areas should be surveyed in the fall and the same treatment should be immediately applied to any remaining live plants. It is absolutely critical that the plants do not set viable seed so if it appears that the treatment cannot be implemented prior to seed set the flowering stems should be cut above the rosette leaves and properly disposed of.

Non-Native Annual Grassland and Blue Oak Woodland

Manage non-native annual grasslands on the preserve in order to protect vernal pool hydrology, provide suitable non-breeding habitat for the western spadefoot toad, maintain quality habitat for a diversity of native plants and wildlife, and reduce wildfire hazards.

- GOAL: Significantly reduce the density or eliminate non-native invasive plant species (NIS) in the grasslands and shift the vegetation to earlier flowering species that will have less of an impact on vernal pool hydrology. The following upland NIS have been identified as aggressively invasive: yellow starthistle, St. Johnswort, barb goatgrass, medusahead, and tree-of-heaven.

  There are alternative methods for NIS control, depending on the species, the extent of the invasion, and site conditions. The following are suggested control options for each NIS.

  TASK: Reduce the plant density and thatch layer of barb goatgrass and medusahead invaded areas. Mow all of the upland except the areas that have been invaded by St. Johnswort. After two years of the

treatment to eradicate St. Johnswort, as described in a following task section, the former invaded area will be included in all upland management actions. In order to be effective mowing must be conducted during a very narrow period of time at the proper stage in the species' life cycle for two consecutive years and the mower blades must be set as high as possible but just below the spikes or seed heads. This height will vary somewhat each year depending upon spring weather conditions. Setting the mower blade at this height is necessary to ensure that later yellow starthistle management action is effective. This technique partially mimics the effects of controlled burns (DiTomaso et al., 2001) and requires that mowing be conducted during the short period of time after the plants have begun flowering and before they set viable seed. Depending upon the pattern of spring rainfall, this period might start on May 1, if the wet season ends early, or as late as June 30, if the wet season ends late. This treatment will probably need to be reapplied every few years as determined by the monitoring protocols. It is essential that the entire mower be cleaned prior to the mowing so that no new invasive species are introduced into the PPVPP from the PFER or other areas. Therefore, all parts of the mower that may harbor seed must be pressure-washed to remove any adhering seed or soil prior to the equipment entering the PPVPP.

TASK: Reduce the plant density of yellow starthistle.

Mechanical control: Dense patches of yellow starthistle may be reduced by mowing when about 10 percent of the plants are flowering for three consecutive years. The mower blade should be set as close to the ground as possible. Generally, mowing when about 2 percent of the plants are flowering is the typical management recommendation but, given the variability in soil depth and fertility across the site, and given the mowing treatment for barb goatgrass and medusahead, a slightly later mowing will allow more plants to reach the vulnerable growth stage before the mowing and reduce yellow starthistle densities more evenly across the PPVPP uplands. There is some fire hazard with this technique as the blade may cause sparks that could ignite the dry grasses. Fire fighting equipment should be present during any dry season mowing. It is essential that the entire mower be cleaned prior to the mowing so that no new invasive species are introduced onto the PPVPP from the PFER or other areas. Therefore, all parts of the mower that may harbor seed must be pressure washed to remove any adhering seed or soil prior to the equipment entering the PPVPP. Manual removal using a shovel to cut the stem approximately one inch below the soil surface is an alternative for areas with only a few scattered plants. The shovel technique may be used as a follow-up treatment about three to four

weeks after the mowing to manually remove any misses or skips. Plants eradicated during the follow-up treatment should be removed from the site and properly disposed of to ensure that no viable seeds are produced.

Prescribed burning: Fire is a very effective control tool if used when approximately 2 percent of the plants are flowering. A prescribed burn in 2002 at the PPVPP significantly reduced the density of yellow starthistle and appeared to benefit native plant species (Clark and Hobbs, 2002). Ideally, this treatment should be implemented after a year or two of mowing treatments to ensure that enough fine early season grass fuel is available to carry the burn to all areas of the uplands and should be conducted in two consecutive years. Additionally, prescribed burning should be part of an integrated program using both prescribed burning and either Milestone® or Transline® herbicide (DiTomaso et al., In press). The recommended integrated program recommends a prescribed burn followed by an herbicide application in the following season. However, a number of native species on the site are susceptible to these herbicides and the cautions specified in the following chemical control section should be observed. Weed whips can be used to create fire breaks around oak trees and near the fence line as necessary.

Chemical control: If individual plants are more numerous than can be effectively eradicated using a shovel, and if mowing or prescribed burning will not be conducted, then individual or small groups of plants may be sprayed with RoundUp Pro® during the plant's bolting and early flowering stages as an alternative control method. More specific herbicides such as Milestone® or Transline® may be considered for larger areas of yellow starthistle but these herbicides will also kill some native species and should not be used more often than one year in five on the site. Care must be taken to ensure that no herbicide overspray or drift is deposited on the vernal pools or swales and that any impacts to native upland plants are minimized. Ideally (except for applications of Milestone® or Transline® that must be applied in late fall or early winter), in order to more easily see and identify individual yellow starthistle plants, herbicide treatments should not begin until at least two weeks after the barb goatgrass and medusahead mowing treatment with an additional shovel treatment follow up approximately three to four weeks later to manually remove any misses or skips. Plants eradicated during the follow up treatment should be removed from the site and properly disposed of to ensure that no viable seeds are produced.

TASK: Eradicate St. Johnswort: Clip all seed capsules off all St. Johnswort plants in August and dispose of them properly to prevent the spread of seed. In the fall, mow the area of the invasion as close as possible to the soil surface prior to the beginning of the wet season. It is essential that the mower be cleaned prior to and immediately after the mowing so that no new invasive species are introduced onto the PPVPP from the PFER or other areas and to ensure that no St. Johnswort seed is moved from the PPVPP to other areas. Therefore, all parts of the mower that may harbor seed must be pressure-washed to remove any adhering seed or soil prior to the equipment entering the PPVPP and immediately after the mowing treatment. Use a sponge applicator (Appendix C) to apply RoundUp Pro®, at the highest labeled rate for perennial plants, to individual St. Johnswort plants. The application should be made to as much green tissue as practical and, because St. Johnswort has both fall/winter and late spring growth phases, the herbicide must be applied during dry periods in mid-January, the first week of April, and the first week of June. St. Johnswort seed persists in a dormant state in the soil for a relatively long time so the locations of the current invasion will have to be monitored and treated annually for at least five years.

TASK: Eradicate tree-of-heaven and other woody NIS. Use the "cut stump" method for stems equal to or less than one inch in diameter and the "hack and squirt" method for stems greater than one inch in diameter. In both methods, the plants will be treated between May to early July with an herbicide mixture of Stalker® and Garlon 3a® mixed in water at the highest labeled concentration for the "tree injection" or hack and squirt methods. These particular formulations have been chosen for their ability to kill the target species and their relatively low toxicities to aquatic organisms. Eye protection is required while using either herbicide as they can cause permanent eye damage. A dye should also be included in the mix to help determine if the mixture has been applied properly. Both herbicides photo-degrade rapidly if exposed to light while in a water-based solution so a light-proof squirt bottle must be used for the application. A regular squirt bottle can be made light proof by carefully wrapping it with aluminum tape that is available from the auto parts section of hardware stores. The cut stump method requires that the stem be cut level with the ground at a height of about 10 inches and the herbicide mix to be immediately applied to the cambium layer that extends parallel to and approximately 0.5 inch inward from the inner side of the bark. The hack and squirt method requires that a series of downward 0.5- to 0.75-inch-deep hatchet cuts (30 degrees from the horizontal) be made around the circumference of the stem with gaps of between one and two inches between the ends of the cuts. These cuts should also be made at a

height of 10 inches above the ground. Approximately 2 to 3 ml of the herbicide mix must be immediately applied to the cut, focusing on the area of the cambium, after each hack. Both techniques require a two person crew for proper application. Additionally, these herbicides are very slow-acting as they work to kill the entire root system so the treated plants should be left standing for two years after treatment. These treatments should be applied to any live shoots that are detected during the May surveys in the following years.

Public Use Elements: Goals and Tasks

Phoenix Field Ecological Reserve

Recreation

No goals or tasks are applicable.

Education

- GOAL: Provide educational materials to homeowners in the vicinity of the preserve or whose property is adjacent to the preserve so that impacts to the preserve due to yard waste disposal, excess irrigation, and herbicide drift are minimized.

  TASK: Distribute interpretive materials to homeowners surrounding the PFER. Materials should be specific to explain which types of activities may impact vernal pools.

  TASK: Give a presentation to homeowners that provide basic information about vernal pools, their functions and values, and how to minimize unintended adverse impacts on them.

- GOAL: Facilitate scientific research in the preserve with appropriate approval from CDFG.

  TASK: Conduct hydrological and ecological studies to determine the cause of the different population sizes of Sacramento orcutt grass in the Orcuttia pool versus the Main pool.

Phoenix Park Vernal Pool Preserve

Recreation

- GOAL: Make available recreation opportunities to the public, including persons with limited mobility.

TASK: Construct pathways such that the general public and persons of limited mobility, including those using wheelchairs, may enjoy the preserve.

Identify locations where a pathway could be constructed without compromising vernal pool habitat.

Prepare required environmental documents and obtain appropriate approval from USFWS and CDFG.

Use USFWS and CDFG approved methods and pathway materials such as a pervious concrete, which will minimize impacts on vernal pool hydrology and chemistry.

Education

- GOAL: Provide educational and interpretive features so that the general public may understand the reasons behind creating the preserve, realize the importance of preserving the vernal pool habitat, and identify and enjoy both the rare and common plants and wildlife on the preserve.

  TASK: Educate the public:

  Place interpretive signs or materials at the entrance to the vernal pool preserve that provide information on vernal pool ecology, conservation, and vernal pool plants and wildlife. Include information about special-status species, including the Sacramento orcutt grass, pincushion navarretia, and California fairy shrimp. Interpretive materials, for example, may include signs, posters, brochures, bird lists, wildlife lists, and plant lists.

  Promote educational enjoyment and stewardship of the PPVPP by the public by encouraging appropriate educational opportunities such as natural history walks by trained docents.

  Provide educational or interpretive materials to homeowners, and board members of homeowners associations in the vicinity of the PPVPP or whose property is adjacent to the PPVPP. Interpretive materials, for example, may include brochures or pamphlets.

- GOAL: Facilitate scientific research in the preserve with appropriate approval from the Fair Oaks Park District and the CDFG.

  TASK: No hydrological studies have been conducted at the PPVPP and the ability of the different pools to support rare species such as Sacramento orcutt grass and California fairy shrimp is unknown.

Both species require long periods of inundation and it is not known if the loss of 19 or 27 acres of watershed above the Baseball Diamond pool has significantly reduced the habitat suitability for these species.

Facility Maintenance Elements: Goals and Tasks

Phoenix Field Ecological Reserve

- GOAL: Maintain and complete cyclone fencing around perimeter of reserve so that there are no holes or gaps to prevent vandalism of the property or dumping of yard waste.

  TASK: Repair or install fencing as needed.

- GOAL: Maintain a firebreak around the perimeter of the reserve to protect the property as well as the neighboring residences surrounding the property.

  TASK: Mow a 10-foot-wide strip along the edge of the reserve so that the vegetation is 6 inches or less in height. The initial mowing should be accomplished at the same time as the barb goatgrass and medusahead management technique described in the Non-native Annual Grassland section of the Biological Elements section. A subsequent mowing may be needed at the same time as the yellow starthistle management technique described in the Non-native Annual Grassland section of the Biological Elements section. Woody species growing adjacent to the fence line should be controlled using the techniques described in the tree-of-heaven management technique described in the PPVPP Non-native Annual Grassland section of the Biological Elements section. Finally, herbaceous vegetation growing in the fence line and in the narrow area between the fence line and the wooden fence of the neighboring properties should be treated with RoundUp Pro® in early February and again in April.

Phoenix Park Vernal Pool Preserve

- GOAL: Maintain all equipment, vehicles, and infrastructure (i.e. plumbing) used near vernal pools so as to prevent breakdowns or leaks that may impact vernal pools.

  TASK: Regularly inspect infrastructure and service equipment and vehicles.

- GOAL: Maintain all pathways, signage, and perimeter fencing so as to prevent trespassing into sensitive vernal pool areas.

  TASK: Regularly inspect these items and correct or repair as necessary.

- GOAL: Maintain a firebreak around the perimeter of the preserve to protect the property as well as the neighboring residences surrounding the property.

  TASK: Mow a 10-foot-wide strip along the southern edge of the reserve so that the vegetation is 6 inches or less in height. The initial mowing should be accomplished at the same time as the barb goatgrass and medusahead management technique described in the Non-native Annual Grassland section of the Biological Elements section. A subsequent mowing may be needed at the same time as the yellow starthistle management technique described in the Non-native Annual Grassland section of the Biological Elements section. Woody species growing adjacent to the fence line should be controlled using the techniques described in the tree-of-heaven management technique described in the PPVPP Non-native Annual Grassland section of the Biological Elements section. Finally, herbaceous vegetation growing in the fence line should be treated with RoundUp Pro® in early February and again in April.

Chapter 5
Monitoring and Adaptive Management

CHAPTER 5
Monitoring and Adaptive Management

Vernal Pools and Swales

Monitoring of Sacramento Orcutt Grass, Pincushion Navarretia, and Vernal Pools and Swales

- Establish a sufficient number of permanent digital photo points to characterize the Orcuttia vernal pool, Main vernal pool sub-basins, Baseball Diamond pool sub-basins and other vernal pools where these species are known to occur. These photo points should be located immediately outside of the vernal pool or vernal pool sub-basin. Each photo point location will be assigned a unique photo point identification number (e.g., "OP 1a" for the *Orcuttia* pool landscape photograph) and its location and compass bearing will be mapped by hand drawing them onto a base aerial photograph or map. The photos will be taken at the flowering stage of the Sacramento orcutt grass and repeated from the same location each season. During each subsequent monitoring action, the compass bearing and prints of the previous year's photos will be used to visually orient the camera's field of view. Additionally, two photos will be taken at each photo point. One photo will be taken to record the landscape view and one photo will be angled downward to capture an overview of the density of vegetation in the vernal pool.

- Map the presence and extent of Sacramento orcutt grass and pincushion navarretia at the time of the photo in each vernal pool or vernal pool sub-basin by hand-drawing the boundary of each occurrence on a print of the aerial photograph base map.

- Estimate the population size of Sacramento orcutt grass at the time of the photo in each sub-basin by counting the number of individuals up to 100 and estimating the number in excess of 100. The population size will then be reported as the actual number or by estimated size class as follows: 0-10, 11-100, 101-1000, and >1000. If the population size of either the *Orcuttia* pool population or the Baseball Diamond pool population drops to a size class of 11 to 100 individuals or less immediate adaptive management actions must be taken to ensure the species' continued survival.

- Determine if any species of *Glyceria* or perennial pepperweed are present in any of the vernal pools or swales and if any individuals are found immediately institute the appropriate eradication action as described above.

- Note the presence of any obvious changes or impacts (such as summer irrigation) to the vernal pools and swales in the field monitoring notes.

- Obtain the daily and cumulative rainfall data for the current season for the Folsom station from the CalClim web site (<www.calclim.dri.edu/>), save the data file, and make a note as to the amount of precipitation and its seasonal distribution in the field monitoring notes.

Adaptive Management of Sacramento Orcutt Grass, Pincushion Navarretia, and Vernal Pools and Swales

- If either the *Orcuttia* pool population or the Baseball Diamond pool population of Sacramento orcutt grass drops to a size class of 11 to 100 individuals or less take immediate action to determine the cause for the reduction in population size. Factors such as drought, altered hydrology, summer irrigation, invasive species, and potential overspray of herbicides should be considered as potential causes. If the cause cannot be determined a study to identify the cause or causes should be immediately implemented.

- If *Glyceria* spp., perennial pepperweed, or any other NIS is observed to be invading the pools and swales, immediate action should be taken to eradicate all individuals of the NIS, using the methods described above or other methods as appropriate.

Non-Native Annual Grassland and Blue Oak Woodland

Monitoring of Non-Native Annual Grassland, Blue Oak Woodland and Non-Native Invasive Species

- Prior to the first non-native annual grass species mowing treatment, the location of permanent photo points will be chosen to represent the pre-treatment range of variation of the upland grassland vegetation (5 at PFER; 10 at PPVPP plus 2 additional of the St. Johnswort patch). Each location will be assigned a unique photo point identification number (e.g., PFER NG 1a for the Non-native Annual Grassland landscape view at PFER) and its location and compass direction will be mapped by hand drawing it onto a base aerial photograph. During each subsequent monitoring event, the compass bearing and prints of the previous year's photos can be used to visually orient the photo's field of view. Photo point monitoring should be conducted twice each

year; once during the flowering period of barb goatgrass and medusahead grass but before any treatments are applied, and once after the yellow starthistle treatment approximately 2 weeks after its peak blooming period. A landscape view and surface view photo will be taken at each location. The landscape photo will provide an overall view of each area and the surface view photo should be angled downward to capture a 3-foot by 3-foot overview of the density of vegetation. Adaptive management actions should be taken if there is either no decrease or an increase in the cover of the target NIS (barb goatgrass, medusahead, yellow starthistle, St. Johnswort, and tree-of-heaven or other wood NIS).

Adaptive Management of Non-Native Annual Grassland, Blue Oak Woodland and Non-Native Invasive Species

- If the densities of barb goatgrass and medusahead grass are not noticeably reduced through the specified mowing regime after the second year of treatment, alternative methods such as prescribed burns should be considered prior to beginning the third year of the mowing treatment.

- If the density of yellow starthistle is not noticeably reduced through the specified mowing regime after the second year of treatment, alternative methods such as prescribed burns should be considered prior to beginning the third year of the mowing treatment.

- If the density of St. Johnswort is not noticeably reduced through the specified herbicide regime after the second year of treatment, alternative methods should be considered prior to beginning the third year of the mowing treatment. The management goal for this species is complete eradication.

- If woody NIS such as tree-of-heaven are not eradicated by the specified herbicide regime after the second year of treatment, alternative methods should be considered prior to beginning the third year of the mowing treatment. The management goal for tree-of-heaven and other woody NIS is complete eradication.

- If any existing non-target NIS or newly introduced NIS is determined to be increasing, immediate action should be take to eradicate or reduce its populations using appropriate means.

Chapter 6
Operations and Maintenance Summary

CHAPTER 6
Operations and Maintenance Summary

Existing Staff and Additional Personnel Needs Summary

The following table identifies existing CDFG staffing needs and purpose as well as an estimate of costs.

Activity / Classification	Mowing PFER Time/Supplies	Calls	Response Letters	Interagency Cooperation
B Range Biologist	Gas $30 2 days x $165.28=$330.56	6-12/season Avg. time-6 min. Max-$24.48/year	3-6/year, 1 hour/letter Max-$123.96/year	Fire Dept. or Fair Oaks Recreation and Parks District 1-4 hours/year Max-$82.64
Fish and Wildlife Scientific Aide	($11.10 hourly rate) 2 days x $88.80= $177.60	4/season Max-$4.44/year	X	X
Totals	$360.56 or $207.60	$28.92	$123.96	$82.64

Addition staff provided either by CDFG or other agencies or organizations such as Fair Oaks Recreation and Parks District would be needed to implement specific tasks needed to meet management plan goals and objectives. The level of effort to meet those staffing needs is yet to be determined. The Fair Oaks Recreation and Park District is currently evaluating management need for the vernal pools, oak woodland and upland grasslands.

Operations and Maintenance Summary

The Operations and Maintenance (O&M) for the two vernal pool areas specifically are focused on the protection of the ecosystem in part through eradication of non-native plant species along with preventing human-caused disturbance. Current O&M for PFER is by protection of the resource by limiting human access. However, non-native plants have become well established and implementing management goals and tasks will become part of the future maintenance activities.

Chapter 7
References

CHAPTER 7
References

Anderton, L., and M. Barkworth. 2004. *Glyceria occidentalis* (Poaceae), *G. declinata*, *G. fluitans*, and *G. plicata*: are they really different? *in* Botanical Society of America Annual Meeting, Snowbird, Utah.

Bauder, E. T. 2005. The effects of an unpredictable precipitation regime on vernal pool hydrology. Freshwater Biology **50**:1229-2135.

Burmester, D. 2002. Final report: restoring a natural hydrological regime for two endangered plant species at the Phoenix Field Ecological Reserve. California Department of Fish and Game, Rancho Cordova.

Burmester, D. 2003. Phoenix Park vernal pools. California Department of Fish and Game, Rancho Cordova.

California Department of Fish and Game. 2004. Scope of work. Rancho Cordova.

California Department of Water Resources. 2004. California's groundwater Bulletin 118, Sacramento Valley groundwater basin, north American subbasin. Sacramento.

California Native Plant Society. 2006. Inventory of rare and endangered plants. *in*.

California Natural Diversity Database. 2006. Rarefind 3 program. *in*. California Department of Fish and Game.

CDFG Wildlife and Habitat Analysis Branch. 2003. List of California terrestrial natural communities recognized by the California Natural Diversity Database. *in*. California Department of Fish and Game.

Clark, C., and M. Hobbs. 2002. Phoenix Park vernal pools burn assessment report. Fair Oaks Recreation and Park District, Fair Oaks.

Clark, G. M., T. J. Roscoe, M. J. van Ess, and N. Wymer. 1998. Management considerations for small vernal pool preserves - the Phoenix vernal pools. Pages 250-254 *in* C. W. Witham, E. T. Bauder, D. Belk, W. R. J. Ferren, and R. Ornduff, editors. Ecology, Conservation, and Management of Vernal Pool Ecosystems. California Native Plant Society, Sacramento.

Clemons, S. 1981. A management plan for the Phoenix Field Ecological Reserve. California Department of Fish and Game, Rancho Cordova.

Crampton, B. 1959. The grass genera *Orcuttia* and *Neostapfia*: a study in habitat and morphological specialization. Madroño **15**:97-110.

DiTomaso, J. M., K. L. Heise, G. B. Kyser, A. M. Merenlender, and R. J. Keiffer. 2001. Carefully timed burning can control barb goatgrass. California Agriculture **55**:47-53.

DiTomaso, J. M., G. B. Kyser, J. R. Miller, S. Garcia, R. F. Smith, G. Nader, J. M. Connor, and S. B. Orloff. In press. Integrating prescribed burning and clopyralid for the management of yellow starthistle. Weed Science.

Griffin, J. R. 1988. Oak woodland. Pages 383-415 *in* M. G. Barbour and J. Major, editors. Terrestrial Vegetation of California. California Native Plant Society, Davis.

Griggs, F. T. 1976. Life history strategies of the genus *Orcuttia* (Gramineae). Pages 57-63 *in* S. Jain, editor. Vernal pools, their ecology and conservation. University of California, Davis.

Hanes, T., and L. Stromberg. 1998. Hydrology of vernal pools on non-volcanic soils in the Sacramento Valley. Pages 38-49 *in* C. W. Witham, E. T. Bauder, D. Belk, W. R. J. Ferren, and R. Ornduff, editors. Ecology, Conservation, and Management of Vernal Pool Ecosystems. California Native Plant Society, Sacramento.

Hanes, W. T., B. Hecht, and L. Stromberg. 1990. Water relationships of vernal pools in the Sacramento region, California. Pages 49-60 *in* D. H. Ikeda and R. A. Schlising, editors. Vernal pool plants - their habitat and biology. California State University, Chico.

Hobson, W. A., and R. A. Dahlgren. 1998. Soil forming processes in vernal pools on northern California, Chico area. Pages 24-37 *in* C. W. Witham, E. T. Bauder, D. Belk, W. R. J. Ferren, and R. Ornduff, editors. Ecology, Conservation, and Management of Vernal Pool Ecosystems. California Native Plant Society, Sacramento.

Holland, R. F. 1982. Letter to Scott Clemons. Orangevale.

Holland, R. F. 1986. What constitutes a good year for an annual plant? Two examples from the Orcuttieae. *in* T. S. Elias, editor. Conservation and management of rare and endangered plants. California Native Plant Society, Sacramento.

Holland, R. F. 1988. List of plant species recorded from Phoenix Field Ecological Reserve, Sacramento County, California, as of 28 April 1988.

Holland, R. F., and V. I. Dains. 1990. The edaphic factor in vernal pool vegetation. Pages 31-48 *in* D. H. Ikeda and R. A. Schlising, editors. Vernal pool plants - their habitat and biology. California State University, Chico.

Holland, R. F., and S. Jain. 1988. Vernal pools. Pages 515-533 *in* M. G. Barbour and J. Major, editors. Terrestrial Vegetation of California. California Native Plant Society, Davis.

Horenstein, J., and T. Roscoe. 1997. DFG land conservation and stewardship program funds application. California Department of Fish and Game, Rancho Cordova.

J. H. Kleinfelder & Associates. 1976. Preliminary soils investigation Rollingwood Subdivision - Unit No. 10, Sacramento County, California. Sacramento Savings, Sacramento.

Jones and Stokes Associates. 1987. Draft environmental impact report for Rollingwood II general plan amendment, community plan amendment and rezone. Sacramento County Planning and Community Development Department, Sacramento.

Keeley, J. E., and P. H. Zedler. 1998. Characterization and global distribution of vernal pools. Pages 1-14 *in* C. W. Witham, E. T. Bauder, D. Belk, W. R. J. Ferren, and R. Ornduff, editors. Ecology, Conservation, and Management of Vernal Pool Ecosystems. California Native Plant Society, Sacramento.

Kie, J. G. 2005. Annual grassland. *in* K. E. Mayer and W. F. J. Laudenslayer, editors. A guide to wildlife habitats of California. California Department of Fish and Game, Sacramento.

Marty, J. T. 2005. Effects of cattle grazing on diversity in ephemeral wetlands. Conservation Biology **19**:1626-1632.

Murray Smith & Associates Engineering, Huffman & Associates, and Balance Hydrologics. 1991. Evaluation of the Phoenix Field Unit No. 4 vegetated swale alternative. Sacramento County Department of Environmental Review and Assessment, Sacramento.

Pyke, C. R., and J. T. Marty. 2005. Cattle grazing mediates climate change impacts on ephemeral wetlands. Conservation Biology **19**:1619-1625.

Rains, M. C., G. E. Fogg, T. Harter, R. A. Dahlgren, and R. J. Williamson. In press. The role of perched aquifers in hydrological connectivity and biogeochemical processes in vernal pool landscapes. Hydrological Processes.

Ritter, L. V. 1988. Blue oak woodland. *in* K. E. Mayer and W. F. J. Laudenslayer, editors. A guide to wildlife habitats of California. California Department of Fish and Game, Sacramento.

Roscoe, T. 1997. Annual orcutt grass survey at Phoenix Field Ecological Reserve (PFER). California Department of Fish and Game, Sacramento.

Sawyer, J. O., Jr., and T. Keeler-Wolf. 1995. A manual of California vegetation. California Native Plant Society, Sacramento.

Simovich, M. A. 1998. Crustacean biodiversity and endemism in California's ephemeral wetlands. Pages 107118 *in* C. W. Witham, E. T. Bauder, D. Belk, W. R. J. Ferren, and R. Ornduff, editors. Ecology, Conservation, and Management of Vernal Pool Ecosystems. California Native Plant Society, Sacramento.

Smith, D. W., and W. L. Verrill. 1998. Vernal pool-soil-landform relationships in the Central Valley, California. Pages 15-23 *in* C. W. Witham, E. T. Bauder, D. Belk, W. R. J. Ferren, and R. Ornduff, editors. Ecology, Conservation, and Management of Vernal Pool Ecosystems. California Native Plant Society, Sacramento.

Stromberg, L., and Balance Hydrologics. 1989. Final report: vernal pool hydrology study Rollingwood II site and adjacent vernal pool preserves. Sacramento County Department of Planning and Community Development, Sacramento.

Trugel, A. J. 1993. Soil survey of Sacramento County, California. Soil Conservation Service, Washington.

U.S. Fish and Wildlife Service. 2006. Sacramento Fish and Wildlife office online endangered species accounts. *in*.

U.S. Fish and Wildlife Service. 2003. Final designation of critical habitat for four vernal pool crustaceans and eleven vernal pool plants. *in*. August 6, 2003.

van Ess, M. J. unknown date. Plants of the upland area in Phoenix Park. Fair Oaks.

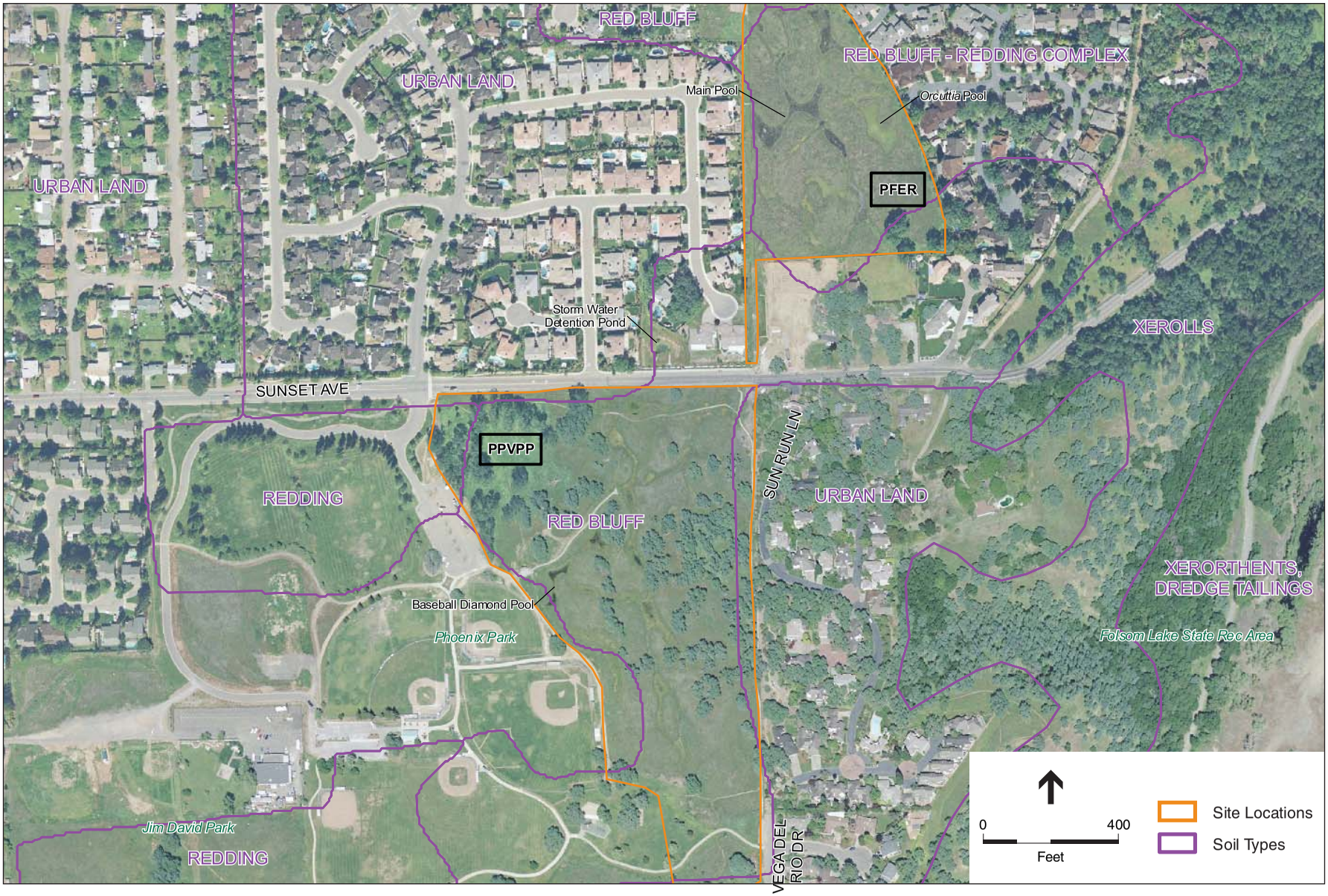
Western Regional Climate Center. 2005. Period of record general climate summary, Folsom Dam, California. *in*. CalClim, Western Regional Climate Center.

Williamson, R. J., G. E. Fogg, M. C. Rains, and T. Harter. 2005. Final technical report: hydrology of vernal pools at three sites, southern Sacramento Valley. California Department of Transportation, Davis.

Workmann, M. 1992. Field observations - Phoenix Field. California Department of Fish and Game, Rancho Cordova.

Woyshner, M., and B. Hecht. 1988. Letter to Laurence Stromberg. Kleinfelder, Albany.

Appendix A
Soil Survey Map



SOURCE: USDA, 2004; Globe Explorer, 2004; and ESA, 2006

Appendix A
Soil Types

Appendix B
Animal and Plant Species Inventories

APPENDIX B
Animal and Plant Species Inventories

TABLE B-1
ANIMAL SPECIES INVENTORY

Scientific Name	Common Name	Scientific Name	Common Name
Invertebrates		**Birds (Continued)**	
Diaptomidae	Copepod	*Buteo jamaicensis*	Red-tailed hawk
Linderiella occidentalis	California linderiella	*Carpodacus mexicanus*	House finch
Veromessor andrei	Harvester ant	*Cathartes aura*	Turkey vulture
Cypridinae	Seed shrimp	*Corvus brachyrhynchos*	American crow
Daphniidae	Water fleas	*Melanerpes formicivorus*	Acorn woodpecker
Corixidae	Water boatmen	*Meleagris gallopavo*	Wild turkey
Amphibians		*Zenaida macroura*	Mourning dove
Bufo boreas halophilus	California toad	*Zonotrichia leucophrys*	White-crowned sparrow
Hyla regilla	Pacific tree frog	**Mammals**	
Spea (=Scaphiopus) hammondii	Western spadefoot	*Lepus californicus*	Black-tailed jackrabbit
Reptiles		*Felis catus*	Domestic cat (feral)
Sceloporus occidentalis	Western fence lizard	*Microtus californicus*	California vole
Thamnophis sirtalis fitchi	Valley garter snake	*Odocoileus hemionus*	Black-tailed deer
Birds		*Peromyscus* sp.	Mouse
Pica nuttali	Yellow-billed magpie	*Scapanus latimanus*	Broad-footed mole
Anas platyrhynchos	Mallard	*Sciurus griseus*	Western gray squirrel
Aphelocoma californica	Western scrub jay	*Sorex* sp.	Shrew
Baeolophus inornatus	Oak titmouse	*Spermophilus beecheyi*	California ground squirrel
		Thomomys sp.	Pocket gopher

SOURCES: CDFG, 2005-CNDDB; Endangered Plant Project - paper with no references; Holland, memos – observations; CDFG, 1981 - Management Plan; ESA biologist observations; Memo to Scott Clemons, ES Coordinator from DFG, 1981

TABLE B-2
PLANT SPECIES INVENTORY

Scientific Name	Common Name	Family
Amaranthus albus *	Tumbleweed	Amaranthaceae
Amaranthus blitoides	Prostrate amaranth	Amaranthaceae
Amaranthus cruentus *	Red amaranth	Amaranthaceae
Amaranthus deflexus *	Low amaranth	Amaranthaceae
Amaranthus powellii	Powell's amaranth	Amaranthaceae
*Pistacia atlantica**	Pistachio	Anacardiaceae
Toxicodendron diversilobum	Poison oak	Anacardiaceae
Daucus pusillus	Rattlesnake weed	Apiaceae
Eryngium vaseyi var. *vaseyi*	Vasey's coyote-thistle	Apiaceae
Lomatium caruifolium var. *denticulatum*	Caraway-leaved lomatium	Apiaceae
Lomatium marginatum	Hartweg's lomatium	Apiaceae
Sanicula bipinnata	Poison sanicle	Apiaceae
Sanicula bipinnatifida	Purple sanicle	Apiaceae
Sanicula crassicaulis	Pacific sanicle	Apiaceae
Torilis arvensis *	Hedge parsley	Apiaceae
*Torilis nodosa**	Knotted hedge parsley	Apiaceae
Achillea millefolium	Yarrow	Asteraceae
Achyrachaena mollis	Blow wives	Asteraceae
Aster subulatus var. *ligulatus*	Slim aster	Asteraceae
Blennosperma nanum	Yellow carpet	Asteraceae
Carduus pycnocephalus *	Italian thistle	Asteraceae
Centaurea solstitialis *	Yellow star thistle	Asteraceae
*Chamomilla suaveolens**	Pineapple weed	Asteraceae
Cichorium intybus *	Chicory	Asteraceae
*Conyza bonariensis**	South American horseweed	Asteraceae
Conyza canadensis	Western horseweed	Asteraceae
*Conyza floribunda**	Tropical horseweed	Asteraceae
*Cotula australis**	Australian cotula	Asteraceae
Evax caulescens	Dwarf dwarf cudweed	Asteraceae
*Filago gallica**	Narrow-leaved filago	Asteraceae
*Gnaphalium luteo-album**	Weedy cudweed	Asteraceae
Helianthus annuus	Western sunflower	Asteraceae
Hemizonia fitchii	Fitch's tarplant	Asteraceae
Holocarpha virgata	Pitgland tarweed	Asteraceae
*Hypochaeris glabra**	Smooth cat's ear	Asteraceae
Lactuca serriola *	Prickly wild lettuce	Asteraceae
Lasthenia californica	California goldfields	Asteraceae
Lasthenia fremontii	Fremont goldfields	Asteraceae
Lasthenia glaberrima	Rayless goldfields	Asteraceae
Layia fremontii	Fremont tidy tips	Asteraceae
*Leontodon taraxacoides**	Hairy hawkbit	Asteraceae
Madia gracilis	Slender tarweed	Asteraceae
Madia subspicata	Gumweed	Asteraceae
Micropus californicus	Slender cottonweed	Asteraceae
Microseris douglasii	Douglas' microseris	Asteraceae
Psilocarphus brevissimus	Woolly marbles	Asteraceae
Psilocarphus tenellus	Slender woolly heads	Asteraceae

TABLE B-2
PLANT SPECIES INVENTORY

Scientific Name	Common Name	Family
Senecio vulgaris *	Common groundsel	Asteraceae
Silybum marianum *	Milk thistle	Asteraceae
*Soliva sessilis**	South American soliva	Asteraceae
Sonchus asper *	Prickly sow-thistle	Asteraceae
Sonchus oleraceus *	Common sow-thistle	Asteraceae
Taraxacum officinale *	Dandelion	Asteraceae
*Tragopogon dubius**	Yellow salsify	Asteraceae
Amsinckia menziesii var. *intermedia*	Common fiddleneck	Boraginaceae
Amsinckia menziesii var. *menziesii*	Menzies' fiddleneck	Boraginaceae
Plagiobothrys greenei	Greene's allocarya	Boraginaceae
Plagiobothrys nothofulvus	Rusty popcornflower	Boraginaceae
Plagiobothrys stipitatus var. *micranthus*	Small stipitate popcornflower	Boraginaceae
Brassica rapa *	Field mustard	Brassicaceae
Capsella bursa-pastoris *	Shepherd's purse	Brassicaceae
Cardamine oligosperma	Bitter cress	Brassicaceae
*Coronopus didymus**	Lesser wart cress	Brassicaceae
Lepidium nitidum	Common peppergrass	Brassicaceae
Lepidium oblongum var. *oblongum*	Pepper grass	Brassicaceae
Raphanus raphanestrum *	Jointed charlock	Brassicaceae
Raphanus sativus *	Wild radish	Brassicaceae
Rorippa curvisiliqua	Western yellow cress	Brassicaceae
*Sisymbrium officinale**	Hedge mustard	Brassicaceae
Thysanocarpus curvipes	Sand fringepod	Brassicaceae
Thysanocarpus radians	Ribbed fringepod	Brassicaceae
Callitriche heterophylla var. *bolanderi*	Bolander's water starwort	Callitrichaceae
Callitriche marginata	California water-starwort	Callitrichaceae
Downingia bicornuta	Bristled downingia	Campanulaceae
Downingia concolor	Spotted-throat downingia	Campanulaceae
Downingia cuspidata	Toothed downingia	Campanulaceae
Downingia pusilis	Dwarf downingia	Campanulaceae
Cerastium glomeratum *	Mouse-ear chickweed	Caryophyllaceae
Minuartia californica	California sandwort	Caryophyllaceae
*Silene gallica**	Windmill pink	Caryophyllaceae
*Spergula arvensis**	Stickwort	Caryophyllaceae
*Spergularia rubra**	Purple sandspurry	Caryophyllaceae
Stellaria media *	Common chickweed	Caryophyllaceae
Chenopodium album *	Lamb's quarters	Chenopodiaceae
*Chenopodium pumilio**	Tasmanian goosefoot	Chenopodiaceae
Convolvulus arvensis *	Bind weed	Convolvulaceae
Crassula aquatica	Water pigmyweed	Crassulaceae
Crassula connata	Sand pigmyweed	Crassulaceae
Cuscuta howelliana	Howell's cuscuta	Cuscutaceae
Cyperus bipartitus	Slender flatsedge	Cyperaceae
*Cyperus difformis**	Variable flatsedge	Cyperaceae
Cyperus eragrostis	Tall flatsedge	Cyperaceae
Cyperus niger	Black flatsedge	Cyperaceae
Cyperus strigosus	Straw-colored cyperus	Cyperaceae
Eleocharis macrostachya	Common spike-rush	Cyperaceae

TABLE B-2
PLANT SPECIES INVENTORY

Scientific Name	Common Name	Family
Elatine californica	California waterwort	Elatinaceae
*Chamaesyce maculata**	Contura Creek spurge	Euphorbiaceae
Chamaesyce ocellata	Spotted spurge	Euphorbiaceae
Eremocarpus setigerus	Turkey mullein	Euphorbiaceae
Lotus corniculatus *	Bird's-foot trefoil	Fabaceae
Lotus micranthus	Small-flowered trefoil	Fabaceae
Lotus purshianus	Spanish lotus	Fabaceae
Lotus wrangeliensis	Calf lotus	Fabaceae
Lupinus bicolor	Bicolored lupine	Fabaceae
Medicago polymorpha *	California Bur-clover	Fabaceae
*Trifolium campestre**	Hop clover	Fabaceae
Trifolium depauperatum var. *depauperatum* *	Dwarf sack clover	Fabaceae
*Trifolium glomeratum**	Clustered clover	Fabaceae
Trifolium microcephalum	Small-headed clover	Fabaceae
*Trifolium pratense**	Red clover	Fabaceae
*Trifolium repens**	White clover	Fabaceae
*Trifolium subterraneum**	Subterranean clover	Fabaceae
Trifolium variegatum	White-tipped clover	Fabaceae
Vicia benghalensis *	Purple vetch	Fabaceae
Vicia sativa ssp. *nigra**	Spring vetch	Fabaceae
Vicia villosa ssp. *varia**	Thick-fruited vetch	Fabaceae
Vicia villosa ssp. *villosa**	Hairy vetch	Fabaceae
Quercus douglasii	Blue oak	Fagaceae
Quercus wislizenii	Interior live oak	Fagaceae
Centaurium muehlenbergii	Muehlenberg's centaury	Gentianaceae
Centaurium venustrum	Canchalagua	Gentianaceae
Cicendia quadrangularis	Common microcalis	Gentianaceae
Erodium botrys *	Long-beaked filaree	Geraniaceae
Erodium cicutarium *	Redstem filaree	Geraniaceae
Erodium moschatum *	White-stemmed filaree	Geraniaceae
Geranium carolinianum	Carolina geranium	Geraniaceae
Geranium dissectum *	Dissected geranium	Geraniaceae
*Geranium molle**	Dovefoot geranium	Geraniaceae
Hypericum perforatum *	St. Johnswort	Hypericaceae
Sisyrinchium bellum	Blue-eyed grass	Iridaceae
Isoetes howellii	Howell's quillwort	Isoetaceae
Isoetes nuttallii	Nuttall's quillwort	Isoetaceae
Isoetes orcuttii	Orcut's quillwort	Isoetaceae
Juncus bufonius	Toad rush	Juncaceae
*Juncus capitatus**	Leafy bracted dwarf rush	Juncaceae
Juncus kelloggii	Kellog's dwarf rush	Juncaceae
Juncus tenuis	Poverty rush	Juncaceae
Juncus uncialis	twelfth rush	Juncaceae
Lilaea scilloides	Flowering quillwort	Juncaginaceae
Lamium amplexicaule *	Henbit	Lamiaceae
Pogogyne zizyphoroides	Sacramento mesamint	Lamiaceae
Trichostema lanceolatum	Vinegar weed	Lamiaceae
Brodiaea coronaria	Harvest brodiaeae	Liliaceae

TABLE B-2
PLANT SPECIES INVENTORY

Scientific Name	Common Name	Family
Brodiaea elegans	Elegant brodiaea	Liliaceae
Brodiaea minor	Dwarf brodiaea	Liliaceae
Calochortus luteus	Yellow Mariposa lily	Liliaceae
Chlorogalum angustifolium	Narrow-leaved soaproot	Liliaceae
Chlorogalum pomeridianum	Soaproot	Liliaceae
Dichelostemma capitatum	Blue dicks	Liliaceae
Triteleia hyacinthina	Wild hyacinth	Liliaceae
Triteleia laxa	Ithuriel's spear	Liliaceae
*Lythrum hyssopifolium**	Hyssop loosestrife	Lythraceae
*Malva parviflora **	Cheeseweed	Malvaceae
Sidalcea calycosa	Annual checker-mallow	Malvaceae
Pilularia americana	American pillwort	Marsileaceae
*Mollugo verticillata **	Green carpet-weed	Molluginaceae
Clarkia purpurea	Purple clarkia	Onagraceae
Clarkia unguiculata	Elegant clarkia	Onagraceae
Epilobium brachycarpum	Panicled willow-herb	Onagraceae
Epilobium ciliatum	Northern willow-herb	Onagraceae
Epilobium cleistogamum	Cleistogamous bousduvalia	Onagraceae
Epilobium torreyi	Narrow-leaved boisduvalia	Onagraceae
Oenothera elata ssp. *hirsutissima*	Hooker's evening primrose	Onagraceae
*Oxalis corniculata **	Creeping woodsorrel	Oxalidaceae
Eschscholzia californica	California poppy	Papaveraceae
Eschscholzia lobbii	Frying pan poppy	Papaveraceae
*Phytolacca americana**	Pokeweed	Phytalaccaceae
*Plantago coronopus **	Cut-leaved plantain	Plantaginaceae
Plantago elongata	Long-leaved plantain	Plantaginaceae
*Plantago lanceolata **	Narrow-leaved plantain	Plantaginaceae
*Aegilops triuncialis**	Barb goatgrass	Poaceae
*Agrostis avenaceae **	Pacific bentgrass	Poaceae
*Aira caryophyllea **	Silver hairgrass	Poaceae
*Alopecurus pratensis**	Meadow foxtail	Poaceae
Alopecurus saccatus	Pacific foxtail	Poaceae
Andropogon virginicus var. *virginicus**	Broomsedge	Poaceae
Aristida oligantha	Oldfield three-awn	Poaceae
*Avena barbata **	Slender wild oat	Poaceae
*Avena fatua **	Wild oat	Poaceae
*Brachypodium distachyon **	Purple false brome	Poaceae
*Briza maxima **	Big quakinggrass	Poaceae
*Briza minor **	Little quakinggrass	Poaceae
*Bromus cartharticus **	Rescue brome	Poaceae
*Bromus diandrus **	Ripgut grass	Poaceae
*Bromus hordeaceus **	Soft chess	Poaceae
Bromus madritensis ssp. *madritensis**	Red brome	Poaceae
*Crypsis schoenoides **	Swamp timothy	Poaceae
*Cynodon dactylon **	Bermuda grass	Poaceae
*Cynosurus echinatus **	Hedgehog dogtail grass	Poaceae
*Dactylis glomerata **	Orchard grass	Poaceae
Deschampsia danthonioides	Annual hairgrass	Poaceae

TABLE B-2
PLANT SPECIES INVENTORY

Scientific Name	Common Name	Family
Digitaria sanguinalis *	Hairy crabgrass	Poaceae
Echinochloa crus-galli *	Barnyard grass	Poaceae
*Festuca pratensis**	Meadow fescue	Poaceae
*Gastridium ventricosum**	Nit grass	Poaceae
Glyceria declinata *	Little manna grass	Poaceae
Hordeum depressum	Low barley	Poaceae
Hordeum marinum ssp. *gussoneanum* *	Mediterranean barley	Poaceae
Hordeum murinum ssp. *leporinum* *	Foxtail barley	Poaceae
Leptochloa fascicularis	Sprangletop	Poaceae
Lolium multiflorum *	Italian ryegrass	Poaceae
Lolium perenne *	Perennial ryegrass	Poaceae
Melica californica	California melic	Poaceae
Nassella cernua	Nodding needlegrass	Poaceae
Nassella pulchra	Purple needlegrass	Poaceae
Orcuttia viscida	sacramento orcutt grass	Poaceae
Paspalum dilatatum *	Dallis grass	Poaceae
Phalaris lemmonii	Lemmon's canary grass	Poaceae
Poa annua *	Annual bluegrass	Poaceae
Polypogon monspeliensis *	Rabbitsfoot grass	Poaceae
Taeniatherum caput-medusae *	Medusa head	Poaceae
Vulpia bromoides *	Brome fescue	Poaceae
Vulpia microstachys var. *ciliata*	Eastwood fescue	Poaceae
Vulpia myuros var. *hirsuta* *	Hairy rattail fescue	Poaceae
Vulpia myuros var. *myuros**	Rattail fescue	Poaceae
Vulpia octoflora var. *octoflora*	Six-weeks fescue	Poaceae
Navarretia intertexta	Needle-leaved navarretia	Polemoniaceae
Navarretia leucocephala	Whiteheads	Polemoniaceae
Navarretia minima	Little whiteheads	Polemoniaceae
Navarretia myersii ssp. *myersii*	Pincushion navarretia	Polemoniaceae
Navarretia tagetina	Marigold navarretia	Polemoniaceae
Polygonum arenastrumm *	Common knotweed	Polygonaceae
Polygonum persicaria *	Lady's thumb	Polygonaceae
*Rumex acetocella**	Sheep sorrel	Polygonaceae
*Rumex conglomeratus**	Cluster Dock	Polygonaceae
Rumex crispus *	Curly dock	Polygonaceae
*Rumex pulcher**	Fiddle dock	Polygonaceae
Calandrinia ciliata	Red maids	Portulacaceae
Claytonia perfoliata	Miner's lettuce	Portulacaceae
Montia fontana	Water chickweed	Portulacaceae
*Portulaca oleracea**	Common purslane	Portulaceae
Anagallis arvensis *	Scarlet pimpernel	Primulaceae
Centunculus minimus	Chaffweed	Primulaceae
Dodecatheon clevelandii ssp. *sanctarum*	Padre's shooting star	Primulaceae
Dodecatheon hendersonii	Henderson's shooting star	Primulaceae
Delphinium hansenii	Hansen's larkspur	Ranunculaceae
Delphinium variegatum	Royal larkspur	Ranunculaceae
Ranunculus bonarienis var. *trisepalus*	Vernal pool buttercup	Ranunculaceae
Ranunculus californicus	California buttercup	Ranunculaceae

TABLE B-2
PLANT SPECIES INVENTORY

Scientific Name	Common Name	Family
Ranunculus muricatus *	Prickle-fruited buttercup	Ranunculaceae
*Prunus cerasifera**	Purple-leaved plum	Rosaceae
*Prunus dulcis**	Almond	Rosaceae
*Pyracantha angustifolia**	Firethorn	Rosaceae
Rubus discolor *	Himalayan blackberry	Rosaceae
Galium aparine	Common bedstraw	Rubiaceae
Galium nuttallii	Climbing bedstraw	Rubiaceae
Galium porrigens var. *tenue*	Graceful bedstraw	Rubiaceae
Castilleja attenuata	Valley tassels	Scrophulariaceae
Castilleja campestris	Yellow owl's clover	Scrophulariaceae
Collinsia heterophylla	Chinese houses	Scrophulariaceae
Gratiola ebracteata	Bractless hedge-hyssop	Scrophulariaceae
*Kickxia spuria**	Round-leaved fluellin	Scrophulariaceae
Lindernia dubia var. *anagallidea*	Yellowseed false pimpernel	Scrophulariaceae
Mimulus guttatus	Common monkeyflower	Scrophulariaceae
Mimulus tricolor	Tricolor monkeyflower	Scrophulariaceae
Triphysaria eriantha	Butter and eggs	Scrophulariaceae
Veronica peregrina ssp. *xalapensis*	Purslane speedwell	Scrophulariaceae
Nicotiana acuminata var. *multiflora**	Tobacco	Solanaceae
Solanum americanum	American black nightshade	Solanaceae
Typha latifolia	Broad-leaved cattail	Typhaceae
Viola pedunculata	Johnny jump-up	Violaceae
Phoradendron villosum	Oak mistletoe	Viscaceae
Tribulus terrestris *	Puncture vine	Zygophyllaceae

* Non-native species

Appendix C

Glyceria spp. Photograph and Perennial Pepperweed Description

Glyceria spp.

PERENNIAL PEPPERWEED

Integrated Pest Management for Home Gardeners and Landscape Professionals

Perennial pepperweed (*Lepidium latifolium*) (Fig. 1), an introduced plant from southeastern Europe and Asia, is invasive thoughout the western United States. It can establish in a wide range of environments and is a common problem in flood plains, irrigation structures, pastures, wetlands, riparian areas, roadsides, and residential sites. Recent surveys identify perennial pepperweed as a weed problem in nearly all of California, and both the California Department of Food and Agriculture (CDFA) and California Invasive Plant Council (Cal-IPC) list it as a noxious weed of greatest ecological concern. Populations form dense monocultures that are easily spread by root fragments and seed. Perennial pepperweed has many common names including tall whitetop, perennial peppercress, ironweed, perennial peppergrass, and broad-leaved pepperweed.

IDENTIFICATION

Perennial pepperweed is a member of the Brassicaceae (mustard) family. Stems range from 2 feet to over 4 feet tall. Mature plants have numerous erect, semi-woody stems that originate from large, interconnected roots. Roots are long, minimally branched, and enlarged at the soil surface forming a semi-woody crown (Fig. 2). The foliage is glabrous and green to gray-green in color. Rosette leaves are ovate to oblong with entire to serrate margins on long petioles. Rosette leaves are about 4 to 11 inches long and 1 to 3 inches wide. Stem leaves are sessile and lanceolate, have entire to toothed margins, and become smaller toward the top of the stem. Small, white flowers form dense clusters arranged in panicles at the tip of each stem (Fig. 3). Perennial pepperweed is often confused with hoary cress (*Cardaria draba*) also called whitetop. However, unlike the taller perennial pepperweed, hoary cress stems are less than 3 ft tall and have leaves that clasp the stem and lack an obvious petiole.

LIFE CYCLE

Perennial pepperweed is a long-lived herbaceous perennial that thrives in seasonally wet areas or areas with a high water table. Perennial pepperweed is typically found invading fine-texture, saline/sodic soils, although populations can establish and persist on coarse-textured, alluvial soils. Plants reproduce from perennial roots or seed. In early spring, new shoots emerge from root buds forming low-growing rosettes (basal leaves with no obvious stem). Plants remain in the rosette stage for several weeks before developing a flowering stem. Flowering typically begins in late spring with mature seed being produced by mid-summer. After seed production, flowering shoots die back, although rosettes can emerge again in fall and persist through winter in frost-free areas. Dead stems are slow to decay and accumulate over time, forming dense thickets that prevent growth of desirable species. Perennial pepperweed is a prolific seed producer. Laboratory tests suggest seeds germinate readily with fluctuating temperatures and adequate moisture; however, seeds do not appear to remain viable in the soil for extended periods.

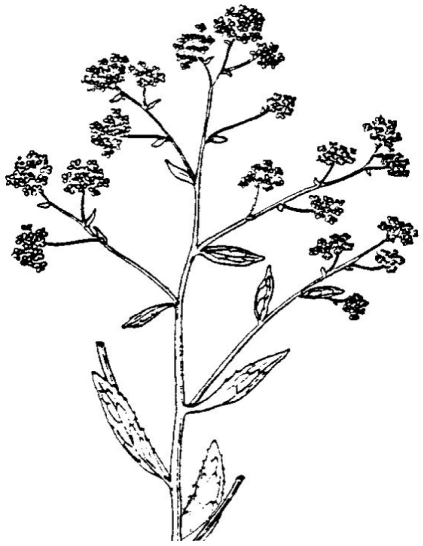


Figure 1. Flowering stalk of perennial pepperweed.

Figure 2. Woody crown and roots.

PEST NOTES **Publication 74121**

University of California
Agriculture and Natural Resources

October 2004

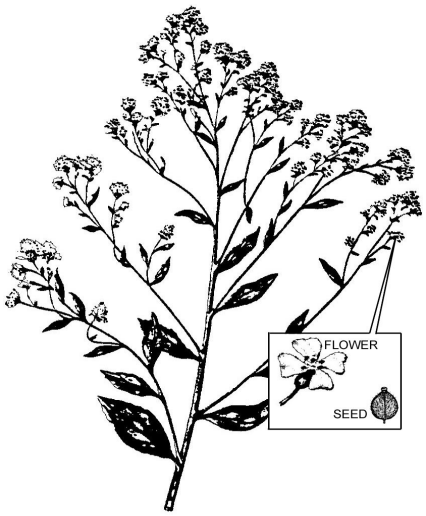


Figure 3. Flower of perennial pepperweed (*inset*: individual flower and seed).

Established perennial pepperweed plants develop an extensive root system capable of storing large amounts of energy. Root segments also produce adventitious buds capable of generating new shoots. Perennial pepperweed's root system is the foundation of the plant's competitiveness and the major target of control efforts.

IMPACT

Perennial pepperweed can rapidly form large, dense stands that displace desirable vegetation. Populations easily spread along waterways and can infest entire stream corridors, riparian areas, or irrigation structures. Flooded streams often wash away roots growing along the streambank, and new infestations develop downstream. Once established, perennial pepperweed is persistent and difficult to control in crops, natural areas, and ornamental plantings. Perennial pepperweed also reduces forage quality in hay or pasture.

MANAGEMENT IN ORNAMENTAL PLANTINGS AND HOME LANDSCAPES

Prevention is the best management strategy for avoiding problems with perennial pepperweed in and around home landscapes. If perennial pepperweed is found growing in landscaped areas, immediately control the plant before it can spread. Pulling plants (try and remove as much of the root as possible) is an effective way of controlling a few scattered plants growing within landscaped areas. Use of glyphosate (Roundup and other products) is another option but care must be taken to avoid injuring nearby plants. Large populations of perennial pepperweed are unusual in landscape areas, unless new housing or commercial developments have been built on infested land.

To control perennial pepperweed infestations before landscaping newly developed areas, start by applying glyphosate to the entire infestation and wait a couple weeks to allow the herbicide to translocate to the roots. After the initial herbicide treatment, carry out any necessary soil preparation activities. Wait an additional 2 to 6 months before seeding or transplanting desired vegetation to allow any remaining pepperweed to resprout so it can be treated again. Once perennial pepperweed ceases to resprout, apply landscape fabric or mulch and transplant closely spaced, herbaceous plants to prevent invasion. If resprouts grow through or around mulch barriers, hand pull or spot treat them with glyphosate. Turf is also an excellent ground cover for preventing reinvasion of perennial pepperweed. The frequent mowing schedule and common herbicides (2, 4-D) used for turf management are not conducive to perennial pepperweed establishment.

MANAGEMENT IN PASTURES, RANGELAND, RIGHTS-OF-WAY, AND CROPS

Established perennial pepperweed populations are difficult to control and require multiple years of intensive management. Suppressing the extensive root system is critical for successful control. A management program should include prevention, monitoring, and treatment of small satellite populations before plants develop extensive roots. If large populations exist, focus management on containing the infestation and preventing further spread to surrounding areas.

Prevention

Prevention is the foundation of any weed management program. Techniques that prevent perennial pepperweed establishment save time and resources in the future. Perennial pepperweed root fragments or seed have been found in straw, hay bales, mulch, and crop seed; so be sure that these items are free of weed seed and propagules before applying them to an area. Periodic surveys of property lines, roadsides, waterways, and riparian corridors help detect new infestations before they become well established. If construction or soil disturbance occurs in infested areas, make sure root fragments and seed are not transported to other sites. Always clean vehicles, machinery, and clothing after visiting infested areas. If livestock graze perennial pepperweed, hold the animals in closely monitored paddocks for several days to allow seed to pass through their digestive system before transporting them to new areas.

Cultural Control

Establishing and maintaining competitive perennial vegetation can dramatically slow the introduction and spread of perennial pepperweed. Vigorous sod-forming grasses, alfalfa, or cropping systems with annual tillage help prevent perennial pepperweed introduction and establishment in agricultural areas. Closely spaced plantings of herbaceous perennials, shade trees, and/or fabric or plastic mulches can help prevent its introduction in ornamentals.

Hand-pulling and tillage. Seedlings are easily controlled by hand-pulling or tillage, but these techniques do not control established plants because shoots quickly resprout from the vast root reserves. Root segments as small as 1 inch are capable of producing new shoots.

Mowing and burning. Mowing and burning are not effective at reducing

perennial pepperweed stands, but they are helpful at removing accumulated thatch. Perennial pepperweed thatch burns best in winter or spring under dry conditions before initiation of spring growth. Mowing breaks old stems into small fragments and helps prevent shading of favorable species. Mowing also stimulates perennial pepperweed plants to resprout and produce new growth. Combining mowing with herbicides has been shown to be an effective control strategy. For best results, mow plants at the bolting or flower bud stage and apply herbicides to resprouting shoots once they have reached the flower bud stage.

Revegetation. Establishing desirable vegetation in disturbed areas is crucial to managing perennial pepperweed and preventing future weed problems. Because perennial pepperweed is very competitive, seed or transplant desirable vegetation after dense perennial pepperweed stands are controlled. Choose vigorous, fast-growing plant species that are adapted to the site. Perennial grasses are a good choice for natural areas and pastures. Grasses are tolerant of some selective herbicides used for perennial pepperweed control and over time form a thick sod that prevents future weed establishment. In pastures, promote grass expansion and vigor with fertilization and grazing management.

Chemical Control

Several postemergent herbicides control perennial pepperweed, but repeat applications are usually necessary for several years to treat resprouting shoots and seedlings. Extended control with herbicides is greatly enhanced by establishing competitive vegetation at the site. In areas with a dense buildup of thatch, mow or burn old shoots before applying herbicides.

Herbicide application timing is critical. Herbicides work best when applied at the flower bud stage and worst at the rosette or early bolting stage. Because plant phenology differs between location and year, regularly observe infested areas in spring and begin applying herbicides when flower buds

Table 1. Summary of Herbicides Available to Control Perennial Pepperweed in Rangeland, Pasture, Rights-of-Way, and Crop Situations. (Most products NOT for Home Gardens and Landscape)

Herbicide (trade name)	Site	Rate*	Efficacy	Comments
chlorsulfuron (Telar)	rangeland, pasture, noncrop areas	0.75-1.5 oz a.i.	Most effective herbicide; provides 1-3 years of over 90% contol.	Has soil residual activity. Selectively controls many broadleaf plants. Do not apply near sensitive crops or water. Add a nonionic surfactant.
2, 4-D ester or amine (Several names)	rangeland, pasture, noncrop areas, ditches	1-2 lb a.e.	Yearly applications required for 2 or more years to control established stands. Provides between 50-70% control 1 year after treatment.	Inexpensive. Selectively controls broadleaf plants. Multiple applications necessary because plants often resprout after treatment. Do not apply near sensitive broadleaf plants. Add a nonionic surfactant.
glyphostate (Roundup, Rodeo, Aquamaster, and others)	rangeland, pasture, crops, ditches, aquatic sites, wetlands, riparian areas, noncrop areas	2-3 lb a.e.	Variable results. Provides between 40-85% control 1 year after treatment. Repeat applications needed to control established stands.	Nonselective. If thatch is dense, mow and apply to resprouting plants. Good treatment if reseeding after application. Add a nonionic surfactant.
imazamox (Raptor)	alfalfa, "Clearfield" crops (see label)	0.047 lb a.i.	Provides good season-long suppression. One application per year needed to control established plants.	Has soil residual activity. Apply to spring rosettes in crops. Controls several broadleaf and annual grass species. Add methylated seed oil and nitrogen fertilizer.
imazapyr (Stalker, Arsenal, Chopper)	noncrop areas, fence rows, highway rights-of-way	4-6 oz a.e.	Provides between 85-95% control 1 year after treatment.	Has soil residual activity. Nonselective at rates applied. Controls most grasses and some broadleaf plants. Do not use in rangeland or pasture.
imazethapyr (Pursuit)	alfalfa, edible legumes (see label)	0.095 lb a.i.	Provides season-long suppression in alfalfa. Repeat applications needed to control established plants.	Has soil residual activity. Apply to fall or spring rosettes in crops. Add methylated seed oil and nitrogen fertilizer for postemergence control.

* a.i.=active ingredient; a.e.=acid equivalent

appear. If herbicide cannot be applied at the flower bud stage, mow plantsand apply the herbicide to regrowth. With seedlings, apply herbicides as soon as possible to prevent plants from producing new lateral shoots from the root. Herbicide choice depends on label restrictions, land use objectives, and cost. See Table 1 for a summary of effective herbicide choices.

REFERENCES

UC Weed Research and Information Center: http://wric.ucdavis.edu

For more information contact the University of California Cooperative Extension or agricultural commissioner's office in your county. See your phone book for addresses and phone numbers.

AUTHORS: R.G. Wilson, J. DiTomaso, M.J. Renz
EDITOR: B. Ohlendorf
TECHNICAL EDITOR: M.L. FLINT
ILLUSTRATIONS: Fig. 1-3 adapted from Krueger, J. and R. Sheley. 1999. *Perennial Pepperweed*. MONTGUIDE (MT9906). MSU Ext. Serv.

Produced by IPM Education and Publications, UC Statewide IPM Program, University of California, Davis, CA 95616-8620

This Pest Note is available on the World Wide Web (http://www.ipm.ucdavis.edu)

This publication has been anonymously peer reviewed for technical accuracy by University of California scientists and other qualified professionals. This review process was managed by the ANR Associate Editor for Pest Management.

To simplify information, trade names of products have been used. No endorsement of named products is intended, nor is criticism implied of similar products that are not mentioned.

This material is partially based upon work supported by the Extension Service, U.S. Department of Agriculture, under special project Section 3(d), Integrated Pest Management.

Appendix D

Herbicide Sponge Applicator Construction

ESA

APPENDIX D
Herbicide Sponge Applicator Construction

Instructions for Building a Cut-Stump Herbicide Wand

This home-made herbicide applicator wand was developed by Jack McGowan-Stinski (Michigan Field Office) as a way to dab herbicides directly onto cut stumps. Easily constructed, its design can be modified for your particular requirements. It costs about $20 to make and is even cheaper if you already have PVC glue and purple primer.

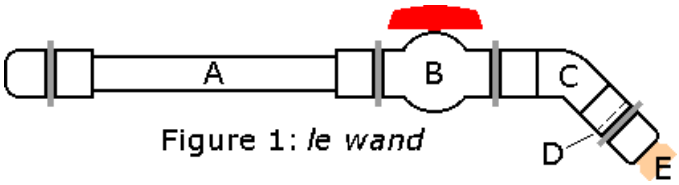


Figure 1: *le wand*

The sponge-tip applicator stores herbicide in its PVC pipe chassis (marked **A** in Figure 1). A ball valve (**B**) is used to supply herbicide to the sponge reservoir (**C**). Herbicide in this small chamber leaks through a flow restricting drip plate (**D**) and moistens the applicator sponge (**E**). When the sponge reservoir is depleted of herbicide, a quick turn of the valve will recharge it. Rubber gaskets (rendered in grey in Figure 1) let the wand be refilled or disassembled for cleaning. The figures in these pages may help clarify the instructions, too.

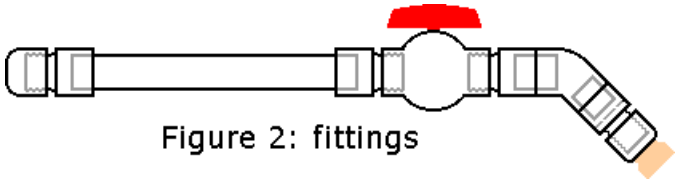


Figure 2: fittings

The ball valve keeps the main reservoir separate from the sponge reservoir. If the sponge is pulled out of the wand, only the herbicide in the sponge reservoir will be able to leak out. Furthermore, the flow restrictor ensures that this leakage would be at a dribble.

Wand Variations

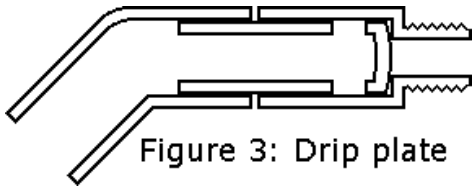


Figure 3: Drip plate

While constructing the wand, feel free to innovate and make your own variations to suit your application and parts availability. Just make sure your wand construction does not result in herbicide leakage. For example, wand-originator Jack McGowan-Stinski (The Nature Conservancy, Michigan Chapter) recommends a slight variation to the wand in which the main handle reservoir is made out of a tube with one female end and one male end (Figure 4). (If you cannot buy a threaded male cap, you may have to construct one out of a regular cap and a threaded

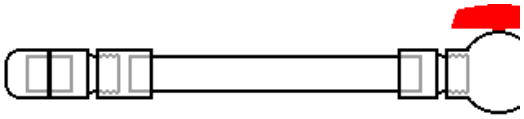


Figure 4: Reservoir variation

male converter, as shown in that figure.) With this configuration, additional tube reservoirs can be stacked together for greater capacity, yet can be broken down for easy transport. If you do this, make sure you are careful when transporting herbicide-soiled PVC connectors to and from your site.

Parts List

1 – 1 inch diameter PVC threaded male cap
1 – 1 inch diameter PVC threaded female cap
1 – ¾ inch diameter PVC cap, unthreaded
1 – 1 inch diameter PVC threaded female coupling
3 – 1 inch diameter PVC threaded male coupling
1 – 1 inch diameter PVC 45° elbow coupling, unthreaded
1 – 1 inch diameter PVC threaded ball valve
1 – 1 inch diameter PVC pipe (12 to 15 inches)
2 – 1 inch diameter PVC pipe pieces, approximately 1 inch long
4 – 1 ¼ inch diameter rubber lavatory gaskets
Heavy duty sponge (2 x 4 x 1 ½ inches)
PVC cement
PVC pipe cutters or hacksaw
Drill, 1/16 inch bit, ¾ inch bit
Ruler
Scissors

Assembly Instructions

Cement threaded male coupling onto one end of a length of PVC pipe (12- to 15-inch length suggested). Cement the threaded female coupling onto the other end of the pipe (reservoir). Additional PVC sections can be threaded together to make a longer handle or reservoir when needed. Slip one rubber gasket over a threaded male cap and attach it to the threaded female end of reservoir. Slip one rubber gasket over threaded male end of reservoir and attach one end of a threaded ball valve. The rubber gaskets will allow the sections of applicator to be tightened together snugly so that no herbicide will leak out around coarse PVC threads.

To make the "drip holes" for herbicide, cut off the bottom of the ¾-inch-diameter PVC cap so that a flat disk remains. File disk until it fits snugly into the unthreaded 1-inch-diameter PVC 45° elbow coupling. A ridge inside the elbow will keep the disk centered. Use a 1/16-inch drill bit to make two holes near the center of the disk. Cement the disk inside one end of the elbow coupling.

Using the 1-inch-diameter PVC pipe pieces (1-inch length or less), cement the 1-inch-diameter threaded male couplings onto each end of the elbow. Slip rubber gaskets over each threaded male coupling. The end of the completed elbow without the drip holes disk attaches to the other end of the ball valve.

Drill a ¾-inch hole into the end of the 1-inch-diameter PVC threaded female cap. The sponge tip twists into this ¾-inch hole, and this cap is then threaded onto the end of the elbow with the drip holes disk.

The sponge tip, which is roughly 1 inch in diameter by 1.5 inches long, can be cut with scissors, or a 1-inch-diameter metal pipe section that is sharpened on one end can be used to rapidly cut out numerous sponge tips. Wet the sponge tip before twisting it into threaded female cap with the ¾-inch hole. Allow ¼ to ½ inch of sponge to extend out of the tube to treat stump tops.

To Use

With the ball valve in the "OFF" or "CLOSED" position, pour the herbicide mix into the reservoir and close it with the threaded male cap (the top of applicator). Open the ball valve, then slightly open the threaded male cap to allow air into the reservoir. Once the sponge tip begins to saturate, tighten the threaded male cap and close the ball valve. When the sponge is saturated, only a light touch to a cut stump is needed. Open the ball valve when more herbicide is needed in the sponge tip.

Helpful Hints

- During colder weather, the ball valve may have to be left open to allow enough herbicide to saturate the sponge. Drip holes also can be made larger if faster herbicide flow is desired.
- Do not allow leftover herbicide mix to remain in the reservoir in extreme temperatures.
- Always clear drip holes of any residue before using the applicator again. A paper clip works well for cleaning out residues.
- When the sponge becomes worn, replace it (recommended after every workday at a minimum).
- When using the applicator during freezing conditions, duct tape a disposable chemical hand warmer around the section with the drip hole disk to reduce the chance of the drip holes freezing shut.
- Use an herbicide dye to check for leaks, monitor applications, and identify any exposure to the person using the applicator.