Las Vegas Wash Coordination Committee

Las Vegas Wash Revegetation Master Plan

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Las Vegas Wash
Revegetation Master Plan

SOUTHERN NEVADA WATER AUTHORITY
Las Vegas Wash Project Coordination Team

Prepared For:
Las Vegas Wash Coordination Committee

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1.0 SUMMARY

The lower Las Vegas Wash (Wash) presents an excellent opportunity to create high-quality habitat for a variety of wildlife species. The created aquatic and riparian habitats provide a unique environment in the surrounding dry landscape; however the presence of non-native vegetation has compromised the ecological function of the system. Dynamic native riparian and wetland ecosystems are renowned for their high levels of biodiversity and productivity. As these ecosystems become increasingly imperiled by extensive modification and non-native species invasion, the need for restoration and creation has also become increasingly urgent.

This project is designed to meet two primary goals. The first is to develop a master plan for creating riparian habitats in the Wash by replacing non-native plants with native vegetation in order to develop ecologically functioning wetland, riparian, and upland areas that are self-sustaining in the long-term. The second goal of this project is to implement the first phase of this concept plan by restoring a 60-acre pilot site.

Southern Nevada Water Authority (SNWA) officials as well as other participating members of the Las Vegas Wash Coordination Committee (LVWCC) can use this concept plan as a roadmap that provides direction for future restoration efforts in the Wash. This plan should help guide management decisions by:

- Identifying revegetation sites and prioritizing them.
- Recommending restoration methods and presenting options.
- Recommending monitoring strategies.

Replacing invasive species with native vegetation at the pilot site will build quality habitat native to the Colorado River basin as well as enhance the area's native biodiversity and ecological function. Revegetation activities at the pilot site will not only create essential habitat for wildlife, but will also enhance recreational opportunities, generate a crucial source of native seed for downstream dispersal, and provide a model for other restoration efforts throughout the southwest.

2.0 INTRODUCTION

2.1 Project Description

The lower Wash stretches 12 miles from the southeast part of the Las Vegas Valley to Lake Mead, entering the lake at Las Vegas Bay. Historically, the majority of the Wash remained dry throughout much of the year with flooding events supplying intermittent flow during the wet seasons. In the 1950's, urban runoff and reclaimed wastewater created a perennial source of water in the Wash and subsequently created approximately 2,000 acres (ac.) of wetlands by the 1970's (LVWCC 2000). However, perennial flow combined with periodic flood events increased erosion and created large cut banks. Wetlands began to diminish, which promoted the advancement of non-native weeds and the discharge of large amounts of sediment into Lake Mead. Currently, only approximately 10% of the wetlands remain.

In order to mitigate the effects of increased erosion, the LVWCC, a multi-stakeholder committee dedicated to the stabilization and enhancement of the Wash, has constructed channel and bank control structures to help dissipate the energy from these water inputs. These structures have slowed water and created pools, which have enabled wetland vegetation to establish and habitats to form. In order to further stabilize the banks and enhance riparian areas, the LVWCC has initiated native plant revegetation efforts.

Although restoration has been initiated at the Wash, the wetland and riparian areas are still plagued with high densities of non-native vegetation. Approximately 1,500 ac. of invasive weeds have been documented along the Wash (Bickmore 2003). Non-native plants, particularly invasive non-native plants, are a concern because they could potentially invade Lake Mead and the rest of the lower Colorado River system. The three weeds that have been identified as the priorities for removal include tall whitetop (*Lepidium latifolium*), giant reed (*Arundo donax*), and tamarisk (*Tamarix ramosissima*). Tall whitetop is present in the Wash in relatively low densities, but is highly invasive and is prioritized for removal to keep populations under control. The LVWCC has made great strides to set up a management program to reduce populations of this plant through mechanical and chemical treatments. These management programs have been extremely successful and have contributed to the complete eradication of giant reed along the Wash. Monotypic stands of tamarisk, however, are well established at the Wash and dominate the riparian areas. Tamarisk out competes native vegetation for a number of reasons:

- Its seed production is highly prolific—one plant can produce over 600,000 seeds (Rosenberg et al. 1991).
- It germinates and establishes seedlings rapidly (Brotherson and Field 1987; Neill 1985).
- It grows very quickly (Friederici 1995).
- It tolerates drought well (Cleverly et al. 1997).
- It tolerates salt well (Glenn et al. 1998).
- It can re-sprout after a fire, as well as tolerate fire (Busch and Smith 1993).

Although tamarisk does provide some habitat, shade, and erosion control, its aggressive behavior has created low-quality monocultures. This condition has reduced ecological function by decreasing biodiversity and habitat for neotropical migrating birds (Engel-Wilson and Ohmart 1978; Hunter et al. 1988; Ohmart et al. 1988; Zavaleta 2000). The invasion of tamarisk has presented many challenges for ecologists who want to preserve and restore riparian habitats that support more biodiversity.

In the arid southwest, wetland and riparian areas are extremely rare and thus provide disproportionately valuable habitat for wildlife species (Thomas 1979). Western riparian ecosystems contain approximately 42% of the mammal species, 38% of the birds, 30% of the reptiles, and 14% of the amphibians of North America (Council on Environmental Quality 1978). Because the Wash returns the largest quantity of water from the Las Vegas Valley watershed to Lake Mead, it functions as an ecologically important refuge and habitat for a variety of species in this region. Enhancement and revegetation of the riparian, aquatic, and upland areas will provide the essential criteria for stabilizing high quality habitat for multiple species, prevent erosion, provide natural filtration by removing nutrients and other compounds, and fulfill recreational desires.

2.2 Project Objectives

This plan is designed to meet two primary goals. The first is to develop a master plan that serves as a template for enhancing wetland, riparian, and upland vegetation along the Wash by outlining general tasks to be conducted in order to successfully replace invasive plants with native vegetation. Further, this document is an important planning mechanism to help meet the goals of our funding agencies. The second goal is to implement the first phase of this concept plan by enhancing a pilot site. Detailed revegetation information is provided herein to facilitate future project design and implementation.

2.2.1 Master Plan

SNWA officials, as well as other participating members of the LVWCC can use this concept plan as a roadmap that provides direction for future enhancement and revegetation efforts in the Wash. Appendix A shows the project area along with the sites identified as priority areas for restoration. This plan should help guide management decisions by:

- Identifying revegetation sites and prioritizing them.
- Recommending restoration methods and presenting options.
- Recommending monitoring strategies.

A variety of sites were identified along the Wash as priorities for enhancement and revegetation activities. The sites were ranked from high to low priorities based on the site condition (i.e., hydrology, soils, and size), ease of access, efficiency and duration of irrigation, feasibility of removing invasive vegetation, and total cost of enhancement activities. Six areas were ranked as high priority enhancement sites (Polygons 108, 110 - 114), including the pilot site, because they encompass large areas within the Wash, have easy access, can be feasibly and effectively cleared of invasive vegetation, require a shorter duration of irrigation, and are the most cost effective. Although the selected pilot site (Polygon 108) was ranked as the third priority site, the access permits were obtained prior to those for the top ranked sites thereby granting permission to initiate revegetation efforts on the site. Fourteen areas were identified as medium priority sites (Polygons 81 - 93 and 109). Target vegetation for these areas includes, mesquites (*Prosopis* spp.), saltbushes (*Atriplex* spp.), salt grass (*Distichlis spicata),* Fremont cottonwood (*Populus fremontii*), and willows (*Salix* spp.). These sites encompass small areas of the Wash and occur in relatively dry locations, which require a longer duration of irrigation thereby increasing the cost of the revegetation project. Although the cottonwood-willow site (i.e., Polygon 109) encompasses a larger area than the other medium priority sites, it was ranked as a medium priority because there is currently no road access to the site. Sixteen sites were identified as low priority sites (Polygons 94 - 107, 115 - 116), with target habitats consisting primarily of cottonwood, willow, mesquite and saltbush vegetation and cottonwood and willow emergent vegetation. Two of the sites (Polygons 115 - 116) have poor access and are a part of the Ducks Unlimited Wetlands Project which have high costs associated with implementing the design plan required by Clark County. The other sites are ranked low because they are comprised primarily of common reed (*Phragmites australis*) which is highly invasive and extremely difficult to feasibly or effectively remove as well as have high costs associated with drip irrigation that would be required for the desired planting regime at the sites (i.e., larger plants).

2.2.2 Pilot Site

The first phase of the master plan involves enhancing a pilot site that is approximately 60 ac. (Appendix B). The purpose of this revegetation project is to help stabilize the Wash floodplain as well as to restore and enhance the area's native biodiversity and ecological function. The pilot site has been funded through grants from the Southern Nevada Public Lands Management Act, Nevada Division of Environmental Protection, and the Nevada Division of State Parks. The pilot site would not only create essential habitat for wildlife, but will also enhance recreational opportunities and provide a model for other restoration efforts throughout the southwest. Furthermore, these restoration efforts will improve native plant recruitment in downstream habitats by providing a seed source dispersed by water, wind, or animals.

Native vegetation currently found within the Las Vegas Valley watershed, such as cottonwood, willow, mesquite, saltbush, and a mix of native grasses and herbs will be used in the pilot restoration. Renowned for their ability to support high biodiversity, these plants provide suitable habitat for wildlife, including the southwestern willow flycatcher (*Empidonax traillii extimus*). Appendix C lists other appropriate native plant species that could be used at revegetation sites (Shanahan and Silverman 2006).

2.3 Project Area

The area covered by this plan encompasses approximately 156 ac. of upland, riparian, and wetland areas along a nine mile stretch of the Wash located between Vegas Valley Drive and Lake Las Vegas (Appendix A). Historically, the Wash was an ephemeral dry wash, but as the population of Las Vegas grew, the input of urban runoff, reclaimed water, storm water, and shallow groundwater increased, creating a perennial stream and wetland environment. Currently, average discharge in the Wash is approximately 250 $feet^3$/second (ft^3/s), but during high flow events, typically occurring after summer and winter storms, flows can reach as high as 1750 ft^3/s (USGS 2005). The project area has been highly disturbed by development, recreation, and erosional events, which have promoted the establishment and dominance of highly competitive non-native vegetation.

Despite the disturbed setting, the Wash provides suitable habitat for over 200 species of amphibians, birds, mammals, reptiles, and fish (Larkin 2006, O'Farrell and Shanahan 2006, Shanahan 2005, Shanahan 2005a, and Van Dooremolen 2005), including rare species to the Las Vegas Valley such as the desert pocket mouse (*Chaetodipus penicillatus*), Yuma clapper rail (*Rallus longirostris yumanensis*), and western banded gecko (*Coleonyx variegatus*). Five new bat species not previously found in the Las Vegas Valley were recorded at the Wash, including: western small-footed myotis (*Myotis ciliolabrum*), fringed myotis (*M. thysanodes*), Yuma myotis (*M. yumanensis*), western red bat (*Lasiurus blossevillii*), and Allen's big eared bat (*Idionycteris phyllotis*). With the implementation of revegetation activities outlined in this document, species diversity and abundance is expected to increase.

2.4 Existing Vegetation

Throughout the riparian area in the Wash non-native weeds, particularly tamarisk, flourish while small communities of Fremont cottonwood (*Populus fremontii*) and willows are relegated to grow in marginal habitats. The dominant vegetation found in the Wash is listed in Table 1.

Because the Wash only recently had a permanent water source, the willow-cottonwood community that is typical of many other drainages in the southwestern U.S. was historically non-existent here. Additionally, the native bulrushes (*Schoenoplectus* spp.) that are common to so many wetland/marsh areas in this region are instead functionally represented in the Wash by the weedy common reed and ubiquitous cattail (*Typha domingensis*). A complete inventory of native and non-native plant species recorded along the Wash is listed in Appendix C.

Common Name	Scientific Name
Fourwing saltbush	*Atriplex canescens*
Shadscale	*Atriplex confertifolia*
Quail bush	*Atriplex lentiformis*
Desert saltbush	*Atriplex polycarpa*
Emory waterweed	*Baccharis emoryi*
Desert willow	*Chilopsis linearis ssp. arcuata*
Salt heliotrope	*Heliotropium curassavicum*
Creosote bush	*Larrea tridentata*
Common reed	*Phragmites australis*
Arrowweed	*Pluchea sericea*
Fremont's cottonwood	*Populus fremontii*
Sandbar willow	*Salix exigua*
Goodding willow	*Salix gooddingii*
Tule	*Schoenoplectus acutus*
Desert mallow	*Sphaeralcea ambigua var. ambigua*
Bush seepweed	*Suaeda moquinii*
Tamarisk	*Tamarix ramosissima*
Cattail	*Typha domingensis*

Table 1: Dominant vegetation in the project area.

Several plant communities are represented along the Wash. Upland areas are typically dominated by creosote (*Larrea tridentata*) while wetland areas are dominated by cattails. Many overlapping vegetation types apparently gradate between these communities according to water availability and soil conditions. Saltbush, mesquite, salt grass, willows, and cottonwoods are all important components of these transitional communities.

Unfortunately, many of these habitats are infested with non-native vegetation. A list of the non-native vegetation that occurs along the Wash can be found in Appendix C. Often the weeds of concern in these areas are tall whitetop, giant reed, and tamarisk. However, many more weeds are considered important species to monitor in order to prevent large scale infestations, including Russian knapweed (*Acroptilon repens*), Johnson grass (*Sorghum* spp.), fountain grass (*Pennisetum setaceum*), fivehook bassia (*Bassia hyssopifolia*), silverleaf nightshade (*Solanum elaeagnifolium*), and tree tobacco (*Nicotiana glauca*).

3.0 MASTER PLAN

The master plan provides a conceptual task list and timeline in order to successfully complete native vegetation restoration and enhancement projects in the Wash from the permit stage to project completion. The task timeline may vary based on the complexity of the project and size of the revegetation area. The aforementioned priority sites will require distinct revegetation and enhancement planning based on the environmental conditions, the target vegetation, and recreational and aesthetic goals of the site.

3.1 Project Tasks

In order to conduct a successful revegetation project and accomplish all the proposed goals several steps are required, including, but not necessarily in this specific order:

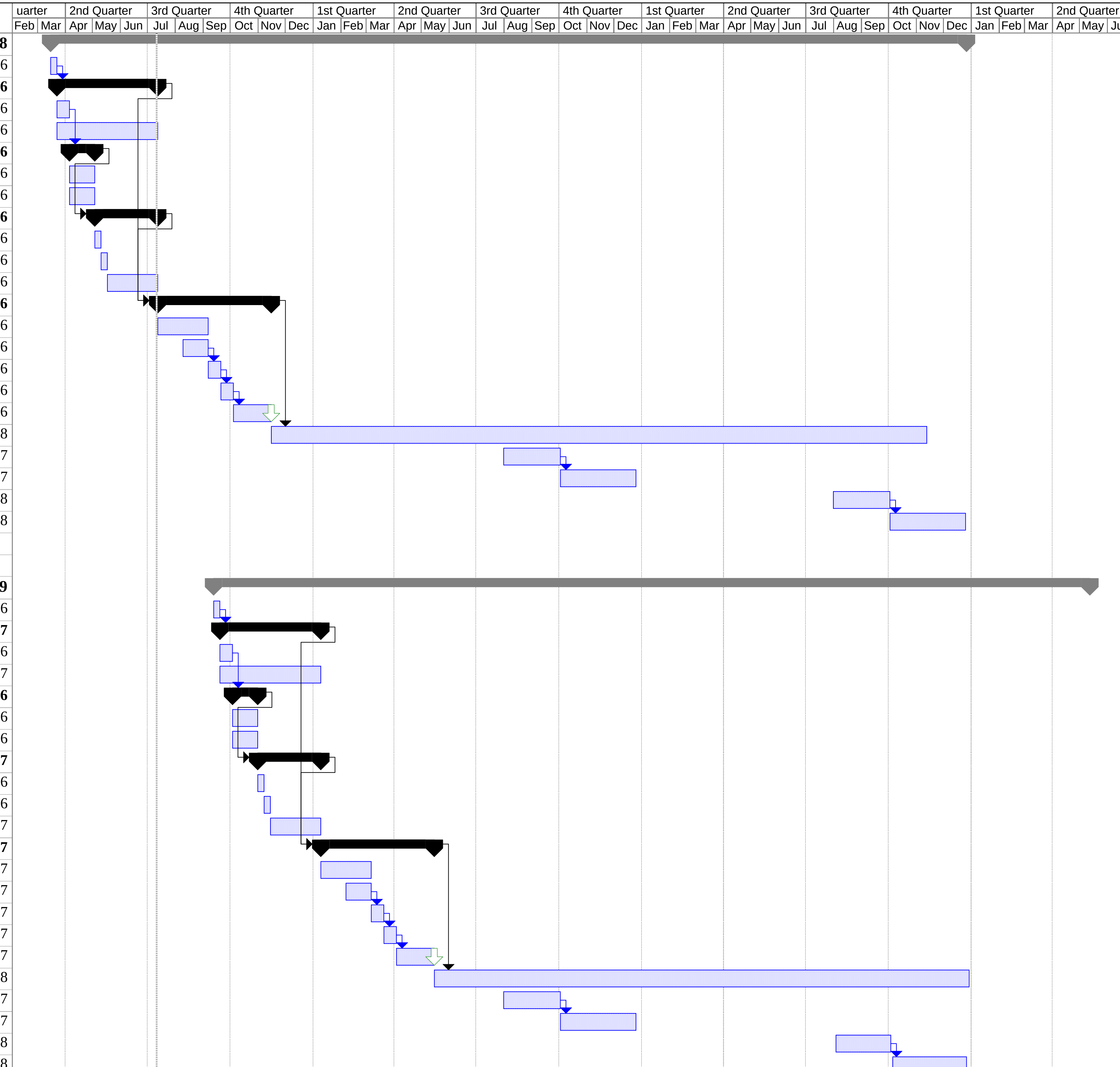
- Identifying and prioritizing sites for enhancement and revegetation activities.
- Obtaining permits and compliance for revegetation activities.
- Conducting a preliminary analysis to assess spatiotemporal abiotic conditions (i.e., soil salinity, soil texture, depth to water, and depth to capillary fringe).
- Preparing revegetation design based on results from preliminary analysis.
- Clearing undesirable vegetation (i.e., tamarisk) from the site.
- Implementing an irrigation strategy.
- Preparing the propagules for planting.
- Planting native species - this may include containerized plantings, pole cuttings, seeding, or a combination thereof.
- Monitoring the site for success.
- Implement additional strategies if required.

Several of the aforementioned tasks may need to go in a stepwise series; however, it is often the case that tasks can be done out of order and parallel with other tasks. Figure 1 shows a detailed timeline of the tasks necessary to accomplish revegetation at the Wash with a fall 2006 and spring 2007 anticipated planting used for illustrative purposes. It is important to realize that revegetation planning activities should be coordinated in anticipation of either a fall or spring planting. These periods have been shown to be the most successful times to plant vegetation. Since monitoring activities always occur from August - October, the monitoring for fall planting will occur almost a full year after planting is complete, whereas for spring planting monitoring will occur two months after planting is complete. Therefore, fall planting will require more days to accomplish project completion than spring planting.

3.1.1 Prioritizing Sites

The initial step to enhancing or revegetating an area with multiple sites is to prioritize the sites for enhancement or revegetation activities. This can be accomplished by establishing a ranking system or similar technique that incorporates the confounding variables that may limit the ability to accomplish a project. These variables can be ranked from 1 - 10, with a 10 indicating high success of achieving a variable and 1 indicating low to no success of achieving a variable. The score for each variable should be added up to get an overall score for each site. The overall scores for each site should be compared to distinguish the high to low priority sites.

ID	Task Name	Duration	Start	Finish
1	**Sample Timeline for Fall 2006 Planting**	**727 days**	**Thu 3/16/06**	**Fri 12/26/08**
2	Prioritizing Sites	5 days	Thu 3/16/06	Wed 3/22/06
3	**Environmental Compliance**	**80 days**	**Thu 3/23/06**	**Wed 7/12/06**
4	Landowner Authorization	10 days	Thu 3/23/06	Wed 4/5/06
5	Other Compliance	80 days	Thu 3/23/06	Wed 7/12/06
6	**Site Assessment**	**20 days**	**Thu 4/6/06**	**Wed 5/3/06**
7	Determine Soil Salinity	20 days	Thu 4/6/06	Wed 5/3/06
8	Determine Depth to Water	20 days	Thu 4/6/06	Wed 5/3/06
9	**Revegetation Design**	**50 days**	**Thu 5/4/06**	**Wed 7/12/06**
10	Grading Plan	5 days	Thu 5/4/06	Wed 5/10/06
11	Plant Selection	5 days	Thu 5/11/06	Wed 5/17/06
12	Planting Design	40 days	Thu 5/18/06	Wed 7/12/06
13	**Project Implementation**	**90 days**	**Thu 7/13/06**	**Wed 11/15/06**
14	Invasive Species Removal	40 days	Thu 7/13/06	Wed 9/6/06
15	Site Grading	20 days	Thu 8/10/06	Wed 9/6/06
16	Irrigation	10 days	Thu 9/7/06	Wed 9/20/06
17	Preparation to Plant Site	10 days	Thu 9/21/06	Wed 10/4/06
18	Plant Site	30 days	Thu 10/5/06	Wed 11/15/06
19	Project Maintenance	520 days	Thu 11/16/06	Wed 11/12/08
20	Monitoring (Year 1)	45 days	Wed 8/1/07	Tue 10/2/07
21	Reporting (Year 1)	60 days	Wed 10/3/07	Tue 12/25/07
22	Monitoring (Year 2)	45 days	Fri 8/1/08	Thu 10/2/08
23	Reporting (Year 2)	60 days	Fri 10/3/08	Thu 12/25/08
24				
25				
26	**Sample Timeline for Spring 2007 Planting**	**695 days**	**Wed 9/13/06**	**Tue 5/12/09**
27	Prioritizing Sites	5 days	Wed 9/13/06	Tue 9/19/06
28	**Environmental Compliance**	**80 days**	**Wed 9/20/06**	**Tue 1/9/07**
29	Landowner Authorization	10 days	Wed 9/20/06	Tue 10/3/06
30	Other Compliance	80 days	Wed 9/20/06	Tue 1/9/07
31	**Site Assessment**	**20 days**	**Wed 10/4/06**	**Tue 10/31/06**
32	Determine Soil Salinity	20 days	Wed 10/4/06	Tue 10/31/06
33	Determine Depth to Water	20 days	Wed 10/4/06	Tue 10/31/06
34	**Revegetation Design**	**50 days**	**Wed 11/1/06**	**Tue 1/9/07**
35	Grading Plan	5 days	Wed 11/1/06	Tue 11/7/06
36	Plant Selection	5 days	Wed 11/8/06	Tue 11/14/06
37	Planting Design	40 days	Wed 11/15/06	Tue 1/9/07
38	**Project Implementation**	**90 days**	**Wed 1/10/07**	**Tue 5/15/07**
39	Invasive Species Removal	40 days	Wed 1/10/07	Tue 3/6/07
40	Site Grading	20 days	Wed 2/7/07	Tue 3/6/07
41	Irrigation	10 days	Wed 3/7/07	Tue 3/20/07
42	Preparation to Plant Site	10 days	Wed 3/21/07	Tue 4/3/07
43	Plant Site	30 days	Wed 4/4/07	Tue 5/15/07
44	Project Maintenance	424 days	Wed 5/16/07	Mon 12/29/08
45	Monitoring (Year 1)	45 days	Wed 8/1/07	Tue 10/2/07
46	Reporting (Year 1)	60 days	Wed 10/3/07	Tue 12/25/07
47	Monitoring (Year 2)	45 days	Mon 8/4/08	Fri 10/3/08
48	Reporting (Year 2)	60 days	Mon 10/6/08	Fri 12/26/08



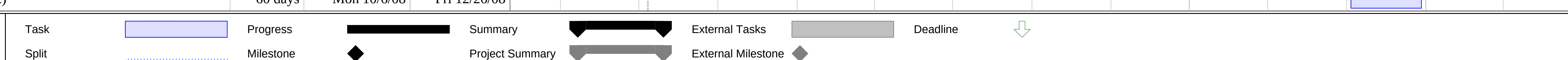


Figure 1: Sample timelines for anticipated planting in fall 2006 and spring 2007.

Enhancement and revegetation activities should be initiated on the highest ranked sites.

Some of the variables that could be used to rank sites include: existing conditions, ease of access, need and duration of supplemental irrigation, feasibility of removing invasive vegetation, total cost of project, and ability to acquire compliance and permits. Variables may overlap, but should encompass the range of factors that may affect enhancement or revegetation activities at a site. The existing conditions of a site may include the size of the site, where larger sites are ranked higher because they would receive the largest benefits from enhancement by providing continuous habitat, having a higher resistance to catastrophic events, and being less affected by edge effects. Other existing conditions include hydrologic conditions and soils, where high ranking sites have areas with low depth to water values and soils with good drainage and decent water retention ability. For access roads, sites are ranked higher if they have access roads already established to the site. Also, a site is ranked higher if it requires minimal supplemental irrigation such as in riparian and wetland areas. Sites that have invasive vegetation that can be feasibly removed are ranked higher. For example, tamarisk can be feasibly and effectively removed from a site whereas common reed is highly invasive and difficult to remove from a site in perpetuity. Low overall enhancement or revegetation costs receive higher scores and may include the total cost of all the variables as well as more costly revegetation methods that may be required by a landowner or criteria outlined in existing management or design plans.

3.1.2 Environmental Compliance Planning

In order to accomplish restoration initiatives along the Wash, environmental compliance activities and interagency coordination is required. Local, regional, and federal permits and consultation are required to initiate enhancement activities on the land. Since the permit application process can take several months, sufficient time should be allotted for this process prior to ground breaking activities. Although some of these requirements have been met for projects along the Wash; for example, an Environmental Impact Statement was completed for National Environmental Protection Act (NEPA) compliance; specific project activities may still require further coordination, consultation, or permitting. The agencies listed below may have regulatory oversight for particular tasks that are required for restoration projects along the Wash.

United States Army Corps of Engineers (Corps) - The Corps regulates activities on the nation’s waters and is charged with protecting our nation’s harbors and navigation channels from destruction and encroachment, and with restoring and maintaining environmental quality. Pursuant to Section 404 of the Clean Water Act, projects that occur along the Wash that impact jurisdictional waters require Corps permits. Given the nature of projects at the Wash, the nationwide permit program has been used extensively. The Corps also has an obligation to ensure that permitted projects comply with NEPA, the Endangered Species Act (ESA), and the National Historic Preservation Act (NHPA).

State Historic Preservation Office (SHPO) - The Nevada SHPO is tasked with administering the NHPA. Under the NHPA, any Federal undertaking that could affect historic properties requires a Section 106 review coordinated through the State Historic Preservation Office. This review process is designed to ensure that historic properties are considered during Federal project planning and execution.

Nevada Department of Environmental Protection (NDEP) - In conjunction with the Corps nationwide 404 permit, NDEP must review the project for compliance with state water quality standards. A 401 water quality certification from NDEP's Bureau of Water Quality Planning is required for all 404 permits. Most projects along the Wash also require storm water and temporary working in waterways permits from NDEP's Bureau of Water Pollution Control.

United States Fish & Wildlife Service (FWS) - The FWS is responsible for enforcing the ESA. Section 7 under this act requires that the FWS be consulted to determine if there are any impacts to federally protected species. Often, the consultation process requires a thorough evaluation of biological resources within a project's boundary. Coordinating activities with the FWS is also a fundamental element of meeting our obligation under NEPA.

United States Bureau of Reclamation (BOR) - The BOR manages much of the land along the Wash, however most of it is on lease to Clark County Parks and Recreation (CCPR). Authorization (i.e., notice to proceed) from the BOR must be received before any ground disturbing activities occur. The BOR usually has primary responsibility in meeting the requirements of NEPA and ESA, however the Corps retains the right to take the lead on specific projects.

Clark County - CCPR is the other major landowner along the Wash. Permission to access CCPR land is required prior to implementing a project. The Clark County Department of Air Quality and Environmental Management (CCDAQEM) is responsible for locally implementing the Clean Air Act, and therefore they must provide a permit to any activity that creates dust.

3.1.3 Site Assessment

The site assessment is conducted to determine the physical attributes of the site in order to create a successful revegetation strategy. Soil composition and soil characteristics are important indicators for determining the potential success of a revegetation project as they can detail the subsurface conditions to which plants will be exposed. Soil texture (i.e., the amount of sands, silts, and clays), soil profile (i.e., the soil horizon characteristics as they change with depth) and below ground moisture gradients can often be the limiting factors for plant survival and growth. Along the Wash, soil descriptions and analyses and depth to water information can be helpful to determine site suitability, limitations, and management for specific uses.

Soil characteristics can be measured in pits excavated by a backhoe or in holes dug by a soil auger or equivalent technique. The methods employed to access the subsurface soil will be based on the materials and funding available. These techniques can be combined in order to make sampling more efficient, where soil pits can be used to determine soil profiles in a few areas and holes can be dug more frequently across a site to gather salinity and depth to water measurements. Soil characteristics such as soil salinity, profile, and texture and depth to water should be systematically sampled across the entire site by creating a grid of the site and sampling at a determined interval. Sampling intervals will vary depending on the size of the enhancement site and variability of the landscape. Landscape features as well as historical information about the site should be used to determine locations for each of the soil pits in order to prevent disturbance of archeological sites and/or to ensure that the selected locations adequately represent the site.

A soil profile model for the potential planting areas at a site can be developed by exposing or excavating the soil layers in multiple pits or holes using the methods mentioned above. Soil texture should be evaluated to determine whether the soil provides good drainage and sufficient water holding capacity as to not limit plant growth. Each profile depth shall be documented along with soil characteristics.

Soil salinity should be measured on the surface and at 2 and 5 feet (ft) below the surface, depending on what type of planting technique is going to be utilized. One-to-five gallon potted plants are typically planted within the soil at a depth of 2-5 ft whereas broadcast seeding occurs on the soil surface. Soil salinity can be measured in the field but typically samples are collected and sent to a certified laboratory for analysis. Certified analytical laboratories in the southwest include: Utah State University Analytical Laboratory (USUAL) in Utah and IAS Laboratories in Arizona. If using a field meter, some soil samples should still be collected and analyzed at a laboratory in order to ensure the accuracy of the data collected.

In order to measure depth to water, the sediment should be excavated or augured until water is encountered. After a brief period of time has passed, the depth from the surface down to the water encountered should be recorded. In systems with fluctuating water tables, permanent wells can be installed across the site to measure depth to water over time. The water table depth in the wells can be measured manually at regular intervals or peizometers can be installed to digitally record groundwater depth over a set period of time.

The locations of each soil profile, depth to water and soil salinity points and/or wells should be recorded with a GPS unit and organized in a GIS database for future map production purposes. Depth to water and soil salinity measurements should be mapped using the appropriate software (i.e., Surfer® software) and put into a GIS format. These data are useful to help determine what species are suitable for the site and develop a detailed planting design that delineates species to be planted, plant spacing, beaver fence location, and a detailed irrigation design.

3.1.4 Revegetation Design

The revegetation design should be developed based on the results obtained from the site assessment and incorporate the recreational and aesthetic needs of the site. This design should include all the components necessary to establish a successful enhancement project, including irrigation and detailed planting designs. The revegetation and other necessary designs should be created using a combination of GIS (ArcGIS) and design (AutoCAD) software. Because the Wash has transitioned from an ephemeral desert wash that supported xeric to mesic plant communities into a perennial stream that supports a more hydric plant community, revegetation activities will not mimic historical conditions, but will attempt to create similar vegetative conditions found along many of the riparian drainages of the lower Colorado River basin. Revegetation sites are generally designed to maximize native vegetative coverage, while also providing for physiognomic features that mimic native riparian conditions.

The riparian drainages of the Colorado River basin typically consist of wetland, riparian, and upland habitats that provide environmental conditions that host distinct native vegetation communities. The hydrologic and edaphic conditions of these habitats dictate what species can occur in them. Wetland habitats are characterized by saturated soils where standing water is present. Native plants suitable for planting in wetland areas along the Wash, include: spikerush (*Eleocharis macrostachya*), Torrey spikerush (*E. rostellata*), alkali bulrush (*Schoenoplectus maritimus*), Olney's three square (*S. americanus*), California bulrush (*S. californicus*), hardstem bulrush (*S. acutus*), common three square (*S. pungens*), Baltic rush (*Juncus balticus*), and Cooper rush (*J. cooperi*). Riparian areas lead from the water's edge up to the upland areas with the depth to water from 0-6 ft. Native plants suitable for planting in riparian areas include Fremont cottonwood, Goodding willow (*Salix gooddingii*), sandbar willow (*Salix exigua*), screwbean mesquite (*Prosopis pubescens*), honey mesquite (*Prosopis glandulosa* var. *torreyana*), arrowweed (*Pluchea sericea*), seepwillow (*Baccharis salicifolia*), salt grass, yerba mansa (*Anemopsis californica*), salt heliotrope (*Heliotropium curassavicum*), alkali sacaton *(Sporobolus airoides*), velvet ash (*Fraxinus velutina*), wolfberry (*Lycium* spp.), and quail bush (*Atriplex lentiformis*). Finally, where the depth to water drops off and no longer supports riparian vegetation, xeric upland plants begin to dominate. Xeric, upland plants include creosote, white bursage (*Ambrosia dumosa*), catclaw acacia (*Acacia greggii*), desert willow (*Chilopsis linearis*), broom baccharis (*Baccharis sarothroides*), fourwing saltbush (*Atriplex canescens*), shadscale (*A. confertifolia*), and desert saltbush (*A. polycarpa*).

For revegetation and enhancement projects, particularly in converted habitats and disturbed areas such as the Wash, the hydrologic and edaphic conditions may not mimic the conditions observed within a natural riparian drainage of the lower Colorado River basin. Therefore, it is important to understand the soil salinity and depth to water requirements for native vegetation in order to ensure the appropriate planting regime. Table 2 displays the soil salinity and depth to water requirements for typical native plant species in riparian drainages on the lower Colorado River. Table 3 lists the relative soil salinity tolerances of common native species used in revegetation projects in the lower Colorado River basin.

Plant	2' EC (mmhos/cm)	5' EC (mmhos/cm)	Depth to Water (ft)
Willow	0-3	0-3	0-6
Fremont cottonwood	0-3	0-3	0-10
Honey mesquite	0-8	0-8	3-12
Screwbean mesquite	0-9.4	0-9.4	3-12
Fourwing saltbush	0-12	0-12	3-15

Table 2: Depth to water (ft) and soil salinity (mmhos/cm) at 2 ft (2' EC) and 5 ft (5' EC) requirements for five native plants of the lower Colorado River. Note that these species grow best under a range of soil salinities and depths to water (Anderson and Ohmart 1982).

3.1.5 Project Implementation

3.1.5.1 Planting Methods and Materials

The timing of planting native vegetation at a site is important for having a successful revegetation project. At the Wash, October 1 - November 15 and March – May 15 have been determined as the best planting periods of the year. Vegetation planted during these periods is

Common Name	Salt Tolerance
Alkali sacaton	High
Arrowweed	High
Fourwing saltbush	High
Inland salt grass	High
Canyon Grape	Medium
Desert broom	Medium
Desert willow	Medium
Emory willow	Medium
Honey mesquite	Medium
Salt heliotrope	Medium
Screwbean mesquite	Medium
Wolfberry	Medium
Fremont cottonwood	Low
Goodding willow	Low
Sandbar willow	Low

Table 3: Salinity tolerance levels for typical native plants of the Colorado River Basin.

helped by above average precipitation that generally falls during the summer and winter months in Las Vegas. Also, vegetation planted during the cooler months of the year has time to establish and acclimatize to the new environment before the short winter days and hot summer months.

Planting should occur after the site has been cleared of non-native vegetation, the irrigation system has been installed, and the soil surface has been prepared for planting (see below). If a site has been sprayed with dust suppressant, the soil should be tilled with a soil ripper to benefit plant recruitment. Planting holes should be pre-dug using shovels, augers, or a Bobcat® skid-steer loader with an attached auger. The width and depth of the planting hole will depend on the planting method and species. Depressions should be created around shrubs and trees so that moisture is retained close to the plant.

Tree spacing and density at a site will differ based on the species being planted and revegetation goals to accomplish. Successful planting regimes have shown that larger trees, such as cottonwoods, should be planted 10-20 ft apart (depending on the type). Smaller trees, such as desert willows, should be planted 5-15 ft apart. Patches of shrubs, including sandbar willow, should be planted 5-10 ft apart. Planting success has been evident at revegetation sites that are densely planted with high species diversity. Although high-density plantings may be most successful in the short-term, long-term competition between species and individuals will likely reduce total plant survivability. This is to be expected, but by crafting revegetation strategies for high diversity and density, the most well adapted species will ultimately dominate. In order to increase planting success, tubex tree shelters (i.e., protective tubing) can be used to protect propagules, to slow competitor growth, and to increase water-use efficiency as needed. To control beaver and other mammal browsing, 4 ft-high, 12-gauge hogwire fences may be placed around plantings.

The planting method utilized for revegetation projects on the Wash will depend on access, availability of a native stock of plants on site, and type of vegetation being planted. Some of these methods include containerized plants, cuttings and plugs, and seeds.

Containerized Plants - Propagated containerized plants typically establish rapidly once planted because of their well established root systems and are typically available all year round, which increases the chance of success in a project. However, this method can be expensive, labor intensive and require excessive transport costs, which may be of concern for some restoration projects. Tree species are often planted in five-gallon containers while shrubs and other low vegetation are planted as one-gallon containers. Wetland plants or herbs that naturally grow with multiple stems or rhizomatous roots are grown in flats of various sizes. There are two local nurseries around the Las Vegas area that provide plants for revegetation projects, including the Nevada Division of Forestry nursery at Floyd Lamb State Park and the National Park Service nursery at Lake Mead National Recreation Area. If desirable species are not available from either nursery, local commercial native plant nurseries can be used.

Cuttings and Plugs - Live cuttings or plugs of native trees, shrubs, grasses, and forbs can be taken from local genetic stock on site if available and used for revegetation activities. Local stock can be either naturally growing native vegetation established on site from past revegetation projects, natural colonization, or from a nursery established on site with local seed. This method of planting is advantageous because it is relatively inexpensive, light and easy to transport, and, in the case of plugs, the root system is established with native, intact soil. However, some disadvantages include the specific timing required for harvesting native species and, in the case of cuttings, the root systems are not established. Also, cuttings require that they are planted in the groundwater table. To achieve the appropriate planting hole depth for cuttings, a hand auger or similar technique can be used to dig down in the soil until groundwater is reached. Planting holes should be at least 18 inches (in.) in diameter and 6–8 ft deep (or to the water table).

Live cottonwood and willow cuttings should be harvested and planted in accordance with the following guidelines. Cuttings should be taken from large, vigorous, local genetic stock and, if possible, removed during dormancy, prior to bud swelling. Visibly diseased or obviously old wood should not be used for cuttings, which should be at least 1/2 in. diameter and 2–6 ft tall, depending on specific needs of planting area. No more than 25% of each source plant should be removed. The terminal bud should be removed with a horizontal cut. The basal end—that is, the portion to be planted—should be cut at a 45° angle to ensure that cuttings are planted with the basal end down. Immediately after harvesting, cuttings should be stored in water—not in direct sunlight. It is important to prevent cuttings from drying out. Cuttings should be soaked no less than 24 hours (hrs) and no longer than 4 days prior to planting. The basal end of the cutting should be inserted into moist or saturated soil so that approximately 1/4 of the stem remains exposed. For cottonwood and willow, fencing may be placed around propagules to prevent beavers from browsing.

Seeding - Native seed can be used for establishing a native plant nursery on site or applied on a revegetation site before or after tree/shrub planting. A native plant nursery can be established and used to provide cuttings or plugs for revegetation projects on the site. Applying native seed across a revegetation site will help stabilize soils and create a native ground cover, which can help deter competition from invasive plants.

The method used for seed application on a site will depend on the materials and funding available and the size of the site. Larger sites are most efficiently seeded by mechanized broadcasting whereas smaller sites can be seeded by hand casting. Prior to application, seeds can be combined with amendments (i.e., fertilizer, mulch, and endomycorrhizae) and a tackifier to aid in germination and growth. When hydroseeding methods are used, hydro mulch is a beneficial amendment to add to seed because it makes sure seed is distributed evenly, retains moisture longer thus enhancing seed survival rates, and helps control erosion. Hydro mulch should be applied at a rate of 1500-2500 pounds/acre (lbs/ac.) depending on the steepness of the slope. A tackifier (i.e., guar or corn starch) can be mixed with a hydroseed mixture as a bonding agent that will help prevent erosion, control dust, enhance germination, and prevent seed from washing out during irrigation or rainy weather conditions. Tackifier should be applied at a rate of 50-100 lbs/ac. depending on the steepness of the slope and soil type.

The edaphic and hydrologic conditions of a site will dictate the appropriate species to use for seeding the site. Seeds applied to a site can consist of a single species or a mix of native plant species depending on the availability of seed and the goals of the project. Typically seeds are broadcasted at four lbs/ac. After seeding is complete, an implementer can be used to roll seed down into the topsoil (approximately 0.5 in.). Seed mixes are available from Granite Seed, Utah, Comstock Seed, California, and S&S Seed, California. Recommended seed mixes for both low salinity dry areas (Table 4) and medium to high salinity mesic areas (Table 5) are listed below.

Common Name	Scientific Name	Seed (% per pound)
Brittlebush	*Encelia farinosa*	40
Creosote	*Larrea tridentata*	40
Salt heliotrope	*Heliotropium curassavicum*	5
Globe mallow	*Sphaeralcea ambigua*	10
Desert marigold	*Baileya multiradiata*	5

Table 4: Recommended seed mixes for low salinity dry areas. Four pounds of seed mix per acre is recommended. The percentages shown are the percent of that seed per pound in the mix.

Common Name	Scientific Name	Seed (% per pound)
Alkali sacaton	*Sporobolus airoides*	50
Wolfberry	*Lycium andersonii*	30
Salt heliotrope	*Heliotropium curassavicum*	10
Iodine bush	*Allenrolfea occidentalis*	10

Table 5: Recommended seed mix for medium to high salinity mesic areas. Four pounds of seed mix per acre is recommended. The percentages shown are the percent of that seed per pound in the mix.

3.1.5.2 Invasive Species Management

The federal government defines an "invasive species" as: (1) non-native (or alien) to the ecosystem under consideration, and (2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health. Once vegetation has been provided general survival requirements (i.e., water, sunlight, air, minerals, and space), competition with other plants for these resources may be the only impediment towards achieving a successful planting site. Typically, invasive species out compete native species for resources or are more tolerant to diminishing resources and therefore displace native species to marginal habitats. This often results in the decline of native taxa.

At revegetation sites along the Wash, invasive species can be controlled by a variety of methods. These activities allow the optimal conditions for native plants to succeed. The invasive species removal technique should be selected based on the soil and water conditions and extent of the weed infestation. Clearing techniques should also consider the presence of native vegetation, impacts to resources and the public. A summary of techniques that could be used to control invasive species pre- and post- revegetation within the Wash are as follows.

Manual Removal - This method is most effective in areas where invasive species infestation is minimal or invasive species are re-sprouting in areas that were previously cleared by other methods. Hand tools (i.e., picks, pulaskis, and shovels) can be used to loosen the soil surrounding the plants and remove the entire root system or below the root crown. Also, simple hand-pulling, without the use of tools, can be used to remove re-sprouting plants.

Chemical Removal - Chemical application techniques have proven to be very effective in controlling many invasive species. Foliage application with herbicides such as: Rodeo® (glyphosate; Dow AgroSciences, Indianapolis, IN), Escort® (metsulfuron methyl; DuPont, Wilmington, DE), and Habitat® (imazapyr; BASF, Research Triangle Park, NC) is effective for controlling and reducing infestations of invasive herbs such as tall whitetop. For this control method, the herbicide should be applied as needed to continually reduce the infestation.

In order to control invasive trees, such as salt cedar, Garlon® 4 (triclopyr; Dow AgroSciences, Indianapolis, IN) herbicide is most affective when applied basally to the cut stumps. This method involves cutting the tree to ground level with a chain saw, and then immediately spraying the remaining stump with the herbicide. The tree's phloem absorbs the mixture and transports it to the roots, therefore immediate application to the cut stump increases its effectiveness. The material can than be moved to a stockpile location to await permanent disposal (i.e., by controlled burn, turned to mulch, or moved to a landfill).

Mechanical Removal - For extensive infestations (particularly of tamarisk), mechanical clearing can be an effective control technique. Mechanical clearing is achieved by removing the plants root crown from the soil using a root plow or bulldozer. Cleared vegetation can be piled into windrows on site, burned, or turned to mulch. This method can be followed up by herbicide applications if required. If native vegetation exists on the site, selective cutting can be employed with an articulating arm mounted to a backhoe to preserve the natives while removing the invasive vegetation.

3.1.5.3 Irrigation

Supplemental irrigation is important for plant establishment since precipitation near the Wash is generally less than five in. a year. Wetland plants, however, do not require supplemental irrigation as long as they are in saturated or standing water conditions. Therefore, irrigation strategies will primarily concentrate on riparian and upland plants. Riparian plants quickly develop extensive root systems that exploit groundwater sources, which allows them to depend less on supplemental irrigation. Upland plants, however, often require extensive irrigation to become successful.

Many irrigation systems can be utilized to irrigate a site, selecting an appropriate one will depend on desired water conservation strategies, re-usability, water allocation, water quantity necessary to irrigate the site, and the funding available. The irrigation system should be constructed and set in place prior to planting in order to minimize disturbance to the plants. If soil salinities are high, irrigation can be utilized in order to leach salts prior to planting. Irrigation should continue throughout the year on a regular basis until roots reach the water table (1-3 years).

The water that will be used for revegetation irrigation will come directly from the Wash. Therefore, a gasoline or diesel generated pump is required to deliver water from the Wash to the irrigation pipe infrastructure. These pumps may be either manually engaged by hand or automatically engaged by using a system that has a propane generator to start the pump and open the irrigation valves. Regardless of the method preferred for starting the irrigation system, a minimum of one person will be required to maintain the system by checking fuel levels and filters every time the irrigation system is used. There are multiple irrigation systems that can be utilized to irrigate a revegetation site. Below are descriptions of some that are possible to use.

Hand Watering and DRiWATER® Cartons - DRiWATER® (DRiWATER Inc., Santa Rosa, CA) cartons can be initially planted adjacent to the root ball of riparian and upland plants to supply a temporary source of water. DRiWATER® provides a source of water directly to the roots during the critical establishment period. DRiWATER® is composed of 98% purified water and 2% food grade ingredients. Typically, DRiWATER® can provide adequate moisture to the root system of a developing plant for up to three months. It has, however, shown limited effectiveness at planting areas along the Wash (S. Shanahan, pers. obs.). In order for this technique to be effective, replacement DRiWATER® must be provided to the plant several times throughout the year. This has shown to be too costly for projects along the Wash. In addition to DRiWATER®, riparian and upland plants can be manually watered throughout the growing season. Manual watering consists of hand watering plant depressions with a hose. Hand watering is an intensive irrigation strategy that should be limited to the hottest, driest part of the year. This method delivers large quantities of water directly to the plant. It is highly recommended that this irrigation method be used in combination with another irrigation system, such as the ones described below, to insure irrigation for the long term.

Impact Sprinklers - This sprinkler system can deliver large quantities of water across a revegetation site, providing irrigation to the entire site in order to benefit plant recruitment. This system has a subsurface pipe infrastructure that consists of a buried grid of PVC pipe along which a series of 1-3 ft high stub-ups are placed. Stub-ups are fitted with quick-connect pipe connectors that fasten to impact sprinkler heads. Quick-connect fittings allow easy removal of impact sprinkler heads, which helps reduce potential acts of vandalism or theft. Stub-ups are properly spaced so that water delivered through the impact sprinklers can cover the entire site. Pipe diameter and impact sprinkler head sizing is determined based upon site conditions. This system can be easily transported between site, which maximizes irrigation efficiencies and minimizes capital investment.

Drip Irrigation - Drip irrigation works by applying water slowly and directly to the soil around a plant. Drip irrigation consists of 2 in. PVC mainline pipe that delivers water to valves connecting to drip tubing (3/4 in. polyline) fitted with a series of emitters. The total length of the mainline and the sub-main together should not be more than 400 ft. This system can be subsurface, particularly the main and sub-main lines. A minimum of two emitters should be fitted for each plant placed at a minimum of 18 in. apart. Water should be supplied at a rate of 8-15 gallons per hour (gal/hr) for 1.5-2.0 hrs a day to each planting hole. Since this system provides irrigation to individual plants, water loss due to evaporation and runoff is reduced. The irrigation tubing can be cleaned and reused at another site if maintained properly. This system is relatively easy to install, easy to design, and can be inexpensive. Drip irrigation has been used at several revegetation sites along the Wash with good success (S. Shanahan, pers. obs.). With the use of solar panels, electric pumps, and irrigation clocks, these systems can be fully automated.

Flood Irrigation - The flood irrigation method pumps water to a levee or pipe on site that releases the water and relies on the gravity transport to flood a lower-lying revegetation area. The revegetation area should be surrounded by windrows or berms to help contain the water to the site. This type of irrigation should be applied at regular intervals, which reduces excess runoff. This method is the least expensive, requires minimal maintenance and easy to install, however water loss due to evaporation and runoff is high and it requires an adequate water supply. Inevitably the excess water used by this method would return to the Wash.

3.1.6 Project Maintenance

Although the objective of a revegetation project is to create functioning wetland, riparian, and upland areas that are self-sustaining in the long-term, it is possible for environmental (e.g. flood events) and/or anthropogenic (e.g. vegetation destruction by off highway vehicle users) disturbances to reduce the success of planted vegetation. Further, although every effort is made to pair plants with locations that appear to provide edaphic and hydrologic conditions favorable for their survival, it is possible that other, more obscured site conditions do not permit plant success. For this reason additional vegetation may need to be planted during future periods.

Invasive plant re-colonization is likely to occur on revegetation sites before native vegetation establishes and creates a mature canopy. Therefore, periodic weeding using hand pulling methods or small mechanical tools will be necessary until native plants are established. Also, there are other factors that may contribute to plant mortality, including root shock, herbivore activity, maintenance negligence, and competition, therefore replanting may be necessary to ensure sufficient native plant cover at a site. Finally, irrigation systems should be checked periodically to ensure that they are working properly and that planted vegetation is receiving sufficient water. Project maintenance should occur for at least 2-3 years after planting is completed to ensure success of the revegetation project.

Typically mitigation permits along the Wash require 80% survival of native species planted with less than 20% encroachment of invasive species within a 2-5 year monitoring period to ensure the objective of developing long-term, self-sustaining wetlands that are not dependent on further human intervention after the establishment period is reached. Thorough site maintenance and monitoring will determine if this objective will be obtained or if further mitigation activities should be developed and implemented.

3.1.7 Project Monitoring

In order to determine the effectiveness of the revegetation activities, a variety of general vegetation parameters should be measured. Monitoring parameters that may be evaluated for a revegetation site may include plant growth, percent cover, plant condition, survival rates, and percent estimate of non-native weed encroachment. Monitoring should occur at a minimum during the first two growing seasons (August-October) after planting is complete. Long-term monitoring of a site can be conducted once vegetation establishes and matures (> 2 years) at an interval of every 2-5 years to ensure long-term revegetation success.

Monitoring data should be collected for wildlife populations on a revegetation site in order to evaluate the success of the revegetation effort as usable habitat. Baseline data should be collected prior to non-native vegetation clearing, and monitoring of the site post planting should continue for two years. The wildlife monitoring protocols developed by the LVWCC should be used to monitor these populations in the Wash.

There are multiple sampling regimes that can be applied to measure the vegetation parameters discussed above, however establishing randomly selected transects is the most common technique for monitoring revegetation projects in the first two years. Transects should be randomly selected and replicated to cover all of the vegetation species planted and environmental conditions (salinity and depth to water) present. The number of transects and transect length will be determined on a case by case basis depending on several factors, including patch size, restoration technique, species, and environmental variation within each stand. Within each sample transect, each tree and shrub species will be measured and recorded. Some measurements that would provide useful information to the success of a revegetation project are listed below.

3.1.7.1 Plant Growth

Measuring plant growth over time is important to determine if the planted vegetation has established and is thriving. The height of all trees and shrubs within a transect should be measured. Vegetation less than 12 ft tall should be measured with a measuring rod to the tallest, outstretched leaf. Vegetation over 12 ft tall should be measured using a clinometer. Grass and herbaceous plant growth should be monitored using repeat photography and cover estimates (see below).

3.1.7.2 Plant Survivorship and Condition

Revegetation sites are often deemed a success by the number of plants that survive after planting is complete and a period of time has passed since intensive management. This is a general indicator that plants will continue to survive in the environment after revegetation activities have been completed. In order to calculate percent survivability in the subset of the population sampled, the total number of viable plants in all transects is divided by the total number of plants surveyed and then multiplied by 100. Survivability should be calculated for each different plant species because different factors affect different species. This survivability measure can be compared from growing season to growing season and ultimately expressed as a rate of survival. Along with identifying survivorship in plants, it is also important to evaluate the condition of the surviving plants. In order to accomplish this, the condition of the plants in the designated transects are ranked and recorded based on the appropriate condition category:

0—dead plants
1—poor condition
2—fair condition
3—good condition
4—excellent condition

Along with ranking the condition of the planted vegetation, it is valuable to identify the factors that are affecting their condition. Some factors that may affect a plant's condition include:

- Browsing by beaver and small mammals = MB
- Insect browsing = IB
- Insect presence= IP
- Pruned = P
- Volunteer competition = VC
- Herbicide affects = H
- Water stress = WS
- Dead = DE
- Hogwire rub = HWR
- Dormant = DO
- Unknown = U
- Not applicable or no factors affecting = N/A
- Other (Describe)

3.1.7.3 Percent Cover
Percent cover is an important characteristic to monitor in a stand of vegetation because it can serve as a criterion for relative dominance within the community. Cover is expressed as a percentage value and in a multi-layered community it can often exceed 100%. In a multi-layered community, it may be important to separate cover estimates into different stratums. Cover estimates can also estimate non-native species encroachment. Depending on the site conditions, planting regime, and density, several methods could be used to determine percent cover for revegetation sites, including line-intercept, point-intercept, and ocular estimation.

Line-intercept - This method comprises of stretching a tape between two stakes, and the canopy of each species that vertically projects over the tape is measured along its length. The percent cover is calculated by the total length of tape that is intercepted by the vertical projections of a species by the total length of tape. Line-intercepts should be of sufficient length to reflect the vegetation community and allow for an accurate estimate of percent cover by species. This technique is most effective for vegetation with dense canopies, such as shrubs or matted vegetation. It is not ideal for measuring cover of grasses or some herbs.

Point-intercept - This method measures cover by counting the number of times a point "hits" a plant species and dividing the number of "hits" by the total number of points measured. Although this method is most applicable for low grasses and other herbaceous material, it is the least biased and most objective of the three basic cover methods (Bonham 1989). A disadvantage of this method is that it is intensive, species with low cover values are often misrepresented, and small changes in plant cover are hard to detect, especially at low cover values (BLM 1998).

Ocular estimation - This method visually estimates cover in a selected area by using previously defined cover classes. One large plot (15 ft x 15 ft) could be located along a transect or several 10 ft^2 plots can be systematically placed every 5-15 ft along a transect for visual cover estimates. The Daubenmire (1959) or Braun-Blanquet (1965) cover class systems are the most commonly used to estimate cover. Cover data using this method is obtained relatively fast and easy. The largest concern with this method of estimating cover is with observer bias, however this may be resolved by having multiple observers estimating cover and averaging values.

3.1.7.4 Repeat Photography

Repeat photography reveals the growth success of grasses and herbs as well as the growth of the entire site over time. Permanent photo points for each transect and for the entire site should be established at a vantage point with a view of the entire transect or site to document the growth of the entire site over time. Photo points should be marked with a permanent re-locatable object, such as an iron rod painted with fluorescent paint. This object should be labeled with an identification number and site description, and GPS coordinates taken of the location. In order to relocate the photo point, a photograph of the photo point should also be taken. Repetitive site photos should be taken at the same orientation, therefore it is important to capture a distinguishing background feature that can be used to orientate every photo.

4.0 PILOT SITE

The 60-ac. pilot site represents the first major phase of implementing this concept plan. This section outlines the scope of work for this project, describing revegetation methods for the site. Revegetation activities at the pilot site have been initiated. Compliance, site analysis, revegetation design, site clearing, irrigation and seeding have been accomplished whereas future activities including planting native containerized plants, site maintenance, and monitoring activities are being conducted or are approaching.

4.1 Project Tasks

The revegetation activities at the 60-ac. pilot site have been initiated and are close to completion. Several major steps were required to accomplish the revegetation goals at the pilot site, including, but not necessarily in this specific order:

- Selecting the site for the revegetation pilot project based on priority ranking criteria.
- Obtaining permits and compliance for revegetation activities.
- Conducting a preliminary analysis to assess spatiotemporal abiotic conditions (i.e., soil salinity, soil texture, depth to water table, and depth to capillary fringe).
- Preparing revegetation design based on results from preliminary analysis.
- Clearing undesirable vegetation (i.e., tamarisk) from the site.
- Implementing an irrigation strategy.
- Preparing the propagules for planting.
- Planting native species - this may include containerized plantings, pole cuttings, seeding, or a combination thereof.

- Monitoring the site for success.
- Implement additional strategies if required.

Several of the aforementioned tasks may need to go in a stepwise series; however, it is often the case that tasks can be done out of order and in parallel with other tasks. Figure 2 shows a detailed timeline of the tasks that were necessary to accomplish revegetation at the 60-ac. pilot site with planting occurring in the spring 2006. The revegetation planning activities were coordinated to accomplish planting in the spring, since spring and fall have shown to be the best periods to plant vegetation at the Wash.

4.1.1 Prioritizing Sites

The 60-ac. pilot site was selected for the initial revegetation effort by a ranking system that prioritized sites based on multiple variables, including site condition (i.e., hydrology, soils, and size), ease of access, efficiency and duration of irrigation, feasibility of removing invasive vegetation, and total cost. The pilot site was ranked as the third highest priority because it encompasses a large area with amenable soils, it has access roads leading directly to the site, the large stands of tamarisk could be feasibly and effectively cleared, it requires a shorter duration of irrigation, and is cost effective. Although the site was ranked as the third priority, the access permits were obtained prior to those for the top ranked sites thereby granting permission to initiate revegetation efforts on the site.

4.1.2 Environmental Compliance Planning

Environmental compliance and permitting was accomplished in 62 days during July through September 2005 for the pilot revegetation project at the Wash. NEPA compliance had been previously completed for the entire Wash, as had requirements under Section 7 of the ESA. The following are the agencies and the permits acquired to conduct the revegetation:

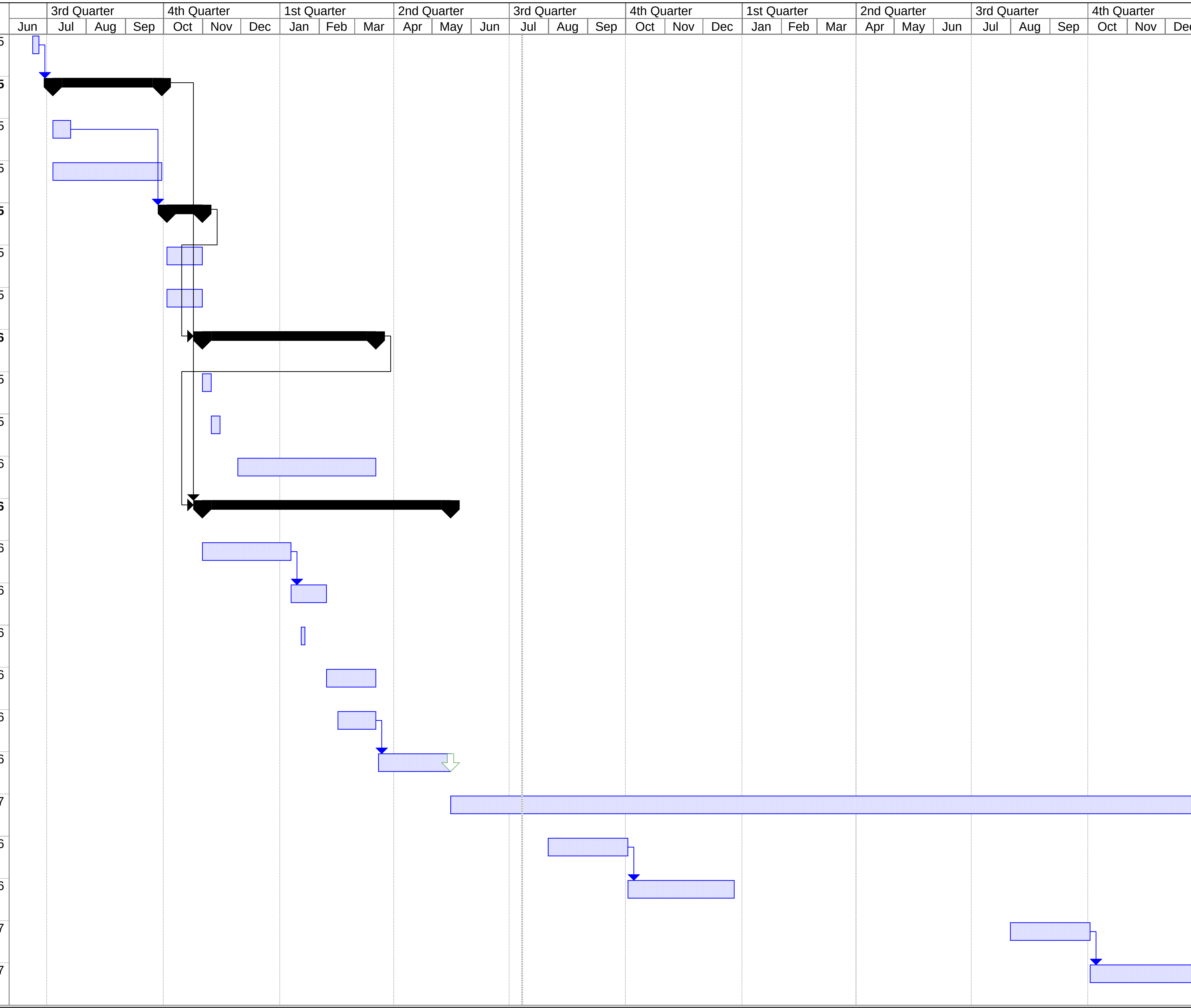
- Section 404 of the CWA administered by the Corps.
- Section 106 of the NHPA of 1966 administered by the Nevada SHPO.
- 401 Water Quality Certification administered by NDEP.
- Notice to proceed on any ground disturbing activities granted by the BOR, one of the land managers.
- Permission to access the land owned by CCPR and a dust permit granted by CCDAQEM.

4.1.3 Site Assessment

The site assessment is conducted to determine the physical attributes of a site in order to create a successful revegetation strategy. Depth to water, salinity, and soil texture measurements across a site help provide a model of environmental conditions that aid in determining what plant species are suitable for a site. With this information a detailed planting design can be created that delineates species to be planted, plant spacing, and a detailed irrigation design.

Intensive soil sampling was conducted using a post hole digger to collect soil at a depth of 18 in. below ground surface for salinity and texture analyses. A total of 60 sampling points were collected on a 230 ft grid across the entire site. Soil samples were sent to USUAL for salinity analysis by saturated paste and soil texture by a hydrometer. In order to get depth to water on the site, five permanent wells were drilled across the entire site and eight existing wells were

ID	Task Name	Duration	Start	Finish
1	Prioritizing Sites	5 days	Mon 6/20/05	Fri 6/24/05
2	**Environmental Compliance**	**62 days**	**Wed 7/6/05**	**Thu 9/29/05**
3	Landowner Authorization	10 days	Wed 7/6/05	Tue 7/19/05
4	Other Compliance	62 days	Wed 7/6/05	Thu 9/29/05
5	**Site Assessment**	**20 days**	**Tue 10/4/05**	**Mon 10/31/05**
6	Determine Soil Salinity	20 days	Tue 10/4/05	Mon 10/31/05
7	Determine Depth to Water	20 days	Tue 10/4/05	Mon 10/31/05
8	**Revegetation Design**	**99 days**	**Tue 11/1/05**	**Fri 3/17/06**
9	Grading Plan	5 days	Tue 11/1/05	Mon 11/7/05
10	Plant Selection	5 days	Tue 11/8/05	Mon 11/14/05
11	Planting Design	79 days	Tue 11/29/05	Fri 3/17/06
12	**Project Implementation**	**140 days**	**Tue 11/1/05**	**Mon 5/15/06**
13	Invasive Species Removal	50 days	Tue 11/1/05	Mon 1/9/06
14	Site Grading	20 days	Tue 1/10/06	Mon 2/6/06
15	Install GW Wells	3 days	Wed 1/18/06	Fri 1/20/06
16	Irrigation	29 days	Tue 2/7/06	Fri 3/17/06
17	Preparation to Plant Site	22 days	Thu 2/16/06	Fri 3/17/06
18	Plant Site	41 days	Mon 3/20/06	Mon 5/15/06
19	Project Maintenance	422 days	Tue 5/16/06	Wed 12/26/07
20	Monitoring (Year 1)	45 days	Tue 8/1/06	Mon 10/2/06
21	Reporting (Year 1)	60 days	Tue 10/3/06	Mon 12/25/06
22	Monitoring (Year 2)	45 days	Wed 8/1/07	Tue 10/2/07
23	Reporting (Year 2)	60 days	Wed 10/3/07	Tue 12/25/07



Task		Progress		Summary		External Tasks		Deadline	
Split		Milestone		Project Summary		External Milestone			

Figure 2: Pilot project timeline.

measured. Wells were drilled to a depth between 10-25 ft, until groundwater was reached. A GeoExplorer GPS unit was used to identify grid locations for both soil sampling points and wells. Soil salinity and depth to water data was mapped using Surfer 8® software (Golden Software Inc.) and put into a GIS format. Appendix D displays the depth to water levels and Appendix E displays the map of the site's soil salinity.

4.1.4 Revegetation Design

The revegetation design was created with the information collected during the site assessment and incorporated the aesthetic and recreational needs of the area. Since the pilot project has dual goals of creating habitat for wildlife species and providing an area to recreate, the revegetation design accommodates these goals by having an inviting mesquite bosque lining access routes while maintaining productive native habitat in the core. The core native habitat was created based on the hydrologic and edaphic conditions required by the different plant species. The revegetation design was created using ArcGIS 9.1 and AutoCAD 2004.

The depth to water data showed that the water table was between 5 and 13 ft deep and salinity was broken down into four polygons including low (0-3 mmhos/cm), moderate (4-8 mmhos/cm), medium (8-25 mmhos/cm) and high (>25 mmhos/cm). These data indicate that the site was suitable for native drought and salt tolerant vegetation and some riparian species. Salinity was highest along the southern edge of the pilot project area and lowest in the northwest corner. The high salinities at the site are caused by a shallow, saline groundwater table formed from irrigation runoff. Based on the hydrologic and edaphic conditions determined at the site, eleven plant matrices were created with different combinations of plants for the core habitat. Another five matrices (Matrices 12-16) were created using available plant material for the initial planting conducted as the Green-Up volunteer planting day. Finally, four planting schemes were developed to accommodate the aesthetic properties of the access trails and roads including trail entrance, trail planting, scenic drive, and dry wash plantings. These planting matrices and schemes are listed below and displayed in the revegetation design in Appendix B.

4.1.4.1 Matrices

Matrix 1 (Honey Mesquite) - Dense stands of honey mesquite provide valuable habitat and food resources for multiple wildlife species including invertebrates, birds, and small mammals. Honey mesquite tolerates relatively deep depth to water and moderate soil salinities. Therefore a large area of a monotypic stand of honey mesquite will be planted in low to moderate salinity areas. Five-gallon containers of honey mesquite will be planted 12-15 ft on center (O.C.) at densities of 300 trees/ac. Trees will be randomly grouped in areas to mimic the natural mesquite bosque ecosystem. This matrix will cover a total of 7.81 ac.

Matrix 2 (Desert Willow and Catclaw Acacia) - Desert willow and catclaw acacia have low soil salinity tolerance and thrive in desert washes. Therefore they will be planted within the low salinity polygon along the dry wash. Five-gallon containers of catclaw acacia and desert willow will be planted in alternating clumps for a total of two clumps of each. Each clump will be comprised of 60 individuals planted 12-15 ft O.C. at densities of 240 trees/ac. This matrix will cover a total of 0.81 ac.

Matrix 3 (Screwbean Mesquite) - Screwbean mesquites often occurs along riparian corridors and they typically require shallower depth to water and more moderate salinities than honey mesquites. Therefore monotypic stands of screwbean mesquite will be planted in the moderate salinity polygons and along the dry wash. Five-gallon containers of screwbean mesquite will be planted 10-15 ft O.C. with random grouping at a density of 328 trees/ac. A total of 4.65 ac. will be planted with this matrix.

Matrix 4 (Fourwing Saltbush, Broom Baccharis, and Desert Mallow) - Fourwing saltbush, broom baccharis, and desert mallow are common native plants found in the upland areas of the Wash. They have a high to medium tolerance for soil salinity, and therefore will be planted in areas that present these edaphic conditions. One-gallon containers of each of the plants will be randomly grouped together and planted 12 ft O.C. Planting density will be 302 plants/ac. with 100 fourwing saltbush, 154 broom baccharis, and 48 desert mallow. The matrix will be planted in 4.5 ac.

Matrix 5 (Fourwing Saltbush, Emory Baccharis, and Seep Willow) **-** Emory baccharis and seep willow require a shallow depth to water whereas fourwing saltbush tolerates a range of depths to water. Therefore this selection of plants will be planted in lower areas with a more shallow depth to water. There will be a total of four ac. with a density of 297 plants/ac. Fourwing saltbush, Emory baccharis, and seep willow will be planted in random groupings 12 ft O.C. at densities of 239 plants/ac., 29 plants/ac., and 29 plants/ac. respectively.

Matrix 6 (Honey and Screwbean Mesquite) **-** This matrix mimics the natural transition from a honey mesquite bosque ecosystem into a screwbean mesquite bosque ecosystem. Five-gallon containers of honey and screwbean mesquite will be planted 10-15 ft O.C. in random single species groups. There will be 167 individuals of each species per ac. for a combined density of 334 trees/ac. This matrix will be planted in 9.81 ac. throughout the site.

Matrix 7 (Fourwing Saltbush, Arrowweed, and Alkali Sacaton) **-** Fourwing saltbush, arrowweed, and alkali sacaton have high soil salinity tolerances, therefore will be planted in the area determined as having the highest soil salinity. One-gallon containers of each species will be planted in random groups 10-15 ft O.C. Per ac. there will be 130 fourwing saltbush individuals, 63 arrowweed individuals, and 98 alkali sacaton individuals for a total density of 291 plants/ac. This matrix will be planted within 6.58 ac.

Matrix 8 (Emory Baccharis, Seep willow, and Alkali Sacaton) **-** Emory baccharis and seep willow are moderately tolerant to soil salinity and require relatively shallow depth to water as compared to the other species mentioned. Alkali sacaton is commonly found in higher salinity riparian areas. Matrix 8 will be planted in areas with moderate to medium salinity levels and shallow depth to water levels in a total of 7.68 ac. One-gallon containers of each species will be planted in random groups 10-15 ft O.C. In each ac. there will be 140 individuals of Emory baccharis, 140 individuals of seep willow, and 48 individuals of alkali sacaton for a total density of 328 plants/ac.

Matrix 9 (Fourwing Saltbush, Emory Baccharis, and Broom Baccharis) **-** This matrix will be planted in two ac. within the site, with one ac. that was planted during the Green-Up volunteer planting. One-gallon containers of each species will be planted in random groups 10-15 ft O.C. For each ac. there will be 210 fourwing saltbush, 57 Emory baccharis, and 55 broom baccharis for a total of 322 plants/ac.

Matrix 10 (Fourwing Saltbush, Emory Baccharis, Seep Willow, Arrowweed, and Alkali Sacaton) This matrix will be planted on four ac. in areas with a relatively shallow depth to water and medium to high salinities. There will be a total of 328 plants /ac. with 74 fourwing saltbush, 61 Emory baccharis, 82 seep willow, 63 arrowweed, and 48 alkali sacaton.

Matrix 11 (Screwbean Mesquite, Emory Baccharis, and Seep Willow) **-** The monoculture of screwbean mesquite in Matrix 3 will transition into this matrix which contains a mix of plants with a relatively low salinity tolerance. Therefore, this matrix will be planted in two ac. with relatively low salinities. There will be a total of 328 plants/ac. including 252 screwbean mesquites, 38 Emory baccharis, and 38 seep willows.

Matrix 12 (Honey Mesquite) - A monoculture of honey mesquite will be planted in a total of three ac. in areas with a deeper depth to water and relatively low salinity. Each ac. will be planted with different densities of honey mesquite. The first ac. will be planted with a total of 240 honey mesquite trees, including 200 planted in five-gallon containers and 40 planted in 15-gallon containers. The second ac. will be planted with a total of 150 trees in 15-gallon containers. The third ac. will be planted with 250 trees in 15-gallon containers.

Matrix 13 (Brittle bush) - Brittle bush is a common upland shrub found along the Wash. This matrix will be planted in a total of one ac. with a total of 300 brittle bush plants in short pot containers.

Matrix 14 (Screwbean and Honey Mesquite) - One ac. of screwbean and honey mesquite were planted during the volunteer planting day. Both 5 and 15-gallon screwbean mesquite containers were planted with 50 and 47 individuals respectively. A total of 82 individual honey mesquite trees in 15-gallon containers were planted in this matrix as well.

Matrix 15 (Arrowweed) - A one ac. area with a relatively deep depth to water and low salinity will be planted with a monoculture of arrowweed at a density of 300/ac.

Matrix 16 (Fremont Cottonwood, Seep Willow, Goodding Willow, and Honey Mesquite) - The area that will be planted with this matrix lies outside the pilot site boundary in the riparian zone next to the Wash. This area has more riparian edaphic and hydrologic conditions than the rest of the Pilot Site, and therefore will be planted with more riparian species. This area encompasses 0.43 ac. and will be planted with 116 Fremont cottonwoods in five-gallon containers, 31 seep willows in one-gallon containers, 50 Goodding willows in five-gallon containers, and 78 honey mesquites in 15-gallon containers.

4.1.4.2 Planting Schemes

Trail Entrance - In order to create an aesthetically pleasing trail corridor, the first 300 linear feet (L.F.) of each of the trail entrances will provide a dense and tall native mesquite gateway. Five- or 15-gallon containers of screwbean mesquite and honey mesquite will be densely planted at 15 ft O.C. and offset 7.5-8 ft from the edge of the trail. Trees will be offset at variable distances from the trail in order to mimic a more natural setting. Based on the quantity of trees available for planting, 12 screwbean and 28 honey mesquites will be planted at each entrance for a total of 40 trees. The total trees allocated for the trail entrance schemes will be 47 screwbean and 112 honey mesquites for a total of 159 trees.

Trail Planting - After the first 300 L.F. of trail entrance, in order to maintain the aesthetic value of the trail, honey mesquite in five or 15-gallon containers will be planted 17 ft O.C. along the entire trail system. Trees will be planted 8 ft off the trail. A total of 336 honey mesquite trees will be allocated for the trail planting scheme.

Scenic Drive - A dense honey mesquite corridor along the scenic drive will also provide native upland vegetation cover and aesthetic scenery for people to enjoy. Honey mesquites in five or 15-gallon containers will be planted 30 ft O.C. and will be set back 10 ft from the edge of the scenic drive and main roads. Approximately 125 honey mesquite trees will be planted along the scenic drive and main roads. Additionally, approximately 25 trees will be planted along the southwestern main road and 25 trees will be planted along the southeastern main road.

Dry Wash - Aerial photographs identify the presence of a dry wash traversing the 60-ac. pilot project site. While this wash still functions somewhat naturally with water flow occurring during wet periods, the revegetation design mimics the natural vegetation that thrives in wash environments by planting desert willow. Part of this dry wash will be developed as a part of the scenic drive, but a total of 2,235 L.F. will remain a wash. Five-gallon containers of desert willow will be planted at varying distances of 5-20 ft O.C. on both sides of the dry wash slope and above the slope. Desert willow will be planted in groups and as individuals with a planting density of 60 trees per 200 L.F., for a total of 684 individuals.

4.1.5 Project Implementation

4.1.5.1 Planting Methods and Materials

Native plant revegetation typically occurs in two distinct stages. The first stage includes spreading a mixture of native grass and shrub seeds with water (i.e., hydroseeding) onto the entire site. This stage has been completed. Two seed mixes were created, one for low salinity areas (< 8 mmhos/cm) and the second for higher salinity areas (> 8 mmhos/cm). The second stage consists of planting containerized plants according to the planting regime outlined in the revegetation design. Initial containerized planting activities began in March 2006 and will continue until the end of 2006. Irrigation construction has been completed on the 60-ac. revegetation site prior to container planting activities. In order to moisten the soil, the site is usually irrigated for two days prior to planting activities. Below are the planting criteria utilized for the two stages of planting.

Seeding **-** After the pilot site was cleared of non-native vegetation, the seed mixture was applied to the entire site in late winter (February). Seed mixes were hydroseeded with a broadcast sprayer onto dry soil. All seed mixes were combined with 80 lbs/ac. of fertilizer, 50 lbs/ac. of Hydro Mulch 1000 (Conwed Fibers), 10 lbs/ac. of endomycorrhizae, and 100 lbs/ac. of Guar Tackifier (Northstar Impex Corp.). The fertilizer contains a mix of 27% ammonium sulfate, 28%

potassium chloride, 36% ammonium phosphate, and 9% urea. The 30-ac. area with salinity levels between 0-8 mmhos/cm (low and moderate) were covered with 3 lbs/ac. of alkali sacaton. The 30-ac. area with salinity levels >8 mmhos/cm (medium and high) were covered with a seed mix of alkali sacaton and fourwing saltbush at quantities of 4 lbs/ac.

Containerized Plants - Augured planting holes will be dug to a depth of 3 ft (or to the water table) with a 12-18 in. diameter soil auger attached to a bobcat. The native soil from the augured holes will be utilized to secure the plantings and no amendments will be added. A water well ring will be formed on the surface soil around all tree plantings to enhance water retention. If exotic weeds are present in the native tree containers they will be removed prior to planting. When the plants are removed from the container, the root ball will be pulled apart and loosened prior to planting.

Immediately after planting, all plantings will receive a deep watering. Because spray irrigation will be used, irrigation will be activated for 4 hrs, commencing at sunrise (from 6 am and ending at 10 am) to prevent leaf burn from water on leaves/branches. During October through April irrigation will occur on a bi-weekly basis and during May through September irrigation will occur on a weekly basis. Any herbicide application will be avoided in the revegetation site after the trees/shrubs are planted.

4.1.5.2 Invasive Species Management

A dense monoculture of non-native tamarisk plagued the 60-ac. pilot site prior to revegetation implementation. In order to clear the site of tamarisk, mechanical removal was employed using heavy machinery to dig up root crowns and masticate plant material. The masticated material was partially burned on site and later removed by dumpster to the landfill.

4.1.5.3 Irrigation

The site will be irrigated with a system typically used in large-scale agriculture that can be re-used and moved to other revegetation locations at the end of the project. The water for irrigation will be pumped out of the Wash using a John Deere® motor with a 6-cylinder Cornell Pump (172 HP at 1886 RPM) mounted on an axle tank trailer with a 10 in. diameter suction and 8 in. diameter discharge. The pump pad and ramp will be located five ft above the Wash, which will be a sufficient distance for the suction hose. Ten in. diameter mainline CERTA-LOK piping will transport the water from the pump to multiple three in. diameter above ground CERTA-LOK lateral lines spaced approximately 45 ft apart. The lateral lines will run west to east from the north to south axis of the mainline. The lateral lines will transport the water to Nelson R2000 WF Rotator heads with a three in. take off assembly on a 30 x 40 ft grid. The rotator heads will be connected to flexible hose heads and movable posts to reposition the heads as needed during plant growth. The spray radius of each head is 25 ft, therefore spraying overlaps to ensure that the entire site receives complete coverage.

Lateral and mainline tubing will be buried in culvert sleeves 6-12 in. down in the sediment at trail and road locations. The tubing will also be staked and secured where it crosses existing surface flow channels in order to prevent the tubing from washing away in high flow events. Each lateral line will have a shutoff valve located on the mainline in order to control the amount of water available to each section. There will also be a mainline isolation valve, which controls the delivery of water to an entire section of lateral lines. These shut-off and isolation valves will be useful to isolate areas that require more or less irrigation without having to reassemble the entire system. Also, they will be useful in the case of a water leak or irrigation malfunction, by terminating water flow to a section under repair prevents an unnecessary waste of water. The irrigation design is located in Appendix F.

4.1.6 Project Maintenance

Although this revegetation design aims at creating a functioning habitat that is self-sustaining in the long-term, project maintenance, particularly for the first three years, is required to ensure the success of the planted vegetation. Before the planted native vegetation establishes and matures, there is potential for non-native vegetation to re-colonize the site and compete with native vegetation. Periodic weeding using hand pulling methods or small mechanical tools will be necessary until native plants are established. This is often accomplished by crews from the Nevada Division of Forestry. Environmental (e.g. high winds) and/or anthropogenic (e.g. vegetation destruction by off highway vehicle users) disturbances may cause mortality in planted vegetation and therefore replanting may be necessary in order to ensure successful native plant establishment. Irrigation systems must also be checked regularly to ensure that plants are receiving sufficient water.

Finally, if the permit requirements of 80% survival of native species planted with less than 20% encroachment of invasive species is not achieved within the two year monitoring period, further mitigation activities will be developed and implemented at the site to ensure the objective of developing long-term, self-sustaining habitat that is not dependent on further human intervention after the establishment period is reached.

4.1.7 Project Monitoring

In order to determine the effectiveness of the revegetation activities, a variety of general vegetation parameters can be measured. Parameters that can be monitored for Wash revegetation projects include plant growth, percent cover, plant condition, survival rates, and encroachment of non-native weeds. Monitoring should occur toward the end of the first three growing seasons (April-October) after planting is complete. Some baseline wildlife data was collected on site prior to non-native vegetation clearing, which will be used to evaluate the success of the revegetation effort as wildlife habitat. The monitoring protocols developed by the LVWCC will be used to continually monitor wildlife throughout the revegetation process.

Belt transects will likely be used to evaluate the success of the various types of plantings that occur on the site. Each transect will be randomly located within the planting design with the intention of capturing the different planting types.

Measuring plant growth is important to determine the success of the revegetation. The height of all planted trees and shrubs in the transect will likely be measured with a measuring rod to the tallest, outstretched leaf. Grass and herbaceous plant growth will be monitored using repeat photography and cover estimates.

Repeat photography reveals the growth success of grasses and herbs as well as the growth of the entire site over time. Permanent photo points for each transect and for the entire site should be established at a vantage point with a view of the entire transect or site. Several photo points of the entire site should be established to document the growth of the entire site over time. Photo points should be marked with an iron rod painted with fluorescent paint, and GPS coordinates taken of the location. In order to relocate the photo point, a photograph of the photo point should also be taken. Repetitive site photos should be taken at the same orientation therefore it is important to capture a distinguishing background feature that can be used to orientate every photo.

Percent cover is an important characteristic to monitor in a stand of vegetation because it can serve as a criterion for relative dominance within the community. Cover is expressed as a percentage value and in a multi-layered community it can often exceed 100%. In a multi-layered community it may be important to separate cover estimates into different stratums. In order to determine percent cover for revegetation sites, line-intercept methods are used. In the line-intercept method, a tape is stretched between two stakes placed at the beginning and end of a transect, and the canopy of a species that vertically projects over the tape is measured along its length. The total length of tape that is intercepted by the vertical projections of a species by the total length of tape is the percent cover. Line-intercept data also provides an estimate of cover for both native (i.e., planted and passive) and non-native weed encroachment. As community physiognomy changes, the line-intercept method may prove too difficult to implement and other methods may have to be used (e.g. cover estimates from aerial photographs, Braun-Blanquet cover class, etc.). Methodologies to determine percent cover are dictated by site conditions.

Revegetation sites are often deemed a success by the number of plants that survive after plantings have stopped and a period of time has passed since intensive management. This is a general indicator that plants will continue to survive in the environment after revegetation activities have been completed. It is also important to evaluate the condition of the plants and the factors that may be affecting their condition. In order to accomplish this, the condition of the plants in the transects will be ranked and recorded based on the appropriate condition category:

0—dead plants
1—poor condition
2—fair condition
3—good condition
4—excellent condition

Along with data on plant condition, the factors that are affecting the plant condition should be recorded as:

- Browsing by beaver and small mammals = MB
- Insect browsing = IB
- Insect presence = IP
- Pruned = P
- Volunteer competition = VC
- Herbicide affects = H
- Water stress = WS
- Dead = DE

- Hogwire rub = HWR
- Dormant = DO
- Unknown = U
- Not applicable or no factors affecting = N/A
- Other (Describe)

In order to calculate percent survivability in the subset of the population sampled, the total number of viable plants in a transect is divided by the total number of plants surveyed and then multiplied by 100. Survivability should be calculated for each different plant species because different factors affect different species. This survivability measure can be compared from growing season to growing season and ultimately expressed as a rate of survival.

5.0 RECOMMENDATIONS

The Wash is a unique environmental resource for Southern Nevada because it serves as the Las Vegas Valley's primary outlet for surface and shallow subsurface water flow. Because of increasing water usage and therefore discharge from the Las Vegas Valley, the Wash has become a perennial river that attracts a diverse assemblage of hydrophilic plants and animals not found elsewhere in the region. Increasing valley discharge along with intermittent flood events, however, have destabilized the Wash's floodplain. In 2000, the multi-stakeholder LVWCC developed a comprehensive channel stabilization plan that aims to protect the Wash from further erosion. Several large erosion control structures have been built to protect the Wash by reducing the erosive velocities of valley flood events. Lands adjacent to these structures serve as primary areas for revegetation activities. In addition, grant funding from a variety of sources provides impetus for additional revegetation. Revegetation helps protect and enhance the valuable ecological functions of the Wash by minimizing erosion, buffering against floods, improving wildlife habitat, improving water quality, and creating opportunities for recreation and research.

This plan outlines specific tasks that are required for successful revegetation including prioritization, environmental compliance planning, site assessment, revegetation design, project implementation, project maintenance, and project monitoring. Often it is a simple stepwise process; however, it is important to adapt the specific methods described herein to the needs of the project. It is recommended that revegetation activities along the Wash incorporate each of the described tasks. Only by fully completing these tasks will the goal of developing ecologically functioning wetland, riparian, and upland areas that are self-sustaining in the long-term be achieved.

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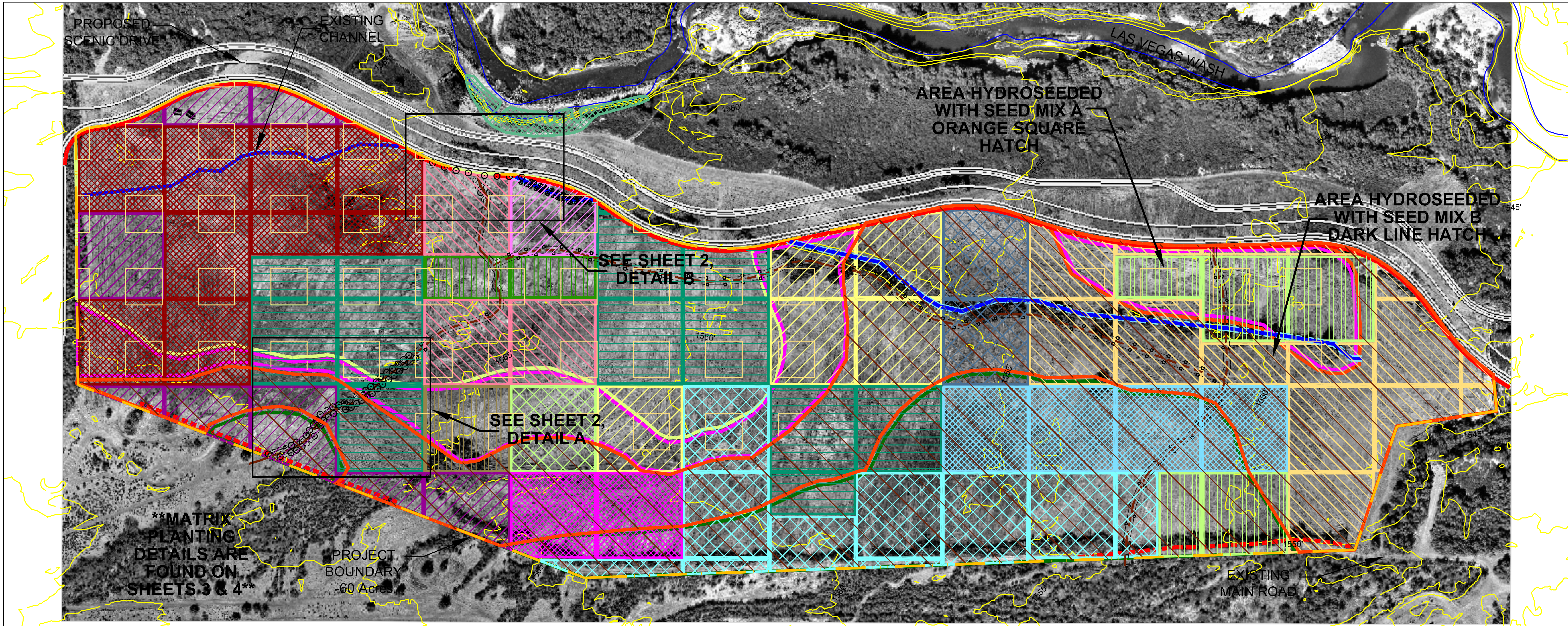
Appendix A

Las Vegas Wash Revegetation Concept plan

Appendix B

Revegetation Design Map and Planting Details for the 60-Acre Pilot Project



PLANT SCHEDULE SHOWING SOIL SALINITY / PLANTING TOLERANCE/ HYDROSEED SCHEDULE

SYMBOL	PLANTS ZONES	SIZE	QUANTITY	ZONE ACREAGES
	LOW SALT TOLERANT PLANTS 0-3 dSm			
	Acacia greggii	5 Gallon	100	23.00 Acres
	PLANT TOTALS	5 Gallons	100	

Hydroseed Mix A applied in this area. Mix A consists of: *Sporobolus airoides* at 3lbs/acre PLUS 80lbs/acre of fertilizer, 50lbs/acre of fiber mulch, 10lbs/acre endomycorrhizae, and 100lbs/acre tackifier.

SYMBOL	PLANTS ZONES	SIZE	QUANTITY	ZONE ACREAGES
	MODERATE SALT TOLERANT PLANTS 3-9.4 dSm			
	Baccharis salicifolia	1 Gallon	1628	9.00 Acres
	Chilopsis linearis	5 Gallon	804	
	Encelia farinosa	1 Gallon	300	
	Prosopis glandulosa var. torreyana	5 Gallon	4784	
	Prosopis glandulosa var. torreyana	15 Gallon	700	
	Prosopis pubescens	5 Gallon	3772	
	Prosopis pubescens	15 Gallon	47	
	PLANT TOTALS	1 Gallons	1928	
		5 Gallons	9360	
		15 Gallons	747	

Hydroseed Mix A applied in this area. Mix A consists of: *Sporobolus airoides* at 3lbs/acre PLUS 80lbs/acre of fertilizer, 50lbs/acre of fiber mulch, 10lbs/acre endomycorrhizae, and 100lbs/acre tackifier.

SYMBOL	PLANTS ZONES	SIZE	QUANTITY	ZONE ACREAGES
	MEDIUM SALT TOLERANT PLANTS 9.4-25 dSm			
	Baccharis emoryi	1 Gallon	1628	23.00 Acres
	Baccharis sarothroides	1 Gallon	804	
	Sphaeralcea ambigua	1 Gallon	241	
	PLANT TOTALS	1 Gallons	2673	

Hydroseed Mix B applied in this area. Mix B consists of: *Sporobolus airoides* at 3lbs/acre, *Atriplex canescens* at 1lbs/acre PLUS 80lbs/acre of fertilizer, 50lbs/acre of fiber mulch, 10lbs/acre endomycorrhizae, and 100lbs/acre tackifier.

SYMBOL	PLANTS ZONES	SIZE	QUANTITY	ZONE ACREAGES
	HIGH SALT TOLERANT PLANTS 25-50 dSm			
	Atriplex canescens	1 Gallon	2975	12.00 Acres
	Pluchea sericea	1 Gallon	965	
	Sporobolus airoides	1 Gallon	1206	
	PLANT TOTALS	1 Gallons	5146	
	PROJECT PLANT TOTALS	1 Gallons	9447	
		5 Gallons	9460	
		15 Gallons	747	
	GRAND TOTAL		19654	

Hydroseed Mix B applied in this area. Mix B consists of: *Sporobolus airoides* at 3lbs/acre, *Atriplex canescens* at 1lbs/acre PLUS 80lbs/acre of fertilizer, 50lbs/acre of fiber mulch, 10lbs/acre endomycorrhizae, and 100lbs/acre tackifier.

PLANTING MATRIX LEGEND

- MATRIX 1- ***P. glandulosa*** **,** 5 GALLON, 300 TREES / ACRE, SPACED AT 12'-15' OC IN RANDOM GROUPINGS
- MATRIX 2- ***C. linearis & Ac. greggii,*** 5 GALLON, 240 TREES / ACRE- (120 each specie), SPACED AT 12'-15' OC IN RANDOM GROUPINGS
- MATRIX 3- ***P. pubescens,*** 5 GALLON, 328 TREES / ACRE, SPACED AT 10'-15' OC IN RANDOM GROUPINGS
- MATRIX 4- ***At. canescens, Ba. sarothroides, & Sph. ambigua,*** 1 GALLON, 312 PLANTS / ACRE- (100,154,48 respectively), SPACED AT 12' OC IN RANDOM GROUPINGS
- MATRIX 5- ***At. canescens, Ba. emoryi, & Ba. salicifolia,*** 1 GALLON, 328 PLANTS / ACRE, (239,29,29 respectively), SPACED AT 12' OC IN RANDOM GROUPINGS
- MATRIX 6- ***P. glandulosa & P. pubescens,*** 5 & 15 GALLON, 334 TREES / ACRE- (167 each specie), SPACED AT 10'-15' OC IN RANDOM GROUPINGS
- MATRIX 7- ***At. canescens, Pl. sericea, & Spo. airoides,*** 1 GALLON, 291 PLANTS / ACRE- (130, 63, 98 respectively), SPACED AT 10'-15' OC IN RANDOM GROUPINGS
- MATRIX 8- ***Ba. emoryi, Ba. salicifolia & Spo. airoides,*** 1 GALLON, 328 PLANTS / ACRE- (140, 140, 48 respectively), SPACED AT 10'-15' OC IN RANDOM GROUPINGS
- MATRIX 9- ***At. canescens, Ba. emoryi, Ba. sarothroides,*** 1 GALLON, 322 PLANTS / ACRE, (210, 57, 55 respectively), SPACED AT 10'-15' OC IN RANDOM GROUPINGS
- MATRIX 10- ***At. canescens, Ba. emoryi, Ba. salicifolia, Pl. sericea, & Spo. airoides,*** 1 GALLON, 328 PLANTS / ACRE- (74, 61, 82, 63, 48, respectively), SPACED AT 12'-15' OC IN RANDOM GROUPINGS
- MATRIX 11- ***P. pubescens, Ba. emoryi, & Ba. salicifolia,*** 1-5 GALLON, 328 TREES / ACRE, (252, 38, 38 respectively), SPACED AT 10'-15' OC IN RANDOM GROUPINGS
- MATRIX 12- ***P. glandulosa,*** 1st Acre- 200x 5 GALLON and 40x 15 GALLON, 2nd Acre- 150x 15 GALLON, 3rd Acre- 250x 15 GALLON.
- MATRIX 13- ***En. farinosa,*** 1 GALLON, 300 PLANTS / ACRE, SPACED AT 12' OC IN RANDOM GROUPINGS
- MATRIX 14- ***P. pubescens & P. glandulosa,*** 5-15 GALLON, 179 PLANTS / ACRE- (50x 5 GALLON SBM, 47x 15 GALLON SBM, 82x 15 GALLON HM respectively)
- MATRIX 15- ***Pl. sericea,*** 1 GALLON, 300 PLANTS / ACRE- SPACED AT 10'-15' OC IN RANDOM GROUPINGS
- MATRIX 16- ***Po. fremontii, Ba. salicifolia, Sa. gooddingii & P. glandulosa,*** 5-15 GALLON, 275 PLANTS / ACRE- (116x 5 GALLON, 31x 1 GAL, 50x 5 GAL, 78x 15 GAL respectively)

SITE FEATURE LEGEND

- Project Site Boundary
- Proposed Scenic Drive
- Proposed Trails Throughout the Project Site- 1 Mile Length
- Existing Dry Wash Channel
- Project Elevation Contours- 5' Intervals
- Existing Las Vegas Wash

PLANTING SCHEME LEGEND

- Scenic Drive and Main Road / Trail Entrances- ***P. glandulosa,*** 30' OC spacing on south side of Scenic Drive & north side of main road
- Trail Entrance, 300LF each- ***P.glandulosa*** and ***P. pubescens,*** 15' OC spacing
- Trail Plantings, 300LF, ***P.glandulosa*** only- 17' OC spacing
- Dry Wash Channel- ***Chilopsis linearis ssp. arcuata,*** 5'-10' OC spacing in random groupings

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9730 NORTH ROSEWOOD DRIVE
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Ecosystem Restoration Land Planning

WATER TECH AG SUPPLY
2610 EAST 16TH STREET
YUMA, AZ
85365
TEL 928 341 8000
FAX 928 341 9342

REV.	COMMENT	DATE

Southern Nevada Water Authority
Las Vegas Wash Revegetation

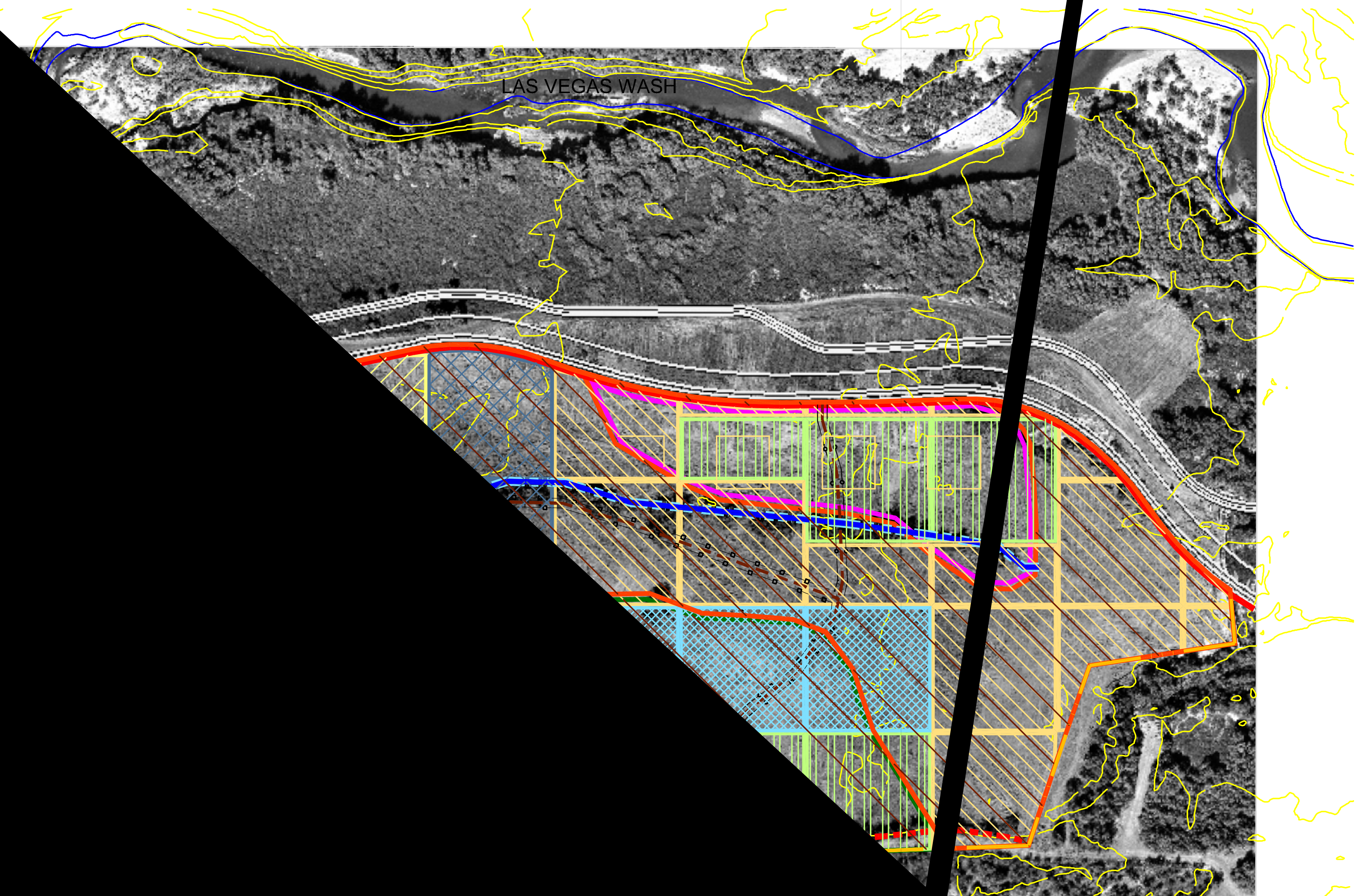
LAS VEGAS, NEVADA

100%COMPLETE

0 60 120 240ft NORTH

DATE: APRIL 1, 2006
JOB NO.:
DRAWN BY: AH
DESIGNED BY: FOP
CHECKED BY: FOP
DRAWING TITLE: PLANTING PLAN

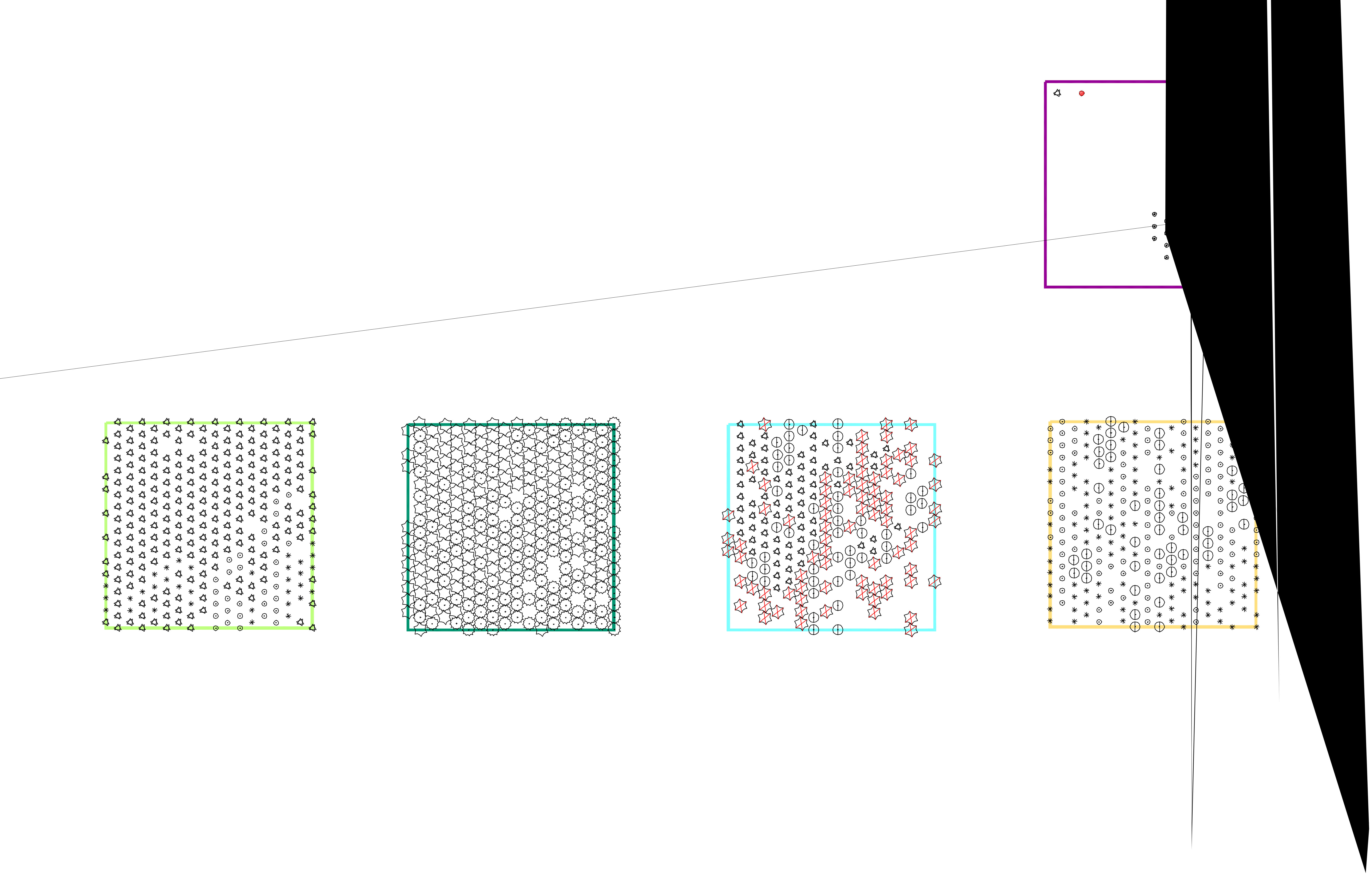
SHEET NO.:

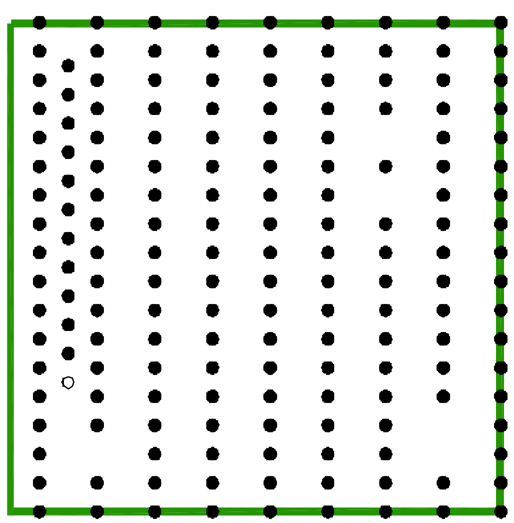


- SCENIC DRIVE AND PLANTINGS

PLANTING SCHEME: ***Prosopis glandulosa***
ed along the Scenic Drive and main roads
ll be planted 10' offset from the edge of
ly 182 trees shall be allocated for the
ees shall be allocated for the
tely 35 trees shall be allocated

earis ssp. arcuata - 5
sh channels
s ssp. arcuata





Appendix C
Native and Non-Native Plant Species in Las Vegas Wash

Family Scientific Name	Species Name	Introduced	Native
Amaranthaceae	Amaranthus albus		1
	Amaranthus blitoides	1	
	Amaranthus powellii		1
	Tidestromia oblongifolia		1
Asteraceae	Acroptilon repens	1	
	Ambrosia dumosa		1
	Amphipappus fremontii		1
	Aster subulatus var. ligulatus		1
	Atrichoseris platyphylla		1
	Baccharis emoryi		1
	Baccharis salicifolia		1
	Baccharis sarothroides		1
	Baileya multiradiata		1
	Brickellia atractyloides		1
	Calycoseris wrightii		1
	Chaenactis carphoclinia		1
	Chaenactis fremontii		1
	Chaenactis macrantha		1
	Chrysothamnus paniculatus		1
	Conyza canadensis		1
	Conyza coulteri		1
	Eclipta prostrata		1
	Encelia farinosa		1
	Encelia virginensis		1
	Enceliopsis argophylla		1
	Erigeron divergens		1
	Eriophyllum lanatum		1
	Eriophyllum wallacei		1
	Filago arizonica		1
	Geraea canescens		1
	Gnaphalium luteo-album	1	
	Helianthus annuus		1
	Hymenoclea salsola var. fasciculata		1
	Hymenoclea salsola var. salsola		1
	Isocoma acradenia var. eremophila		1
	Lactuca cf. biennis		1
	Lactuca serriola	1	
	Machaeranthera pinnatifida ssp. gooddingii		1
	Malacothrix glabrata		1
	Perityle emoryi		1
	Peucephyllum schottii		1
	Pluchea odorata		1
	Pluchea sericea		1
	Prenanthella exigua		1
	Psathyrotes ramosissima		1
	Psilostrophe cooperi		1
	Rafinesquia neomexicana		1
	Sonchus asper	1	
	Sonchus oleraceus	1	
	Stephanomeria pauciflora var. pauciflora		1
	Stylocline micropoides		1
	Xanthium strumarium		1
	Xylorhiza tortifolia		1
Azollaceae	Azolla sp.		1

List of species detected along the Las Vegas Wash by Shanahan and Silverman (2006). Species presence is indicated by a 1. Family scientific name, species name, and introduced or native status follows the Integrated Taxonomic Information System (www.itis.usda.gov).

Family Scientific Name	Species Name	Introduced	Native
Boraginaceae	Cryptantha dumetorum		1
	Cryptantha holoptera		1
	Cryptantha inaequata		1
	Cryptantha maritima		1
	Cryptantha nevadensis		1
	Cryptantha pterocarya var. cycloptera		1
	Cryptantha pterocarya var. pterocarya		1
	Cryptantha recurvata		1
	Cryptantha utahensis		1
	Heliotropium curassavicum		1
	Pectocarya heterocarpa		1
	Pectocarya linearis		1
	Pectocarya platycarpa		1
	Plagiobothrys jonesii		1
Brassicaceae	Brassica tournefortii	1	
	Descurainia pinnata ssp. glabra		1
	Descurainia sophia	1	
	Draba cuneifolia var. integrifolia		1
	Guillenia lasiophylla		1
	Lepidium fremontii var. fremontii		1
	Lepidium lasiocarpum		1
	Lepidium latifolium	1	
	Lesquerella tenella		1
	Malcolmia africana	1	
	Rorippa nasturtium-aquatica		1
	Sisymbrium irio	1	
	Streptanthella longirostris		1
Cactaceae	Cylindropuntia echinocarpa		1
	Cylindropuntia ramosissima		1
	Echinocactus polycephalus		1
	Mammillaria tetrancistra		1
	Opuntia basilaris var. basilaris		1
	Sclerocactus johnsonii (=Echinomastus johnsonii)		1
Campanulaceae	Nemacladus glanduliferus var. orientalis		1
Chenopodiaceae	Allenrolfea occidentalis		1
	Atriplex canescens ssp. canescens		1
	Atriplex confertifolia		1
	Atriplex elegans var. fasciculata		1
	Atriplex hymenelytra		1
	Atriplex lentiformis var. lentiformis		1
	Atriplex polycarpa		1
	Bassia hyssopifolia	1	
	Chenopodium album	1	
	Chenopodium ambrosioides	1	
	Chenopodium berlandieri		1
	Chenopodium glaucum	1	
	Salsola paulsenii	1	
	Salsola tragus	1	
	Suaeda moquinii		1
Convolvulaceae	Convolvulus arvensis	1	
Cyperaceae	Cyperus erythrorhizos		1
	Eleocharis cf. montevidensis		1
	Eleocharis sp.		1
	Schoenoplectus acutus var. occidentalis		1
	Schoenoplectus americanus		1
	Schoenoplectus californicus		1
	Schoenoplectus maritimus		1
	Schoenoplectus pungens		1
Ephedraceae	Ephedra torreyana		1

List of species detected along the Las Vegas Wash by Shanahan and Silverman (2006). Species presence is indicated by a 1. Family scientific name, species name, and introduced or native status follows the Integrated Taxonomic Information System (www.itis.usda.gov).

Family Scientific Name	Species Name	Introduced	Native
Euphorbiaceae	Euphorbia micromeria (=Chamaesyce micromera)		1
	Euphorbia prostrata (=Chamaesyce prostata)		1
Fabaceae	Acacia greggii		1
	Dalea mollissima		1
	Medicago sativa	1	
	Melilotus alba	1	
	Melilotus indica	1	
	Prosopis alba	1	
	Prosopis glandulosa var. glandulosa		1
	Prosopis glandulosa var. torreyana		1
	Prosopis pubescens		1
	Psorothamnus fremontii var. fremontii		1
	Senna armata		1
Geraniaceae	Erodium cicutarium	1	
	Erodium texanum		1
Hydrophyllaceae	Eucrypta micrantha		1
	Nama pusillum		1
	Phacelia crenulata var. ambigua		1
	Phacelia ivesiana		1
	Phacelia neglecta		1
	Phacelia palmeri		1
	Phacelia petrosa		1
	Phacelia pulchella var. gooddingii		1
	Phacelia rotundifolia		1
Juncaceae	Juncus balticus		1
	Juncus cooperi		1
Krameriaceae	Krameria erecta		1
Lemnaceae	Lemna sp. (ca. minor)		1
Liliaceae	Androstephium breviflorum		1
Loasaceae	Mentzelia albicaulis		1
	Mentzelia involucrata var. involucrata		1
	Mentzelia obscura		1
	Mentzelia pterosperma		1
	Mentzelia tricuspis		1
	Petalonyx nitidus		1
Malvaceae	Eremalche rotundifolia		1
	Malva parviflora	1	
	Sphaeralcea ambigua var. rugosa		1
	Sphaeralcea emoryi		1
Moraceae	Morus alba	1	
Nyctaginaceae	Allionia incarnata		1
	Mirabilis bigelovii var. bigelovii		1
Oleaceae	Fraxinus latifolia		1
	Fraxinus velutina		1
Onagraceae	Camissonia boothii ssp. condensata		1
	Camissonia brevipes ssp. brevipes		1
	Camissonia brevipes ssp. pallidula		1
	Camissonia chamaenerioides		1
	Camissonia claviformis var. aurantiaca		1
	Camissonia refracta		1
	Camissonia walkeri ssp. tortilis		1
	Oenothera caespitosa var. crinita		1
Papaveraceae	Arctomecon californica		1
	Eschscholzia californica		1
	Eschscholzia glyptosperma		1
	Eschscholzia minutiflora		1
Plantaginaceae	Plantago major		1
	Plantago ovata		1
Plumbaginaceae	Limonium californicum		1

List of species detected along the Las Vegas Wash by Shanahan and Silverman (2006). Species presence is indicated by a 1. Family scientific name, species name, and introduced or native status follows the Integrated Taxonomic Information System (www.itis.usda.gov).

Family Scientific Name	Species Name	Introduced	Native
Poaceae	Aristida adscensionis		1
	Aristida purpurea		1
	Arundo donax	1	
	Bromus madritensis ssp. rubens	1	
	Chloris virgata		1
	Cynodon dactylon	1	
	Dasyochloa pulchella (=Erioneuron pulchellum)		1
	Distichlis spicata		1
	Echinochloa crus-galli	1	
	Leptochloa fusca ssp. uninerva		1
	Muhlenbergia asperifolia		1
	Panicum capillare		1
	Panicum cf. hirticaule		1
	Paspalum distichum		1
	Phragmites australis		1
	Pleuraphis rigida		1
	Polypogon monspeliensis	1	
	Polypogon viridis	1	
	Schismus barbatus	1	
	Setaria pumila	1	
	Sorghum halepense	1	
	Sporobolus airoides		1
	Vulpia octoflora var. hirtella		1
Polemoniaceae	Gilia cana		1
	Gilia clokeyi		1
	Gilia latifolia		1
	Gilia scopulorum		1
	Ipomopsis polycladon		1
	Langloisia setosissima var. setosissima		1
	Linanthus bigelovii-jonesii		1
	Linanthus demissus		1
Polygonaceae	Chorizanthe brevicornu		1
	Chorizanthe corrugata		1
	Chorizanthe rigida		1
	Eriogonum deflexum var. deflexum		1
	Eriogonum inflatum var. inflatum		1
	Eriogonum insigne		1
	Eriogonum thomasii		1
	Eriogonum trichopes var. trichopes		1
	Polygonum arenastrum	1	
	Polygonum lapathifolium		1
	Rumex stenophyllus	1	
Portulacaceae	Portulaca oleracea	1	
Ranunculaceae	Delphinium parishii		1
Resedaceae	Oligomeris linifolia		1
Salicaceae	Populus fremontii		1
	Salix exigua		1
	Salix gooddingii		1
	Salix laevigata		1
Saururaceae	Anemopsis californica		1
Scrophulariaceae	Antirrhinum filipes		1
	Mohavea breviflora		1
	Veronica anagallis-aquatica		1
Solanaceae	Datura wrightii		1
	Lycium andersonii var. andersonii		1
	Lycium fremontii		1
	Lycium sp.		1
	Nicotiana glauca	1	
	Nicotiana obtusifolia		1

List of species detected along the Las Vegas Wash by Shanahan and Silverman (2006). Species presence is indicated by a 1. Family scientific name, species name, and introduced or native status follows the Integrated Taxonomic Information System (www.itis.usda.gov).

Family Scientific Name	Species Name	Introduced	Native
Solanaceae	Physalis crassifolia		1
	Solanum americanum		1
	Solanum elaeagnifolium		1
Tamaricaceae	Tamarix ramosissima	1	
Typhaceae	Typha domingensis		1
Ulmaceae	Ulmus pumila	1	
	Ulmus sp.	1	
Viscaceae	Phoradendron californicum		1
Vitaceae	Vitis arizonica		1
Zannichelliaceae	Zannichellia palustris		1
Zygophyllaceae	Larrea tridentata		1
Grand Total		41	206

Appendix D

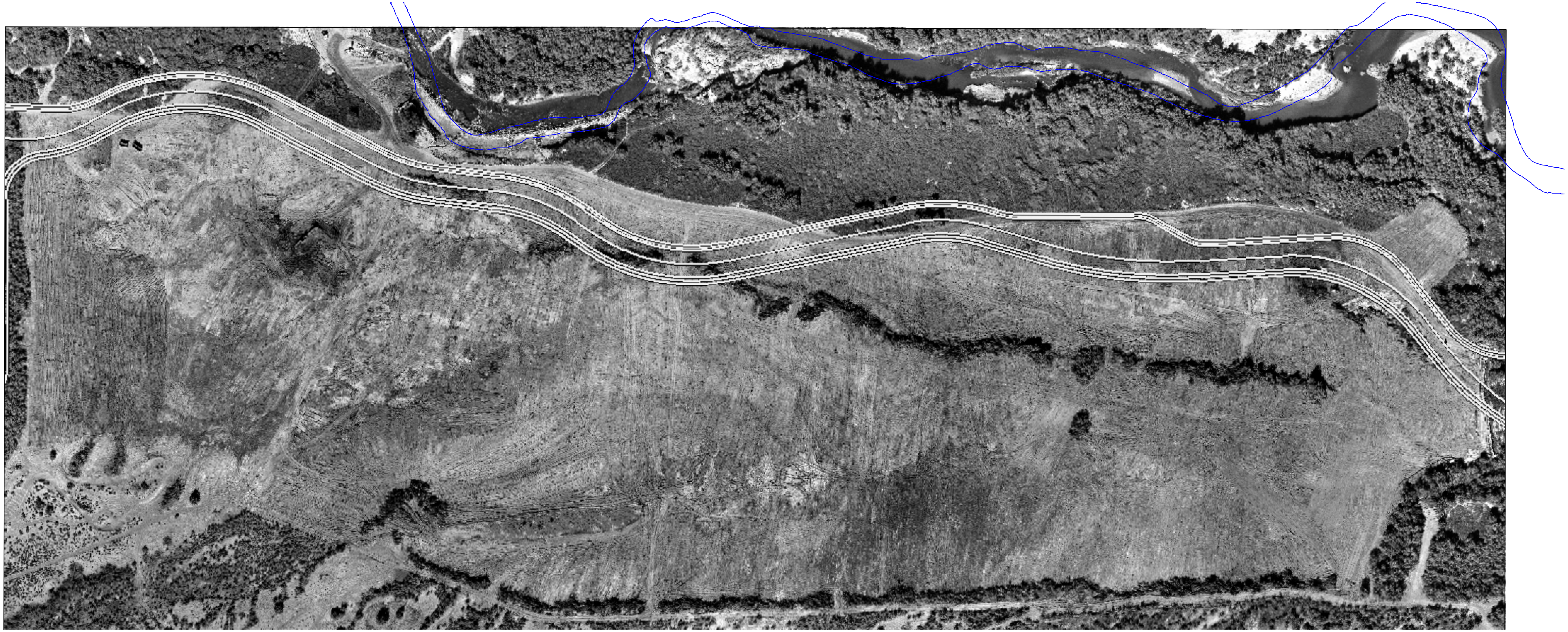
Depth to Water Map for the 60-Acre Pilot Project

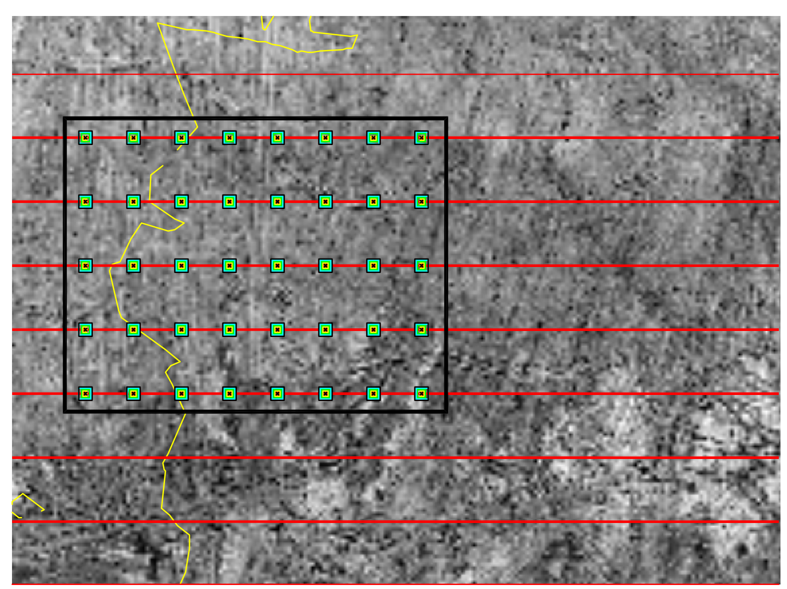
Appendix E

Soil Salinity Map for the 60-Acre Pilot Project

Appendix F

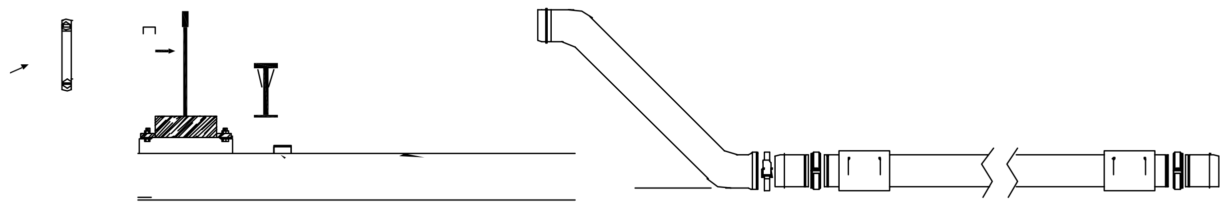
Irrigation Design for the 60-Acre Pilot Project

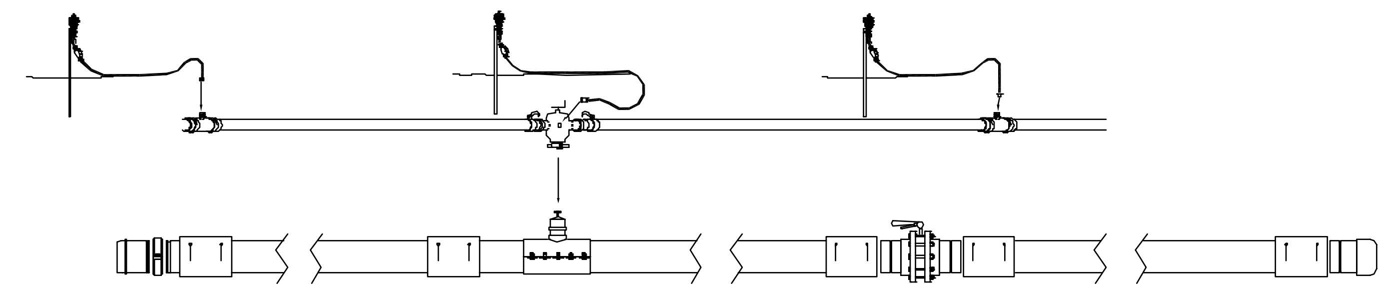


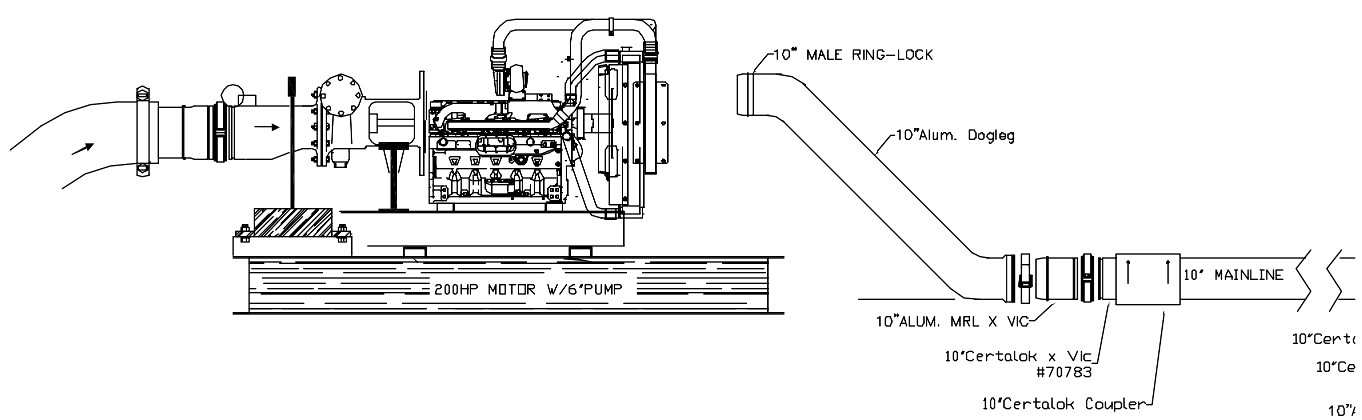


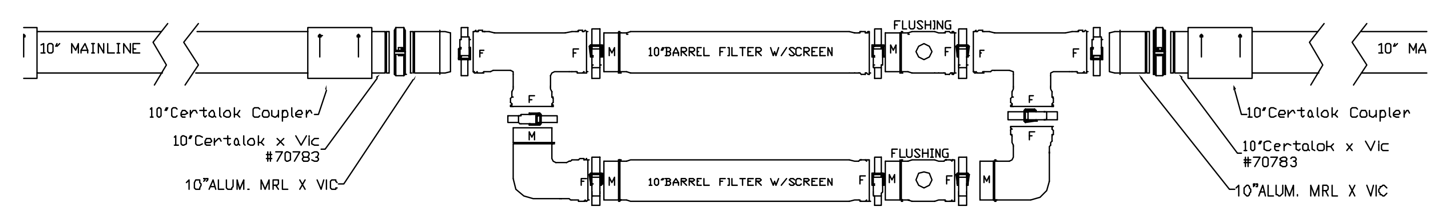
IRRIGATION NOTES

1. Laterals and Mainline will be buried at trail and road locations in 6" - 12" culvert sleeves.
2. Piping will be staked / secured where laterals and mainline piping crosses existing surface flow channels.
3. Pump pad / ramp will be graded down to an elevation no higher than 5' above wash for the suction hose. The pad ramp shall be stabilized with gravel rip rap for pump placement.






10" MALE RING-LOCK
10"Alum. Dogleg
200HP MOTOR W/6"PUMP
10" MAINLINE
10"ALUM. MRL X VIC
10"Certalok x Vic
#70783
10"Certalok Coupler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10"BARREL FILTER W/SCREEN
FLUSHING
10"BARREL FILTER W/SCREEN
FLUSHING
10"Certalok Coupler
10"Certalok x Vic
#70783
10"ALUM. MRL X VIC
10"Certalok Coupler
10"Certalok x Vic
#70783
10"ALUM. MRL X VIC

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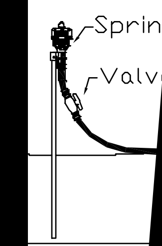

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