

# AGUA FRIA

WATERCOURSE MASTER PLAN

## *Habitat Enhancement Opportunities/Techniques*

### *Lower Agua Fria River Corridor*

### *New Waddell Dam to Confluence with Gila River*

Prepared for



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## Acknowledgements

This watercourse master plan was prepared by a group of Maricopa County and Consulting professionals dedicated to improving the way we protect people and property from flood damages while meeting the multiple use needs of a growing population. The commitment to this ideal was demonstrated throughout this project by the Maricopa County Board of Supervisors and by leaders of the Flood Control District of Maricopa County. Finally, the plan for the West Valley Recreation Corridor captures the vision of John F. Long — a man who has spent his entire life trying to improve and promote quality of life for families in the West Valley.

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## 1.0 Introduction

As part of the study for the Agua Fria Watercourse Master Plan an evaluation was conducted to identify existing areas in or near the Agua Fria River corridor (**Figure 1**) that might be candidates for restoration or habitat enhancement. Section 2.0 of this technical report explains the identification methodology and the habitat evaluation criteria used to identify the candidate areas. Section 3.0 describes and locates the identified areas and recommends potential habitat enhancement strategies. Appendix A contains ground photography of the various areas, and Appendix B contains proposed vegetation enhancement lists for the various sites.

## 2.0 Methodology

The evaluation of potential habitat enhancement areas was performed in three general phases. The first phase established which areas of the Agua Fria River corridor contain sites that because of some characteristic or combination of circumstances have some unique, rare, or limited natural resource that sets them apart from the remainder of the corridor. Conducted almost concurrently with the first phase, the scientists evaluated historical habitat conditions, habitat needs, and habitat desires for the Agua Fria River corridor. This was done to establish some general recognition of what habitats were desirable. The final phase identified the various enhancement areas and recommended goals and strategies for potential enhancement. It should be noted that while the process was conducted in Phases the process was fluid and exclusion of an area from the Phase I process did not eliminate its inclusion in later phases, if new data warranted its inclusion.

There were many tasks and procedures common to all three phases. Numerous field reconnaissances were conducted during each phase to evaluate specific issues or to solicit input from other team members relating to site-specific enhancement. Field reconnaissances were timed both seasonally and diurnally to coincide with different flora and fauna activity cycles. Aerial photograph was used in all three phases of the evaluation and limited GIS data was incorporated in to the analysis.

EDAW and J E. Fuller, members of the Agua Fria Watercourse Master Plan Team, augmented the evaluation with additional input on geomorphology, water recharge requirements, landscape architecture techniques, and recreational uses.

Methodology more specific to each phase is noted below:

### ***Phase I – Base Conditions and Identification of Potential Habitat Enhancement Areas***

This phase was conducted utilizing the data from the ecological evaluation of the corridor (See Master Plan Technical Report – [Ecological Evaluation of the Agua Fria River Corridor from New Waddell Dam to the Gila River](#) Kimley-Horn 2001). This information established a baseline or common conditions description for the river corridor.

Utilizing the baseline character of the river corridor, areas were identified that exhibited characteristics different from the baseline in that area of the corridor. The differentiation criteria was primarily floristic (i.e. an inclusion of trees in an otherwise low shrub or herbaceous community, hydrophytic species in an



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**FIGURE 1**  
**Agua Fria River Study Corridor**

**WEST VALLEY RECREATION CORRIDOR**  
 AGUA FRIA WATERCOURSE MASTER PLAN

HABITAT ENHANCEMENT





otherwise xeric or mesic community). Occasionally areas were chosen for their location within the landscape or based on a particular outside influence (i.e. point source discharge sites, grade-control structures). The characteristics of each site were documented with field notes and ground photography and the location/access was noted for later visits. The scientists also identified or speculated on the conditions responsible for the different characteristics.

In general, Phase I contained two primary areas of evaluation, one concentrating on the site attributes and the other concentrating on the site's surroundings (**Figure 2**). The evaluation for the site's attributes included:

### ***Size and shape***

Habitat fragmentation is the process of reducing large-scale habitat areas into small parcels and severing habitat areas from each other. This intrusive and encroaching process is a by-product of area development and has affected habitat area size and connectivity in portions of the Agua Fria River corridor. Most wildlife species require a minimum parcel size for nesting and cover habitat. This requirement varies with the species. In terrestrial species, the requirement is primarily a function of species size, while in avian species, it is more a function of predator pressures during nesting.

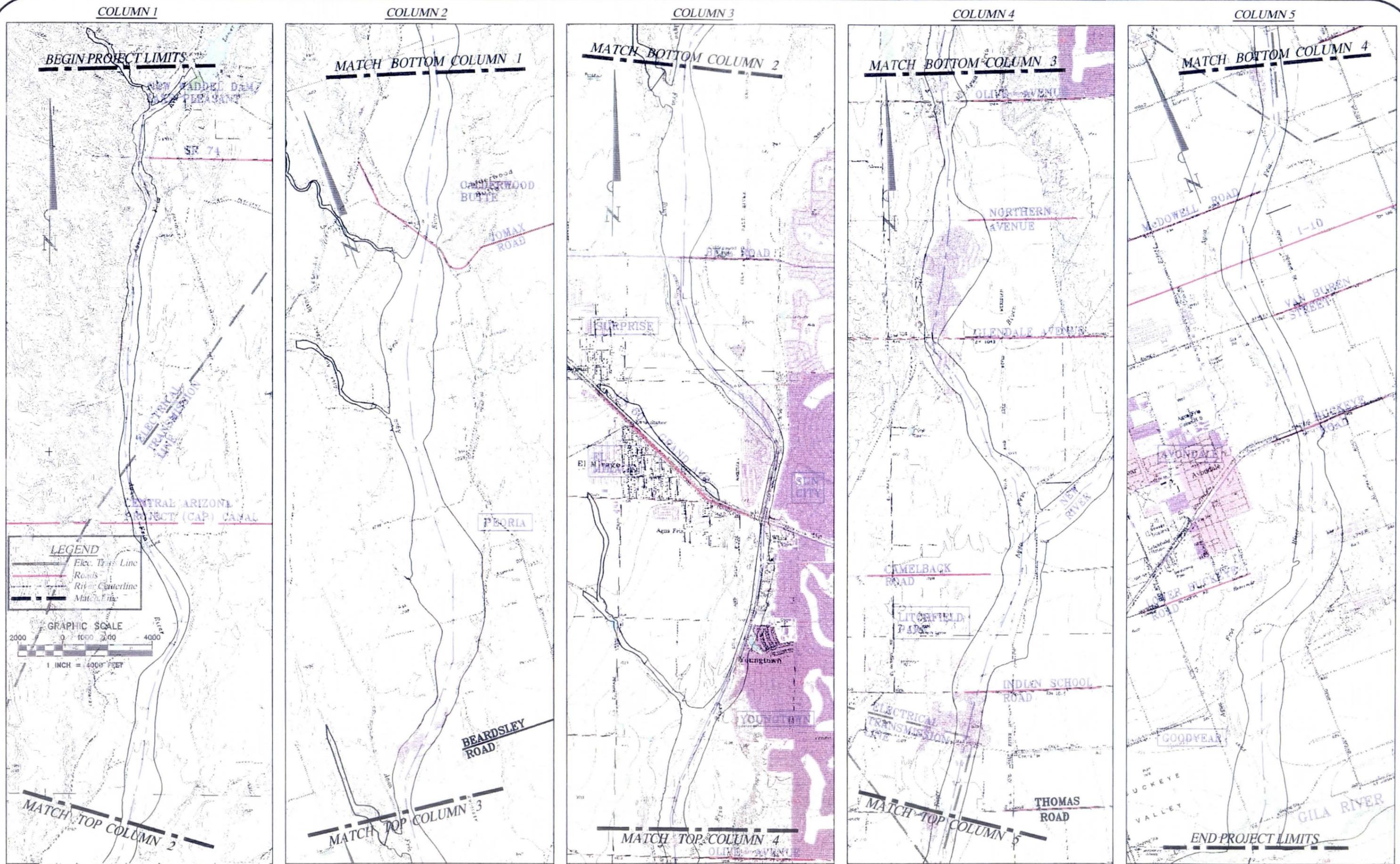
The shape of the parcel is also important. Long linear communities may have value as linkage zones providing they meet certain minimum width requirements. Irregular shaped parcels may provide more edge or margin. The edge is normally an interface between two or more habitats, has a more diverse vegetation mix, and therefore provides more habitat functional value.

The size and shape of a parcel may also affect the success of a restoration or enhancement opportunity. Very small parcels may not be able to sustain themselves in the overall system. Most vegetation communities do not form abrupt boundaries. Instead, the two communities blend across the boundary. This ecotone contains species from both communities and does not represent a "pure" example of either community. If the relic vegetation community is too small, it will rapidly lose its integrity as it is overrun by the larger surrounding community.

While small parcels have less value as linkage zones or as habitat for size sensitive species, they may still be valuable for wildlife less sensitive to anthropogenic pressures. Therefore, while parcel size is an important attribute in the selection of potential enhancement areas, smaller parcels were not automatically excluded from further evaluation.

### ***Floristic Value***

For this study, the floristic value refers to the communities' level of vegetative integrity. It is a function of the amount of native species, conservative species, and the botanical and ecological value of the component species. High floristic value communities normally contain species that exhibit a fidelity to a specific habitat regime. Such species are very conservative and will only survive within a very narrow habitat band. A high floristic value might suggest a more stable community or a relic of a high value community, like a cottonwood-willow riparian area. Interestingly, the species that form the higher value community may themselves be early successional or colonizing species (such as the cottonwood and willow).



WEST VALLEY RECREATION CORRIDOR

AGUA FRIA WATERCOURSE MASTER PLAN

HABITAT ENHANCEMENT STUDY AREA

FIGURE 2



The floristic value does not directly equate to wildlife functional values, as early seral communities (such as wetlands) provide high value habitat. However, in general a higher floristic value community can supply the habitat for both eurytopic (wide tolerance) species and supply niche habitat for stenotopic (narrow tolerance) species. These areas are very rare along the corridor and regardless of size are good candidates for enhancement.

### ***Hydrology***

In an arid environment, the most limiting factor for successful enhancement of an area is availability of water. The moisture regime or hydroperiod of the parcel controls the vegetation composition. Areas that received additional water discharge or are able to retain moisture were considered for additional enhancement. Water discharge was either from a natural source, such as Morgan City Wash, or from nuisance water point source discharges along the corridor. The point sources include wastewater treatment facilities, groundwater recharge sites, irrigation tail water discharges, stormwater discharges, and aggregate mine site discharges.

The river corridor contains numerous concrete grade control structures. These structures are concrete walls that are buried several feet deep and continue across the channel. They are designed to stabilize the channel and reduce channel degradation. They also tend to detain surface water flows and near surface groundwater. When combined with a nearby surface water discharge the structures create an artificially elevated moisture regime. These areas were also considered for enhancement.

The evaluation for the site's surroundings included:

### ***Landscape Positioning***

From an ecological perspective, landscape positioning is a measure of the site's relationship to its surroundings. This "big-picture" look at the site includes the sites juxtaposition to other ecologically valuable attributes. Convergence of multiple vegetation communities into one area provides for multiple habitats. These areas are sometimes referred to as guilds and can represent the complete habitat requirements for a specific species.

Habitat areas surrounded by relatively undisturbed open range desert are likely to be better habitat sites than an equal area in an urbanized environment. The surrounding habitat acts as a buffer to isolate the vegetation community from adjacent influence. Topography can also serve to create an isolated environment. Dissimilar habitat types, such as riparian corridors adjacent to the Sonoran Upland community can also provide habitat isolation. The overlap or ecotone between the two communities also provides a high value habitat grouping. These so-called mosaic habitats provide very diverse habitat for a variety of wildlife.

Connectivity is also an important consideration in landscape positioning. Parcels that provide a link between other habitat areas add value to the habitat system. The connection can be to other similar habitats or dissimilar habitats. Strings of habitat parcels can create wildlife linkage zones providing that the parcel string connects useful habitat areas. The useful habitat, known as destination habitat can include water or forage sources, similar habitat areas, or dissimilar habitat areas. The wildlife travel can be daily, migratory, or life phase driven.



### ***Land Use***

Adjacent existing and future land uses were also used as evaluation criteria. Primarily the evaluation concentrated on identifying potential land uses that might conflict with various habitat enhancement scenarios. Industrial and commercial land uses might reduce the overall habitat value of a particular area, but some modifications, such as water discharge or impoundment, might increase habitat values. Also taken into consideration were existing or planned residential areas, as were existing or planned recreational facilities.

Consideration was also given to the need to establish urban wildlife habitat. Most developed areas have very little viable wildlife habitat. Therefore, areas that might otherwise be shunned by wildlife will become favored habitat in a habitat-poor area. The urban habitat islands provide a valuable resource in many residential or commercial areas. These areas must be carefully located and designed with specific wildlife usage in mind to minimize wildlife/human utilization conflicts.

### ***Infrastructure***

The effect of grade control structures and surface discharge points has been noted previously. Bridges, at-grade road crossings, and above ground and buried utilities were included. Bridges provide shade, thus moderating daily temperatures and reducing evaporation losses. The same bridges create a conflict between vehicular traffic and wildlife use.

### ***Phase II- Status and Trend Analysis***

The evaluation team used historical and current aerial photographs and historical reports of the river corridor to establish past trends and current conditions along the corridor. Historical photography was reviewed to establish trends in vegetation development over the course of various hydrologic, geomorphic, and floristic events. It also helped to identify relatively stable vegetation and areas that are ephemeral in nature. The aerial photography information was supplemented with historical narratives of the area and discussions with some long time residents of the valley.

This information was correlated with the information from Phase I to identify remnant native communities, long-term conditions, vegetation seral stage, and the general trend of the potential enhancement area. This review was intended to identify specific issues that might be contributing to the success or decline of the area and to eliminate short-term anomalies.

The evaluation criteria noted in Phase I was applied as applicable during the Phase II analysis.

### ***Phase III- Assess Potential and Define Enhancement Strategy***

The third phase of the evaluation concentrated on identifying the area's potential in the context of its overall surroundings and on the likelihood of the application of enhancement procedures. The purpose of this portion of the evaluation was to establish reasonable objectives for habitat enhancement given the overall goal of the Agua Fria Watercourse Master Plan as a flood control project.

This requires the establishment of a target use for the particular site. The evaluation examined the projected future use of the enhancement site and the surrounding area for compatibility. As an example,



it is of little ecological value to develop an elk migration corridor in an area without elk or where there is no destination elk habitat, nor is it a good idea to develop a large mammal habitat area adjacent to an existing or planned major highway corridor. On the other hand, it might be advantageous to plan a riparian enhancement project along the route of a planned recharge facility or to develop avian habitat within a passive recreational facility.

Each of the potential sites was evaluated to determine if the site should have:

- **Restoration.** To create an ecosystem that is exactly identical to the ecosystem in place prior to the disturbance or change. This is a difficult undertaking unless the disturbance identified is a very recent occurrence and future disturbance can be prevented. It is also very difficult to establish a meaningful “original condition” for the ecosystem as most ecosystems are constantly evolving. An example of a restoration might be the re-creation of the cottonwood/willow community along the river corridor. It would require the complete eradication of exotic species, the introduction of a more varied hydroperiod for the river, and the isolation of the site from most activity. Such a community might not be in the best interest of the Agua Fria River Master Plan’s goal of providing flood control for the Agua Fria River.
- **Rehabilitation.** Creation of a similar, but not identical ecosystem. This process maintains the overall structure and identity of the target community but may modify vegetation composition, land use, or moisture regime. As an example, a cottonwood/willow community may be enhanced with additional woody species and perhaps open water bodies or wetlands might be added to the system. Rehabilitation is a less strict approach to enhancement and offers more flexibility for manipulation of the system. There is no established limit for the amount of change acceptable in a rehabilitation project, and the boundaries between it and the replacement strategy are indistinct.
- **Replacement.** This strategy replaces an identified ecosystem with a different system. Existing vegetation is removed or significantly altered, and the area’s hydroperiod might be modified. This might result in the cottonwood/willow community being replaced by a mesquite bosque or in the extreme by an upland community. This strategy offers the most flexibility in a multiple use project.

### **3.0 Potential Enhancement Techniques**

Regardless of which enhancement approach was considered, enhancement techniques will be required to achieve the goal of restoring, rehabilitating, or replacing the identified communities. The following methodologies and management techniques have been identified for use as part of the habitat enhancement process for the Agua Fria Watercourse Master Plan.

#### ***Hydroperiod Adjustment.***

The most limiting factor for habitat enhancement along this reach of the Agua Fria River corridor is the xeric hydroperiod. The majority of the corridor does not receive enough moisture to support vegetation that would provide enhanced habitat areas.

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This evaluation concentrated on identifying existing surface water sources as well as potential future surface water sources. The management technique also looked at ways to increase the length of site inundation or soil saturation, increase the periodicity of the water delivery, and reduce evaporation and infiltration losses.

The strategies include:

- Reduction in high transpiration vegetation at the enhancement sites
- Construction of ground water dams – such as grade control structures
- Creation of detention ponds at the surface discharge outlet to detain some surface runoff and prolong the delivery to the enhancement site.
- Creation of depressional areas within the enhancement sites to pond and retain surface runoff
- Establishment of ground cover species that reduce evaporation and soil drying
- Negotiation with water recharge facilities to “harvest” additional water for vegetation enhancement
- Investigation of localized precipitation harvesting for discharge to the enhancement sites
- Addressing the public negative perceptions of effluent water sources

### ***Invasive Species Management***

Many of the enhancement areas identified have vegetation communities that have been impacted by various invasive or weedy species such as tamarisk, Russian thistle, and others. This enhancement strategy was developed to remove or control the invasive species in the habitat area.

Several control measures are identified:

- **Mechanical control.** Mechanical control measures range from hand removal to mechanized equipment. Hand removal includes cutting, picking, or pulling of the targeted species. It is labor intensive but has the advantage of minimizing additional stress on the adjacent non-target vegetation species. Mechanized machinery can range from select removal with small ground equipment to complete removal of surface vegetation and root zone plowing. It is less labor intensive but causes more collateral damage to the system. Mowing and pruning can also be used to retard or eradicate species. Mechanized control normally requires multiple applications to assure success.
- **Biological control.** Biological control is normally applied by introducing another species into the ecosystem. The introduced species can be either plant or animal. Ideally, the introduced species is a narrow niche species that is only keyed to the invasive species. The very real danger is that the biological control species will become a second invasive species or somehow target desirable species in the community.
- **Chemical control.** There are several methods of chemical control. Herbicides such as glyphosate (active ingredient in Roundup®) and imazapyr (active ingredient in Arsenal®) are normally used in chemical applications for control of herbaceous or woody vegetation. These systemic herbicides are absorbed into the plant and distributed throughout its system. Herbicide control can be very effective and is normally relatively economical. Herbicide control normally results in the destruction of



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additional non-targeted vegetation and may affect water and air quality. Glyphosate is relatively stable, immobile, and does not form long-term residual concentrations.

- **Controlled Burning.** Some invasive species do not tolerate periodic fire, while many native species have adapted to the regime. Controlled burns can help control invasive species and promote healthy native ecosystems. Tamarisk and some other invasive species appear to tolerate periodic fire, and their propagation is not markedly affected.
- **Hydroperiod manipulation.** Increasing or decreasing site moisture conditions can be used to control invasive species. Some invasive species do not tolerate long periods of inundation or soil saturation. Additionally, seasonal variations in moisture can be used to constrain further propagation. Unfortunately, one of the more serious invasives, tamarisk is very tolerant to fluctuating moisture conditions.
- **Combination of above measures.** In many cases, a combination of the above techniques is the most successful eradication/control method. There are records of success with mechanical cutting of tamarisk and immediate application of glyphosate to the stump. This approach has the advantage of select, limited application of herbicide, and minimal collateral damage. Controlled burns have also been used in combination with chemical and mechanical removal.

### ***Land Use Management***

Some of the identified sites have been impacted by land use practices. Development of a site management strategy will include identifying current land use practices causing pressure on the enhancement site and devise methods to mitigate that pressure. The strategies include both passive and active measures. The proposed Agua Fria River Master Plan may implement some of the strategies, but it will also require the participation of area municipalities.

This procedure also evaluated proposed strategies or enhancement areas based on their proposed future use. It is difficult to accurately predict future land use practices, but this evaluation made the general assumption that the area would have continued residential and urban growth and development. That assumption infers that land use would shift further away from agricultural practices. It also assumed that the public would continue to place a high value on natural areas, open space, and passive recreation.

It should also be noted that the various management techniques all assume a level of preservation or protection to stabilize the site and site use while the other management strategies are employed. Many of the management techniques proposed (such as access controls) are techniques that would be employed to enforce the preservation strategy. Preservation with no other intervention management may be suitable for isolated sites (Some of the alluvial fan sites in Area 2) but most sites will benefit from a combination of the various management strategies noted.

Some of the strategies included:

- Preservation (with no other intervention)
- Reduce or eliminate grazing in riparian areas

- 
- Limit off-road vehicle use in riparian areas
  - Establish buffer zones in high value areas (natural areas, open space, and passive recreation)
  - Match wildlife habitat type to surrounding area and proposed uses
  - Increase public awareness of enhancement opportunities and projects
  - Identify and promote special interest groups for longer-term management/monitoring of the specific sites
  - Identify potential funding sources

### ***Vegetation Enhancement***

Many of the identified areas contain remnant or relic vegetation communities. These communities can be enhanced through various management techniques. Many of these techniques are related to land use practices and invasive species management.

Appendix B of this document contains a series of recommended plant mixes for the various areas along the Agua Fria River corridor. The species within these mixes were chosen based on a variety of criteria, including the need to not restrict flow volumes within the channel.

Additional strategies included:

- Restrict access in select areas
- Initiate invasive species controls
- Utilize vegetation thinning
- Implement burning programs
- Reseed or replant specific species

## **4.0 Identified Enhancement Areas**

A brief description of the chosen enhancement sites is included in this section, along with recommendations for habitat enhancement techniques. **Figure 3** notes the location of the chosen enhancement areas.

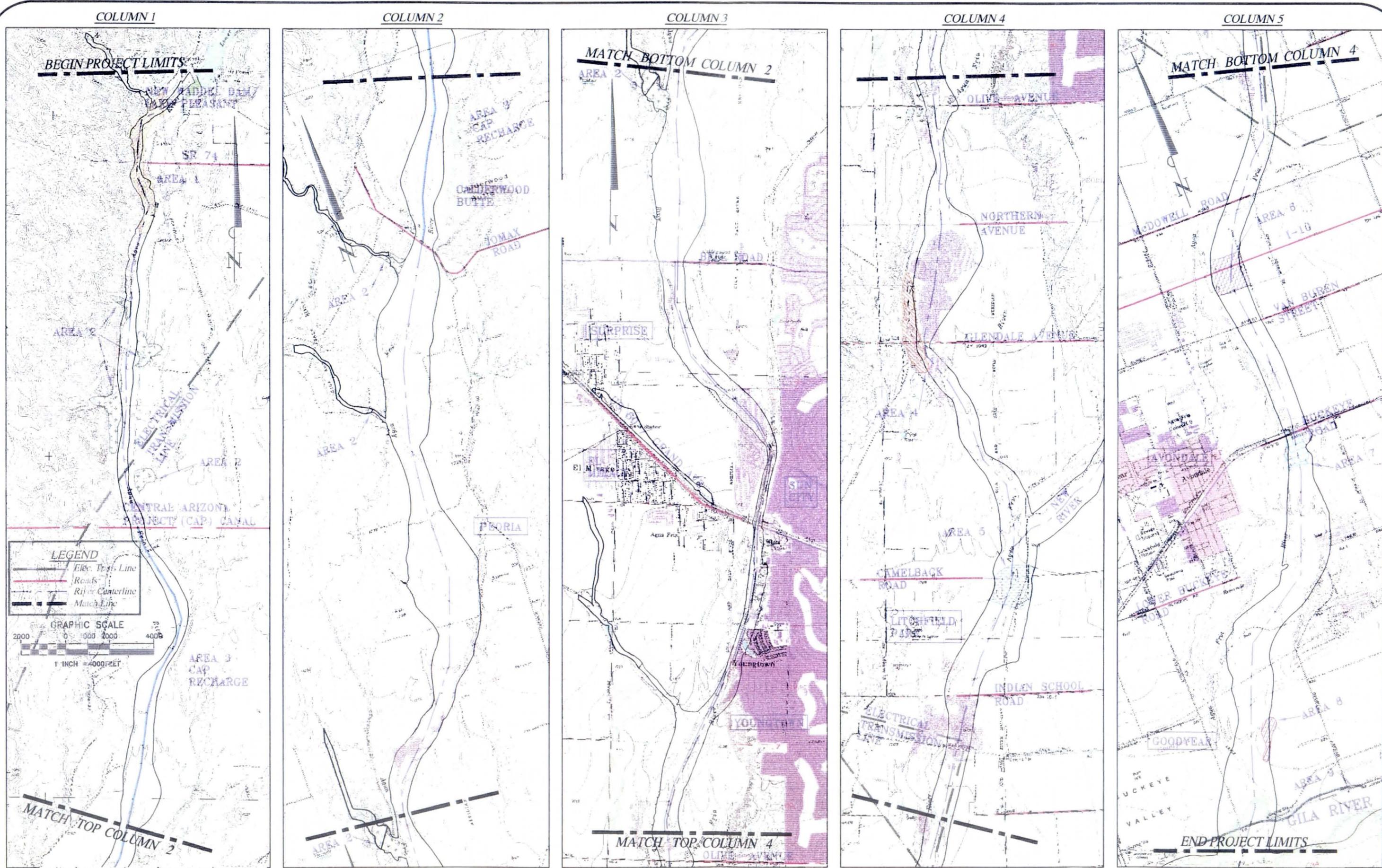
### ***Area 1- George's Pond/SR74 Riparian Area***

#### ***Land Ownership***

Land ownership for the George's Pond/SR74 riparian area includes the United States Bureau of Reclamation and the State of Arizona.

#### ***Existing Conditions***

The riparian area noted begins at the near perennial Morgan City Wash discharge and continues to the south past the State Route (SR) 74 Bridge and downstream for several thousand feet (**Appendix A-Area 1**). The site contains several near perennial pools in the northern portion and several intermittent pools in the southern section. The discharge has formed a sub-channel within the main channel that is lined with cottonwood (*Populus fremontii* and isolated *P. angustifolia*), willow (*Salix goodii* or hybrid), desert





willow (*Chilopsis linearis*) and other woody species. The majority of the species are mature specimens with minimal sapling populations. The site also supports hydrophytic herbaceous vegetation such as bulrush (*Scirpus* spp.), cattails (*Typha* spp.), and others.

The northern pond area (George's Pond) supports amphibian and aquatic species, and the entire system supports a very diverse group of small and moderate sized mammals and reptiles. The area is isolated by the high cliff banks of the geographic floodplain of the river corridor and by the relatively undeveloped Sonoran Upland vegetation communities along those banks. The closed canopy vegetation around the upper pond area and portions of the sub-channel, the rock cliffs, and the SR 74 Bridge provide shade and temperature moderation.

This community exhibits the remnants of a cottonwood/willow riparian community, provides open water and riparian habitat juxtaposed to a large stand of Sonoran upland habitat, and provides a level of isolation and cover. The nearby cliffs provide potential nesting and roosting habitat for species, such as the peregrine falcon (*Falco peregrinus anatum*), cliff swallow (*Hirundo pyrrhonota*), and several bat species. The utilization of this area by wildlife has been documented in the Ecological Evaluation Technical Report prepared as part of the Agua Fria River Watercourse Master Plan Study. The area has been grazed, impacted by off-road vehicular traffic, and has minor amounts of invasive species infestation.

The site may contain potentially suitable habitat for species listed under the Endangered Species Act. The United States Fish and Wildlife Service (USFWS) should be contacted prior to activity in this area.

The proposed enhancement techniques include:

- **Invasive Species Management**
  - Perform mechanical and limited herbicide treatments for invasive species control.
- **Vegetation Enhancement**
  - Develop a long-term vegetation management strategy.
  - Install various sapling willow and cottonwood to enhance community stability.
- **Land Use Management**
  - Establish local group to manage/monitor site.
  - Establish agreement with local users to prohibit or restrict grazing and off road vehicle use
    - Remove scattered debris from fugitive dumping.
    - Create physical barriers (fencing, boulder road blocks etc) to restrict or prohibit access
- **Hydroperiod Adjustments**
  - Coordinate with water user group to determine potential for additional discharge to the site.



### ***Area 2 – Xeric Riparian Communities on Alluvial Fans (Several locations)***

#### ***Land Ownership***

The location of these alluvial fan areas is scattered on primarily publicly owned lands. However, a few privately owned parcels are involved in this area.

#### ***Existing Conditions***

There is a series of ephemeral washes of varying size that discharge to the Agua Fria River channel. The majority of the washes identified are in the upper and northern portion of the central wash. These areas are vegetated primarily with acacia (*Acacia* spp.), mesquite (*Prosopis* spp.), ironwood (*Olneya tesota*) and paloverde (*Cercidium* spp). The vegetation community is located on small alluvial fans with multiple sub-channel discharge points. These areas represent the typical Sonoran desert xeric riparian vegetation community and provide valuable natural habitat to small mammals and avian species (**Appendix A – Area 2**).

Most are established communities with mature woody species and little invasive species development. Several blend to dense stands of saguaro and other succulents located on the upper reaches of the alluvial fan. These areas provide a linkage zone for upland wildlife to access the incised Agua Fria channel. The mature woody species also provide nesting and cover for avian and small mammals. Wildlife activity was high in these areas.

Proposed Enhancement techniques include:

#### **▪ Land Management Practice**

- A plan for preservation of some of these sites should be developed. Where practical, if these areas are utilized as recreational access points for the corridor, they should be developed as natural areas with minimal manipulation.
- Identify a local group to manage monitor and document these areas.
- No specific active enhancement strategies are proposed.

### ***Area 3 - CAP and Other Groundwater Recharge Sites (Several Locations)***

#### ***Land Ownership***

Area 3 landowners are comprised of the Maricopa County Municipal Water Conservation District, the United States Bureau of Reclamation and scattered private owners.

#### ***Existing Conditions***

The Central Arizona Project (CAP) canal crosses the Agua Fria channel via the Hayden Rhodes aqueduct south of the SR74 Bridge crossing. This area is the site of the discharge for the proposed CAP groundwater recharge project. There are several other areas along the Agua Fria River corridor where groundwater recharge facilitates are planned or in place.



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These areas will provide some additional wildlife habitat value with the creation of an open water area in an otherwise arid environment. However, the current regulatory structure promotes a utilitarian design of the facilities to reduce potential evapotranspiration losses (which would reduce potential groundwater recharge volumes). **Appendix A** contains ground photography of what an “institutionalized” groundwater recharge facility might look like and includes several photographs of possible vegetation treatments for groundwater recharge facilities.

Enhancement Techniques proposed for these sites include:

- **Land Management Strategies**
  - Promote a change in regulatory requirements to encourage a habitat enhancement approach to a portion of the recharge facility. Design techniques might include irregular shaped basins, sinuous delivery channels, interspersed deep pools, and variable pool depths.
- **Vegetation Enhancement**
  - Develop vegetation species recommendations that include low transpiration plants and develop vegetation communities with species that will promote shading of recharge areas (to reduce evaporation).

#### ***Area 4 - Colter Channel/Glendale Road site***

##### ***Land Ownership***

This area known referred to as the Colter Channel/Glendale Road site is primarily privately owned by various parties. The City of Glendale also owns a portion of this area.

##### ***Existing Conditions***

This site begins at the Colter channel point source discharge north of the Glendale Road crossing and continues several hundred feet to the south of the Glendale Road bridge (**Appendix A – Area 4**). The site apparently receives some discharge from the channel, the Luke Air Force Wastewater Treatment Plant (WWTP), and perhaps from the aggregate operation to the north.

The river channel is constricted along the west side of the channel above the Glendale Bridge and widens south of the bridge. The vegetation consists of riparian woody species and hydrophytic herbaceous vegetation. The vegetation community includes cottonwood, willow, common reed, and bulrush and contains invasive species such as tamarisk.

Enhancement Techniques proposed for these sites include:

- **Invasive Species Management**
  - Perform mechanical and limited herbicide treatments for invasive species control.
- **Vegetation Enhancement**
  - Coordinate vegetation enhancement with recreational development of the site (planned trail).



- Install various sapling willow and cottonwood to enhance community stability.

- **Land Use Management**

- Coordinate with aggregate operator for channel management.
- Coordinate development of proposed recreation trail to enhancement strategies.

- **Hydroperiod Adjustments**

- Coordinate with Luke Air Force Base WWTP to determine potential for additional discharge to the site.

### ***Area 5 - Camelback Road/ Channel Point Source Discharge***

#### ***Land Ownership***

The land ownership in Area 5 is primarily private.

#### ***Existing Conditions***

This area has been altered by recent activity in the channel to the north. Based on this site's proximity to the arrival and departure patterns of the Glendale Municipal Airport no enhancement is planned. Federal Aviation Administration (FAA) Bird Strike regulations discourage open water habitat within 10000 feet of the runway.

### ***Area 6 – Interstate -10 Bridge Area***

#### ***Land Ownership***

The lands in Area 6 are owned by the Arizona Department of Transportation, Maricopa County and the State of Arizona.

#### ***Existing Conditions***

This site is located adjacent and to the south of the I-10 Bridge crossing. The I-10 outfall channel discharges from parallel concrete channels that convey storm water and irrigation tail water to the site. The site includes a nearby grade-control structure that acts as a groundwater dam further enhancing moisture at the site. There are several surface channels across portions of the site, and the site was wet during most of the site visits. Appendix A contains ground photography of this area (**Appendix A – Area 6**).

The site is vegetated with herbaceous plants and some small woody species. The ground cover is 70 to 100 percent across most of the channel. There is evidence of small mammal and avian activity, throughout the area, including evidence of cliff swallow nesting under the bridge structures. Coyote and shorebird tracks were noted along the muddy shore of one small pond during an early spring visit.

The surrounding area is heavily developed. Residential and commercial development lines portions of the western bank. The soil cement river channels are relatively high and provide a fair level of isolation



for the site. The McDowell Road Bridge crosses the channel to the north of the site. The I-10 Bridges also provide shade to moderate temperatures and reduce evaporations losses.

This site has been chosen by the US Army Corps of Engineers (Corps) as a habitat enhancement area and may be funded under a Corps habitat enhancement program. The plans for the site are not complete, but the Master Plan suggests some small stilling basins for primary treatment of surface runoff, some minor reshaping of the surface to pond water and form channels, and revegetation with primarily herbaceous species. If shrub species are used, they will be planted in the excavated basin areas to reduce their overall height and potential effect on channel flows.

Enhancement techniques for these sites will be included in the proposed Corps habitat enhancement plans for the area. They will include techniques for:

- **Hydroperiod Enhancement**
  - Excavate shallow pond area, place additional low berms or grade control structures to retain/detain surface runoff.
  - Create “stream channel” for existing runoff
- **Invasive Species Management**
  - Perform mechanical and limited herbicide treatments for invasive species control.
- **Vegetation Enhancement**
  - Augment excavation, channel and berm areas with various plant mixes noted in Appendix B
  - Enhance vegetation to provide specific habitat for bat and avian species
  - Enhance vegetation with select placement of woody species to minimize affects to channel capacity and minimize the potential for development of snag areas.

### ***Area 7 - Buckeye Road site***

#### ***Land Ownership***

The Buckeye Road area land ownership consists of Maricopa County and the State of Arizona.

#### ***Existing Conditions***

This site currently contains a narrow band of cottonwood and some hydrophytic herbaceous vegetation starting at the railroad bridge and continuing to the south for several hundred feet before terminating at a pond area. The area exhibits evidence of periodic surface flow and retention of water after the cessation of the flow event (**Appendix A – Area 7**).

The Durango Channel, located on the north side of the roadway corridor is the point source discharge that supplies the site with water. The channel is a reliable source of precipitation generated surface runoff that is sometimes augmented by irrigation tailwater discharge.



This site has the potential for small mammal and avian wildlife habitat. Its proximity to the larger and permanent open water source at the Gila reduces its value as a unique or limited resource. However, if it could be linked to the Gila River corridor, the habitat value would increase.

This site may be included in the Corps proposed habitat enhancement project noted for Area 6. Potential enhancement opportunities include:

- **Hydroperiod Enhancement**
  - Excavate shallow pond area, place berms or grade control structures to retain/detain surface runoff.
- **Invasive Species Management**
  - Perform mechanical and limited herbicide treatments for invasive species control.
- **Vegetation Enhancement**
  - Introduce willow species into the cottonwood stand.
- **Land Use Management**
  - Coordinate with Corps and other stakeholders in proposed Corps habitat enhancement project
  - Explore funding opportunities with the Arizona Department of Environmental Quality (ADEQ) for agricultural discharge and storm water discharge..

### ***Area 8- City of Avondale's Waste Water Treatment Facility Wetland and Riparian Area***

#### ***Land Ownership***

The wetland and riparian areas referred to as Area 8 are privately owned.

#### ***Existing Conditions***

The Avondale Waste Water Treatment Plant (WWTP) is located on the east bank for the Agua Fria River to the north of the Gila River confluence. The facility discharges to a small wetland complex adjacent to the river channel and overflow from the wetland discharges to the Agua Fria channel. The wetland contains mature cottonwood species and hydrophytic herbaceous species. The channel discharge area also contains cottonwood, cattails, and bulrush. It also contains tamarisk. The wetland area has documented use by blue heron (*Ardea herodias*), grebes, and several other waterfowl species.

The Gila River confluence and the western bank area are included in a proposed riparian/wetland enhancement plan for the Gila River. Appendix A contains ground photography of this site (**Appendix A – Area 8**)



The proposed enhancement for this area includes:

- **Hydroperiod Enhancement**
  - Coordinate with the WWTP to determine if discharge rates can be increased.
- **Invasive Species Management**
  - Perform mechanical and limited herbicide treatments for invasive species control.
- **Vegetation Enhancement**
  - Supplement existing wetland vegetation with hydrophytic species, including species recommended for tertiary/polish treatment of municipal effluent.
- **Land Use Management**
  - Coordinate with the Flood Control District, City of Avondale, and other stakeholders to assure those enhancement strategies are compatible with plans.
  - Coordinate with City of Avondale WWTP to determine potential for creating/expanding wetland area as tertiary treatment facility.
  - Explore funding opportunities with the Arizona Department of Environmental Quality (ADEQ).

### ***Gila River Confluence***

The confluence of the Agua Fria River and the Gila River is also noted as a potential enhancement site. The site extends to the east and west along the braided channel of the Gila River. It includes an area of previous enhancement, known locally as the Chicken Ranch site. This portion of the Gila River has a perennial flow from upstream WWTP discharges. It also contains a large open water area that is part of the irrigation delivery system.

The site is vegetated with a dense stand of woody species that is dominated by tamarisk with inclusions of cottonwood and other species. Many areas exhibit a closed canopy. Several large snag trees are also located within the area, which can be important roosting or nesting sites. Active agricultural fields or the abandoned land of the Chicken Ranch site surrounds the enhancement site. The Avondale WWTP discharge is to the north of the site. Avian activity is very high, and includes an apparent heron rookery on Gila River bank just east of the Agua Fria channel. (See Ecological Evaluation of the Lower Agua Fria River Corridor New Waddell Dam to Confluence with the Gila River). Small and moderate sized mammal activity (mice, rabbit, hare, raccoon and coyote) was also high.

This area is currently included in several additional proposed enhancement plans being promoted by various agencies. Any enhancement strategies should be closely coordinate with those agencies. Additionally, the site contains habitat that might be considered suitable habitat for several species listed on the Endangered Species Act. The USFWS should be contacted prior to any activity in the area.

- **Hydroperiod Enhancement**



- The lower portion of the Agua Fria channel could be excavated and receive water from the Gila River or from the elevated water table of the area.
- **Vegetation Enhancement**
  - Additional woody species could be planted outside of the channel, along the banks, and at the edges of the adjacent fields. This would provide additional avian habitat.
- **Land Use Management**
  - Coordinate with the Flood Control District, City of Avondale, and other stakeholders to assure those enhancement strategies are compatible with plans for the Gila River and adjacent areas. Of particular interest is the potential to connect the Avondale WWTP wetland site to the Gila confluence site.
  - Create local interest group to track site progress and record avian species use.
  - Coordinate with USFWS to determine potential for enhancement as protected species habitat.

#### ***Park Sites and Trails***

The Agua Fria Watercourse Master Plan recommends a series of parks and trails along the majority of the corridor. These parks range from trailhead staging areas to interactive stops along the trail. Some of these areas, particularly those that will be irrigated will be vegetated with a Mediterranean vegetation mix that is designed to provide the setting necessary for the park user and to enhance avian habitat.

It has been noted that many passerine birds (songbirds) respond favorably to a mix of mesic shrubs, trees, and herbaceous species. Many of the species in this mix are not natives of the Sonoran desert community or the xeric riparian community. However, this community does provide viable habitat for avian species. There is little concern about the community invading other areas of the corridor because of the artificial moisture regime required to sustain it.

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## ***Documents, Agencies, Internet Sources***

Agua Fria Watercourse Master Plan – Visual Resources Inventory and Scenic Quality Assessment. Jay Hicks EDAW 2001

Arizona Guidance Manual for Constructed Wetlands for Water Quality Improvement. Document TM 95-1 Arizona Department of Environmental Quality. May 1995

Determination of Resistance Due to Shrubs and Woody Vegetation. ERDC/TR-00-25. Gary Freeman, William H. Rahmeyer and Ronald R. Copeland. US Army Corps of Engineers - Engineer and Development Center - Coastal and Hydraulics Laboratory. October 2000.

Ecological Evaluation of the Lower Agua Fria River Corridor from New Waddell Dam to the Confluence with Gila River. Marcie Martin, Jennifer Simpkins and Bruce Wilcox. Kimley-Horn and Associates, Inc. 2001

Groundwater Recharge – Alternative Analysis Report. Fluid Solutions. 2001

Guiding Principles for Constructed Treatment Wetlands: Providing Water Quality and Wildlife Habitat (Working Draft). Interagency Workgroup on Constructed Wetlands June 1999

Method to Estimate Effects of Flow-Induced Vegetation Changes on Channel Conveyances of Streams in Central Arizona. Water Resources Investigation Report 98-4040. USGS and Flood Control District of Maricopa County. 1998

Once a River – Bird Life and Habitat Changes on the Middle Gila. Amadeo M. Rea. University of Arizona Press 1983

Recreation Corridor Master Plan Cornoyer-Hedrick 2001

Riparian Ecosystem Restoration in the Gila River Basin Opportunities and Constraint. Workshop Proceedings. Water Resource Center, University of Arizona. October 1999

Verification of Roughness Coefficients for Selected Natural and Constructed Stream Channels in Arizona. USGS Professional Paper 1584. USGS and Flood Control District of Maricopa County 1998

West Valley Common Ground: The Agua Fria as A Corridor of Natural, Historic, Cultural and Recreational Resources. Nancy Dallett 2001



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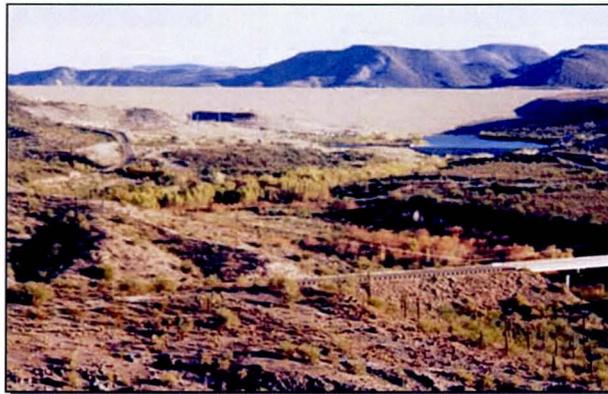
## *Appendix A – Ground Photography*

### ***Area 1 – George’s Pond and Riparian Areas at State Route 74 Bridge***

These photographs are examples of the habitat provided by the increased moisture regime of a near perennial discharge from the Morgan City Wash and perhaps seepage from the river channel. The riparian area continues under the SR 74 bridge downstream and forms several seasonal pools that further enhance the wildlife habitat value.

The first photograph provides an overview of the portion of the site north of the SR 74 Bridge. Morgan City Wash can be seen entering from the left (west) side of the photograph (the tree-lined corridor). Hidden in the central portion of the tree-cover is a small wetland/pond area that provides aquatic habitat.

The second photograph is a close-up of the wetland area. The wetland is surrounded by cottonwood, willow and tamarisk, which provide excellent cover and temperature moderation. The third photograph is taken at the downstream extent of this area. It illustrates one of the seasonal/ephemeral pools formed by the surface runoff. Although dry at the time of the photograph, the large number of tracks in the mud/sand indicates the level of wildlife traffic to the area.



## **Area 2 – Scattered Alluvial Fan Vegetation Areas**

These photographs illustrate several of the washes/channels that discharge into the Upper and Middle Reaches of the Agua Fria River channel. The upper two photographs are of a moderate sized (sized by apparent flow not topographic features) wash in the Upper Reach and the third photograph is of a wash in the Middle Reach. The distance photograph of the Upper Reach wash clearly shows the dense green vegetation associated with the alluvial fans of these areas. The close-up photograph, of the same wash, illustrates the vegetation along the bottom of the wash immediately above the alluvial fan discharge. These areas are excellent xeric riparian habitat, providing cover, nesting and forage material for avian and small/moderate sized mammals.

The third photograph illustrates a wash in the Middle Reach with less dramatic topography and vegetation. This wash has an apparent “low flow channel” and has established low terraces adjacent to the channel. The bottom and terraces of these areas retain moisture (surface and near surface saturates soils) from surface runoff and therefore provide an increased hydroperiod for vegetation. Vegetation established on the first terrace level is isolated from the scouring action of most ordinary flow events and therefore can become more established. The woody species in the right-center of the photograph are an example of the results of that increased hydroperiod. The incised banks of the wash form a degree of isolation and cover for area wildlife and the increased vegetation further augments the cover along with adding some forage value.



### **Area 3 – Recharge Facilities**

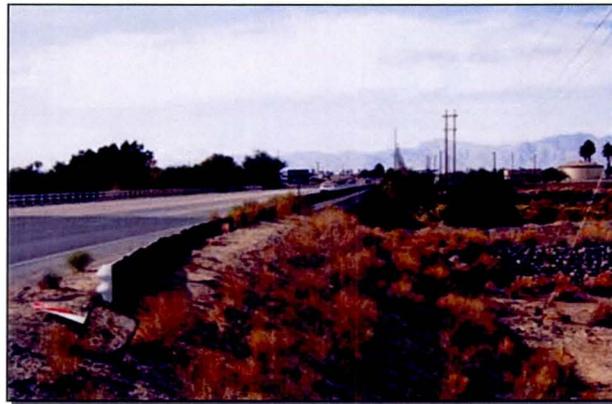
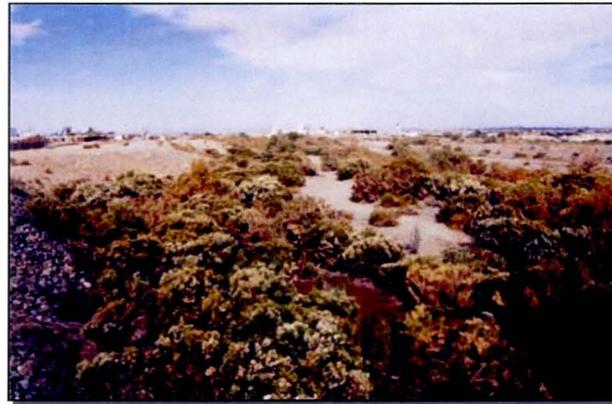
The first photograph illustrates the “institutional” recharge facility configuration. This highly managed approach results in the greatest amount of recharge to the aquifer (which is the purpose of the facility). The second two photographs illustrate vegetation enhancement and construction of delivery channels/basins to provide habitat and aesthetic values. The addition of the vegetation and the sinuous channels reduces recharge efficiency, makes maintenance more difficult and is construction that is more expensive. Currently, the regulatory restrictions on groundwater recharge do not promote the addition of vegetation.

It should be noted that the facilities in this photography are not groundwater recharge sites. The basins are apparently part of a water management system for an aggregate plant and the channel and wetland areas are part of an effluent discharge facility. They are however, very similar to what could be expected in a recharge site.



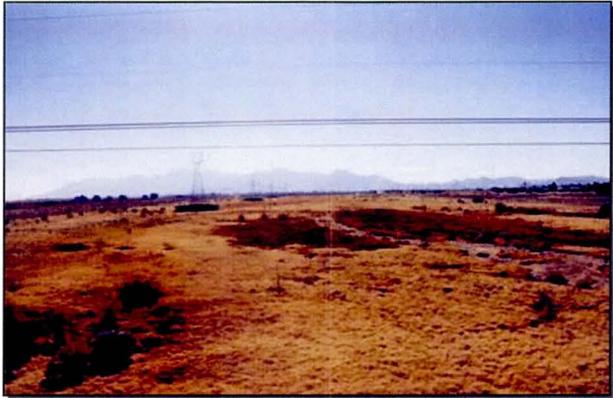
**Area 4 – Collter Channel/Glendale Road Site**

These photographs illustrate the riparian vegetation associated with the narrow channel discharge along this portion of the Agua Fria River. The woody vegetation includes cottonwood, willow and is dominated by tamarisk. The hydroperiod for this site varied during the numerous reconnaissance visits from running water to dry soil. The site apparently receives varying discharge from the stormwater channel (Collter), Luke Air Force Base WWTP and the upstream aggregate site.



**Area 6 – Interstate 10 Bridge Area**

These photograph illustrate the vegetation cover noted at the I-10 Bridge site. The area receives discharge from a large stormwater channel that parallels the north side of the I-10 corridor. While the amount of runoff varies, the adjacent grade control structure retains soil moisture and vegetation growth is enhanced. The herbaceous cover noted includes hydrophytic species such as bulrush and water pepper as well as mesic graminoids (near the fringes of the area).



**Area 7 – Buckeye Road Area**

This site receives runoff from a storm channel adjacent to the railroad/roadway route. The “pond area” illustrated in the photograph was inundated during one visit and was wet or had near-surface saturate soils during all of the visits. Woody vegetation (cottonwood, tamarisk and other) is located along the perimeter of the pond. This area exhibited multi-aged stands of woody vegetation (left center of photograph shows sapling sized woody species)



***Area 8 – Avondale WWTP Discharge Site***

This site receives effluent discharge from the City of Avondale WWTP facility. A small wetland area is visible in the right center of the photograph (sunlight glint on open water). The wetland and the discharge channel are vegetated are lined with woody species (cottonwood, tamarisk and others) and contain hydrophytic herbaceous species (cattails, bulrush). This area is adjacent to active agricultural fields and is close to the Gila River confluence.





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*Appendix B – Vegetation Enhancement Species Mixes*

Wetland Pond Vegetation Emergent palustrine early-level successional community		Attributes					
Common Name	Botanical Name	Hydrologic Component <sup>1</sup>	Water Quality <sup>2</sup>	Moisture Regime <sup>3</sup>	Wildlife Value		General Comment
					Species <sup>4</sup>	Type <sup>5</sup>	
Arrowhead	<i>Sagittaria cuneata</i>	Low	Good	Aquatic	Waterfowl Shorebirds Small Mammals	Cover, Forage	Emergent or submerged. Rhizomes
Big galleta	<i>Hilaria rigida</i>	Low	Moderate	Upland Ground	Ground Birds Small Mammals	Cover, Forage	Bunchgrass up to 1 meter tall. Withstands high temperatures w/o dormancy.
Bulrush	<i>Scirpus acutus</i> Varied other species	Moderate	Excellent	Aquatic, Shoreline	Waterfowl Shorebirds Small Mammals	Cover, Nesting	Persistent emergent (2-4 meters tall). Dense monotypic stands. Rhizomes
Button-bush	<i>Cephalanthus occidentalis</i>	High	Good	Shoreline Low Upland	Song Birds Small Mammals	Cover, Forage, Nesting	Shrub (< 3 meters tall), Wet soils
Cattail	<i>Typha latifolia</i>	Moderate	Excellent	Aquatic Shoreline	Waterfowl Shorebirds, Songbirds Small Mammals	Cover, Nesting	Persistent emergent (<2 meters). Dense monotypic stands. Rhizomes
Coyote willow	<i>Salix exigua</i>	High	Moderate	Shoreline Low Upland	Song Birds Ground Birds Small Mammals	Cover, Nesting	Shrub (can exceed 3 meters). Very pliable stems.
Duckweed	<i>Lemna spp.</i>	Low	Good	Aquatic, Shoreline	Waterfowl Shorebirds	Cover, Forage	Floating aquatic. Invasive. Aesthetically unpleasing
Horsetail	<i>Equisetum laevigatum</i>	Low	Moderate	Shoreline Low Upland	Shorebirds	Cover, Forage	Emergent/wet soil. Rhizomes
Knotweed	<i>Polygonum spp.</i>	Low	Moderate	Aquatic, Shoreline	Waterfowl Shorebirds Small Mammals	Cover, Nesting	Emergent/wet soil. Forms large masses.
Panic grass	<i>Dichanthelium oligosanthes</i>	Low	Moderate	Shoreline Low Upland	All Birds Small Mammals	Cover, Forage, Nesting	Wet soils. Normally at elevations > 3000 feet.
Pondweed	<i>Potamogeton spp.</i>	Low	Good	Aquatic, Shoreline	Waterfowl Shorebirds	Cover, Forage, Nesting	Several species floating and submerged. Aesthetically unpleasing.
Red-osier dogwood	<i>Cornus stolonifera</i>	High	Good to Moderate	Shoreline Low Upland	Waterfowl Shorebirds Small Mammals	Cover, Forage, Nesting	Shrub 1 -3 meters tall. Can form dense stands at shoreline.
Reed	<i>Phragmites communis</i>	Moderate to High	Excellent	Aquatic, Shoreline	Waterfowl Shorebirds Song Birds	Cover, Forage, Nesting	Persistent emergent (2-4 meters). Very invasive w/ dense monotypic stands. Rhizomes
Rush	<i>Juncus balticus</i>	Moderate	Excellent	Aquatic, Shoreline	Waterfowl Shorebirds Small Mammals	Cover, Forage, Nesting	Persistent emergent (1-2 meters). Dense monotypic stands. Rhizomes

Wetland Pond Vegetation Emergent palustrine early-level successional community		Attributes					
Common Name	Botanical Name	Hydrologic Component <sup>1</sup>	Water Quality <sup>2</sup>	Moisture Regime <sup>3</sup>	Wildlife Value		General Comment
					Species <sup>4</sup>	Type <sup>5</sup>	
Salt grass	<i>Distichlis spicata</i>	Low	Moderate	Shoreline Low Upland	Shorebirds Small Mammals	Cover	Salt tolerant sod-forming grass
Sedge	<i>Carex spp</i>	Low	Moderate	Aquatic Shoreline Low Upland	Waterfowl Shorebirds Song Birds Small Mammals	Cover, Forage	Varying habitats from inundated to wet soil.
Spike-rush	<i>Eleocharis spp.</i>	Low	Moderate	Aquatic, Shoreline	Small Mammals, Upland Avian, Water Fowl	Cover, Forage	Several species, one salt tolerant

**NOTES:**

- 1 Hydrologic Component is a measure of the vegetations contribution to resistance to channel flows. It is a combination of the N-Value ( a friction coefficient) and the species flexibility and propensity for creating channel clogging snag material
- 2 Water quality is a measure of the vegetations aboility to retain sediment, stabilize shorelines or uptake constituents. See accompanying text.
- 3 . **Aquatic** mositure regime areas are normally inundated. **Shoreline** moisture regime is normally saturated or barely inundated. **Low Upland** moisture regime is occasionally inundated but is mostly dry. **Upland** mositure regime is normally dry, with occasional short duration wet periods. The upland moisture regime includes the Xeric-ripraian areas found along desert washes..
- 4 **Waterfowl** are species that normally float or swim. **Shorebirds** are normally wading birds and do not swim. **Songbirds** are primarily passerine migratory speices. **Raptors** are upland birds of prey, that will utilize all of the vegetation communities for hunting. **Small Mammals** are normally upland species coyote sized or smaller.
- 5 Habitat Types include **Cover**, which supplies wildlife with hiding areas and protected travel corridors; **Forage** which supplies wildlife with vegetative food (predation is not included in forage) and **Nesting** which includes the location of the nest and material necessary to build the nest.

Hydric Riparian (Riparian Vegetation) Hydric/mesic mid-level successional to climax riparian community		Attributes					
Common Name	Botanical Name	Hydrologic Component 1	Water Quality 2	Moisture Regime 3	Wildlife Value		General Comment
					Species 4	Type 5	
Big galleta	<i>Hilaria rigida</i>	Low	Moderate	Upland	Ground Birds Small Mammals	Cover, Forage, Nesting	Bunchgrass up to 1 meter tall. Withstands high temperatures w/o dormancy.
Blue paloverde	<i>Cercidium floridum</i>	High	Low	Upland	Songbirds Raptors Small Mammals	Cover, Forage Nesting	Small Tree
Bulrush	<i>Scirpus acutus</i> Varied other species	Moderate	Excellent	Aquatic, Shoreline Low Upland	Waterfowl Songbirds Shorebirds Small Mammals	Cover, Nesting	Persistent emergent (2-4 meters tall). Dense monotypic stands Rhizomes
Button-bush	<i>Cephalanthus occidentalis</i>	Moderate	Good	Aquatic, Shoreline Low Upland	Songbirds Small Mammals	Cover, Forage, Nesting	Shrub (< 3 meters tall), Wet soils
Sedge species	<i>Carex spp.</i> <i>Cyperus spp.</i>	Low	Moderate	Aquatic, Shoreline	Shorebirds Songbirds Small Mammals	Cover, Forage, Nesting	Hydric to mesic grass-like species
Coyote willow Other willows	<i>Salix exigua</i>	High	Moderate	Shoreline Low Upland	Songbirds Ground Birds Small Mammals	Cover, Nesting	Shrub (can exceed 3 meters). Very pliable stems. Other species such as <i>S. gooddingii</i> are tree-sized
Cottonwood	<i>Populus fremontii</i>	Extreme	Low, High Transporation	Low Upland Upland	Songbirds Raptors Small Mammals	Cover, Forage, Nesting	Large tree. Potential for large snags
Ironwood	<i>Olneya tesota</i>	High	Low	Upland	Songbirds Raptors Small Mammals	Cover, Forage, Nesting	Moderate height tree w/branches to surface.
Knotgrass	<i>Paspalum distichum</i>	Low	Low	Shoreline	Waterfowl Songbirds Shorebirds Small Mammals	Cover, Forage, Nesting	Low-growth grass along banks
Reed	<i>Phragmites communis</i>	Moderate to High	Excellent	Aquatic, Shoreline	Waterfowl Songbirds Shorebirds Small Mammals	Cover, Forage, Nesting	Persistent emergent (2-4 meters). Very invasive w/ dense monotypic stands. Rhizomes
Sycamore	<i>Plantus wrightii</i>	Extreme	Low, High Transporation	Upland Ground	Songbirds Raptors Small Mammals	Cover, Forage, Nesting	Large tree. Potential for large snags.

**NOTES:**

1 Hydrologic Component is a measure of the vegetations contribution to resistance to channel flows. It is a combination of the N-Value ( a friction coefficient) and the species flexibility and propensity for creating channel clogging snag material

2 Water quality is a measure of the vegetations aboility to retain sediment, stabilize shorelines or uptake constituents. See accompanying text.

3 . **Aquatic** moisture regime areas are normally inundated. **Shoreline** moisture regime is normally saturated or barely inundated. **Low Upland** moisture regime is occasionally inundated but is mostly dry. **Upland** moisture regime is normally dry, with occasional short duration wet periods. The upland moisture regime includes the Xeric-riparian areas found along desert washes..

4 **Waterfowl** are species that normally float or swim. **Shorebirds** are normally wading birds and do not swim. **Songbirds** are primarily passerine migratory speices. **Raptors** are upland birds of prey, that will utilize all of the vegetation communities for hunting. **Small Mammals** are normally upland species coyote sized or smaller.

5 Habitat Types include **Cover**, which supplies wildlife with hiding areas and protected travel corridors. **Forage** which supplies wildlife with vegetative food (predation is not included in forage) and **Nesting** which includes the location of the nest and material necessary to build the nest.

Mesic Riparian (Bosque Vegetation) Mesic mid-level successional community		Attributes					
Common Name	Botanical Name	Hydrologic Component <sup>1</sup>	Water Quality <sup>2</sup>	Moisture Regime <sup>3</sup>	Wildlife Value		General Comment
					Species <sup>4</sup>	Type <sup>5</sup>	
Acacia	<i>Acacia greggii</i>	High	Low	Upland	Songbirds Raptors Small Mammals	Cover, Forage, Nesting	
Big galleta	<i>Hilaria rigida</i>	Low	Moderate	Upland	Songbirds Raptors Small Mammals	Cover, Forage	Bunchgrass up to 1 meter tall. Withstands high temperatures w/o dormancy.
Curly mesquite	<i>Hilaria belangeri</i>	Low	Moderate	Upland	Songbirds Raptors Small Mammals	Cover, Forage, Nesting	Sod forming grass.
Desert Hackberry	<i>Celtis pallida</i>	High	Low	Upland	Songbirds Small Mammals	Cover, Forage, Nesting	Moderate sized trees. Dense growth pattern
Ironwood	<i>Olyena tesota</i>	High	Low	Upland	Songbirds Raptors Small Mammals	Cover, Forage	Moderate sized tree.
Jojoba	<i>Simmondsia chinensis</i>	Low	Low	Upland	Songbirds Small Mammals	Cover	
Knotweed	<i>Polygonum spp.</i>	Low	Moderate	Low Upland	Small Mammals	Cover, Nesting	Emergent/wet soil. Forms large masses.
Mesquite	<i>Prosopis spp.</i>	High	Moderate	Upland	Songbirds Raptors Small Mammals	Cover, Forage, Nesting	Large shrub to tree. Can form tickets.
Panic grass	<i>Dichanthelium oligosanthos</i>	Low	Moderate	Shoreline Low Upland	Songbirds Small Mammals	Cover, Forage, Nesting	Wet soils. Normally at elevations > 3000 feet.
Sedge species	<i>Cyperus spp.</i>	Low	Moderate	Shoreline Low Upland	Songbirds Small Mammals	Cover, Forage	Hydric to mesic grass-like species

**NOTES:**

1 Hydrologic Component is a measure of the vegetations contribution to resistance to channel flows. It is a combination of the N-Value ( a friction coefficient) and the species flexibility and propensity for creating channel clogging snag material

2 Water quality is a measure of the vegetations aboility to retain sediment, stabilize shorelines or uptake constituents. See accompanying text.

3 . **Aquatic** mositure regime areas are normally inundated. **Shoreline** moisture regime is normally saturated or barely inundated. **Low Upland** moisture regime is occasionally inundated but is mostly dry. **Upland** moisture regime is normally dry, with occasional short duration wet periods. The upland moisture regime includes the Xeric-ripraian areas found along desert washes..

4 **Waterfowl** are species that normally float or swim. **Shorebirds** are normally wading birds and do not swim. **Songbirds** are primarily passerine migratory speices. **Raptors** are upland birds of prey, that will utilize all of the vegetation communities for hunting. **Small Mammals** are normally upland species coyote sized or smaller.

5 Habitat Types include **Cover**, which supplies wildlife with hiding areas and protected travel corridors; **Forage** which supplies wildlife with vegetative food (predation is not included in forage) and **Nesting** which includes the location of the nest and material necessary to build the nest.

Xeric Riparian (Intermittent Flow Vegetation) Mesic/Xeric early-level successional community		Attributes					
Common Name	Botanical Name	Hydrologic Component <sup>1</sup>	Water Quality <sup>2</sup>	Moisture Regime <sup>3</sup>	Wildlife Value		General Comment
					Species <sup>4</sup>	Type <sup>5</sup>	
Alkali sacaton	<i>Sporobolus airoides</i>	Low	Low	Upland	Songbirds Small Mammals	Cover, Forage	Bunchgrass up to 1 meter tall. Withstands alkali soils.
Big galleta	<i>Hilaria rigida</i>	Low	Moderate	Upland	Songbirds Small Mammals	Cover, Forage	Bunchgrass up to 1 meter tall. Withstands high temperatures w/o dormancy.
Brittlebush	<i>Encelia farinosa</i>	Low	Low	Upland	Songbirds Small Mammals	Cover, Forage	
Bursage	<i>Ambrosia spp</i>	Low	Low	Upland	Songbirds Small Mammals	Cover, Forage	Low-growth shrub. Several species
Bush mulhy	<i>Muhlenbergia porteri</i>	Low	Low	Upland	Songbirds Small Mammals	Cover, Forage	Bunchgrass up to 1 meter tall. Tends to form large singular bunches.
Cereus	<i>Peniocereus greggii</i>	Low	Low	Upland	Songbirds Small Mammals	Cover, Forage	
Creosotebush	<i>Larrea tridentata</i>	Moderate	Low	Upland	Songbirds Small Mammals	Cover	Medium growth shrub w/ open structure
Desert broom	<i>Baccharis sarothroides</i>	Moderate	Low	Upland	Songbirds Small Mammals	Cover, Forage	
Paloverde	<i>Cercidium spp</i>	High	Low	Upland	Songbirds Raptors Small Mammals	Cover, Forage, Nesting	Moderate height tree w/ branches to surface
Sidecoats gramma	<i>Bouteloua curtipendula</i>	Low	Moderate		Songbirds		Bunchgrass up to 1 meter tall.
Bluc gramma	<i>Bouteloua gracilis</i>	Low	Moderate	Upland	Small Mammals	Cover, Forage	Bunchgrass no higher than 0.5 meters
Snakeweed	<i>Gutierrezia sarothrae</i>	Low	Low	Upland	Songbirds Small Mammals	Cover, Forage	Small bushy herbaceous plant
Spike dropseed	<i>Sporobolus contractus</i>	Low	Low	Upland	Songbirds Small Mammals	Cover, Forage	Bunchgrass grows to 1.5 meters

NOTES

1 Hydrologic Component is a measure of the vegetations contribution to resistance to channel flows. It is a combination of the N-Value ( a friction coefficient) and the species flexibility and propensity for creating channel clogging snag material

2 Water quality is a measure of the vegetations ability to retain sediment, stabilize shorelines or uptake constituents. See accompanying text.

3 . **Aquatic** moisture regime areas are normally inundated. **Shoreline** moisture regime is normally saturated or barely inundated. **Low Upland** moisture regime is occasionally inundated but is mostly dry. **Upland** moisture regime is normally dry, with occasional short duration wet periods. The upland moisture regime includes the Xeric-riparian areas found along desert washes..

4 **Waterfowl** are species that normally float or swim.**Shorebirds** are normally wading birds and do not swim. **Songbirds** are primarily passerine migratory species. **Raptors** are upland birds of prey, that will utilize all of the vegetation communities for hunting.**Small Mammals** are normally upland species coyote sized or smaller.

5 Habitat Types include **Cover**, which supplies wildlife with hiding areas and protected travel corridors.**Forage** which supplies wildlife with vegetative food (predation is not included in forage) and **Nesting** which includes the location of the nest and material necessary to build the nest.

Ephemeral Flow Vegetation (Dry Channel Vegetation) Xeric early-level successional community		Attributes					
Common Name	Botanical Name	Hydrologic Component <sup>1</sup>	Water Quality <sup>2</sup>	Moisture Regime <sup>3</sup>	Wildlife Value		General Comment
					Species <sup>4</sup>	Type <sup>5</sup>	
Acacia	<i>Acacia greggii</i>	High	Low	Upland	Songbirds Small Mammals	Cover, Forage, Nesting	Small tree w/ dense branching close to ground
Big galleta	<i>Hilaria rigida</i>	Low	Moderate	Upland	Songbirds Small Mammals	Cover, Forage	Bunchgrass up to 1 meter tall. Withstands high temperatures w/o dormancy.
Bursage	<i>Ambrosia spp</i>	Low	Low	Upland	Songbirds Small Mammals	Cover, Forage	Low-growth shrub. Several species
Creosotebush	<i>Larrea tridentata</i>	Moderate	Low	Upland	Songbirds Small Mammals	Cover, Forage, Nesting	Medium growth shrub w/ open structure
Curly mesquite	<i>Hilaria belangeri</i>	Low	Moderate	Upland	Raptors Songbirds Small Mammals	Cover, Forage, Nesting	Sod forming grass.
Desert broom	<i>Baccharis sarothroides</i>	Moderate	Low	Upland	Songbirds Small Mammals	Cover, Forage	
Fluffgrass	<i>Erioneuron pulchellus</i>	Very Low	N/A	Upland	Songbirds Small Mammals	Cover, Forage	Forage choice for tortoise
Foothill paloverde	<i>Cercidium microphyllum</i>	N/A	N/A	Upland	Raptors Songbirds Small Mammals	Cover, Forage, Nesting	Moderate height tree w/ branches to surface
Saltbush	<i>Atriplex spp.</i>	Low	N/A	Upland	Songbirds Small Mammals	Cover, Forage	Low-growth shrub. Several species
Sidecoats gramma	<i>Bouteloua curtipendula</i>	Low	Moderate		Songbirds		Bunchgrass up to 1 meter tall.
Blue gramma	<i>Bouteloua gracilis</i>	Low	Moderate	Upland	Songbirds Small Mammals	Cover, Forage	Bunchgrass no higher than 0.5 meters
Snakeweed	<i>Gutierrezia sarothrae</i>	Low	Low	Upland	Songbirds Small Mammals	Cover, Forage	Small bushy herbaceous plant
Spike dropseed	<i>Sporobolus contractus</i>	Low	Low	Upland	Songbirds Small Mammals	Cover, Forage	Bunchgrass grows to 1.5 meters
<b>NOTES:</b>							
1 Hydrologic Component is a measure of the vegetations contribution to resistance to channel flows. It is a combination of the N-Value ( a friction coefficient) and the species flexibility and propensity for creating channel clogging snag material							
2 Water quality is a measure of the vegetations ability to retain sediment, stabilize shorelines or uptake constituents. See accompanying text.							
3 . <b>Aquatic</b> moisture regime areas are normally inundated. <b>Shoreline</b> moisture regime is normally saturated or barely inundated. <b>Low Upland</b> moisture regime is occasionally inundated but is mostly dry. <b>Upland</b> moisture regime is normally dry, with occasional short duration wet periods. The upland moisture regime includes the Xeric-riparian areas found along desert washes..							
4 <b>Waterfowl</b> are species that normally float or swim. <b>Shorebirds</b> are normally wading birds and do not swim. <b>Songbirds</b> are primarily passerine migratory species. <b>Raptors</b> are upland birds of prey, that will utilize all of the vegetation communities for hunting <b>Small Mammals</b> are normally upland species coyote sized or smaller.							
5 Habitat Types include <b>Cover</b> , which supplies wildlife with hiding areas and protected travel corridors; <b>Forage</b> which supplies wildlife with vegetative food (predation is not included in forage) and <b>Nesting</b> which includes the location of the nest and material necessary to build the nest.							

Upland Shrub (Dry Hill Slope Vegetation) Xeric climax community		Attributes					
Common Name	Botanical Name	Hydrologic Component <sup>1</sup>	Water Quality <sup>2</sup>	Moisture Regime <sup>3</sup>	Wildlife Value		General Comment
					Species <sup>4</sup>	Type <sup>5</sup>	
Barrel Cactus	<i>Ferocactus spp</i>	N/A	N/A	Upland	Songbirds Small Mammals	Forage, Nesting	Various species
Cholla	<i>Opuntia spp</i>	N/A	N/A	Upland	Songbirds Small Mammals	Cover, Nesting	Various species
Pincushion cacti	<i>Mammillaria spp</i>	N/A	N/A	Upland	Songbirds Small Mammals	Forage, Nesting	Various species
Foothill paloverde	<i>Cercidium microphyllum</i>	N/A	N/A	Upland	Songbirds Small Mammals	Cover, Forage, Nesting	Primarily along wash banks
Ocotillo	<i>Fouquieria splendens</i>	N/A	N/A	Upland	Songbirds Small Mammals	Cover, Forage	
				Upland			
Saguaro	<i>Carnegiea gigantea</i>	N/A	N/A	Upland	Songbirds Small Mammals	Cover, Forage, Nesting	

**NOTES:**

- 1 Hydrologic Component is a measure of the vegetations contribution to resistance to channel flows. It is a combination of the N-Value ( a friction coefficient) and the species flexibility and propensity for creating channel clogging snag material
- 2 Water quality is a measure of the vegetations aboility to retain sediment, stabilize shorelines or uptake constituents. See accompanying text.
- 3 . **Aquatic** moisture regime areas are normally inundated. **Shoreline** moisture regime is normally saturated or barely inundated. **Low Upland** moisture regime is occasionally inundated but is mostly dry. **Upland** moisture regime is normally dry, with occasional short duration wet periods. The upland moisture regime includes the Xeric-ripraian areas found along desert washes..
- 4 **Waterfowl** are species that normally float or swim. **Shorebirds** are normally wading birds and do not swim. **Songbirds** are primarily passerine migratory speices. **Raptors** are upland birds of prey, that will utilize all of the vegetation communities for hunting. **Small Mammals** are normally upland species coyote sized or smaller.
- 5 Habitat Types include **Cover**, which supplies wildlife with hiding areas and protected travel corridors; **Forage** which supplies wildlife with vegetative food (predation is not included in forage) and **Nesting** which includes the location of the nest and material necessary to build the nest.