

## Growing Sonoran Desert Native Plants

The conditions that create the incredible diversity of the Sonoran Desert--the extreme temperatures, low rainfall, and the unpredictability of both, in addition to difficult soils--also provide challenges to growers and propagators attempting to understand and grow species from the desert. For instance, our spectacular spring desert wildflower displays are dependent on many unknown variables. Several of those variables are known: fall germination is necessary; fall rain is required; and regular rainfall is needed until March (Dimmit, 2000). These factors are difficult to replicate in a garden to stimulate the kind of display that causes traffic jams at Picacho Peak. The variability that produces the Sonoran Desert landscape are not characteristics the public and nursery industry seeks. The industry has educated the public to expect plants that are as predictable as night and day.

Nurseries generally rely on their ability to sell showy, dependable, easily maintained plants. Some Sonoran Desert plants fit that mold, and are reliable, predictable and as spectacular as any in the world. These particular plants have been captured by propagators and are found in many of our landscapes. An example of this is the broad acceptance and promotion of the xeriscape landscaping model of plants that are more compatible with local conditions. Still, we tend depend on the selection of plants from other arid localities that are developed and sold with a perhaps misleading impression that these are "native" plants.

Nurseries typically operate as small to large, privately operated businesses. Many are family owned and operated, although there are examples of large nurseries which are operated along industrial models. Plant nurseries cater to a variety of needs and purposes, from highly specialized nurseries catering to a very specific need such as orchid specialists, to the general retail nursery catering to domestic home plants.

Like any business, plant nurseries are dependent upon repeat customers. It is important, especially when selling a living item, to insure to the greatest degree possible that the plant will survive. Therefore, most nursery inventory and sales are oriented towards plants that are most likely to survive. A second factor in marketing plants is plant survivability coupled with the use of showy flowers and other features. Nurseries tend to sell for short-term results, such as the immediate bloom of pansies.

As the horticulture industry seeks to develop plants for mass propagation, there is less interest in maintaining the genetic diversity - the qualities that al-

low plants to adapt to very specific conditions such as soils, microclimate, elevation, and different pollinators. A native plant nursery with a restorative role serves a different function than the commercial nursery. Preserving the diverse genetic composition of plants is essential to providing plants that will be placed in situations where they will receive a minimum amount of maintenance.

A restorative nursery should select plants to propagate, grow and distribute based upon the following qualities:

- preservation and mitigation of rare and endangered species and varieties;
- unusual and unique plants, not commonly available commercially;
- species for study and research;
- plants grown for a specific purpose or use:
  - habitat restoration;
  - food for wildlife;
  - wildlife habitat;
  - medicinal purposes/ ethnobotanical interests;
- preservation of genetic variety;
- educational purposes combined with any of the above qualities.

## Public Sector Plant Nurseries

Public sector nurseries have a limited role in the United States. State forestry plant nurseries produce seedlings for reforestation and timber production. The proposal to establish a publically owned nursery at the county level for the purpose of propagating and distributing native plants may be unusual in the United States. Because no example could be found in the United States, the following paragraphs describe a case history of publically owned nurseries in Australia.

The 1970's saw revival of Australian nationalism. This emerging identity turned it focus away from European traditions towards discovery of itself as a Pacific nation. Evidence of this new culture is most recognized in films, literature, visual arts, design and an increasing interest in understanding and protecting its very unique flora and fauna.

The State of New South Wales operates nine nurseries throughout the state. Nursery sales totaled 1.4 million seedlings in 1998 (State Forest Facts and Figures 1998-99. New South Wales Forests) in a state with the population approximating that of Arizona. Plants are distributed in inexpensive tubestock, which are metal sleeves approximately 8 inches long and 2 inches in diameter containing young seedlings. The retail price for tubestock is now less than US\$2. At this price consumers are feel safe in taking risks, es

pecially with some of the more difficult to grow species. This price is affordable for the sale of large quantities, which are distributed for mass planting in revegetation projects. Plants are propagated for a variety of purposes including windbelts for farms, land stabilization, fodder, revegetation and domestic ornamental horticulture.

One of the nurseries is located in a Sydney suburb; the country's most populated metropolitan area. The nursery's catalogue contains 217 species and varieties. Many plants in the catalogue are not native to Australia, and the selection of species is not restricted to locally derived species. As in the United States the argument over what is considered a native plant has become obscure and confusing.

In the Sonoran Desert there is a parallel to the self-discovery that is evidenced in Australia for the last 30 years. There is growing recognition and appreciation of the Sonoran Desert as a bioregion that transcends international, cultural and economic boundaries. The interest includes materials and products that are indigenous or have a longer history as part of this region. This includes interest in architecture, crafts, foods, food crops, and natural history.

Non-profit enterprises have developed as a result of this increasing appetite. Native/SEED Search, Arizona Sonoran Desert Museum, Tohono Chul Park are a few of the examples of agencies which continue to grow as they develop programs that respond to as well as increase the public appetite for knowledge about the Sonoran Desert and its cultures.

While public sector nurseries generally cater to the needs for commercial reforestation and production purposes, in Pima County and elsewhere in the United States, non-profit enterprises have stimulated interest in native plants by offering sales and education as a means of raising funds and augmenting the mission of the organization. In the Tucson area, Tucson Botanic Gardens, Desert Survivors and Tohono Chul Park, for example, raise funds through plant sales while filling a broader purpose through education about native desert-adapted plants. Additionally, Desert Survivors provides employment opportunities for the physically and mentally impaired.

Local generalist nurseries are offering increasing numbers of native plants. The market does not appear large enough to support a nursery specializing in local native plants. Most nurseries augment income through sales of desert adapted plants from a variety of continents. Many nurseries still cater to the expectations of the thousands of migrants to the Sonoran Desert with their expectations of lush habitats by offering water guzzling, broad leafed plants

that are marginal to the desert habitat. A Pima County plant nursery could stimulate interest in local native plants while making plants available to fulfill and number of specific purposes.

#### **LAS ARTES AS MODEL FOR A PUBLIC SECTOR ENTERPRISE**

Pima County operates the Las Artes Youth Art Program through the Community Services Department. Located in the City of South Tucson, this successful enterprise which incorporates public benefits with production goals can serve as a model for the nursery.

Los Artes produces public mural tile art. Professional artists coordinate production of the murals. At-risk youth are hired to carry out the tasks related to production of the art. The program is maintained through grants and commissions for products.

The core of the program is oriented to production. Youth participating in this program are part of a business. Support and enrichment activities are included in the program, but do not dominate over the main activity. Employees participate in a range of activities, have opportunities to experience a variety of tasks, but do not have control over the end product or the production schedule.

Whether or not a youth training component is incorporated into the nursery program, study of the Las Artes model is useful for the following reasons:

- Production is not sacrificed for other needs or programmatic goals.
- The program survives through a combination of grants and commissions for products.
- Its end product is visible in the community and is a means to gain support for the program.

Adherence to these principles could be the key to operation of a successful Pima County Nursery Project (Harmon, personal communication).

#### **Rationale for a Waste Water Management Plant Nursery**

The responsibility for providing the nursery site and infrastructure has been assigned to the Pima County Wastewater Management Department. Nursery operations and administration responsibilities have been assigned to the Pima County Natural Resources, Parks and Recreation Department. The decision to use Wastewater facilities for the nursery is based primarily upon space, and the availability of water. A native plant nursery represents a wise use of wastewater effluent, benefitting both the nursery and the treatment facility. In addition to the nursery, large

buffer zones should be planted around the facilities providing propagation material for the nursery, noise and odor reduction for the treatment plant, and enhanced visual aesthetics.

With careful planning, the buffer zones can be created to provide significant habitat, especially for birds. Wastewater facilities have long been enjoyed by birds, and birders alike. The development of native habitat buffer zones may be particularly important if located near critical habitat such as that needed by the endangered cactus ferruginous pygmy-owl.

Wastewater effluent can be used to irrigate the nursery, and the surrounding buffer zone. The available effluent from the treatment plants is of "controlled access irrigation quality," (secondary treated and chlorinated). As a result, measures will be necessary to restrict public access, and monitor the effluent for any potential harm to the nursery plants,

At this time, Wastewater Management personnel have identified facilities that could serve as plant nurseries following the necessary infrastructure development.

#### **INTRODUCTION AND PURPOSE**

A county operated nursery is a beneficial use of treated wastewater effluent. Wastewater facilities are located in areas with good access for the transportation and distribution of native plants. The nutrients in effluent may be very conducive to growing vegetation. There are currently no nursery programs at the treatment facilities, although there are vegetative buffers at some of the facilities. These buffers were created as a way to use some of the effluent produced at the facility, as well as for aesthetic purposes.

In terms of division of responsibilities, Wastewater Management could be responsible for setting up the irrigation piping and maintaining the buffer zone, with Natural Resources, Parks, and Recreation administering and operating the nursery.

Re-vegetated buffer zones around the facilities will serve four main functions:

- the buffer zones will be used as a propagation field-providing seed, cuttings and root stock when needed;
- the buffer zones will provide an educational component on the use of native plants;
- buffer zones will serve to reduce the noise, odor, and visual impacts of treatment facilities; and,
- planted buffer zones will have some habitat value.

The nursery and buffer zone planting could also provide ongoing research in the use and effects of treated effluent.

The design of buffer zone planting must include the input of treatment plant operators to avoid any harmful effects to the wastewater facility such as "leaf fall" or "root intrusion."

This report addresses three areas where immediate establishment of nurseries could begin, and two larger areas where nurseries could be established in the future. The Department is gathering detailed information about the precise locations of buffer areas, and the primary plant species currently in use, and will provide more specific data as we proceed.

#### **DESCRIPTION AND LOCATION OF TREATMENT FACILITIES- SHORT-TERM NURSERY POTENTIAL**

##### ***Avra Valley Wastewater Treatment Plant***

The Avra Valley Wastewater Treatment Facility, one of the Department's outlying facilities, is located north of Ryan Air Field and east of Sandario Road (Figure 5).

##### ***Green Valley Wastewater Treatment Facility***

The Green Valley Wastewater Treatment Facility, one of the Department's outlying facilities, is located just north of Duval Mine Road and approximately one mile east of I-19 on the east bank of the Santa Cruz River (Figure 6).

##### ***Marana Wastewater Treatment Facility***

The Marana Wastewater Treatment Facility, one of the Department's outlying facilities, is located north of Trico-Marana Road near the Santa Cruz River (Figure 7).

#### **QUANTITY OF EFFLUENT AVAILABLE**

##### ***Avra Valley Wastewater Treatment Plant***

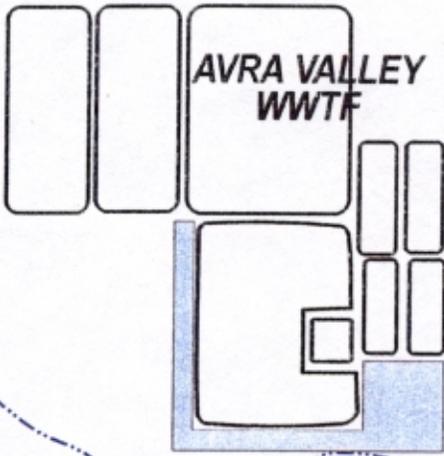
About 200,000 gallons per day (gpd) are available under the current reuse permit and could potentially be used for the nursery.

##### ***Green Valley Wastewater Treatment Facility***

It is anticipated that about 1 million gallons per day (mgd) of effluent will be available from the Green Valley plant upon completion of construction in January 2002. This is in addition to the 1 mgd already contractually guaranteed to Quail Creek. As part of this agreement, Quail Creek does have the right to request additional effluent. Therefore, the amount of available effluent depends on Quail Creek's needs.

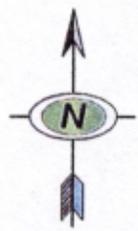
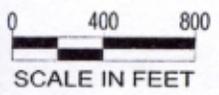


36



BLACK WASH

SNYDER HILL ROAD



**LEGEND**

POTENTIAL NURSERY SITE  
APPROXIMATELY 1.5 ACRES

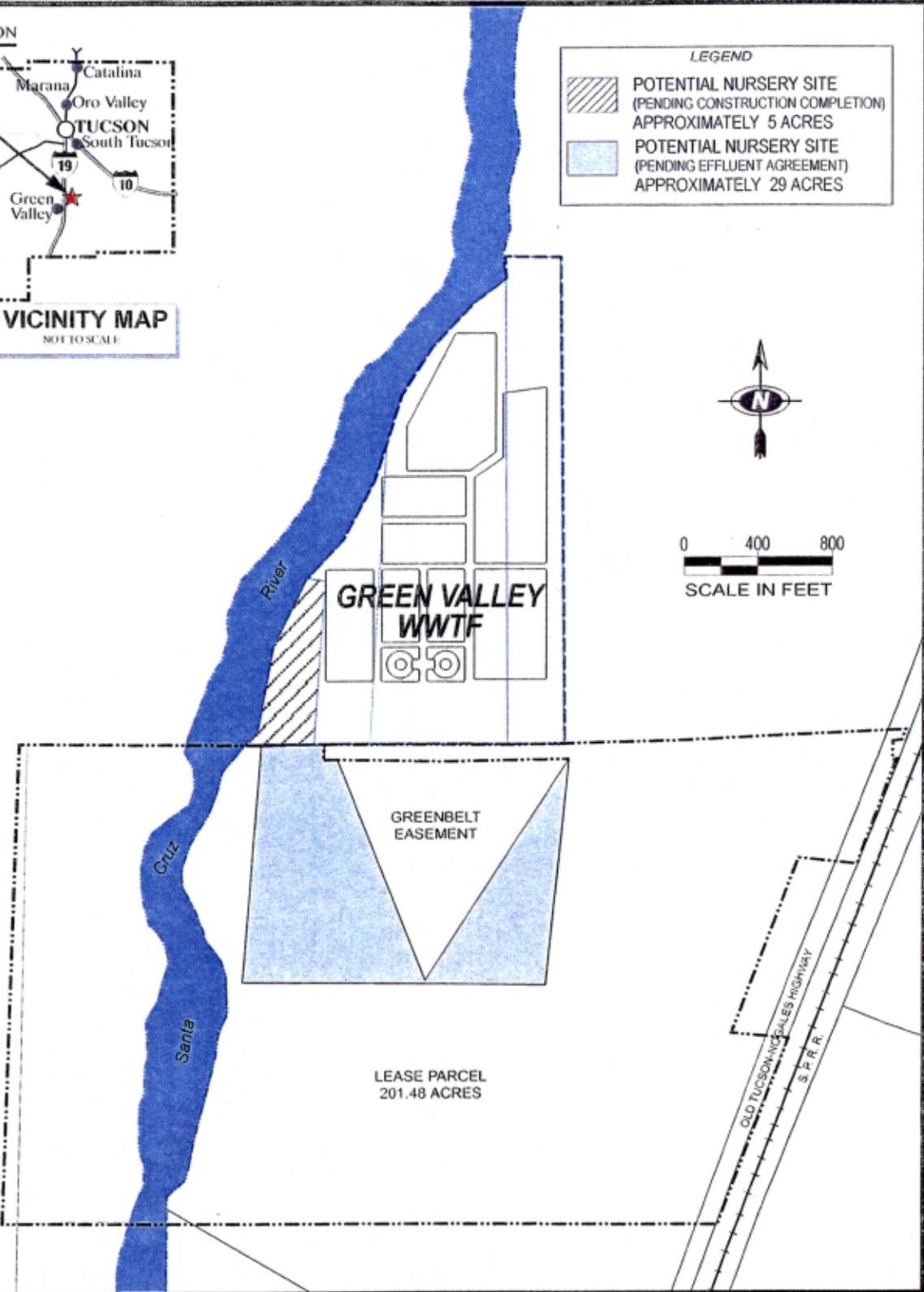
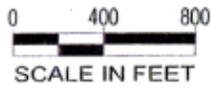
<p><b>PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT</b></p>	<p>PROJECT: AVRA VALLEY WWTF EFFLUENT REUSE</p>	<p>TITLE: POTENTIAL NURSERY SITE</p>
	<p>DRAWN BY:</p>	<p>FILE: AVRANRS1.CDR</p>

Figure 5

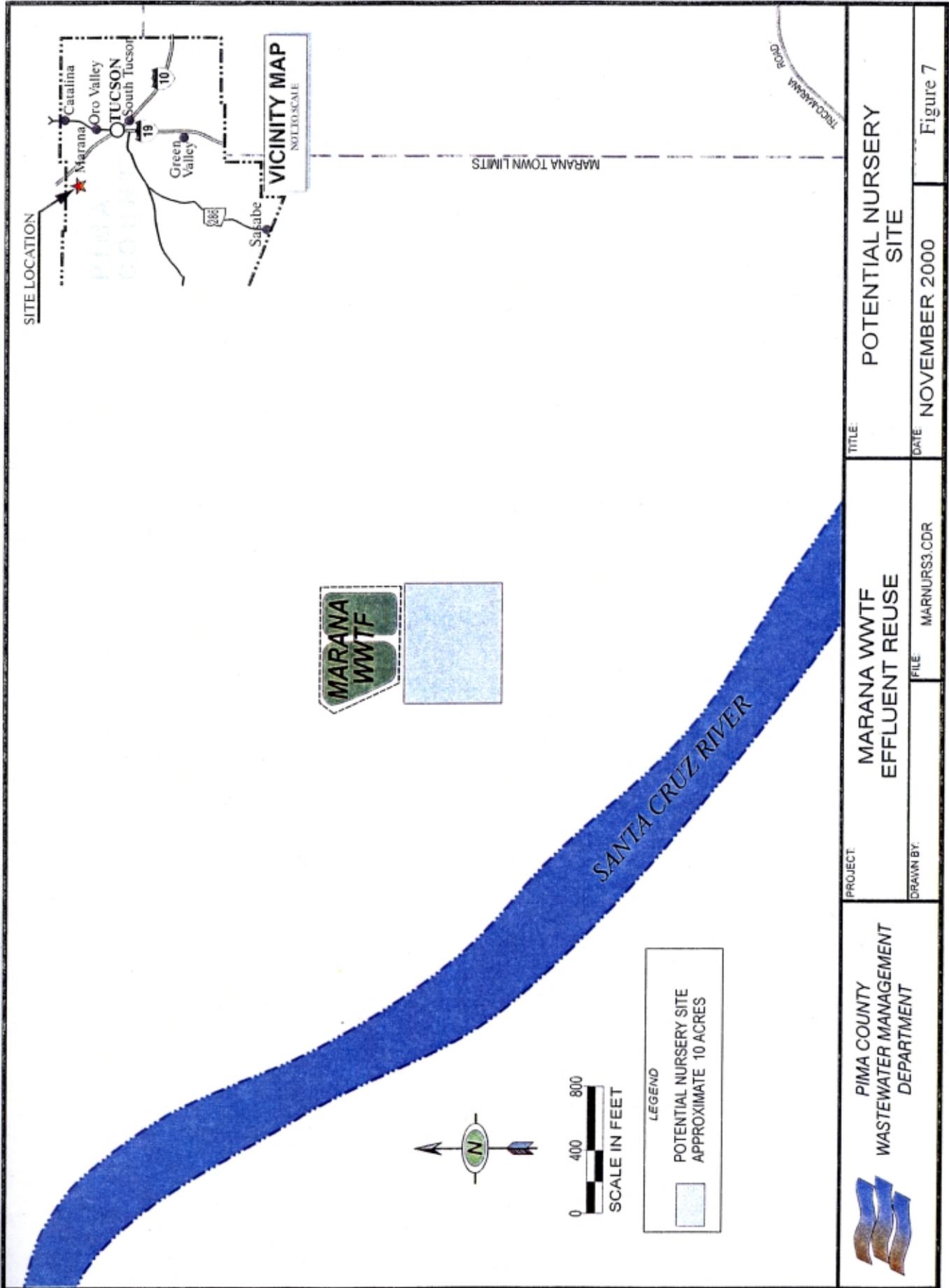
**SITE LOCATION**



LEGEND	
	POTENTIAL NURSERY SITE (PENDING CONSTRUCTION COMPLETION) APPROXIMATELY 5 ACRES
	POTENTIAL NURSERY SITE (PENDING EFFLUENT AGREEMENT) APPROXIMATELY 29 ACRES



 <p>PIMA COUNTY WASTEWATER MANAGEMENT DEPARTMENT</p>	<p>TITLE: <b>POTENTIAL NURSERY SITE (PENDING EFFLUENT AGREEMENT)</b></p>	
	<p>PROJECT: <b>GREEN VALLEY WWTF EFFLUENT REUSE</b></p>	<p>DRAWN BY:</p> <p>CHECKED BY:</p> <p>FILE: <b>GVNURSE1.CDR</b></p>



### ***Marana Wastewater Treatment Facility***

It is projected that the Marana facility will have an average of 30,000 gpd available for nursery purposes.

#### **AMOUNT OF LAND AVAILABLE FOR NURSERIES**

### ***Avra Valley Wastewater Treatment Plant***

Avra Valley will soon have a project under construction to create a spray irrigation system for an open area encompassing approximately 13 acres. The contract was awarded a few weeks ago, with construction expected to be complete in about one to one and one-half years. This project includes the construction of piping and plumbing for a large volume irrigation system (discharging 200 gpm), intended to discharge large quantities of effluent. As such, the spray guns might require modification for nursery purposes. Use of this spray field for a nursery might result in complications under the NPDES permit, and as such, would not be advisable.

However, there is a total of about 1.5 acres of land at Avra Valley WWTF along the south fence and at the turf areas which could be used for a nursery.

### ***Green Valley Wastewater Treatment Facility***

Green Valley WWTF currently sprays effluent onto about 200 acres of leased land south of the plant, and the amended Emerald Fico agreement would deed the County a 29 acre parcel south of the plant. A portion of the acreage included in the effluent agreement could be a nursery site. There is approximately five acres of land between the river and the fenced area around the treatment plant. This property is currently being used as a staging area for the ongoing construction. However, once the construction is complete around January 2002, this land will need to be restored, and a nursery could be placed here-within a convenient distance from the effluent supply.

### ***Marana Wastewater Treatment Facility***

It is projected that there will be about 9.5 acres of land adjacent to the Marana facility which could be used for nursery purposes. There is a main line in this area, but no irrigation sprinklers have been put in place yet. As there are several application alternatives, and the system is temporary until the new plant is built, sprinklers could be rented until the permanent system could be put in place.

#### **QUALITY OF EFFLUENT - PERMITS IN PLACE AND MODIFICATIONS REQUIRED**

### ***Avra Valley Wastewater Treatment Plant***

The available effluent meets restricted access irrigation quality (secondarily treated, denitrified and chlorinated); the plant is already fenced to restrict public access. The existing reuse permit allow irrigation of 19.13 acres of alfalfa, trees, turf and groundcover veg-

etation. We are currently growing groundcover, landscaping and turf. A modification of the existing permit will be required to include a recalculation of the consumptive water use rate for the nursery vegetation.

### ***Green Valley Wastewater Treatment Facility***

The available effluent will be restricted access irrigation quality (secondarily treated and chlorinated-when the new plant is completed some effluent will also be denitrified). The plant is already partially fenced to restrict public access, and construction of additional fencing has been planned. The exiting reuse permit allows landscape irrigation; we are currently growing natural vegetation in this area. A modification in the existing permit will be required to include a recalculation of the consumptive water use rate for the nursery vegetation.

### ***Marana Wastewater Treatment Facility***

The available effluent will be restricted access irrigation quality (disinfected - when the new plant is complete some effluent will also be denitrified); the plant is already fenced to restrict public access. An application for a reuse permit has been made, however, to date, there has been no final reuse permit issued. The reuse permit would allow irrigation of riparian landscape.

#### **OPPORTUNITIES FOR LONG-TERM NURSERY ESTABLISHMENT**

### ***Ina Road Water Pollution Control Facility***

Located at Ina Road and I-10 (Figure 8), the Ina Road Water Pollution Control Facility has a current capacity of 25 mgd. Construction to increase the facility's capacity to 37.5 mgd is underway, with completion projected for summer 2002. This facility, established in 1977, serves the northern parts of the Tucson metropolitan area, Oro Valley, and a major portion of the Town of Marana. Although the Department has filed for a re-use permit, to date it has not been issued by ADEQ. The reuse permit application included irrigation, agricultural use and golf course (restricted access). It could be modified for nursery irrigation. There is a 25 mgd that is currently being discharged to the Santa Cruz River; 10% of the total effluent is allocated to the County and may be made available for nursery purposes.

There are about 15 acres of land between the facility and the Santa Cruz River which could be a potential nursery site. However, it is on the floodplain and some of the property is not very stable. The land closer to the facility could be more useable. The 10 acre transfer to the City of Tucson could affect the siting potential for the nursery.

As the available effluent will be restricted access quality (secondarily treated, disinfected and dechlori-

nated), we would need to address the issue of fencing or other measures to restrict public access. In addition, construction of an access road and irrigation piping would be required.

### **The Roger Road Wastewater Treatment Plant**

The Roger Road Treatment Plant was established in 1951. It serves the urban Tucson area that lies south of the Rillito Creek (Figure 9). Although the Department has filed an APP application, we do not have a re-use permit. However, we would need our own reuse permit to allow for the use of effluent for a nursery.

On average, the Roger Road plant currently treats 39 mgd. The City of Tucson currently takes about 12.5 mgd, and has the right to take additional effluent. Nursery needs could be supported by the County's 10% allocation of total effluent.

Roger Road Treatment Plant is located on 69 acres. There is a land exchange called for under the Supplemental Intergovernmental Agreement (IGA) between the County and the City. Once this occurs, the nursery site can be selected.

The available effluent will be restricted access quality (secondarily treated and chlorinated). The Roger Road property is fenced except for the berm by the river. Currently, there is some irrigation system in place at the Treatment Plant, as the lawn in flood irrigated. However, most of the irrigation system has been dismantled.

## **Pima County Native Plant Nursery**

Initially, the county nursery should specialize in growing a very limited variety of plants, eventually expanding variety and inventory as the facilities are developed. This will provide an opportunity for the involved departments to adjust to their new roles while the nursery evolves, and to phase in nursery expansion based on initial performance. As a result, the nursery program can be divided into two distinct phases as follows:

### **PHASE ONE**

Establish a growing program for a limited number of species, targeting the growth of rare, endangered, or vulnerable species including plants that have been extirpated from Pima County.

The initial phase could also include those plants and trees required to establish the buffer/propagation zones once the site infrastructure is established.

The phase one portion of the plan can be implemented in concert with the construction and improvement of nursery infrastructure, such as an irrigation system, thereby insuring that plants chosen will have the ba-

sic requirements for successful growth.

Following is a list of plants suggested for initial trial:

- Huachuca water umbel (*Lilaeopsis schaffneriana* ssp. *recurva*)--may require a controlled environment for propagation.
- Screwbean mesquite ( *Prosopis pubescens*)--for Santa Cruz River re-establishment.
- Arrowwood (*Pluchea sericea*)--for re-establishment.
- Ironwood, (*Olneya tesota*)--to supplement limited natural regeneration where frost conditions permit (Figure 10). This species is not suitable to grow at the Green Valley facility because of the higher elevation and the species sensitivity to frost.

The unimproved facilities are already capable of growing seed sources for many native plants including the native grasses, (sacaton, tobosa, etc.). The planting of native grasses on open irrigated fields would also help to prevent the proliferation of non-native weeds such as Russian thistle which is already prominent in some fields.

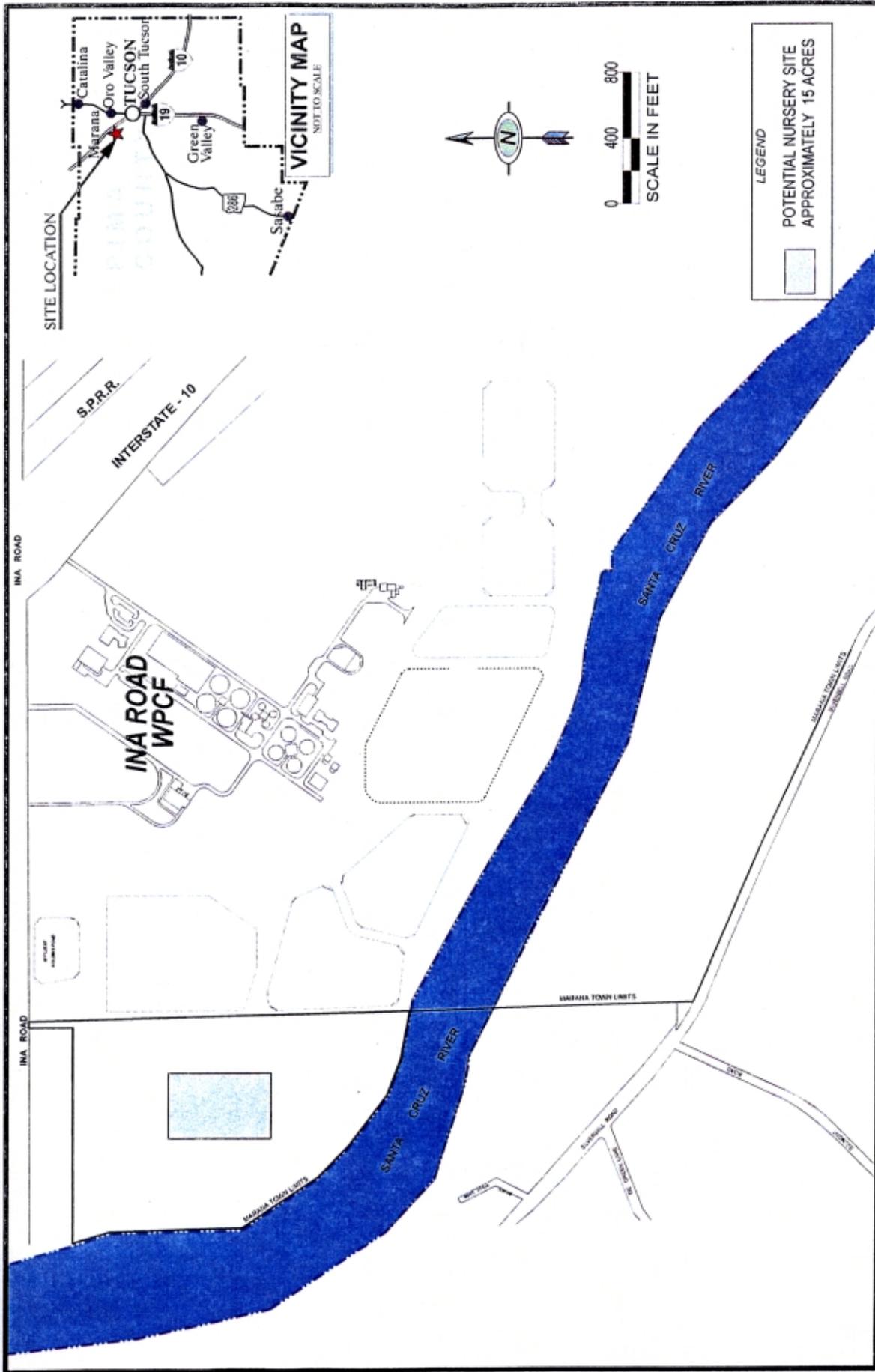
In order to execute the initial phase of the nursery plan, experienced personnel must be hired for the nursery, or a temporary task force must be established to plan, manage, and operate the initial nursery effort. Staff can be increased as needed.

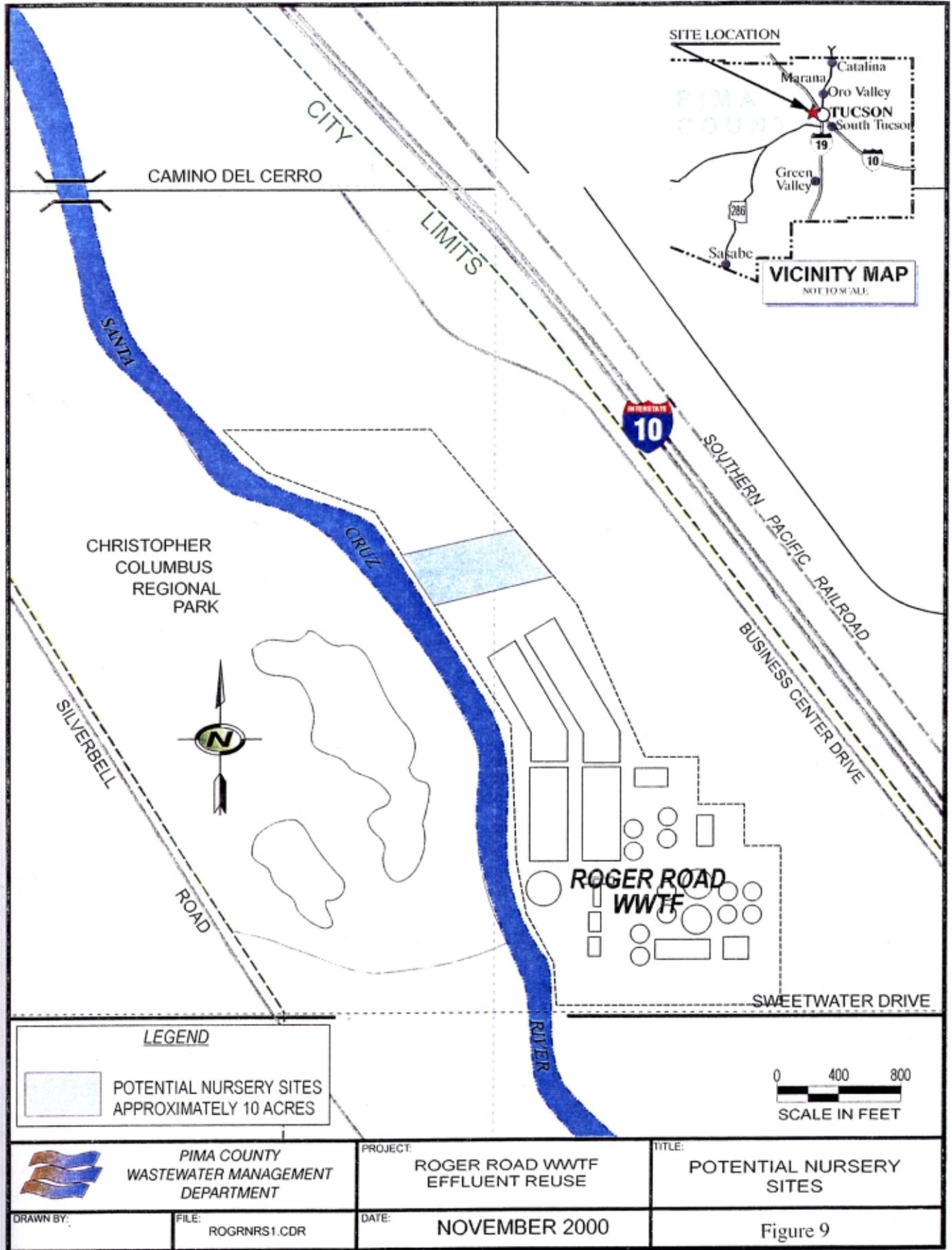
### **PHASE TWO**

This phase consists of the establishment of a high volume native plant nursery supplying plants and trees for county landscaping, mitigation projects, and habitat re-vegetation projects. The variety of plants grown, should be based in part on the types of plant associations found within the county. Examples would include certain native grasses, or plants from the different types of riparian habitats. Until a specific site is chosen, this proposal is based on the assumption that a high production nursery would consist of approximately five acres, fully secure, and with ample effluent and ground water (for flushing salt build-up, and for liquid based root or foliar feeding).

The high volume nursery is composed of six principal components :

- The Main Nursery
- Buffer Zones (also serve as a source for propagation material)
- Propagation Center
- Seed Bank
- Native Plant Research
- Exotic Invasive Species Research Center





With the exception of the last component, all components function together, and should be located at the same facility. There is some benefit to establishing a production nursery fairly close to town to minimize plant damage while transporting, and to provide a central work site for nursery personnel. Considering this, the Avra Valley Facility would be better suited than Green Valley for any high production

nursery program. Other outlying facilities, including the Green Valley Facility can be used for special projects such as using effluent irrigated open space for seed production. This would be particularly helpful for generating a productive seed source for native grasses, native perennial and annual wildflowers, and large container trees that can utilize low maintenance drip irrigation methods.

Figure 10

## Ironwood *Olneya tesota*

Ironwood is one of the largest and longest-lived Sonoran Desert plants, reaching 45 feet in height and persisting as long as 1,500 years. It is a single or multi-trunked tree, and displays lavender to pink flowers starting in March. By early summer, the pods mature. Each 2-inch pod contains one to four shiny brown seeds that are relished by many Sonoran animals, from small mammals and birds to humans. Its iron-like wood is renowned as one of the world's densest woods.

The shaded sanctuary and richer soils created by the ironwoods increase plant diversity and provide benefits to wildlife. Some 160 species of plants and 80 species of birds use ironwoods in some way. Ironwoods are too hard to provide nesting cavities for birds, but the cacti that grow beneath them provide such opportunities. Insects abound within the ironwood complex, attracting birds and reptiles. As with other legumes, the ironwood's leaf litter supplies nitrogen to the soil and its seeds provide a protein-rich resource for doves, quail, coyotes, and many small rodents.

This tree is found only in the Sonoran Desert. Ironwood functions as oases of fertile and sheltered habitat within a harsh and challenging desert landscape. As a tree becomes established, it tempers the physical environment beneath it, creating a micro-habitat with less direct sunlight, lower surface temperatures, more organic matter, higher water availability, and protection from herbivores. Air temperatures may be 15 degrees cooler under ironwoods than in the open desert sun five feet away. Ironwood also shelters frost-sensitive young saguaros, organ pipe cactus, and night-blooming cereus.



---

For more information on ironwood, refer to:

Lipsky, Andrew A. "Ironwood (*Olneya tesota*)."  
*Non-game Field Notes*. Arizona Game and Fish Department. Non-game Branch. 11/17/00 Website <[http://www.gf.state.az.us/frames/fishwild/ngame\\_d.htm](http://www.gf.state.az.us/frames/fishwild/ngame_d.htm)>

## **THE MAIN NURSERY**

The main growing grounds comprise the largest portion of the site and must be laid out with consideration for irrigation run-off, microclimate generation, and container mobility. The growing area should consist of 10 foot wide, crowned rows, with access lanes between rows. Each crowned row should be bounded by drainage tiles that will transport excess irrigation or storm water to surrounding buffer zone plants, thus minimizing a constant mud problem, and the potential for limiting conditions favorable for soil born fungal growth. Plant containers should be evenly spaced within the rows, which should be slightly graveled to lift containers off of the bare ground. The growing area, and the wastewater facility, should be surrounded by a vegetative buffer zone of native plantings that will support the propagation function, reduce wastewater facility odor, and serve to demonstrate the beauty of native plant landscaping.

Nurseries generally operate using a "bump-up" methodology whereby plants and trees start out in small containers, and are bumped-up into larger containers as they grow. This allows the root systems to infiltrate and utilize the entire soil mass. If the growing area for container plants consists of 2.5 acres, then the nursery is capable of nurturing over 3000 5 to 15 gallon size trees, and over 30,000 1.5 gallon shrubs and perennial plants at one time. Many large box trees can also be stored and utilized for shade and frost protection. These figures allow for access lanes, and enough space between plants to provide unimpeded growth and ventilation (which stimulates full luxuriant growth, stronger trees due to wind action, and limits the spread of diseases).

Due to the expensive machinery requirements, limited transplant viability, and the care needs of plants and trees that have been grown in the ground, dug up, and then boxed, it is suggested that most plants be container grown including 4 foot box trees. Trees that are field grown require the use of root balling machines, and suffer extended periods of transplant shock. Container grown plants suffer little, if any, transplant shock. Given the fast growth rate of most native trees, it may be advisable to limit container trees at the 1.5 gallon size, thus eliminating the need for the expensive machinery required for larger containers such as 4ft. box trees. It would also make it easier for the people planting the trees. On the other hand, salvaged trees will require large containers, forklift capability, and long transplant care to avoid any shock decline. Smaller plants and shrubs should be grown in 1-5 gallon containers. There is no point in using oversized containers for small plants as root systems will rarely occupy the entire soil mass. Roots hold the root ball together when transplanting, otherwise the root ball will fall apart during handling and shock or kill the plant.

Irrigation needs of container plants vary widely. Over-watering is as destructive as insufficient water. As a result, watering schedules are created for each species on an "as needed" basis, rather than a routine daily watering of all plants. For instance, all riparian trees and shrubs will require considerably more water than mesquites and ironwoods. Larger plants may be placed on drip irrigation, but a scheduled flushing of containers is suggested to reduce salt and chemical build-up in the soils. Each growing row should be provided with its own water source for hoses and drip methods.

Fertilization of plants can be accomplished using any one of several methods and products. The correct product and application method can be determined once the nutrient potential of the effluent is determined. All native plants can be sensitive to excess feeding. As a result, the feeding program should be carefully planned.

The light requirements of shade loving plants can be met by creating microclimates with the use of lath-houses, shade cloth covers, or the strategic planting of certain trees that provide filtered shade and some frost protection. Native mesquites are ideal for this purpose since their canopy allows light penetration. Non-native hybrid mesquites are of no use due to their heavy canopy and the deep shade they create. Also, depending on the orientation of the rows, the container trees can also be used to shield smaller plants.

The nursery can also contain smaller sections for container or tube grown native grasses, cacti, and salvaged native plants of all kinds. This section can also be used for special projects such as growing large numbers of plants in 2 inch tube containers designed for large project plantings (i.e., road easements, etc.).

Plant diseases and other problems can be reduced using wise nursery planning. Most nurseries suffer problems due to overcrowding and poor watering practices that rapidly spread disease, especially if the plants are stressed. If planned properly, most problems can be avoided, thus reducing the need for constant chemical applications.

The following list briefly describes some of the facility requirements and labor needs for the nursery.

### **Facility Requirements**

(Pima County Wastewater Management Dept., and Natural Resources, Parks and Recreation Dept.)

- Acreage for the growing areas, and the boundary buffer zones, complete with security fencing, and adequate water (effluent and fresh ground water).

- Graded lot with crowned rows and drainage tiles installed.
- Building for office, crew room, restrooms, and the seed bank (with chest freezers). The buildings may be portable or modular.
- Storage for fertilizers, tools etc.
- Contract for 5 part soil mix delivery. (AAA fertilizer can custom mix soils)
- Soil storage bins, portable potting ramada, potting benches, nursery carts and tools,
- Nursery containers of all sizes and types, including tree boxes.
- Trailer mounted tanks with pumps.
- Forklift or small bobcat.
- Flat bed truck with lift gate, and tree carts.
- Propagation facilities (listed in this section)

**Personnel Requirements**

(Pima County Natural Resources, Parks, and Recreation Department)

The nursery will require the following personnel (at the minimum):

- Nursery manager (experienced with native plants)
- Propagator
- Two trained nursery workers.
- Lead irrigator
- One or two, seasonal irrigation helpers

All full-time personnel shall be safety certified for machinery, chemical, and wastewater effluent use.

**PROPAGATION FIELDS - BUFFER ZONES**

Nurseries that propagate their own plants must have adequate supplies of seed, cuttings, and root stock necessary for in-house propagation. I advise the use of the buffer zones that surround the nursery and treatment facilities, as one of the sources for this material. The buffer zones will be planted with native trees and under-story plants from which propagation material can be acquired. This should be combined with specialized growing areas designed specifically for seed and cutting stock, and material obtained from other areas for genetic variety.

Besides providing propagation material, the buffer zones can serve as an educational tool for native landscaping classes, increase habitat for birds, reduce noise and odor, and enhance the appearance of the facilities.

Outlying facilities such as the Green Valley plant, have effluent irrigated open fields that could be planted with native grasses, and desert perennial and annual wildflowers, The field could be used to generate a substantial seed source for plants such as sacaton, tobosa, and other native bunch grasses. The

seeds can then be used on county re-vegetation projects in an attempt to restore native plant associations and habitat.

Outlying facilities can also be used to store and grow extra large box trees that can be drip irrigated with minimal care. One acre of land can support over 150 large 4 ft. box trees.

**PROPAGATION CENTER**

The propagation center is a small complex of green houses (portable), a lathe-house, potting benches, and a small green house with a timer activated misting array for small cuttings. Once new plants have grown sufficient root systems, they are then transplanted into larger containers and moved to the growing areas.

Depending on funding for the nursery, the propagation center might also add a section to experiment with aquatic flora and fauna. However, this task could be performed using a research agreement with other groups or agencies such as the Environmental Research Lab.

The propagation center is the heart of any nursery, providing an continuous supply of plants, and experimentation with native plant species that are endangered or extirpated from Pima County. The propagation of native plants requires experience and expertise, and should not be performed by amateurs.

**SEED BANK**

The seed bank should store all seeds acquired through purchase, or harvested from the propagation fields. Seed banks usually consist of chest freezers, storage containers, and a small lab bench to monitor seed viability. Seed banks are valuable tools for native plant conservation. If enough seed is harvested, then extra amounts can be made available to the public, and for government and non-profit restoration projects. However, since the seed industry is heavily regulated, all seed made available outside the nursery should be distributed free of charge. Providing homeowners with small packets of native seed, along with educational materials, could be an interesting public outreach and education program.

**NATIVE PLANT RESEARCH AT THE CONSTRUCTED ECOSYSTEM RESEARCH FACILITY**

Pima County's existing Constructed Ecosystem Research Facility (CERF), located on a 3-acre site next to the Roger Road Treatment Plant, is ideal for riparian and aquatic plant research. CERF consists of six pilot-scale lined ponds with pumps to use secondary effluent that has not been chlorinated. CERF has an

on-site water quality laboratory. Past research has included study of mosquito control using subsurface wetlands and plant response to potable versus secondary effluent. Ongoing research included studies of the suitability of tobosa and salt grass, two native grasses, for use as filter strips for stormwater. These plants can withstand prolonged periods without water and are adapted to periodic flooding. When available, stormwater will be obtained and delivered to the plants.

Some of the topics that can be considered for future research at CERF may include:

- Water quality issues using effluent, including chlorinated effluent, for nursery irrigation.
- Propagation and transplant techniques for the Huachuca water umbel.

A separate facility to facilitate salvage and transplants of upland species is also needed. Topics for research are many. The potential for research grants and cooperative studies may be quite high.

#### **EXOTIC INVASIVE SPECIES RESEARCH CENTER**

The facility can be used to set up carefully designed growing areas for invasive exotics such as buffel and fountain grasses, African sumac, and other species harmful to native ecosystems. These sites can be used to evaluate seed dispersion and to experiment with eradication methods. If office space is adequate, then the facility can be used as the mapping and research headquarters for the exotics species task forces that are currently forming and beginning to generate public outreach programs.

#### **SUMMARY**

The creation of a native plant nursery may generate grant monies that can minimize the county's funding obligations. In so doing, the nursery may become fairly self-sufficient. If the county agrees to establish a systematic replacement of non-native vegetation at county owned facilities, then the nursery can provide all of the plants necessary for the project.

#### **Uses of Nursery Plants**

The Pima County Nursery will offer plants for specific purposes such as:

- County landscaping contracts - roads, parks, riparian and other habitat restoration - County nursery should be source of first refusal to provide plants for county projects.
- Other county projects - housing, public building,

etc. -Nursery plants should be available for county-funded housing developments.

- For sale to nurseries and for public plant sales - non-profit organizations
- For public education purposes - displays at Tucson Botanic Gardens, Arizona Sonoran Desert Museum and other opportunities as well as parks
- Direct sales to public including contracting for private habitat restoration and landscape projects.
- Plants distributed to schools for demonstration/educational projects such as migratory pollinators, ethnobotany, etc. - this could be in conjunction with, Arizona Sonoran Desert Museum, and other organizations. Agencies like Pro Neighborhoods could distribute plants to neighborhood organizations.
- Salvage plants could be used for county projects or sold.
- Plant could be provided to research organizations for scientific purposes - for study, monitoring and other needs.
- Plants could be grown for buffer areas at the nursery and other locations. These plants in turn could serve as sources for seed and cuttings.
- Plants could be sold to county projects at contract rate by means of cost transfers.

Plants that will be selected for propagation through the nursery project will be based on the following criteria. To be considered for nursery propagation, the species should have successful propagation history:

- Plants that have grown or are growing on habitat that has been lost in or is in danger of being lost in Pima County ;
- plants that are potentially impacted by development and future development;
- Pima County native plants that show promise for horticulture;
- Pima County native plants that are needed in the nursery industry or on Pima County projects but are not available;
- plants for demonstration, experimentation, or special projects.

Table 1: Suggested Trees for Nursery Cultivation

<b>Botanical Name</b>	<b>Common Name</b>	<b>Water Cultivation Use</b>	<b>Propagation Method</b>	<b>Growth Rate</b>	<b>Problems</b>
<i>Acacia constricta</i>	Whitethorn acacia	Low	Seed	Fast	None
<i>Acacia greggii</i>	Catclaw acacia	Low	Seed	Fast	None
<i>Celtis reticulata</i>	Canyon hackberry	Low	Seed	Fast-moderate	None
<i>Cercidium floridum</i>	Blue palo verde	Low	Seed	Moderate	None
<i>Cercidium microphyllum</i>	Littleleaf palo verde	Low	Seed	Moderate	None
<i>Chilopsis linearis</i>	Desert willow	Low	Seed	Moderate	None
<i>Cupressus arizonica</i>	Arizona cyprus	Low	Seed-cuttings	Slow	Insect damage
<i>Fraxinus velutina</i>	Arizona ash	High	Cuttings	Fast	None
<i>Juglans major</i>	Arizona walnut	Moderate	Seed	Moderate	Rodent damage
<i>Lysiloma thornberi</i>	Feather tree	Low	Seed	Fast	Frost tender
<i>Olneya testota</i>	Ironwood	Low	Seed	Moderate	Frost tender
<i>Platanus wrightii</i>	Arizona sycamore	High	Cuttings	Fast	None
<i>Populus fremontii</i>	Fremont cottonwood	Hig	Cuttings	Fast	Minor insect damage
<i>Prosopis velutina</i>	Velvet mesquite	Low	Seed	Fast-moderate	None
<i>Psoralea spinosa</i>	Smoketree	Low	Cuttings	Moderate	None
<i>Quercus arizonica</i>	Arizona oak	Moderate	Seed	Slow-moderate	None
<i>Quercus emoryi</i>	Emory oak	Moderate	Seed	Slow-moderate	None
<i>Salix goodingii</i>	Goodding willow	High	Cuttings	Fast	None
<i>Sambucus mexicana</i>	Mexican Elderberry	High	Seed-cuttings	Fast	None
<i>Sapindus saponaria</i>	Soapberry	Low	Seed	Moderate	None

Table 2: Suggested Shrubs for Nursery Cultivation

Botanical Name	Common Name	Water Use	Propagation Method	Growth Rate	Cultivation Problems
<i>Ambrosia ambrosiodes</i>	Canyon Ragweed	Moderate	Seed-cuttings	Fast	Invasive, allergen
<i>Ambrosia deltoides</i>	Triangle leaf bursage	Low	Cuttings	Moderate	None
<i>Aniscanthus thurberi</i>	Desert honeysuckle	Moderate	Cuttings	Fast	Frost tender in containers
<i>Asclepias tuberosa</i>	Butterfly flower	Moderate		Moderate	None
<i>Aster tanacetifolius</i>	Purple aster	Low-moderate	Seed-cuttings	Fast	Frost tender
<i>Atriplex canescens</i>	Fourwing saltbush	Low	Cuttings	Slow-moderate	None
<i>Atriplex lentiformis</i>	Quail bush	Low	Seed-cuttings	Slow-moderate	None
<i>Berberis haematocarpa</i>	Red mahonia	Low	Seed-cuttings	Moderate	None
<i>Calliandra eriphylla</i>	Fairyduster	Low	Seed	Moderate	None
<i>Rumex hymenosepalus</i>	Canaigre	Moderate	Seed	Fast	Grow from seed on demand
<i>Celtis pallida</i>	Desert hackberry	Low	Seed	Moderate	None
<i>Ceanothus greggii</i>	Desert ceonothus	Low	Cuttings	Slow	None
<i>Chrysothamnus nauseosus</i>	Rabbitbrush	Low	Cuttings	Moderate	None
<i>Dasyilirion wheeleri</i>	Sotol	Low	Seed	Slow	None
<i>Dodonaea viscosa</i>	Arizona hopbush	Moderate	Seed	Fast-moderate	None
<i>Encelia farinosa</i>	Brittlebush	Low	Cuttings	Moderate	Insect damage to young shoots
<i>Ephedra trifurca</i>	Joint fir	Low	Cuttings	Slow	None
<i>Ericameria laricifolia</i>	Turpentine bush	Low	Cuttings	Slow	None
<i>Eriogonum fasciculatum</i>	Flat top buckwheat	Moderate	Seed	Moderate	None
<i>Garrya wrightii</i>	Silk tassel	Moderate			
<i>Gutierrezia sarothrae</i>	Snakeweed	Moderate			
<i>Hymenoclea monogyra</i>	Burro bush	Moderate	Cuttings	Moderate	None
<i>Jatropha spp.</i>	Limber bush	Low	Cuttings	Moderate	None
<i>Larrea tridentata</i>	Creosote bush	Low-moderate	Cuttings	Slow	Hard to propagate

<i>Lobelia cardinalis</i>	Monkey flower	High-moderate	Seed-cuttings	Fast	Sun protection
<i>Lycium spp.</i>	Wolfberry	Low	Seed-cuttings	Slow-moderate	None
<i>Mimosa biuncifera</i>	Wait-a-minute bush	Low	Seed	Fast	None
<i>Nolina microcarpa</i>	Beargrass	Low	Seed	Moderate	None
<i>Pathenium incanum</i>	Mariola				
<i>Proboscidea parviflora</i>	Devil's claw	Moderate	Seed	Fast	None
<i>Prosopis pubescens</i>	Screwbean mesquite	Low	Seed	Fast	None
<i>Rhus glabra</i>	Smooth sumac	Moderate	Cuttings	Fast-moderate	None
<i>Rhus ovata</i>	Sugar bush	Moderate	Cuttings	Fast-moderate	None
<i>Rhus trilobata</i>	Squawbush	Low	Seed-cuttings	Moderate	None
<i>Ribis aureum</i>	Wax currant	Moderate	Seed-cuttings	Moderate	None
<i>Senecio salignus</i>	Senecio	Moderate	Cuttings	Moderate	None
<i>Simmondsia chinensis</i>	Jojoba	Low	Seed	Moderate	Requires male/female plants
<i>Vauquelinia californica</i>	Arizona rosewood	Low	Cuttings	Moderate	None
<i>Vitis arizonica</i>	Canyon grape	High	Seed-cuttings	Fast	None
<i>Zinnia acerosa</i>	Desert zinnia	Moderate	Seed-cuttings	Fast-moderate	None
<i>Zizyphus obtusifolia</i>	Graythorn	Low	Cuttings	Slow-moderate	None

**NOTES**

1. This list represents a “core group” of plants that should be grown regularly at the nursery.
2. This list covers plants for several natural plant association or biomes except cacti, grasses, and aquatic plants.
3. The water use and growth rates are based upon container plants.
4. Only significant cultivation problems are listed.

**HORTICULTURAL PRACTICE**

Sonoran Desert plants are treated poorly when placed in public spaces and in backyards. Practice tends to mimic the tightly controlled designs of European gardens, with sculpted bushes and shrubs. Such practices do not take advantage of the qualities found in Sonoran desert/native plants. Flowering is inhibited, and the genetically determined form of the plant may be discouraged with pruning maintenance. To encourage planting of native species in public areas, the County nursery research and development components can include:

- Research and develop lists of plants that are more appropriately planted in public spaces and are likely to retain a predictable form and size. Low desert composite species tend to develop into rounded sculpted shapes.
- Provide better and more frequent training in horticultural practices such as correct pruning, irrigation and fertilization techniques.
- Public education about appropriate practices with a goal to alter the expectations when native plants are used.

- Experimentation, studies and research on the growth habits and forms of Sonoran Desert plants under different conditions when cultivated.
- Introduction of new plants to replace those which may not be appropriate for public projects.
- New or redesigned landscape installations on all county projects should include guidelines that encourage the use and appropriate maintenance of Sonoran Desert native plants - training of groundskeepers should be provided to insure continued and appropriate practices are employed.
- Plants grown as part of the Pima County nursery should be considered for county projects.
- Plants that are grown in the nursery should consider the future landscaping needs for Pima County Public Works projects.
- Identify and evaluate the biologic impacts of the materials sources (borrow pits, channel excavation) used in public works projects.

**INVASIVE EXOTICS**

An ambitious component of this project will related to education on the issue of invasive exotics and their effect on natural areas.

There are five components to developing an educational program:

- Soliciting cooperation of the nursery industry to cease sales of invasive exotic plants and assist in the education campaign.
- Developing alternative plants that will be promoted to replace the invasive exotics. Replacement plants may have some of the qualities of the exotics. Example: Muhlenbergia spp. can be promoted to replace Fountain Grass. Vaquelinia (rosewood) promoted to replace African sumac.
- Education of the public about problems caused by invasive exotics - the biology of exotics, and promoting replacement species.
- Development of ordinances and their enforcement for the more noxious species.
- Research on predicting the invasiveness of exotics and new introductions. Attempting to determine what qualities will lead to an introduced species becoming competitive in the Sonoran Desert landscape.

**Social and Education Opportunities**

Pima County's Native Plant Nursery will fulfill a significant strategic purpose under the Sonoran Desert Conservation Plan. To become a successful operation that will endure public scrutiny, its purpose must extend beyond the very specific needs and requirements of the SDCP.

The nursery can achieve its purpose when it creates excitement; and inspires interest and curiosity about native plants. This excitement in turn will stimulate interest by residents to grow plants and insure their survival not only in their native habitat, but also throughout urbanized Pima County. One role helps fulfill the other. The Pima County Nursery can fulfill and incorporate a number of public purposes to meet this mission.

The following list may be considered examples, and are not definitive, but intended to be indicative of potential links that can be established with local institutions and projects. These examples are indicative of the overlapping purposes that are contained in the Sonoran Desert Conservation Plan.

- The Arizona Sonoran Desert Museum (ADSM) has expert horticulturists and naturalists on their staff. ADSM has played an important role in public education about desert habitat. In recent years it has embarked on ambitious campaigns on Ironwoods and Migratory Pollinators which have had an impact on public understanding and appreciation of the environment. The Pima County Nursery could propagate or grow plants that could be distributed in conjunction with programs undertaken by ADSM.
- The Native Plant Nursery can be an integral part of the Pima County Resources Management projects. In addition to providing plants for landscape and restoration projects, the nursery could provide an opportunity to introduce youth into the field. A summer/year round program could be developed that where youths could be rotated through the various projects that are related to implementation of the Conservation Plan. Participants in this program who show an interest in resource management could be encouraged to continue in the field by taking courses that are offered at local institutions. Recruitment would include at-risk youth from targeted neighborhoods through the Youth Opportunity Program or other projects administered by Pima County Community Services Department's Employment and Training Division.
- Plants could be grown and distributed as part of research projects. This could include research based

upon plants that are grown in specific localities or habitats. Monitoring is conducted on a formal basis. More general research could be based upon distribution of plants to homeowners. Results are based upon less formal monitoring.

■ Educational programs and projects could be developed in conjunction with the Cooperative Extension Service and Tucson Botanic Gardens. Both organizations are funded by Pima County and have educational missions. Project could be developed that flow directly from SDCP but could also incorporate promotion of specific plants that are grown in the nursery, appropriate landscape gardening practices, etc.

■ As a way to promote the nursery component in schools and to the public, a web page and quarterly newsletter could be developed. Each would contain specific information on plants, projects, habitats, and issues. The Web site would have links to different projects and programs. School children could implement projects or write reports based upon information provided through the website/newsletter. Fact sheets on plants that are grown in the nursery would be posted and published. (see NatureBase-West Australia Department of Conservation and Land Management)

■ The nursery could affiliate with Tucson Audubon Society's Simpson Farm project. The goal of this project will be to restore this retired degraded farm for wildlife habitat. Pima County could assist the project by supplying plants. This could be a site for monitoring results of planting under controlled conditions.

■ The Tohono O'odham Nation may contribute extensive ethnobotanical knowledge and cultural uses of native plants.

### Question-Items Needing Further Study

Study/review to determine start-up costs and budget for nursery - which sites are most feasible.

The quality of the available effluent is designed to comply with regulatory standards and permits. Consultation with CERF and other plant experts may be needed regarding the utilization of effluent within horticultural systems.

■ What funds would be used for initial capital and operating costs?

■ Development of management plan - job descriptions.

■ Development of strategic marketing plan - what does it make sense to grow - what needs to be grown to sustain the nursery?

- Research to determine appropriate nursery plants, species and numbers needed, etc.
- Refinement of the list of potential plants.
- Exploration of potential links to county projects -
  - Restoration
  - Public works
  - Nursery sales
  - Public sales
- Developing a list of plants that are worthy of study/propagation - feasibility of plant on current list.
- Interest from other institutions and possible partnerships - Tucson Botanical Gardens, Arizona-Sonora Desert Museum, Tohono O'odham Nation, Desert Survivors, etc.
- Develop inventory of Pima County native plants in nursery cultivation - why are some not propagated - what are difficulties - what is needed to increase sales of native plants. What are the perceived barriers to getting more native plants used?
- Research cultivation and propagation needs.
- How can this project help the nursery industry - how can the nursery industry help the project?

### Institutional Links/Potential Collaborators-Partners

- Native plant and seed sources from Arizona Native Plant Society web site <<http://...>> See Appendix B.
- Arizona Sonoran Desert Museum- expert horticulturists/propagators-have a migratory pollinator program.
- University of Arizona
- cooperative extension service-important education role
  - Landscape Architecture Program
  - Natural Resources-agricultural department/Office of Arid Lands
  - Water Resources Research Center
  - U.S. Geological Survey-Tumamoc Hill Laboratory
- Desert Survivors
- Tucson Botanic Gardens-interested in selling new interesting plants
- Tohono Chul Garden
- Native Seed/SEARCH
- Arizona Native Plant Society
- Southern Arizona Water Resources Center
- Desert Botanic Gardens-Phoenix
- Pro Neighborhoods
- Boyce Thompson Arboretum
- Pima College-environmental training programs
- Arizona Game and Fish Department
- Arizona Department of Agriculture
- U.S. National Park Service-Saguaro National Park, Organ Pipe Cactus National Monument
- U.S. Fish and Wildlife Service
- Coronado National Forest
- U.S. Bureau of Land Management
- The Nature Conservancy

- Trees for Tucson/ Global Releaf
- Tohono O'odham Nation
- Pima County jurisdictions
  - City of Tucson
  - City of South Tucson
  - Town of Marana
  - Town of Oro Valley
  - Town of Sahuarita
- Private nurseries
- Leverage on Pima County funded programs to work closely with project.
- Local lifestyle magazines
- Natural Resources Conservation Services

## References

Bertelson, Dave. Personal communication 11/2/2000.

Dimmit, Mark. 2000. "Plant Ecology of the Sonoran Desert Region" A Natural History of the Sonoran Desert. Arizona Sonoran Desert Museum; University of California. Pg. 150.

Frye, Robert, 2000. Status of the Endangered Species, *Lilaeopsis shaffneriana* ssp. *recurva*. Final Report to Arizona Department of Agriculture. Soil, Water, Engineering Department, University of Arizona, Tucson.

Harmon, Dorothee. Pima County Community Services Department. Interview, 11/3/99.

Shaw, W. W., L. K. Harris, M. Livingston, J. Charpentier, and C. Wissler. 1996. Pima County Habitat Inventory, Phase II. Final Report to Arizona Game and fish Department, Contract Number G50028-001.