Chapter 5. Implementation Strategies and Analysis of Restoration Element Options

INTRODUCTION

Implementing the three Project Alternatives presented in Chapter 3 can be accomplished in numerous ways. This section discusses various implementation strategies and assesses the cost effectiveness of three implementation approaches to restoration. The analysis of restoration element options (REOs) identified the most appropriate methods for restoring habitats based on combined quantitative and qualitative characteristics.

This chapter presents the following information:

- recommended implementation approaches for site preparation, earthwork, irrigation, and planting; and
- cost benefit analysis of three approaches to implementation.

Implementation Strategies

This section describes several implementation strategies for construction activities necessary to achieve the project goals. Construction activities addressed include site preparation, earthwork, irrigation, and planting.

Site Preparation

Site preparation is a key component to facilitating plant establishment and reducing the seedbank of undesirable or highly competitive plants, especially in grassland communities. A common practice on restoration projects is to mow, burn, chemically treat, or remove and discard the top 4–6 inches of soil in the affected area before construction. Several studies have shown that repeated treatments during the growing season significantly reduce the seedbank and favor stronger establishment of restoration plants (Lanini 1996, Stromberg 1994). The site preparation method used on a project should be proportional to the magnitude of the weedy plant population on the site and the target restored plant community. For example, a site dominated by non-native annual grasses would require significant pre-treatment for a native perennial grassland restoration project, but a less intensive treatment for restoring a plant community dominated by woody plant species. A site dominated by yellow star thistle would need significant pre-treatment regardless of the type of restoration goal.

For most of the restoration actions presented in Chapter 3, a general prescription of light disking is recommended for most planting areas. Disking will facilitate the establishment of cover crops and spot herbicide treatment of problem plants (e.g., yellow star thistle). Major site preparation such as topsoil removal and the addition of soil amendments should not be necessary in most cases. Site preparation would be coordinated with project phasing and land use management practices, such as grazing.

Earthwork

Alternative 3 (Lowered Floodplain) and several restoration elements require significant earthwork to achieve their intended objectives. Although no options for implementing earthwork are available, several methods could be used to handle the excess fill generated by the project. Excess fill generated from excavation of restoration elements could be used on-site for other design elements, including the new weir, the berm in the visual buffer area, access ramps for maintenance equipment in the oxbows, and trails. Alternatively, the material could be sold to another construction project that needs fill, as would be the case for mining under Alternative 3. For the cost benefit analysis for REOs, we have assumed that the fill generated by restoration elements will be used on-site and the fill generated by mining will be transported off-site.

Self-loading scrapers and excavators would probably be used for the restoration elements (i.e., elements 6, 7, 8, and 9). Sand and gravel extraction equipment would be used to implement Alternative 3. Standard practices to reduce noise and air pollution, such as coordination with the local air quality district, would be implemented.

Irrigation

A standard practice on most restoration projects is to provide newly installed plants with some form of supplemental irrigation during the first 3–5 years of establishment. The supplemental water is generally reduced during the third summer to “wean” the young plants from the additional water. It is assumed that by this time the plants roots are strong enough to find sufficient water to survive during the dry season. Numerous irrigation methods are available: flood, drip, temporary overhead spray, or truck watering. In cases where water is simply not available restoration projects may not be irrigated or may use synthetic time-release water capsules to irrigate plants.

Flood Irrigation. A flood system is currently used on the site to irrigate the existing pasture. Water is pumped from the river by an electric pump and dispersed across the site through a series of underground pipes. The current system is quite old and in disrepair. Flood systems create many problems:

- They are an inefficient for watering individual plants;
- They encourage weed growth, creating additional maintenance over a larger area;

- They provide mosquito breeding habitat, creating a public nuisance and additional maintenance for local mosquito abatement districts; and

- The site must be level or terraced for equitable watering.

To control and manage a flood irrigation system, each planting area would require a small berm, similar to that of a rice field, constructed at the periphery of the planting area to contain irrigation water. Large planting areas may be broken into smaller basins for easier management. The planting basins would be flooded periodically for a short duration (1–2 days per month) during the growing season (April through September) for the first 3–5 years after planting.

This type of system could be used for some of the planting areas. The existing system could be retrofitted, assuming the infrastructure is in fair enough condition to warrant continued use. The existing lift pump should be evaluated and repaired if necessary or replaced. A new pump could be located along the river at a site more convenient to the project. If the current electric pump is replaced, the new pump should run on diesel fuel to eliminate some of the overhead power lines. Otherwise, the power lines could be rerouted along the north and eastern edges of the site to reduce conflicts with proposed habitat enhancement elements.

Drip Irrigation. Temporary drip irrigation systems are the most common method for irrigating large restoration sites. Generally, half-inch flexible distribution line is laid on the ground at each plant and connects to a below-ground hard distribution pipe. Drip irrigation uses less water, reduces competition from weeds by watering only individual plants, is relatively inexpensive, and is easy to install. Drip systems require some maintenance and may restrict certain land management activities (e.g., grazing, burning, and mowing). This system would require the installation and maintenance of drip lines and valves and connection to an existing water line. The well near the hay barn could be upgraded, if necessary, to accommodate flow requirements for a drip irrigation system.

Sprinkler Irrigation. A temporary agricultural-grade sprinkler system may be the optimum system for some of the restoration elements. This system would use galvanized pipes and impact sprayers on steel risers. Sprinkler irrigation would be used in place of flood irrigation, if grazing is not used as a management tool, or in place of drip irrigation if the area is subject to flooding by a stream or river (i.e., where water velocity is a concern).

Truck Watering. In some instances, irrigation during critical months can be provided by a water truck. This method is generally used on remote sites, when a water source (a well, pond, or river) on the site does not already exist and the cost of installing a well for a temporary irrigation system is not cost-effective. It is also used when the plantings are widely spaced and there is a relatively short timeframe when the plants will need supplemental water. This method is labor intensive, can be expensive if there are lots of plants that are difficult to find, and requires vehicular access to planting sites.

Time-release Watering. A relatively new product is currently on the market that allows for time-release watering of plants. This product is a gel made of 98% water and 2% food grade ingredients (DriWater 2001). It comes in a 5-inch-long, 3-inch-diameter capsule that is inserted into the planting hole and over 90 to 100 days releases water to the plant. The capsules can be replaced to continue watering over several years until the plants are established.

No Irrigation. Supplemental irrigation does not need to be used for a successful restoration project. However, without irrigation, the length of time required to achieve the habitat goals will be significantly greater and the frequency of replanting or reseeding to achieve the design objective may be greater. Generally, restoration is planned without irrigation in areas where a watering system is not physically feasible or is unnecessary for plant establishment. Wetlands and willow riparian areas close to the groundwater table generally do not use irrigation but rely on runoff, groundwater, and rainfall instead. Plant establishment in these cases relies more on the plants' ability to quickly use natural water sources.

For the cost benefit analysis for REOs, we have assumed that most habitat types will not be irrigated under the low input/output options while primarily drip irrigation will be used for the moderate and high input/output options. Please refer to Table 5-1 for a complete description of the REOs used.

Planting

On most restoration projects, selected areas are planted or seeded with native trees, shrubs, vines, and groundcovers to facilitate plant establishment. One option is to allow nature to take its course and gradually re-colonize the project sites. However, planting seeds, acorns, cuttings, and rooted plants (nursery-grown container plants) creates the desired wildlife habitat much faster, reduces competition from invasive exotic plant species, and establishes a broader seed source for natural recruitment.

Active Planting. Planting methods must closely parallel the selected irrigation method. The use of reliable or more intensive irrigation will require a lower plant density because survival rate will more likely be higher. Likewise, a non-irrigated project requires higher plant density because survival is significantly lower. Plant material should also be sized according to the irrigation methods used. Smaller, less expensive plant material (container volume of 40 cubic inches or Dee-Pots) should be used for flood-irrigated areas, and larger plant material (container volume of 180 cubic inches or 1-gallon pots) should be used for irrigated areas. Areas without irrigation should be seeded or planted with dormant cuttings and acorns.

Natural Recruitment. When a project has restored the natural physical processes of a site, natural recruitment may occur. For example, riparian habitats will naturally establish with the creation or restoration of suitable geomorphic conditions including hydrology and flood inundation frequency. However, an additional risk of natural recruitment is that the site may be dominated by non-native species (e.g., fig, arundo, sesbania). In addition, not all the plant species in a target habitat will be recruited at the same rate. This is because their regeneration methods depend on factors that may not frequently occur (e.g., willows require recent flood deposits, sycamores depend on root sprouts), even though the site would naturally support these species. On the project site, restoration elements including expansion of the intermediate terrace, creation of seasonal and permanent wetlands, and creation of the lowered floodplain have the highest probability of natural recruitment. In these habitats, it is recommended that revegetation focus on species that may have a more difficult time becoming established. Table 5-2 summarizes the species composition for each target plant community type.

COST BENEFIT ANALYSIS OF RESTORATION ELEMENT OPTIONS

This benefits analysis describes the results of qualitative analyses to determine habitat benefits associated with three levels of construction implementation. The objective of this analysis is to assess the cost effectiveness of three different approaches to restoration and to provide a basis for selecting an implementation strategy for each habitat type. The approach, assumptions, and methodology used for this analysis is are very similar to that described in Chapter 4 for the alternatives benefit analysis.

Approach to the Benefits Analysis

The REO benefits analysis was conducted to identify wildlife habitat values that would be provided over a 50-year period under three REOs for restoring habitats. For the purposes of conducting the analysis, Alternative 1 was selected as the baseline restoration plan. Unlike the analysis conducted in Chapter 4, which compared different alternatives, this analysis compares implementation strategies for *one* alternative. The same methods could be applied to any of the other alternatives, but Alternative 1 was selected because it includes the greatest area of each habitat type. The three REOs analyzed for each habitat are:

- **low input/output REO** (application of low-cost restoration measures that generally provide fewer AAHUs than more expensive measures);
- **moderate input/output REO** [application of moderate-cost restoration measures that generally provide fewer AAHUs than more expensive measures, but provide more AAHUs than lower cost measures (This REO corresponds to the restoration input assumed for the alternatives benefit analysis described in Chapter 4.)]; and
- **high input/output REO** (application of high-cost restoration measures that generally provide greater AAHUs than the low and moderate input/output measures).

The REOs vary in the level of effort (i.e., labor, materials, equipment and other cost-related items) required to implement each option and, as a result of different levels of effort, would be expected to provide varying levels of output in the form of Average Annual Habitat Units (AAHUs) generated. The REOs for each habitat type are summarized in Table 5-1.

The results of the REO benefits analysis are expressed as the absolute per-acre AAHUs provided by each REO for each restored habitat and per-acre restoration cost per AAHU generated under each of the REOs for each habitat.

General Assumptions Used

To conduct the benefits analysis, it was necessary to use the best available information to make assumptions about how habitat structure will develop over time for the low, moderate, and high input/output REOs. Assumptions were based on knowledge of the site, past experience, and professional judgement.

To derive AAHUs per acre and costs needed to generate each AAHU, it was necessary to assume a hypothetical restoration design for an area larger than 1 acre, to more realistically reflect actual costs for each REO. (Costs per acre for some restoration measures decrease as the number of acres treated increases. For example, costs associated with economy of scale, such as start-up costs, would not be reflected in the analysis if only 1 acre were restored.) The Alternative 1 restoration design was selected as the spatial template for conducting the REO benefits analysis. A detailed description of assumptions used to conduct the REO benefits analysis are presented in Appendix E.

Cost Estimates Used to Conduct the REO Benefits Analysis

Cost estimates for restoration implementation and maintenance were prepared for each REO. The details of this cost estimate for Alternatives 1, 2, and 3 are provided in Appendix E. No long-term maintenance, remedial actions, or contingency costs were included in these cost estimates. The cost estimates do not include any costs associated with vegetation, hydrology, or wildlife monitoring surveys. The cost estimates were based on estimates prepared for similar projects.

Analysis of the Restoration Element Options

As stated previously, the Alternative 1 restoration design was used as the spatial template for conducting the analysis. Per-acre AAHUs generated under each REO are presented in Figure 5-1 and Table 5-3; the per-acre restoration costs for each REO are presented in Table 5-4.

The initial hypothesis was that greater input would result in greater habitat value measured in AAHUs. According to the analysis, this hypothesis is true as the restoration inputs increase from low to moderate input/output. However, as the inputs are increased again from moderate to high input/output, only a few habitat types show marked increase. These habitats include the seasonal and permanent wetlands and mixed riparian woodland. The AAHUs from moderate to high input/output remain nearly the same for the valley oak/sycamore woodland, valley oak/sycamore savanna, and herbaceous upland habitats.

The per-acre AAHU numeric values for the mixed riparian woodland habitat type are small relative to the other habitat types analyzed. This is a result of the model used and not the value of the habitat itself. It is not the individual habitats that are being compared, but the level of restoration input. Therefore, if the per acre AAHUs for mixed riparian woodland were multiplied by 1,000 they would equal 90, 110, and 120 for the low, moderate, and high input/output respectively and the increase in AAHUs would be more apparent.

The per-acre AAHU costs for implementing each REO are presented in Figure 5-2 and Table 5-5. In most instances, per-AAHU costs progressively increase with the level of input. Exceptions are the per-acre AAHU costs for the seasonal wetland and perennial grassland habitats. In this case the moderate input/output provides more AAHUs for less cost.

DISCUSSION OF RESULTS AND RECOMMENDATIONS FOR RESTORATION ELEMENT OPTIONS

As discussed in the beginning of this chapter, the intent of this analysis was to assist in the selection of implementation strategies for the preferred alternative. Numerous strategies are available for accomplishing the desired restoration based not only on the selected REO, but also combinations of REOs and project phasing. The specifics of an implementation strategy can be determined during the detailed design phase of the project, but the results of the analysis and a comparison with the overall project goals should enable the Conservancy to choose a general direction for the desired level of effort for implementing the preferred alternative.

Several of the project goals may lend additional guidance in selecting the appropriate combination of REOs. Goals addressing minimal long-term maintenance, control of non-native invasive plant species, and visual quality of the site play directly into the initial restoration effort of a project. Often the best way to reduce long-term maintenance is by putting concentrated efforts in the first few years after construction so native plants have an advantage over their non-native competitors. Controlling non-natives will be an on-going issue, but if the desirable native plants establish more quickly, then less disturbed ground will be available for the less desirable species. The Jensen property is highly visible from existing overlooks in Woodward Park and very accessible from the Lewis S. Eaton Trail. Careful consideration should be given to the effect this high visibility could have on the public opinion and understanding of restoration.

Generally the REO cost-benefit analysis illustrated that greater inputs cost more but do not always provide greater habitat benefit. There are exceptions to this and as stated in the introduction to this chapter, there are many possible strategies for implementation and many combinations of strategies that could be employed. Overall, the moderate input/output REOs provide greater benefit than the low input/output REOs. The high input/output REOs are the most expensive, but provide little additional habitat benefit. The most cost effective and habitat beneficial inputs should generally include small plant material at higher densities with irrigation and maintenance for the first 2 to 3 years. This is prescription is a combination of the low and moderate input/output REOs.

Based on the project goals and the results of the REO cost-benefit analysis the following combinations of REOs for each habitat type should be explored during the detailed design phase of the restoration project:

- Mixed riparian woodland – combination of low and moderate inputs
- Seasonal wetland – moderate input
- Permanent wetland – moderate input
- Valley oak/sycamore woodland – combination of low and moderate inputs
- Valley oak/sycamore savanna – combination of low and moderate inputs
- Herbaceous upland – moderate input

The maintenance and irrigation could be adjusted in the first several years after construction depending on the health and vigor of the plants and the level of non-native species invasion.