Wildlife Corridor Planting Plan and Native Plant Nursery For the Hamilton Wetlands Restoration Project, Novato, California

Prepared for
The United States Army Corps of Engineers
San Francisco, California

By

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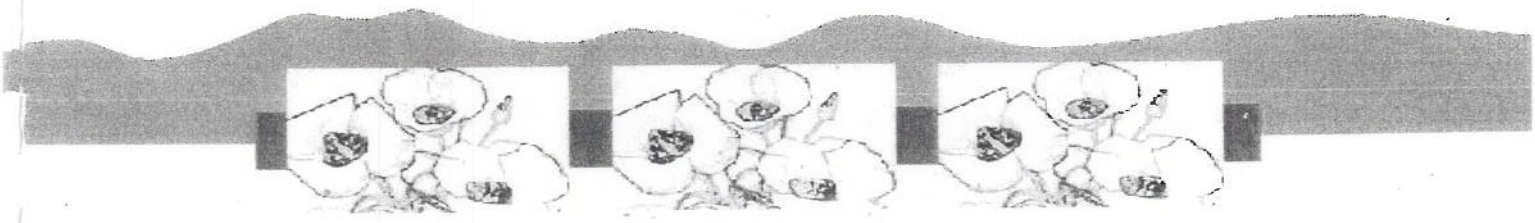

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0.0 INTRODUCTION

The restoration design for the Hamilton Wetlands Restoration Project (HWRP) incorporates a mosaic of habitats covering a wide elevation range, including tidal wetlands, seasonal wetlands, and upland areas. This mosaic will allow tidal conditions to transgress landward with rising sea level as well as with changes in the site itself. The HWRP will restore approximately 400 acres of tidal wetland and pannes, 80 acres of seasonal wetland ponds, and 20 acres of transitional upland habitat just above the wetland edge. Dry upland between the seasonal wetland ponds will comprise another 70 acres of the site. The plan for installing and maintaining native vegetation in the tidal and seasonal wetlands is detailed in another document (PWA and BMP Ecosciences 2010).

Herein we present a design for installing native vegetation in a portion of the dry upland known as the wildlife corridor and a design for an on-site native plant nursery to support ecological restoration in the northwest San Francisco Bay region.

1.0 PLANTING PLAN FOR UPLANDS OF THE WILDLIFE CORRIDOR

The wildlife corridor of the HWRP is an elongated area of about 27 acres running northwest to southeast, linking the seasonal and tidal wetland units and giving access to the outboard marsh and San Pablo Bay (Figure 1). It will be comprised of dry uplands fringed by transitional uplands adjacent to wetlands along its northern and eastern perimeter (PWA and BMP Ecociences 2010). The purpose of the corridor is to accommodate the movement of acceptable, mostly native fauna among all habitats of the site. This broad ecotone will absorb freshwater runoff from uplands and be occasionally exposed to extreme high tides, producing a range of soil moisture and salinity conditions.

The transitional upland habitat in the wildlife corridor will be created by placing dredged sediment (primarily sand with several large lens of bay mud) at an angle of 1:125 sloping down towards tidal wetlands from either the crest of the perimeter levees or existing adjacent upland. The area will be formed into a natural undulating topography to add diversity in surface, substrate depth and subsequent vegetation. After the topography has been created, the soil will be seeded with native grasses and forbs that would naturally occur in this habitat. The seeding will take place quickly after completion of the sculpting to minimize colonization by ruderal, non-native species from adjacent areas. Once the seeding is complete, native shrubs and small trees, such as coyote bush, toyon,

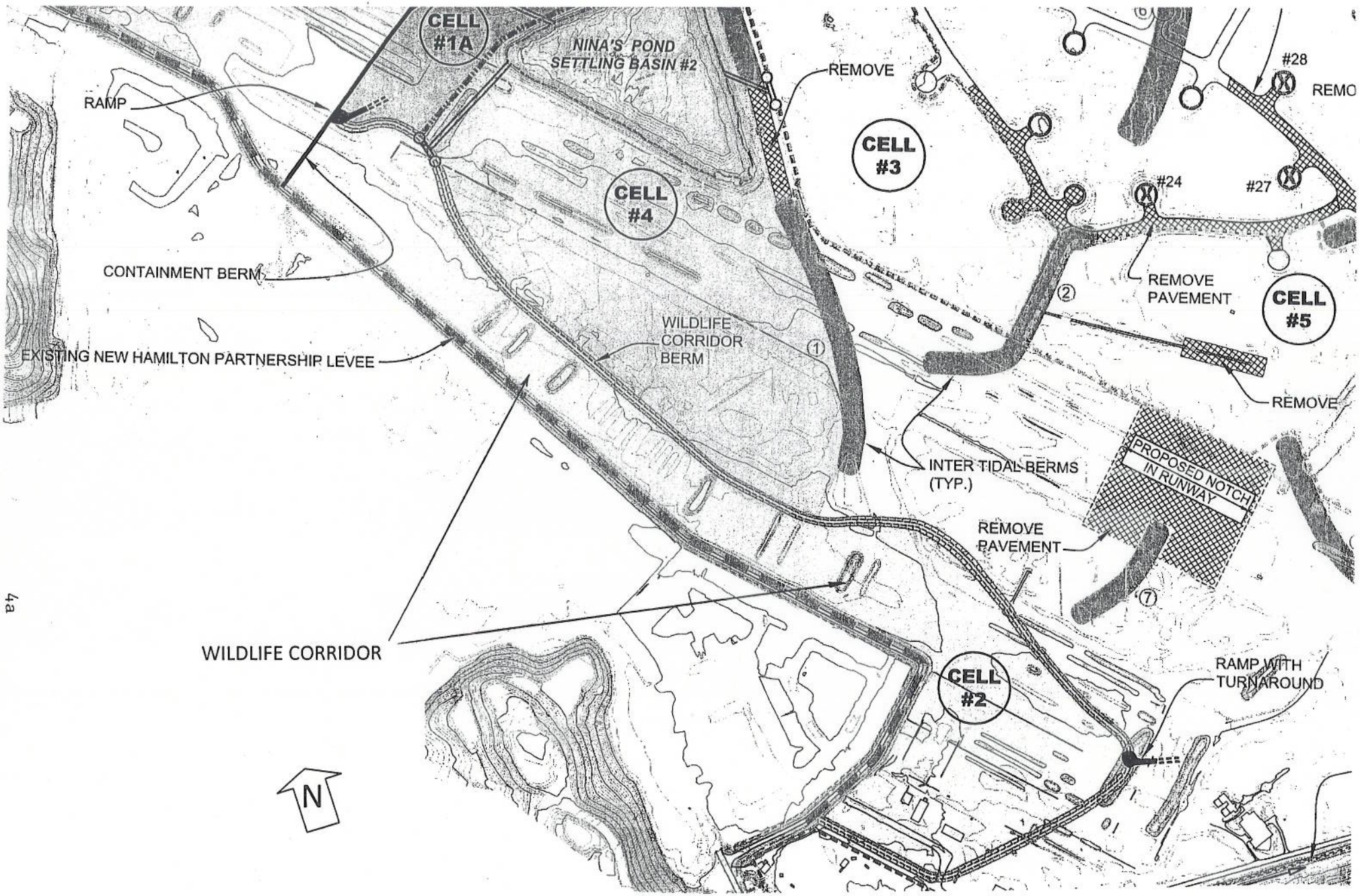


Figure 1. Location of the wildlife corridor (Cell #2) at Hamilton Army Airfield, Novato, CA. Drawing courtesy of BCDC 2005.

coast live oak, California buckeye, buckwheat, and lupine will be outplanted during the first five years of the project to augment vegetation development and plant diversity.

1.1 Ecosystem Characteristics of the Wildlife Corridor

1.1.1. Creation and Development

Dry uplands will develop at the HWRP on constructed levees and berms and in the wildlife corridor on a highly disturbed substrate. The substrate will be dominated by dredged sands and bay muds, sometimes mixed, sometimes layered, and sometimes in exclusive, broad patches. Under local climatic conditions, there will be rapid colonization by ruderal plants and animals, some of which are acceptable with respect to project goals (e.g. most small-statured, non-native grasses and forbs, native rodents, mustelids, procyonids, coyote), some of which are not (e.g. non-native herbaceous perennials and shrubs, red fox).

The wildlife corridor will link the inland and bay edge of the HWRP to accommodate the east-west movement of acceptable vertebrates. Islands extending above 7.5 feet NAVD surrounded by tidal and seasonal wetlands will provide escape terrain to reduce the success of unacceptable predators. Attempts will be made to enrich the upland, corridor and islands with native grasses and forbs (hydroseeding) and with native shrubs and small trees (nursery propagation and outplanting during the first five years of the project, 2011-2016). These efforts will result in vegetation analogous to the local mosaic of coastal prairie, north coastal scrub and scattered live oak woodlands: a one or two-layered canopy with an intermittent, mostly native, woody overstory and a mixed native/non-native understory of grasses and herbs. Long-term weed control, focused on the exclusion of invasive woody trees (e.g. *Acacia*), perennial shrubs and herbs (e.g. *Cytisus, Carpobrotus, Foeniculum*) perennial grasses (e.g. *Cortaderia, Arundo*), vines (*Rubus*) and annuals (*Centaurea*), will be a substantial part of the common practices management program (see PWA and BMP Ecosciences 2010) .

There will be fairly extensive areas of transitional upland habitat (i.e. ecotone) between the upland on the landward side of a floodplain and the surrounding landscape. Lower elevation portions of the wildlife corridor will also grade into wetland edge. As a result, this broad ecotone will absorb storm runoff from uplands and be occasionally exposed to extreme high tides, producing a range of soil moisture and salinity conditions. The transitional uplands will be colonized by a mix of obligate (e.g. *Grindelia, Frankenia, Cotula*) and facultative (e.g. *Lolium*) wetland plants, as well as ruderal upland species in low rainfall years.

Transitional uplands will be created for the HWRP by placing dredged sediment, primarily Merritt sand, from the crest of the perimeter levees on the southern, western and northern edge of the

site, and an existing adjacent upland in the southwestern corner of the site, sloping gently downward at approximately 1:125 ratio. The toe of the transitional uplands will blend into the tidal marsh or seasonal wetlands. Lenses of bay mud will be incorporated into broad, elevated mounds (perhaps 100 to 300 feet across) with greater substrate depth and water holding capacity. The suitability of this "soil" for supporting the growth of woody plants is unknown, however, and considerable effort may be required to augment its basic characteristics (see 1.5.1 below). The entire area will be sculpted to create naturalistic contours and undulating edges to add diversity in topography, substrate and vegetation. The considerable width of the corridor will also buffer more sensitive wildlife species from the public access required along the edge of the site.

Once the sediment is in place and the topography created, the substrate will be hydroseeded with native grasses and forbs that would naturally occur in this habitat. The hydroseeding will happen quickly after completion of the sculpting to minimize colonization by ruderal, non-native species from adjacent areas. Once the hydroseeding is complete, native shrubs, such as coyote bush (*Baccharis*), toyon (*Heteromeles*), buckwheat (*Eriogonum*), and lupine (*Lupinus*) will be outplanted to augment vegetation development and plant diversity. The lens of bay mud will be planted with small numbers of coast live oak (*Quercus agrifolia*) and California buckeye (*Aesculus californica*), local trees whose growth will be constrained by the low freshwater holding capacity of the substrate. Care will be given to outplant species in a natural gradient from higher transition, upland plants to obligate wetland species, such as alkali heath (*Frankenia*). As with the uplands, outplanting transitional uplands will take place during the first five years of the project (2011-2016) and long-term weed control will be required.

1.1.2. Expected Operation of Created Uplands

The low, herbaceous canopy layer provided by hydroseeded grasses and forbs will provide cover, nesting sites, and seed foods for small vertebrates (e.g. California quail, raccoon). Some of these animals are fossorial, some ground-nesting, and some transient. Small perennials, such as buckwheat (*Eriogonum*), may also provide food sources for butterfly larvae. The benefits of this canopy layer to wildlife will be realized within a few years of installation.

The woody canopy layer provided by shrubs and small trees will provide cover, roosting and nesting sites, and fruit and seed foods for vertebrates of all sizes. Most large-bodied animals are transient, moving through the habitat to find seasonal resources and prey. The benefits of this canopy layer to wildlife will be realized after 10 to 20 years of woody growth. That growth will be somewhat constrained by the low water-holding capacity of the substrate, producing much lower tree heights than would otherwise be expected for the selected species. An occasional cluster of tall trees, surrounded by shorter, scattered woodland and savanna trees, should characterize the western, inland side of the corridor, transitioning eastward to mostly prairie with clusters of shrubs. This

habitat and visual gradient will help unite inland and outboard portions of the HWRP. As vegetation complexity develops, there will be more cover and food sources to support an increasing number of animal species.

There are abundant sources of propagules of native plant species in surrounding areas surrounding the HRWP, so it is expected that portions of uplands will be rapidly colonized by appropriate plant species. Hydroseeding will assist in deterring some unacceptable species, but not all. All available methods for weed control should be used to reduce or eliminate unacceptable perennial plants. It is unrealistic, however, to assume all infestations will be completely removed, given the proximity to large source populations in adjacent residential areas and disturbed habitats. Unacceptable species that will be present and eradicated to lowest possible levels include wattle (*Acacia*), fennel (*Foeniculum*), star thistle (*Centaurea*) and perennial pepperweed (*Lepidium*). It will also be important to begin outplanting additional, nursery-raised plants shortly after hydroseeding to promote development of vegetation complexity and to reduce open habitat for weed infestations.

1.3. Vegetation of the Wildlife Corridor

1.2.1. Design of Habitat Elements

Five habitat elements are proposed to create vegetation that reflects and extends the local mosaic of coastal prairie, north coastal scrub and intermittent live oak woodlands: the elements are herbaceous matrix, *Grindelia/Juncus* ecotone, shrub clusters, tree "smears" and tree clusters. Those elements will, over 10 to 20 years, create an open prairie with a single canopy layer, irregularly interrupted by an emergent overstory canopy of tall shrubs and small trees. The majority of the acreage of the corridor will appear open and grassy, irregularly interrupted by tree or shrub clusters (Figure 2).

1.2.1.1 Herbaceous Matrix

The herbaceous matrix will resemble modern coastal prairie in its mixture of native perennial grasses, non-native annual grasses, and native and non-native forbs. The establishment of some native components will be assisted with hydroseeding and limited hand sowing while non-natives will largely invade on their own.

Hydroseeding will be used to establish an appropriate mixture of native perennial grasses from acceptable sources (in accordance with U.S. Department of Agriculture Rules and Regulations under the Federal Seed Act and applicable State of California seed laws). It will take place in the late fall of the year when contouring and surface grading is completed in the corridor area

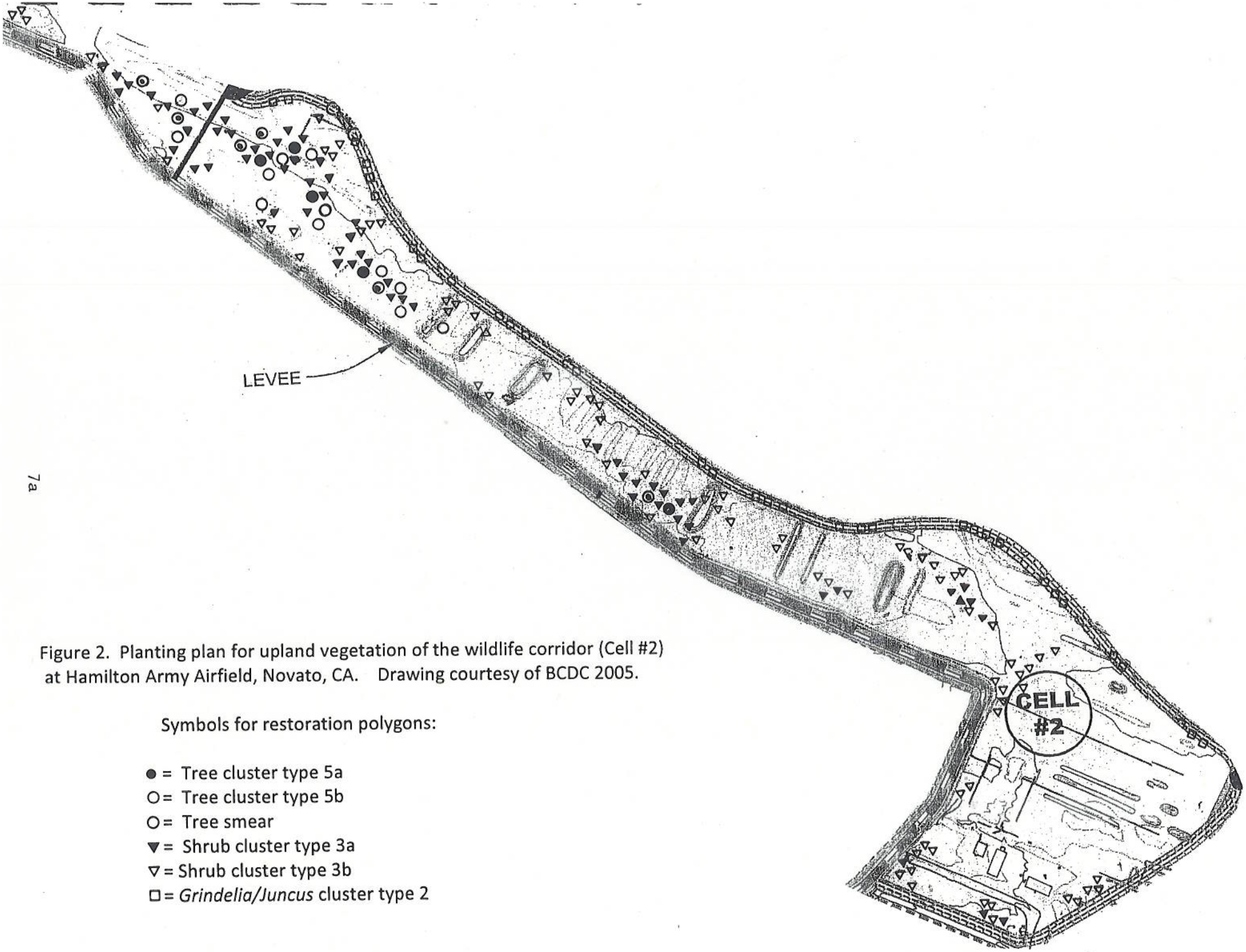


Figure 2. Planting plan for upland vegetation of the wildlife corridor (Cell #2) at Hamilton Army Airfield, Novato, CA. Drawing courtesy of BCDC 2005.

Symbols for restoration polygons:

- ● = Tree cluster type 5a
- ○ = Tree cluster type 5b
- ○ = Tree smear
- ▼ = Shrub cluster type 3a
- ▽ = Shrub cluster type 3b
- □ = *Grindelia/Juncus* cluster type 2

(presumably fall 2010 to winter 2011). Approximately five percent of the seed will be a salt-tolerant, local strain of tufted hairgrass (*Deschampsia caespitosa*), seventy percent will be a salt-tolerant local strain of meadow barley (*Hordeum brachyantherum*, "Salt") and twenty percent a salt-tolerant strain of creeping wild rye (*Leymus triticoides* "Rio"). The combined seed weight & application will be 40 lbs of seed per acre.

Hand sowing will be used to establish patches of locally collected native forbs in every fall of the 2011-2016 period. The first year species will include yarrow (*Achillea millifolium*), spear oracle (*Atriplex patula*) and soap plant (*Chlorogalum pomeridianum*). Other species of wildlife importance (e.g. *Eriogonum* sp., *Scrophularia californica, Artemisia douglasii, Limmonium californica*) will be collected from populations along the west shore of San Pablo Bay and sown into appropriate sectors of the corridor. The locations of those sown patches will be recorded with a GPS so they can be relocated at a later date and evaluated for successful establishment. Record-keeping by the site manager will be an important component of learning how to favor native species in the developing vegetation.

1.2.1.2. *Grindelia/Juncus* Ecotone

Linear clusters of herbaceous perennials will be established in transitional uplands along the wetland edge of the wildlife corridor. Container-grown individuals of gumplant (*Grindelia stricta*) and rush (*Juncus* sp.) will be outplanted in moist soils at irregular intervals along the edge. Functionally, these will serve as seed-producing founders that help populate an extensive and fluctuating ecotone. It may also be necessary to sow seeds in order to inoculate a significant portion of this linear ecotone. Locally collected seeds of alkali heath (*Frankenia salina*) will also be hand sown throughout the ecotone if available.

1.2.1.3. Shrub Clusters

Shrub clusters will be of two types; 3a) associated with tree smears and tree clusters (= woodland) or 3b) lone clusters (= coastal scrub).

Approximately 65 type 3a clusters, each composed of four species of woodland understory dominants (*Rosa californica, Heteromeles arbutifolia, Symphoricarpus albus*, and *Artemesia douglasii*) will be outplanted so as to form a tall understory to accompany the trees. Each cluster will be established with a restoration polygon of 214 ft^2 (r = 8.25 ft), in which 16 founders will be arranged (Figure 3). The spatial pattern and orientation will be standardized by laying a removable canvas template of the polygon on the ground that has pre-cut slots (irregularly spaced) for placing each founder. A GPS point will be taken at the center of the polygon and a unique identification number assigned (perhaps the last 3 digits of the UTM easting) to facilitate relocation for subsequent

monitoring. A record of the final orientation of the plantings in a polygon should be kept along with the identification information and any relevant notes (e.g. depth and composition of substrate at that location. Founders will be protected with small wire cages anchored to stakes. These clusters will "soften" the edges of woodlands, achieve a tall vertical profile (up to 12 ft) and will mostly be associated with more mesic "islands" of bay mud in the substrate.

Approximately 85 type 3b clusters, each composed of 18 individuals of coastal scrub dominants (*Baccharis pilularis, Rosa californica, Heteromeles arbutifolia, Symphoricarpus albus*, and *Artemesia douglasii*) will be outplanted so as to form a tall overstory to portions of the herbaceous matrix. Each cluster will be established with a restoration polygon of 154 ft^2 (r = 7 ft), in which 18 founders will be arranged. The spatial pattern and orientation will be standardized by laying a removable canvas template of the polygon on the ground that has pre-cut slots for placing each founder. A GPS point will be taken at the center of the polygon and a unique identification number assigned (perhaps the last 3 digits of the UTM easting) to facilitate relocation for subsequent monitoring. A record of the final orientation of the plantings in a polygon should be kept along with the identification information and any relevant notes (e.g. depth and composition of substrate at that location. Founders will be protected with small wire cages anchored to stakes. These clusters will extend towards, and essentially reach, the transitional uplands of the wetland edge on mostly sandy substrates. They will be more numerous towards the east and achieve a relatively low vertical profile (below 8 ft). Spacing between clusters will vary from 50 ft to 200 ft and will be irregular.

1.2.1.4. Tree "Smears"

Tree "smears" will be irregular extensions of the edges of tree clusters, less dense with a shorter vertical profile. Approximately 12 type 4 smears will be used on the western end of the corridor to shorten the distance between tree clusters associated with substrate "islands" of bay mud (the mesic tree clusters, see below. Each smear will be established with a restoration polygon of 314 ft^2 (r = 10 ft), in which 4 founders of two tree species (*Quercus agrifolia* and *Aesculus californica*) will be arranged. The spatial pattern and orientation will be standardized by laying a removable canvas template of the polygon on the ground that has pre-cut slots for placing each founder. Mortality or culling of seedlings or saplings will ultimately produce a more natural, irregular spacing. Placement of polygons will ensure that the drip zone of mature canopies (e.g. 50 year-old trees) will be at least 15 ft from the NHP levee toe, approximately 50 ft from the levee's centerline. A GPS point will be taken at the center of the polygon and a unique identification number assigned (perhaps the last 3 digits of the UTM easting) to facilitate relocation for subsequent monitoring. A record of the final orientation of the plantings in a polygon should be kept along with the identification information and any relevant notes (e.g. depth and composition of substrate at that location. Founders will be protected with small wire cages anchored to stakes.

1.2.1.5. Tree Clusters

Tree clusters will be of two types; 5a) associated with substrate "islands" of bay mud clay (= mesic woodland) or 5b) associated with drier, sandy substrate (= dry woodland).

A total of five type 5a clusters, each composed of 22 individuals of over- and understory dominants (*Aesculus californica, Quercus agrifolia, Heteromeles arbutifolia,* and *Baccharis pilularis*) will be outplanted so as to form a tall, relatively dense woodland. Each cluster will be established with a restoration polygon of 804 ft^2 (r = 16 ft), in which 22 founders will be regularly arranged. The spatial pattern and orientation will be standardized by laying a removable canvas template of the polygon on the ground that has pre-cut slots for placing each founder. A GPS point will be taken at the center of the polygon and a unique identification number assigned (perhaps the last 3 digits of the UTM easting) to facilitate relocation for subsequent monitoring. A record of the final orientation of the plantings in a polygon should be kept along with the identification information and any relevant notes (e.g. depth and composition of substrate at that location. Founders will be protected with small wire cages anchored to stakes. Mortality or culling of seedlings or saplings will ultimately produce a more natural, irregular spacing. Once established, these clusters will form domed woodlands, achieving a tall vertical profile (up to 30 ft) due to the relatively greater moisture-holding capacity of the substrate. These will be positioned on the western end of the corridor to suggest a connection with other woodland vegetation on nearby hills. It will soften the transition between the hills and the wetland and mimic the woodland observed at Rush Creek. Placement of polygons will ensure that the drip zone of mature canopies (e.g. 50 year-old trees) will be at least 15 ft from the NHP levee toe, approximately 50 ft from the levee's centerline. A GPS point will be taken at the center of the polygon to facilitate relocation. Founders will be protected with small wire cages anchored to stakes.

A total of six type 5b clusters, each composed of 20 individuals of over- and understory dominants (*Aesculus californica, Quercus agrifolia, Heteromeles arbutifolia,* and *Baccharis pilularis*) will be outplanted so as to form a tall, relatively dense woodland. Each cluster will be established with a restoration polygon of 1018 ft^2 (r = 18 ft), in which 20 founders will be regularly arranged. The spatial pattern and orientation will be standardized by laying a removable canvas template of the polygon on the ground that has pre-cut slots for placing each founder. A GPS point will be taken at the center of the polygon and a unique identification number assigned (perhaps the last 3 digits of the UTM easting) to facilitate relocation for subsequent monitoring. A record of the final orientation of the plantings in a polygon should be kept along with the identification information and any relevant notes (e.g. depth and composition of substrate at that location. Founders will be protected with small wire cages anchored to stakes. Mortality or culling of seedlings or saplings will ultimately produce a more natural, irregular spacing. These clusters will form broken-domed woodlands, achieving a modest

vertical profile (up to 15 ft) due to the relatively low moisture-holding capacity of the substrate. These will be positioned on the western end of the corridor to soften the edges of mesic tree clusters and to suggest a connection with other woodland vegetation on nearby hills. Placement of polygons will ensure that the drip zone of mature canopies (e.g. 50 year-old trees) will be at least 15 ft from the NHP levee toe, approximately 50 ft from the levee's centerline. A GPS point will be taken at the center of the polygon to facilitate relocation. Founders will be protected with small wire cages anchored to stakes.

1.2.2. Timing of Installations

Installation of seeds and propagated herbaceous plants should take place during the late fall and winter to take advantage of seasonal rainfall and cool temperatures. Seeding into the herbaceous matrix and *Grindelia* ecotone should take place as close to the first significant fall precipitation event as possible in order to favor germination and deter seed predation by birds (which can be surprisingly intense). Several cohorts of seeds of each species should be sown at different times during the raining season (e.g. two weeks apart from late November to late January) in order to increase the probability of encountering an optimal germination regime (e.g. the intersection of significant rainfall, proper temperatures and minimal seed predation). This has been called "Founder Cost Averaging" (Pavlik and Stanton 2005, 2006), and is analogous to "Dollar Cost Averaging" used for financial investments. Here we are spreading the risk of encountering poor conditions across seed cohorts. Installations in multiple years will also be an important component of Founder Cost Averaging.

Installation of propagated woody plants should take place during the early winter to ensure that the soil is saturated to at least pot (or tube) depth and that the chance of a warm, dry spell is minimized. Founder Cost Averaging can also be applied to these plants, but because they will be fewer in number and more costly to produce, only two or possibly three cohorts may be installed during a single season. Installations in multiple years will also be an important component of Founder Cost Averaging.

1.3. Propagule Sources and Propagation

With the exception of the hydroseed mix, all propagules (seeds and rhizomes) will be collected from strictly local sources. "Local" means from along the west shore of San Pablo Bay, focusing first on the Hamilton – Belle Marin Keys sites (e.g. Ammo Hill for upland species) and then expanding north and south towards the Petaluma River (especially Rush Creek) and Richardson Bay (especially China Camp

Table 1. Number of individual plants of each species to establish (est) in the uplands of the wildlife corridor of the HWRP. It assumes a 30% mortality of transplanted plants, thus obtaining the number of individual plants to deliver to the site (deliv) in the first year of outplanting. Numbered columns refer to design elements for the wildlife corridor (e.g. 5a, 5b = tree clusters, 4 = tree smears, 3a,3b = shrub clusters, and 5 = *Grindelia/Juncus* ecotone).

	5a		5b		4		3a		3b		2		total number of plants to	
species (common name)	est	deliv	est	deliv	est	deliv	est	deliv	est	deliv	est	deliv	**establish**	**deliver**
QUERCUS AGRIFOLIA	21	30	21	30	18	24							60	84
(coast live oak)														
AESCULUS CALIFORNICA	21	30	21	30	18	24							60	84
(California buckeye)														
BACCHARIS PILULARIS	18	25	21	30			182	260	214	306			435	621
(coyote bush)														
GRINDELIA STRICTA											756	1080	756	1080
(gumplant)														
ROSA CALIFORNIA							182	260	214	306			396	566
(wild rose)														
HETEROMELES ARBUTIFOLIA	18	25	21	30			182	260	214	306			435	621
(toyon)														
SYMPHORICAPOS ALBUS							182	260	214	306			396	566
(snowberry)														
JUNCUS SP. (patens?)											378	540	378	540
(rush)														
ARTEMISIA DOUGLASIANA									214	306			214	306
(mugwort)														
ACHILLEA MILLEFOLIUM	to be direct-seeded only													
(yarrow)														
ATRIPLEX PATULA	to be direct-seeded only													
(spearscale)														
CHLOROGALUM POMERIDIANUM	to be direct-seeded only													
(soap plant)														
FRANKENIA SALINA	to be direct-seeded only													
(alkali heath)														
												sums	**3130**	**4384**

State Park). Collection will take place in the fall and early winter of each year, beginning in 2008. After cleaning the materials will be stored appropriately (e.g. in paper bags at room temperature) and transferred to a local nursery facility for propagation. A record of seed collection conducted in 2008 and 2009 is included in the Appendix as Tables A and B and the plan for propagating, delivering and establishing founders from those seeds is included here as Table 1.

An on-site native plant nursery will greatly facilitate seed cleaning, seed storage, plant propagation and outplanting for the HWRP. Locally collected rhizomes, soil and salt water, which are difficult to transport *en masse*, can be readily attained and stored. The nursery will also be a place for organizing and supporting volunteer labor. A design for that nursery is presented in section 2.0 of this plan.

1.4. Installation of Plants

Numerous installation polygons (Figure 3) will be used to outplant container-grown individuals in the *Grindelia* ecotone, shrub cluster, tree smear and tree cluster habitat elements. The polygons will standardize the outplanting procedure and spatial pattering (important when using volunteer labor) and facilitate subsequent maintenance and monitoring.

Placement of polygons will follow the general design (Figure 2), but the precise location of each will not be predetermined. Volunteers and crew under supervision of the HWRP site manager will determine the final placements. Species composition will include only acceptable species for an element, sometimes limited to single species (e.g. *Grindelia*) or mixtures of up to four species (e.g. shrub clusters). The pattern of plants within the polygon can be either random or regular. Differential mortality among species and individual founders, along with subsequent recruitment of volunteer seedlings, will eventually obliterate any unnatural regularities.

Outplanting of installation polygons will be conducted by volunteers and contract crews. Training and supervision will be required to insure proper placement and transfer of plants to the soil. Using the aforementioned canvas templates, each plant should be placed in a post-hole of proper depth, inoculated with fresh native soil (and its microbial inhabitants), and given a large dose of water to help consolidate the root-soil mass. Larger species, such as the oaks and buckeyes, may require other soil augmentations to allow establishment of a robust (deep and broad) root system. The question of adding fertilizer should be addressed by some preliminary, small scale trials (including soil testing in the corridor to determine its nutrient levels).

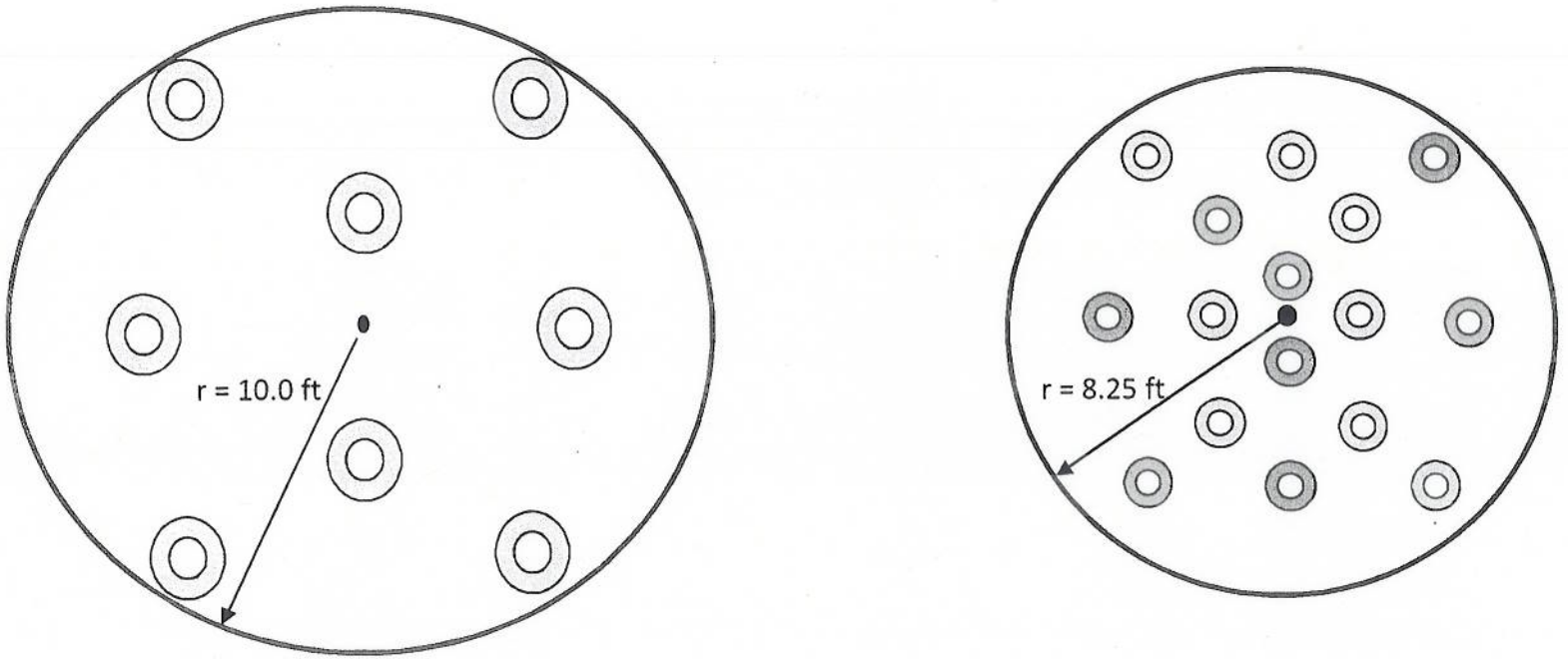


Figure 3. Examples of restoration polygons for outplanting and monitoring tree smears (left) and shrub clusters (right). Tree smear polygon contains four founders of two species, shrub cluster polygon contains four founders of four species. Positions can be regular or random.

It is also conceivable that volunteers could also conduct data collection for the monitoring effort if clear directions, simple measurements, and standardized datasheets were used. These datasheets would be checked for quality and archived, used only to assess efficacy of actions and problems that arise in the future (see below).

1.5. Management of the Plantings

As specified in the adaptive management plan (PWA and BMP 2010), the creation and management of upland habitat will employ a "common practices management" (CPM) regime with simple post-action monitoring. CPM is used when the outcome of an action (e.g. outplanting of upland vegetation, weed control) has low uncertainty. The site manager takes reasonable and timely actions without direct oversight of an adaptive management working group or technical advisory group and science is not required to fill knowledge gaps. Simple monitoring provides a record of those actions and some measures of efficacy. Photoplots, survival tallies (e.g. for hand-sown seed patches, outplanted founders and targeted weeds), and hand-drawn maps are examples of reasonable measures to employ in this kind of monitoring. The site manager should collect enough photos, tallies and maps to learn from previous trials and to document relative success and failure. This does not prevent more sophisticated monitoring (e.g. permanent plots) that could be installed by students of restoration ecology.

1.5.1. Providing Water and Nutrients

Depending on rainfall during the winter of outplanting, the site manager may need to provide water supplements to founding trees and shrubs. Another solution might be to augment the post-holes used for planting with gravel or other soil materials to increase permeability and/or storage. The problem of water stress to woody founders will present itself during dry winters and become acute as summer drought develops. Access to installation polygons across the wildlife corridor will be essential, perhaps achieved by a tank-towing ATV or small truck.

As previously mentioned, the preferred method for providing nutrients to founders would be to inoculate with fresh, native soil to promote root symbioses (e.g. mycorrhizae). But the sandy, potentially barren substrates used to create the corridor may have such low levels of required nutrients that soil organic matter and fertilizer supplements may be necessary. This question should be addressed by some preliminary, small scale trials (including soil testing in the corridor to determine available nutrient levels).

..5.2. Controlling Weeds

tapid development and control of the target vegetation will work to minimize weed populations hroughout the wildlife corridor. However, a comprehensive weed management strategy will also ›e necessary, given the size and exposure of the new, unvegetated surface to be created, and its ›roximity to local source populations of unacceptable species. All practical and legal methods of veed control should be available for use. Actions to remove and/or kill weeds will be regular and ›ngoing, supervised by the site manager. A yearly inspection, conducted by members of the HWRP Technical Advisory Group (PWA and BMP Ecosciences 2010), can be used to verify that sufficient evels of control are sustained.

L.5.3. Simple Monitoring

Given the low level of uncertainty associated with the transitional and dry upland habitats including the wildlife corridor), a simple monitoring plan will be implemented. The created habitat s likely to comprise grassland, north coastal scrub and woodlands (likely a mixture of native and ›on-native grasses, forbs, shrubs and small trees) with some peripheral halophytes. Simple monitoring will require minimal design, effort and data collection. It will be used to confirm or document that management actions were conducted (e.g. founders were outplanted, weeds removed). Less emphasis will be placed on quantifying the outcomes of those actions, although baseline records (number, identity and location of founders) will be kept and survivorship tallied. High mortality of founders due to drought, predation (e.g. browsing by deer), disease, or vandalism will require remediation, perhaps including expanded record-keeping. Permanent photo-documentation stations will be established to provide further evidence for the rate of development of the transitional and dry upland habitats (PWA and BMP Ecosciences 2010).

1.6. Success Criteria

After five years, hydroseeded native grasses and forbs will be present, and at least 30% of the outplanted individuals of native shrubs and small trees of all founding species will have survived. The species richness of native shrubs and trees will be greater than three species. After ten years, native grasses, forbs, and shrubs will be reproducing in some areas and the species richness of native woody species will be greater than six species. Stunted growth or death of tree species or larger shrubs should not be considered as complete failure because of the shallow and hydrologically challenging nature of the substrate within the wildlife corridor. Adoption of the "progress" terminology and perspective suggested by Zedler and Callaway (2000) is highly recommended, emphasizing the trajectory of the vegetation as a whole rather than meeting individual, somewhat arbitrary, objectives.

After five years, all perennial weed infestations will be eradicated on the levees and transitional areas (e.g. wildlife corridor), and after ten years the eradication effort will be significantly lower than in year five.

2.0 DESIGN FOR A NATIVE PLANT NURSERY TO SUPPORT ECOLOGICAL RESTORATION

The scale and complexity of the Hamilton Wetlands Restoration Project (HWRP) requires construction and long-term operation of an on-site, native plant nursery. Furthermore, other wetlands restoration and creation projects are being planned in the vicinity (e.g. Bel Marin Keys) that will also require a large capacity facility for generating high quality native plants from local genetic sources. The central location of the decommissioned Hamilton Army Air Force Base and the availability of a never used, modern building with ample outside space provide a low-cost and practical option for supporting ecological restoration.

The Hamilton Native Plant Nursery (HNPN) will serve several core functions that support adaptive management and ecological restoration in the northern San Francisco Bay region. When fully operational it will; 1) provide high quality native plant material from local genetic sources, 2) serve as a base for organizing and performing adaptive management and ecological restoration using volunteers, government agencies and consulting firms, 3) provide office, field lab, and nursery facilities for the HWRP site manager, HWRP consultants and related government agencies, and 4) act as an education and information hub for ecological restoration in the region. Initially, the HNPN will focus exclusively on meeting the requirements of the HWRP.

In terms of staffing, the HNPN will be run by a "site manager" who oversees the nursery operation, implements site-specific management actions as specified in the adaptive management plan or by the adaptive management working group (PWA and BMP Ecosciences 2010), and coordinates volunteer and educational activities related to ecological restoration. The site manager is a full-time, paid employee with education and experience in horticulture and/or native plant propagation. A second paid employee will be under the direction of the site manager, performing duties related to plant propagation, training volunteers, basic nursery operations and construction, and field work.

2.1. Meeting the Requirements of the HWRP

Phase I of the HWRP will utilize 10,560 uniform, hardened, container-grown plants of eight species in an adaptive management program (PWA and BMP Ecosciences 2010). These "test founders" will

be outplanted in "test polygons" across Cell 1 (the "panhandle) to experimentally determine if there is sufficient control over soil salinity and tidal inundation in the constructed seasonal wetlands. The horticultural challenge of Phase I will be to have all of these test founders ready for outplanting at the same time (the winter before the outer levee is breached).

Phase II of the HWRP will utilize a minimum of 31,440 uniform, hardened, container-grown plants of seven species in a restoration program (PWA and BMP Ecosciences 2010). These "restoration founders" will be outplanted in "restoration polygons" across Cell 1 (the "panhandle), Cell 5 (the "southern seasonal wetlands") and in salt-affected, occasionally inundated transitional areas across the site. The horticultural challenge of Phase II will be to produce large numbers of genetically variable restoration founders over a period of two or three years.

Prior to Phase I, native plant material will be required for the wildlife corridor (see 1.0 above). Multiple attempts at outplanting may have to be undertaken in multiple years due to the unusual soil and hydrologic conditions of these 27 acres. It is likely that some tending of these plants, including periodic watering during summer months, will be necessary. An ATV with a water tank trailer and long hose is probably the easiest solution, using the Bay Trail as access. The first full attempt to outplant the wildlife corridor will require a total of 4,384 container-grown perennials of nine species (Table 1) to establish 3,130 plants (assuming 30% post-outplanting mortality).

A suggested timetable for seed collection, plant propagation and outplanting events with respect to the wildlife corridor and seasonal wetlands is presented in Appendix Table C.

2.2. Comparison to Other Bay Area Native Plant Nurseries

Four established native plant nurseries (Marin Headlands, Presidio, Tennessee Valley and San Pablo Bay) were toured in 2006-2007 to observe their design, basic features and operations. All had greenhouse, shadehouse, headhouse, outdoor work and educational spaces. One (Presidio) could produce a very large number of plants each year (80,000) while another (San Pablo Bay) produced relative few (3,000). A comparison of basic features is presented in Table 2. The HNPN will have most, but not all of the features possessed by these nurseries (e.g. it will lack a greenhouse) and it will have an intermediate capacity for producing plants (between 5,000 and 12,000 per year. Given the large amount of outside space, a greenhouse could be added in the future.

2.3 HNPN Nursery Building

The core building will be the decommissioned groundwater treatment facility found on the western side of the Hamilton property (Figure 4). It has ample inside space for plant propagation, volunteer and staff support, education, storage and administration (Figure 5). The outside space is large

Table 2. Characteristics of native plant nurseries for habitat restoration projects in the San Francisco Bay area, 2007. NPS = National Park Service, USFWS = US Fish and Wildlife Service.

	Marin Headlands NPS	Presidio NPS	Tennessee Valley NPS	San Pablo Bay USFWS
Greenhouse Space				
number of greenhouses	1	2	1	1
size (sq ft)	2100	1,200 & 1,200	120	360
cooling system	vents/shadecloth/evap	vents	vents	vents
misting system	yes	yes	no	no
bench heat	yes	no	no	no
watering system	filtered municipal	filtered municipal	well	filtered well
Shadehouse Space				
number of shadehouses	2	2	1	1
size (sq ft)	2,000 & 3,000	1,800 & 6,400	1,600	720
screen enclosed	yes	no	yes	no
watering system	filtered municipal	filtered municipal	well	filtered well
Planting Beds				
raised	yes	yes	no	not yet
wetland boxes	yes	yes	no	not yet
Headhouse Space				
office	yes	yes	yes	yes
computerized records	yes	yes	yes	yes
seed assession system	yes	yes	yes	no
refrigerated seed storage	yes	yes	yes	no
indoor storage	yes	yes	yes	yes
sinks	yes	yes	yes	not yet
Outdoor Work Space				
pot washing	yes	yes	yes	not yet
covered pot storage	yes	yes	yes	yes
covered soil storage	yes	yes	no	not yet
potting benches	yes	yes	no	yes
soil dump	yes	yes	yes	yes
hazmat storage	yes	yes	yes	not yet
Indoor Education Space				
size (sq ft)	225	800	0	0
student capacity	20	30+	0	20?
bathrooms	2	2	1	1

Table 2 (cont.)

	Marin Headlands NPS	Presidio NPS	Tennessee Valley NPS	San Pablo Bay USFWS
Outdoor Education Space				
demo garden	yes	yes	no	not yet
seating	yes	no	no	not yet
Annual Production				
plant species	250	250	200	22
individual plants	20,000	80,000	7,000	3,000
Comments from Staff	Evaporative cooling system essential	High annual production due to shadehouse space (10 SH:1SH)	Limited by shadehouse space	Still developing
	Needs more indoor education space and bathrooms	GH needs evap cooling system	GH too small, can't be cooled	Movable aluminum benches
	Pest management program a must	Good educational space		GH used as education space if necessary
		Covered outside potting area		Subcontract out seed collection and cleaning
		Vast warehouse provides unlimited indoor work space		Existing ranch buildings

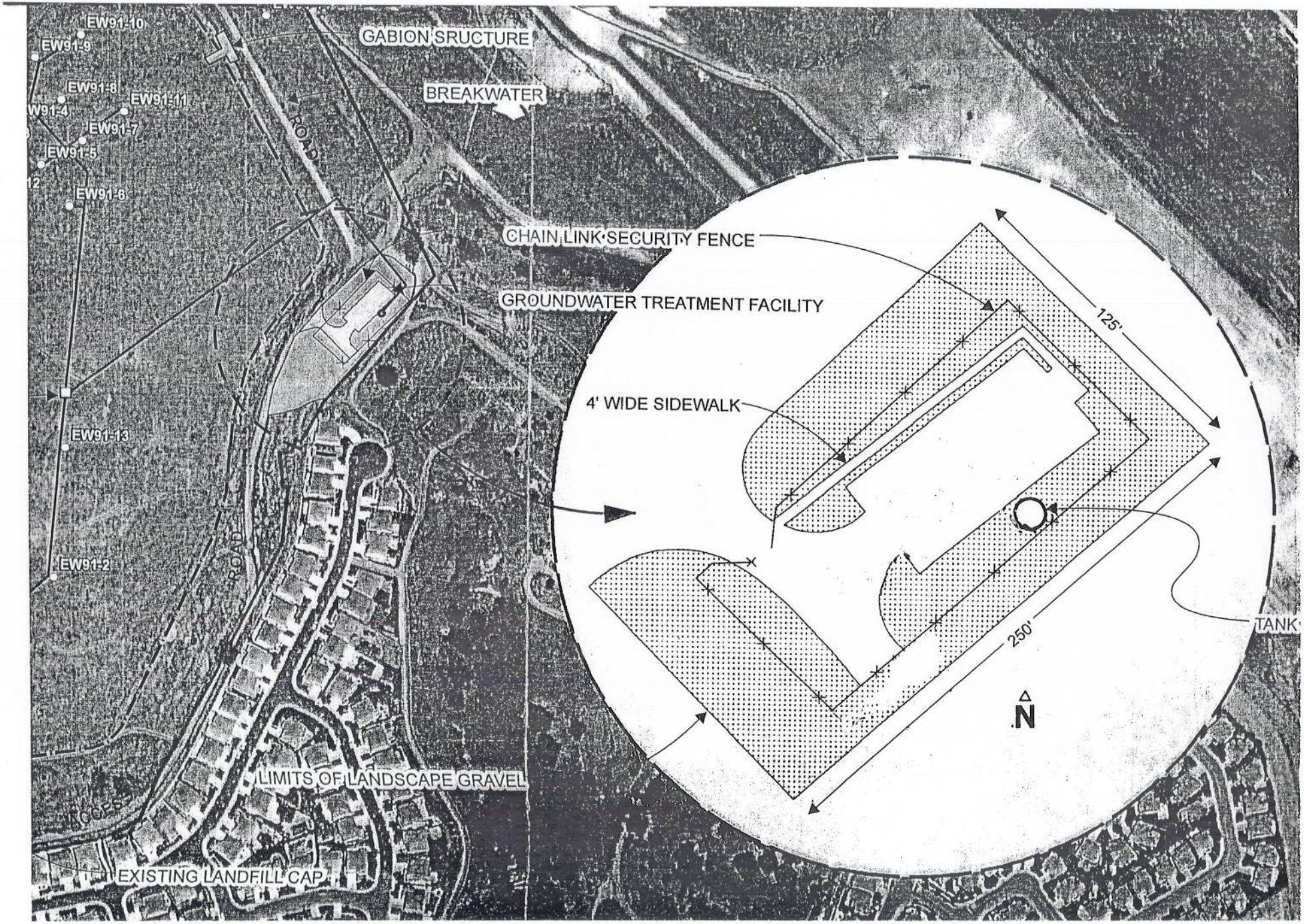


Figure 4. Location and layout of the decommissioned groundwater treatment facility at Hamilton Army Airfield, Novato, CA. Building and grounds (inset) must be rotated 120° clockwise to align with Figures 5 and 6. Photo and layout courtesy of the US Army Corps of Engineers, February 2010.

enough for several lath structures, raised wetland beds, plant hardening, soil storage, demonstration plots, and parking and is protected with a tall fence and lockable gate (Figure 6). A list of local suppliers for nursery features and materials is presented in Appendix D.

2.3.1 Inside Space

2.3.2.1. Entry Area

Visitors, volunteers and large groups will enter the building through the roll-up door on the south side of the building. They have an entry area to store personal items, wash hands, and congregate. Seating may be set up in this area for indoor meals or lectures (when the outdoor space is not available due to weather, etc.). A refrigerator is available to house perishable food. The nearby general information table can provide information on daily activities, project goals, progress and the role that volunteers play in the HWRP.

2.3.2.2. Staging Area

These four 4'x10' benches allow an area to hold plants as they are moved between the indoor and outdoor spaces. These benches are stationary (bolted to floor) and have expanded metal bench tops, which will allow water drainage if the plants need to be watered. This water can drain to the central floor drain and may ultimately lead out to the leach field. Trays of seed can be germinated on these benches, under a grow light, and if needed, over a heating pad. Plants can remain on these benches overnight.

2.3.2.3. Education and Demonstration Area

This area can be multifunctional in its use, although it is designed to allow groups of visitors and volunteers to perform hands-on activities led by staff, such as transplanting seedlings. A series of mobile benches on casters can be positioned for different sizes of groups, all within clear eyesight of a presenter. As drawn in the Building Plan, this bench arrangement can easily accommodate up to 30 people around the outer edge of the benches, with a presenter at one end. Large pictorials showing different plant parts and transplanting techniques can be displayed on the wall along this area to help train volunteers.

2.3.2.4. Propagation Area

This area is for daily use by staff and volunteers, providing workspace for at least eight people. The recommended stainless steel bench surface will not rust, harbor pests or scratch easily. A sink will be included in this space as well, for quick hand-washing and water access.

2.3.2.5. Storage

There is a large, lockable indoor storage space for equipment, tools, containers, trays, soil amendments, etc. Movable storage lockers are designated in a number of other areas and refrigerators for seeds will be added as needed.

2.3.2.6. Office and Lab Space

One office for the site manager is available on the north end of the building. A second office-like space could be used for staff. The lab space, which already includes counters, cabinets and a water distillation system can support testing of soil and plant material as needed.

2.3.2. Outside Space

2.3.2.1. Lath Structure

An 1800 sq. ft lath structure, runs along southern face of building, allowing for a partially shaded (55%) area where nursery plants are protected from full sun. Lath shade structures are generally open on all sides, although lath walls can be added for further protection (wind, sun) or for additional aesthetic appeal. The structure is supported by a series of vertical pressure-treated 4"x4" posts and horizontal 2"x4" planks. Lath can be added as individual pieces along the roof, or rolled out from a prefabricated roll of lath, such as "Osmore Lath Shade" from Hummert in 4'x50' or 6'x50' rolls, costing $113 and $193 respectively. The lath is installed so that the pickets run north to south.

2.3.2.2. Lath Ground Cover

To limit weeds/erosion and to maintain paths (especially during the wet season), polypropylene ground cover cloth can be applied over the entire footprint of the lath shade structure, as well as overflow, staging areas for plants. DeWitt or Pak ground cover rolls and anchoring pegs are available from Hummert and other vendors. Alternatively, 1" rough gravel can be applied at a depth of 3" over the entire square footage of the lath structure, including under the benches.

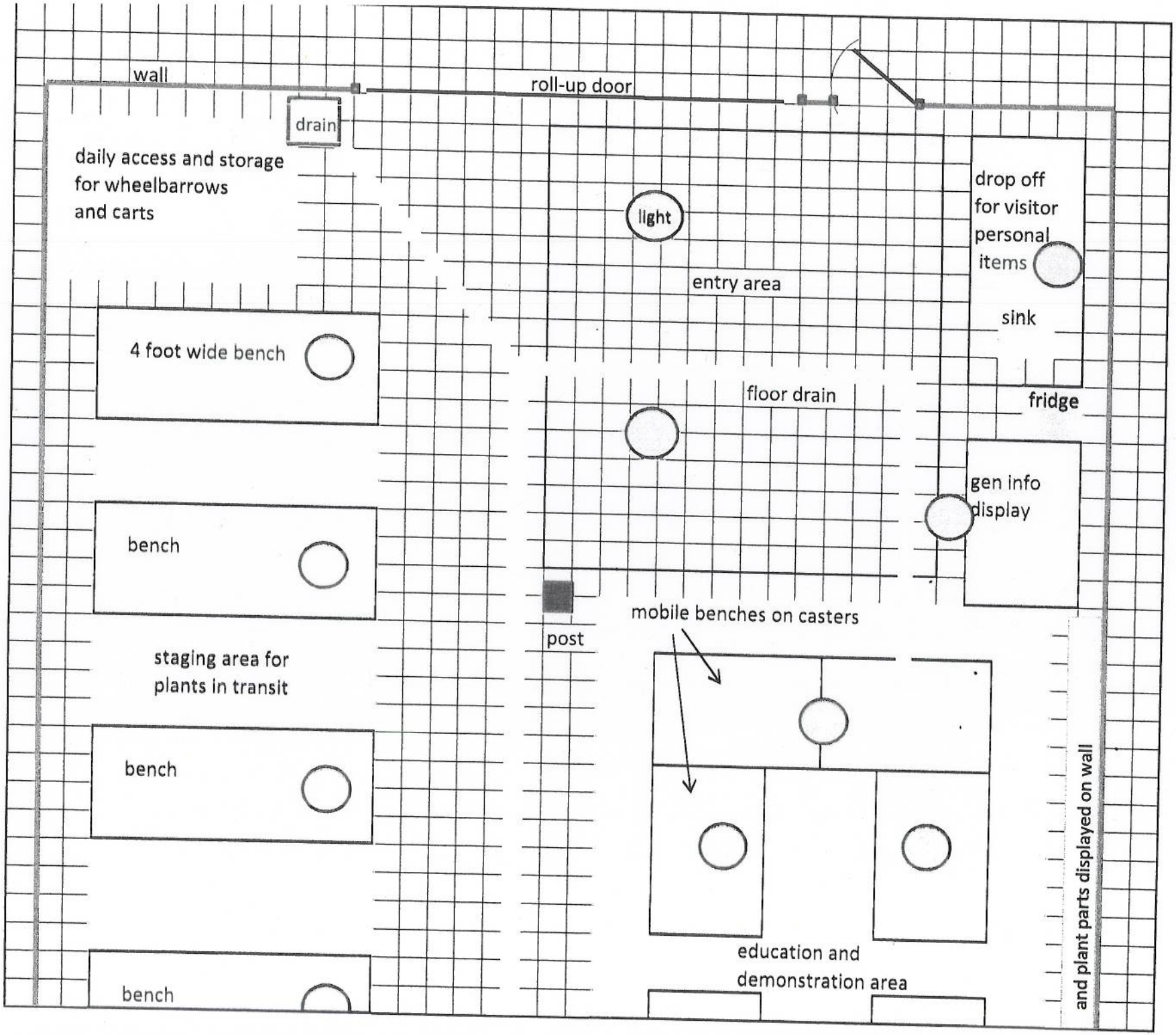
2.3.2.3. Benches

Benches are aligned approximately North to South to allow for maximum exposure to daylight. Centering the main path between rows of benches allows for the shortest distance to access plants at the far end of each bed. A generous path of approximately 4' between benches, allows carts/wheelbarrows to pass between benches. A 10'x20' open area near the main entrance of the lath structure, allows for staging, movement of larger equipment and a place for visitors to assemble.

To accommodate approximately 10,500 plants, as specified in Phase I Adaptive Management, the Outdoor Nursery Area houses a total of 22 4'x8' benches, which can each hold approximately 480 plants per table, assuming plants are in "D40" containers, within a D20T tray. Each 4'x8' table will hold 24 D20T trays, with an extra 6" of bench top space.

To accommodate approximately 31,400 plants, as specified in Phase II Restoration , the Outdoor Nursery Area can be expanded to house an additional 8-20 4'x8' benches and/or additional ground cover cloth can be laid down. Phase 2 can include the expansion of the lath shade structure, to cover additional benches or ground cover cloth.

After consulting with and visiting other restoration nurseries, including the GGNRP and Acterra Nurseries, it was confirmed that a bench top of stainless steel mesh or hard plastic (Dura Bench) were ideal for long-term


wall
roll-up door
drain
daily access and storage
for wheelbarrows
and carts
light
entry area
drop off
for visitor
personal
items
sink
fridge
4 foot wide bench
floor drain
gen info
display
bench
post
mobile benches on casters
staging area for
plants in transit
bench
education and
demonstration area
and plant parts displayed on wall
bench

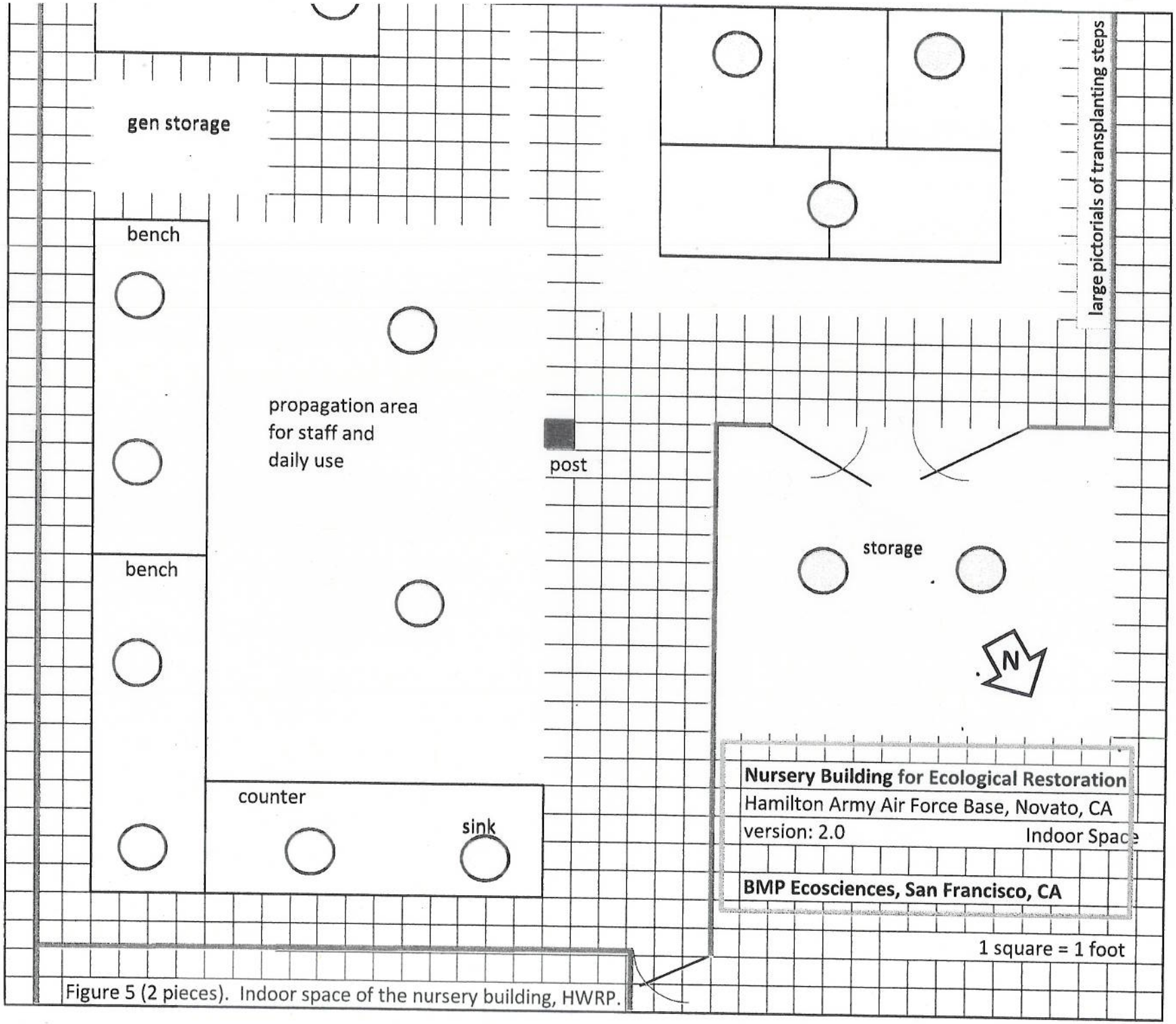


Figure 5 (2 pieces). Indoor space of the nursery building, HWRP.

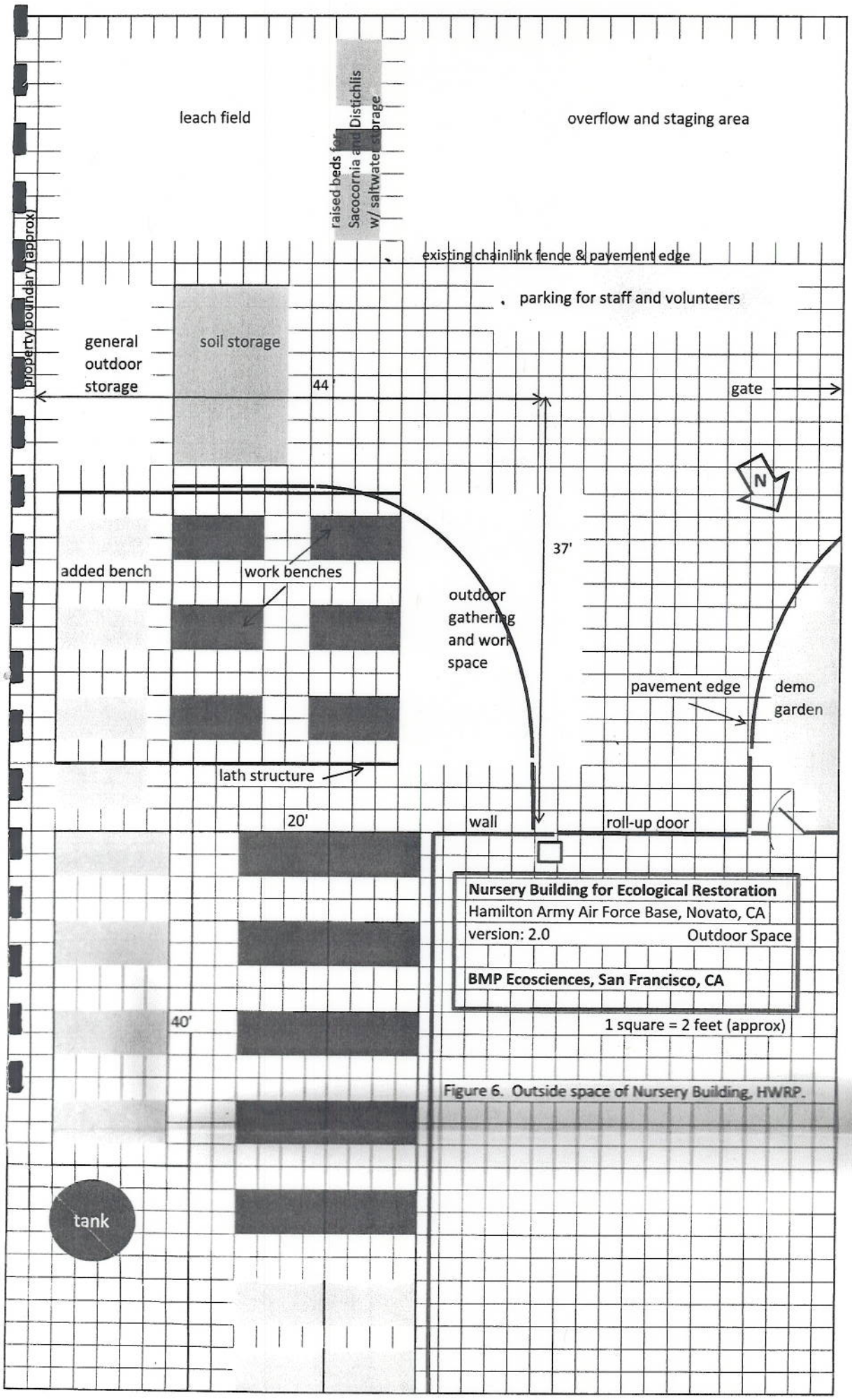


Figure 6. Outside space of Nursery Building, HWRP.

durability, without risk of warping, rusting or snagging. The frame of the bench can be constructed of treated lumber, cinder blocks or metal, although metal offers the longest durability without risk of housing pests/diseases.

2.3.2.4. Irrigation

Hand-watering by volunteers on a regular basis (1-3 times per week) is ideal for monitoring of water stress, pests, diseases, toppled plants, etc. If at some point an automated irrigation system is desired, it can be built accordingly: Control box and valves mounted near the southeast corner of the building, with 1/2" pvc pipe running a few inches below ground and then up along the length of each bench, where it stubs up to spray heads (suitable for lawns).

2.3.2.5. Soil Storage

Approximately 16-20' wide, existing asphalt base, three walls with the option to add a central dividing wall if needed to separate different soil mixes. Walls made of 2"x12" horizontal planks of pressure-treated lumber, up to a height of 4". A "lid" of white or clear corrugated plastic protects the soil from rain and heat and is attached by hinges so that is may be opened during deliveries, etc. Allows for easy drop off of soil from commercial vehicle (9-10' wide).

2.3.2.6. Demonstration Garden

For educational and aesthetic purposes, a small assemblage of most of the native species being grown for the restoration site can be maintained around the building. Weed, amend and mound soil with approx 3 cubic yards of soil with sierra gold rock. No irrigation needed- hand water as needed for first 1-2 summers. Label plants with Latin binomials and common names.

2.3.2.7. Raised Beds

Rhizomatous wetland species such as *Sarcocornia* and *Distichlis* are best grown in large 4'x6' wood raised beds, where the plants can spread vegetatively, under the presence of saltwater. These beds will house the "mother plants" from which small propagules can be divided. Saltwater storage will be in between the two raised beds, or nearby, for easy application. Any saltwater runoff can dissipate into the adjoining leach field.

2.3.2.8. Leach Field

This is a designated area, open and gradually sloped, where used water and saltwater can be spread with insignificant erosion or contamination to the sewage system.

3.0 Literature Cited

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4.0 Appendices

Table A. Seed Collection Record 2008
Table B. Seed Collection Record 2009
Table C. Suggested Timetable for Seed Collection, Propagation and Outplanting Events
Table D. Local Suppliers for Nursery Features and Materials

4.0 Appendices

Table A. Seed Collection Record 2008

Table B. Seed Collection Record 2009

Table C. Suggested Timetable for Seed Collection, Propagation and Outplanting Events

Table D. Local Suppliers for Nursery Features and Materials

Appendix Table A. Record of seed collection for the wildlife corridor of the HWRP, December 2008.

Collections were cleaned and stored at room temperature in paper bags before transfer to North Coast Nursery. "Code" refers to code recorded on each finished seed packet.

AESCULUS CALIFORNICA

Code	Location	GPS	Date	Qty Ind. Plants	# of Cleaned seeds	GERM 95%	SURV 50%
n/a	Rush Creek	UTM 4219036	12/17/2008	4	1788	1698	849
n/a	Ammo Hill	UTM 4212419	12/17/2008	3	32	30	15

BACCHARIS PILULARIS

(no GGNP qty seed per gram)

Code	Location	GPS	Date	Qty Ind. Plants	Yield of Cleaned seeds (g)	Qty seeds/ gram	Approx propagules	GERM 50%	SURV 50%
BP1	Straw Berm	UTM 4211274	12/16/2008	23	21.8	4000	87200	43600	21800
BP2	Straw Berm	UTM 4211274	12/16/2008	31	7.3	4000	29200	14600	7300
BP3	Straw Berm	UTM 4211274	12/16/2008	9	10.7	4000	42800	21400	10700
BP4	Straw Berm	UTM 4211274	12/16/2008	19	6	4000	24000	12000	6000
					45.8				45800
BP5	Berm off main road	UTM 4213405 to 42	12/17/2008	6	4.35	4000	17400	8700	4350
BP6	Berm off main road	UTM 4213405	12/17/2008	12	6.23	4000	24920	12460	6230
BP9	Berm off main road	UTM 4213405	12/17/2008	18	10.76	4000	43040	21520	10760
					21.34				21340
BP7	Pacheco Pond Levee	UTM 4213784	12/16/2008	59	22.28	4000	89120	44560	22280
BP 8	Ammo Hill	UTM 4212419	12/17/2008	12	7.76	4000	31040	15520	7760

Appendix Table A. (cont.) Dec 2008 seed collections.

	GRINDELIA STRICTA					(no GGNP qty seed per gram)		(no GGNP germ %)	
Code	**Location**	**GPS**	**Date**	**Qty Ind. Plants**	**Yield of Cleaned seeds (g)**	**Qty seeds/ gram**	**Approx propagules**	**GERM 20%**	**SURV 50%**
GS1	Waterfront; Red Pipe	UTM 4213417	12/17/2008	32	50.05	exact 390	19519	3903	1951
GS2	Waterfront; East of Pi	UTM 4212255	12/17/2008	14	26.69	exact 460	12277	2455	1227
GS3	Waterfront; near road	UTM 4212459	12/16/2008	9	11.59	exact 380	4404	880	440
GS4	Waterfront; near road	UTM 4212459	12/16/2008	10	6.27	avg 410	2570	514	257
GS5	Waterfront; East of Pi	UTM 4212309	12/17/2008	17	9.03	avg 410	3702	740	370
GS6	Waterfront; near road	UTM 4212459	12/16/2008	11	2.33	avg 410	955	191	95
GS7	Waterfront; near road	UTM 4212459	12/16/2008	10	6.18	avg 410	2533	506	253
GS8	Waterfront; btwn red	UTM 4213417	12/17/2008	9	10.88	avg 410	4460	892	446

	ROSA CALIFORNIA					(no GGNP qty seed per gram)			
Code	**Location**	**GPS**	**Date**	**Qty Ind. Plants**	**Yield of Cleaned seeds (g)**	**Qty seeds/ gram**	**Approx propagules**	**GERM 50%**	**SURV 50%**
RC1	Rush Creek	UTM 4219036	12/17/2008	1 stand	22.89	exact 62	1419	709	354
RC2	Ammo Hill	UTM 4212419	12/17/2008	1 stand	77.67	exact 108	8388	4194	2097
RC3	Ammo Hill	UTM 4212419	12/17/2008	1 stand	39.56	avg 80	3164	1582	791
RC4	Rush Creek	UTM 4219036	12/17/2008	1 stand	20.23	exact 72	1456	728	364
RC5	Pacheco Pond Levee	UTM 4213784	12/16/2008	3 plants	6.35	avg 80	508	254	127

	HETEROMELES ARBUTIFOLIA					GGNP states 33 seeds/gram			
Code	**Location**	**GPS**	**Date**	**Qty Ind. Plants**	**Yield of Cleaned seeds (g)**	**Qty seeds/ gram**	**Approx propagules**	**GERM 50%**	**SURV 50%**
HA1	Rush Creek	UTM 4219036	12/17/2008	8	29	33	957	478	239
HA2	Ammo Hill	UTM 4212419	12/17/2008	3	20.6	33	679	339	169

Appendix Table A. (cont.) Dec 2008 seed collections.

SYMPHORICAPOS ALBUS

GGNP states 150 seeds/ gram

Code	Location	GPS	Date	Qty Ind. Plants	Yield of Cleaned seeds (g)	Qty seeds/ gram	Approx propagules	GERM 75%	SURV 50%
SC1	Rush Creek	UTM 4219036	12/17/2008	11 stands	21.58	130	2805	2104	1052

JUNCUS SP. (patens?)

Code	Location	GPS	Date	Qty Ind. Plants	Yield of Cleaned seeds (g)	Qty seeds/ gram	Approx propagules
J1	Ammo Hill	UTM 4212419	12/17/2008	27	2.59	?	?

ARTEMISIA DOUGLASIANA

Code	Location	GPS	Date	Qty Ind. Plants	Yield of Cleaned seeds (g)	Qty seeds/ gram	Approx propagules
AD1	Ammo Hill	UTM 4212419	12/17/2008	1 stand			
AD2	Straw Berm	UTM 4211257 and	12/16/2008	2 stands	8.31		

ACHILLEA MILLEFOLIUM

Code	Location	GPS	Date	Qty Ind. Plants	Yield of Cleaned seeds (g)	Qty seeds/ gram	Approx propagules
AM1	Ammo Hill	UTM 4212419	12/17/2008	1 stand	0.11		

QUERCUS AGRIFOLIA

Code	Location	GPS	Date	Qty Ind. Plants	Yield of Cleaned seeds (g)	Qty seeds/ gram	Approx propagules
QA1	Rush Creek	UTM 4319036	12/17/2008	2	6 acorns total		

Appendix Table A. (cont.) Dec 2008 seed collections.

ATRIPLEX SP.

Code	Location	GPS	Date	Qty Ind. Plants	Yield of Cleaned seeds (g)	Qty seeds/ gram	Approx propagules		
A1	Pacheco Pond Levee	UTM 4213848	12/16/2008	12					

CHLOROGALUM POMERIDIANUM

Code	Location	GPS	Date	Qty Ind. Plants	Yield of Cleaned seeds (g)	Qty seeds/ gram	Approx propagules		
CP1	Straw Berm	UTM 4211274	12/16/2008	3 stands	123 seeds total				

Appendix Table B. Record of seed collection for the wildlife corridor of the HWRP, December 2009. Collections were cleaned and stored at room temperature in paper bags before propagation or storage at the Mills College Botanic Garden. "Code" refers to code recorded on each finished seed packet.

"Location" abreviations:
CCH = Chicken Coop Hill (in China Camp State Park)
E of CCH = East of CCH
Nature Trail, Miwok Meadow, Shoreline Trail = Other China Camp locations

IND COLL *AESCULUS CALIFORNICA*

Code	Location	GPS	Date	Qty Ind. Plants	Qty Seeds Planted	
AC1	Ammo Hill	4213551	12/9/2009	1	1	
AC2	Officers' Quarters	4211103	12/9/2009	1	8	
AC3	Officers' Quarters	4213111	12/9/2009	2	19	
AC4	Officers' Quarters	4213113	12/9/2009	4	32	
AC5	Officers' Quarters	*4213111	12/9/2009	1	8	
AC6	China Camp	4206523	11/27/2009	2	48	
AC7	Rush Creek	4213040	12/9/2009	1	18	
AC8	Miwok Meadow	4206242	12/9/2009	1	8	

BULK *BACCHARIS PILULARIS*

Code	Location	GPS	Date	Qty Ind. Plants		
BP1	E of CC Hill, inc hillside	4206563, 4206522	11/27/2009	50		
BP2	Nature Trail		11/27/2009	10		
BP3	Rush Creek	4219221, 4219192, 4	11/7/2009	11		

Appendix Table B. (cont.) Dec 2009 seed collections.

IND COLL	*GRINDELIA STRICTA*					
Code	**Location**	**GPS**	**Date**	**Qty Ind. Plants**		
GS1	East of CC Hill	4206663	11/27/2009	116		
GS2	Nature Trail	4207088	11/27/2009	28		
GS3	Nature Trail	4207072	11/27/2009	20		
GS4	Miwok Meadow	4206630	12/9/2009	10		
IND COLL	*ROSA CALIFORNIA*					
Code	**Location**	**GPS**	**Date**	**Qty Ind. Plants**		
RC 1	Rush Creek	4219339	11/7/2009	1		
RC2	Rush Creek	4219194	11/7/2009	1		
RC3	Rush Creek	4219177	11/7/2009	1		
RC4	Ammo Hill	4213567	12/9/2009	1		
RC5	Ammo Hill	4213585	12/9/2009	1		
RC6	Ammo Hill	4213529	12/9/2009	1		
RC7	East of CCH	4206570	11/27/2009	5		

Appendix Table B. (cont.) Dec 2009 seed collections.

IND COLL *HETEROMELES ARBUTIFOLIA*

Code	Location	GPS	Date	Qty Ind. Plants	Qty Seeds Planted
HA1	Nature Trail	4207111	11/27/2009	1	3
HA2	Nature Trail	4207064	11/27/2009	1	3
HA3	Nature Trail	4207070	11/27/2009	1	3
HA4	Nature Trail	4207126	11/27/2009	1	3
HA5	Nature Trail	4207061	11/27/2009	1	3
HA6	Nature Trail	4207077	11/27/2009	1	3
HA7	Miwok Meadow	4206234	12/9/2009	1	3
HA8	Miwok Meadow	4206567	11/27/2009	1	3
HA9	Miwok Meadow	4206506	12/9/2009	1	3
HA10	Miwok Meadow	4206493	12/9/2009	1	3
HA11	Miwok Meadow	4206370	12/9/2009	1	3
HA12	Miwok Meadow	4206249	12/9/2009	1	3
HA13	Miwok Meadow	4206461	12/9/2009	1	3
HA14	Miwok Meadow	4206426	12/9/2009	1	3
HA15	Miwok Meadow	4206485	12/9/2009	1	3
HA16	Miwok Meadow	4206423	12/9/2009	1	3
HA17	ECCH- hillside	4206543	11/27/2009	1	3
HA18	ECCH- hillside	unknown- not rec	11/27/2009	1	3
HA19	ECCH- hillside	unknown- not rec	11/27/2009	1	3
HA20	ECCH- hillside	unknown- not rec	11/27/2009	1	3
HA21	ECCH- hillside	4206547	11/27/2009	1	3
HA22	ECCH- near road	4206566	11/27/2009	1	3
HA23	China Camp- near roa	4206520	11/27/2009	1	3
HA24	CCH	4206717	11/27/2009	1	3
HA25	Shoreline Trail	4206609	11/27/2009	1	3
HA26	Rush Creek	4219270	11/7/2009	1	3
HA27	Rush Creek	4219408	11/7/2009	1	3

Appendix Table B. (cont.) Dec 2009 seed collections.

IND COLL	*LIMMONIUM CALIFORNICA*			
Code	**Location**	**GPS**	**Date**	**Qty Ind. Plants**
LC1	E of CCH	4206655	11/27/2009	40
LC2	E of CCH- middle strat	4206544	11/27/2009	25
LC3	E of CCH- far E end of	4206577	11/27/2009	25
LC4	W of CCH	4206648	11/27/2009	10

IND COLL	*SYMPHORICAPOS ALBUS*			
Code	**Location**	**GPS**	**Date**	**Qty Ind. Plants**
SA1	Rush Creek	4219166	11/7/2009	1
SA2	Rush Creek	4219334	11/7/2009	1
SA3	Rush Creek	4219184	11/7/2009	1
SA4	Rush Creek	4219161	11/7/2009	1
SA5	Rush Creek	4219174	11/7/2009	1

BULK	*ACHILLEA MILLEFOLIUM*			
Code	**Location**	**GPS**	**Date**	**Qty Ind. Plants**
AM1	Rush Creek		11/7/2009	50

Appendix Table B. (cont.) Dec 2009 seed collections.						
IND COLL	*QUERCUS AGRIFOLIA*					
Code	**Location**	**GPS**	**Date**	**Qty Ind. Plants**	**Qty Acorns Planted**	
QA1	Shoreline	4206599	11/27/2009	1	3	
QA2	Shoreline	4206635	11/27/2009	1	3	
QA3	Nature Trail	4207107	11/27/2009	1	1	
QA4	Nature Trail	4206857	11/27/2009	1	3	
QA5	Nature Trail	4207062	11/27/2009	1	2	
QA6	Nature Trail	4206872	11/27/2009	1	2	
QA7	Nature Trail	4207062	11/27/2009	1	2	
QA8	Nature Trail	4206923	11/27/2009	1	3	
QA9	Nature Trail	4206873	11/27/2009	1	2	
QA10	Nature Trail	4206889	11/27/2009	1	2	
QA11	Nature Trail	4207125	11/27/2009	1	2	
QA12	CCH- off the road	4206538	11/27/2009	1	2	
QA13	CCH	4206701	11/27/2009	1	2	
QA14	CCH- west hillside	4206681	11/27/2009	1	2	
QA15	CCH- west hillside	4206679	11/27/2009	1	2	
QA16	ECCH- hillside	4206502	11/27/2009	1	3	
QA17	ECCH- hillside	4206517	11/27/2009	1	3	
QA18	Miwok Meadow	4206557	11/27/2009	1	3	
QA19	Miwok Meadow	4206020	11/27/2009	1	3	
QA20	Miwok Meadow	4206555	11/27/2009	1	2	
QA21	Miwok Meadow	4206235	12/9/2009	1	2	
QA22	Miwok Meadow	4206337	12/9/2009	1	3	
QA23	Miwok Meadow	4206497	12/9/2009	1	2	
QA24	Miwok Meadow	4206252	12/9/2009	1	2	
QA25	Miwok Meadow	4206295	12/9/2009	1	2	
QA26	Miwok Meadow	4206153	12/9/2009	1	3	
QA27	Miwok Meadow	4206418	12/9/2009	1	2	
QA28	Miwok Meadow	4206265	12/9/2009	1	3	

QA29	Miwok Meadow	4206294	12/9/2009	1	2	
QA30	Miwok Meadow	4206487	12/9/2009	1	3	
QA31	Miwok Meadow	4206393	12/9/2009	1	2	
QA32	Miwok Meadow	4206508	12/9/2009	1	2	
QA33	Miwok Meadow	4206274	12/9/2009	1	3	
QA34	Miwok Meadow	4206490	12/9/2009	1	2	
BULK	*ATRIPLEX SP.*					
Code	**Location**	**GPS**	**Date**	**Qty Ind. Plants**		
AT1	Rush Creek	4219363	11/7/2009	22		
AT2	China Camp- CC Hill	4206681	11/27/2009	60		
AT3	China Camp- Nature T	near 4207088	11/27/2009	10		
BULK	*CHLOROGALUM POMERIDIANUM*					
Code	**Location**	**GPS**	**Date**	**Qty Ind. Plants**		
CP	China Camp- Natire Tr	4207088	11/27/2009	50		
BULK	*BULBOSHOENUS ROBUSTUS*					
Code	**Location**	**GPS**	**Date**	**Qty Ind. Plants**		
SR1	Marsh east of CCH	4206648	11/27/2009	100 approx		
BULK	*BULBOSHOENUS ACUTUA*					
Code	**Location**	**GPS**	**Date**	**Qty Ind. Plants**		
SA1	Marsh east of CCH	4206522	11/27/2009	50 approx		

Appendix Table B. (cont.) Dec 2009 seed collections.

IND COLL	*ARBUTUS MENZIESII*					
Code	**Location**	**GPS**	**Date**	**Qty Ind. Plants**		
AM1	Nature Trail	4206720	11/27/2009	1		
AM2	Nature Trail	4207055	11/27/2009	1		
AM3	CCH	4206732	11/27/2009	1		
AM4	CCH	4206751	11/27/2009	1		
AM5	Shoreline Trail	unknown- not record	11/27/2009	1		
AM6	Miwok Meadow	4206339	12/9/2009	1		
AM7	Miwok Meadow	4206020	11/27/2009	1		
AM8	Miwok Meadow	4206502	12/9/2009	1		
AM9	Rush Creek	4219409	11/7/2009	1		
AM10	Rush Creek	4219355	11/7/2009	2		
AM11	Rush Creek	4219278	11/7/2009	1		
IND COLL	*LONICERA HISPIDULA*					
Code	**Location**	**GPS**	**Date**	**Qty Ind. Plants**		
LH1	E of CCH- across road,	4206547 (approx)	11/27/2009	1		
LH2	Nature Trail	unknown- not record	11/27/2009	3		
LH3	CCH	4206764	11/27/2009	1		
LH4	Miwok Meadow	4206150	12/9/2009	1		
LH5	Miwok Meadow	4206209	12/9/2009	1		
LH6	Miwok Meadow	4206155	12/9/2009	1		
LH7	Rush Creek	4219285	11/7/2009	1		
LH8	Rush Creek	4219219	11/7/2009	1		
LH9	Rush Creek	4219202	11/7/2009	1		
LH10	Rush Creek	4219233	11/7/2009	1		

Appendix Table B. (cont.) Dec 2009 seed collections.						
BULK	*SCROPHULARIA CALIFORNICA*					
Code	**Location**	**GPS**	**Date**	**Qty Ind. Plants**		
SC1	Miwok Meadow	4206244	12/9/2009	1		
BULK	*ARTEMISIA DOUGLASIANA*					
Code	**Location**	**GPS**	**Date**	**Qty Ind. Plants**		
AD1	Miwok Meadow	4206098	12/9/2009	1		
AD2	Ammo Hill	4213569	12/9/2009	1		
BULK	*SAMBUCUS MEXICANA (sp?)*					
Code	**Location**	**GPS**	**Date**	**Qty Ind. Plants**		
SM1	Rush Creek	4219402	11/7/2009	1		

Appendix Table C. Suggested timeline for developing live plant materials for outplanting the wildlife corridor(WC) and conducting adaptive management (am) outplantings in seasonal wetland (SW) cell 1, assuming breach of the outer levee in summer 2012. Activities of and adaptive management working group (AMWG) and technical advisory group (TAG) are also shown. BMP Ecosciences Nov 2009.

		Wildlife Corridor (WC) and Seasonal Wetlands (SW)	Seasonal Wetland Cell 1	
		Plant Propagation and Outplanting	**Monitoring and Adaptive Management**	**AMWG/TAG**
2009				
w		seed collection yr 2, propagation yr 2 (WC)-DONE		
2010				
sp		design nursery		
s		build nursery, hire site manager		
f		seed collection yr 3, propagation yr 3 (WC)		
w		outplant yr 1 (WC)		
2011				
sp		rhizome collection yr 1 (SWam)		Selection of members
s		rhizome propagation yr 1 (SWam)		Hire TAG consultant
f		seed collection yr 4, propagation yr 4 (WC)		
w		outplant yr 2 (WC)		AMWG/TAG finalized
2012				
sp		rhizome collection yr 2 (SWam)		Meets to review
s		rhizome propagation yr 2 (SWam)	final outplant design (SWam)	Meets to review
f		outplant yr 3 (WC)		
w		outplant yr 1 (SWam)		
2013				
sp		outplant yr 1 cont. (SWam), rhizome coll yr 3 FINAL (SWam)		
s		rhizome propagation yr 3 (SWam)	monitoring yr 1 (SWam)	Meets to review
f			" "	
w		outplant yr 4 FINAL (WC), outplant yr 2 (SWam)	data analysis yr 1 (SWam)	

Appendix Table C. (cont.) Suggested timeline.			
	Wildlife Corridor (WC) and Seasonal Wetlands (SW)	Seasonal Wetland Cell 1	
	Plant Propagation and Outplanting	**Monitoring and Adaptive Management**	**AMWG/TAG**
2014			
sp	rhizome collection yr 1 (SW)	report yr 1, evaluate, action (SWam)	Meets to review
s	rhizome propagation yr 1 (SW)	monitoring yr 2 (SWam)	
f		" "	
w	outplant yr 3 FINAL (SWam)	data analysis yr 2 (SWam)	
2015			
sp	rhizome collection yr 2 FINAL (SW)	report yr 2, evaluate, action (SWam)	Meets to review
s	rhizome propagation yr 2 FINAL (SW)	monitoring yr 3 (SWam)	
f	ouplant yr 1 (SW)	" "	
w	ouplant yr 1 cont. (SW)	data analysis yr 3 (SWam)	
2016			
sp		report yr 3, evaluate, action (SWam)	Meets to review
s		monitoring yr 4 (SWam)	
f	ouplant yr 2 (SW)	" "	
w	ouplant yr 2 cont. (SW) NURSERY CLOSED	data analysis yr 4 (SWam)	
2017			
sp		report yr 4, evaluate, action (SWam)	Meets to review
s		monitoring yr 5 (SWam)	
f		" "	
w		data analysis yr 5 (SWam)	
2018			
sp		report yr 5, evaluate, action FINAL (SWam)	Meets to review
s			Decides whether to
f			continue AM
w			

Appendix Table D. Hamilton Native Plant Nursery: Vendor Contact Information

Current as of April 2010

BENCHES, GROUND COVER, LATH ROLLS

Stuppy Supply
PO Box 12456
North Kansas City, MO 64116
Toll Free 800-733-5025
Ouiside US 816-842-3071
www.stuppy.com

Hummert in Earth City:
4500 Earth City Expressway
Earth City, MO 63045
800-325-3055
Hours: Monday - Friday 7:30 a.m. - 5:00 p.m.
March-May: Saturdays 8:00 a.m. - 12:00 p.m
http://www.hummert.com

Conleys Greenhouse Manufacturin
4344 Mission Blvd.
Montclair, CA 91763
Toll Free 800-377-8441
Tel 909-627-0981
Fax 909-628-3774
www.conley.com

CONTAINERS AND TRAYS (leach tubes, D40s, Deepot trays, TFLAT prop trays, etc.)

Stuewe & Sons, Inc.
31933 Rolland Drive
Tangent, Oregon 97389
800) 553-5331 toll-free
(541) 757-7798 local
(541) 754-6617 fax
info@stuewe.com

McConkey Co.
1615 Puyallup St.
P.O Box 1690
Sumner, Washington 98390-0369
(253) 863-8111
(800) 426-8124
(253) 863-5833 (FAX)
sales@mcconkeyco.com

LOCAL GENERAL CONTRACTORS FOR LATH SHADE STRUCTURE CONSTRUCTION

West Bay Builders
250 Bel Marin Keys Blvd
Building A
Novato CA 94949
Tel: 415-456-8972

Rempe Construction
1020 Railroad Avenue Suite E
Novato, CA 94945
General Contractors Lic# 453554
Tel: 415-897-9126
Fax: 415-899-1186

Fontana Construction
70 Miwok Drive
Novato, CA 94947-3871
Tel: 415-897-2288

CDK Builders
Gary Suhrke
Marin
Tel: 415-419-5643

A set of costs estimates from these suppliers was submitted to Eric Jolliffe, USACE San Francisco, when this report was submitted in May 2010.