DRAFT

CITY OF TUCSON

HABITAT CONSERVATION PLAN

Prepared by

Ms. Leslie Liberti
Environmental Planning Manager
City Manager's Office
City of Tucson
100 N. Stone Ave., Suite 200
Tucson, Arizona 85701

and

Mr. Michael W. Wyneken, AICP
Principal Planner
Department of Urban Planning & Design
City of Tucson
MacArthur Building, 345 East Toole Avenue
P.O. Box 27210
Tucson, Arizona 85726

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SECTION 1

Introduction and Background

This Preliminary Draft Habitat Conservation Plan (HCP) has been prepared in support of the City of Tucson's (City or Tucson) application for an Incidental Take Permit (Permit) in conformance with Section 10 of the Federal Endangered Species Act of 1973 (ESA). Through this HCP, the City is committing to implement certain actions that will minimize and mitigate the impacts of any take of certain specified species that could occur as a result of planned urban development, future Tucson Water Department water supply projects, and associated capital improvement projects. It is anticipated that the permit length will be 50 years. The HCP addresses proposed development activities in three City of Tucson planning sub-areas: Southlands, Avra Valley, and Santa Cruz River.

The need for an HCP for these planning sub-areas is driven by the anticipation of future activities in these areas, activities that will have impacts on endangered species and/or their habitats. The Southlands planning sub-area (Southlands) is planned for future urban development. The Avra Valley planning sub-area includes parcels of land that may be developed for future water resources projects. The Santa Cruz River planning sub-area contains the river corridor within the corporate limits of the City of Tucson. This segment of the river is approximately 14.5 miles (23.3 kilometers) long, and is approximately one half of a 29-mile (47-kilometer) river segment on which the U. S. Army Corps of Engineers (USACE) is conducting three studies to determine the feasibility of ecological restoration of this part of the river. These projects are discussed in greater detail in Section 2.2.6.

1.1 Background

Tucson is located in southeastern Arizona (Figure 1.1-1). Portions of the City support cactus ferruginous pygmy-owl (CFPO, *Glaucidium brasillanum cactorum*) and Pima pineapple cactus (PPC, *Coryphantha scheeri* var. *robustispina*), species that are currently listed as endangered (62 FR 10730 and 58 FR 49875) under the ESA. Proposed critical habitat for pygmy-owl (68 FR 22353) is located within portions of the City-owned properties in Avra Valley.

The City has been experiencing significant population growth over the past few decades. In 1980, Tucson encompassed 63,758 acres (25,503 hectares) and supported 330,537 residents. Between the years 1980 and 1990, the City's population increased by 74,853 residents (23 percent). From 1990 to 2000, population growth continued with an increase to 486,699 residents (20 percent). This population growth has been accompanied by an increase in the incorporated area of the City. Currently, Tucson encompasses about 145,119 acres (58,048 hectares) and supports 512,023 residents. Over the next decade, Tucson is expected to become home to more than 590,000 people. In the future, residents will likely rely on Avra Valley for water resources, the Santa Cruz River for open space, recreation and municipal water supply benefits, and the Southlands for housing and employment.

The City HCP planning sub-areas encompass three broad geographic areas, which are shown in Figure 1.1-2:

1. Southlands,
2. Avra Valley, and
3. Santa Cruz River.

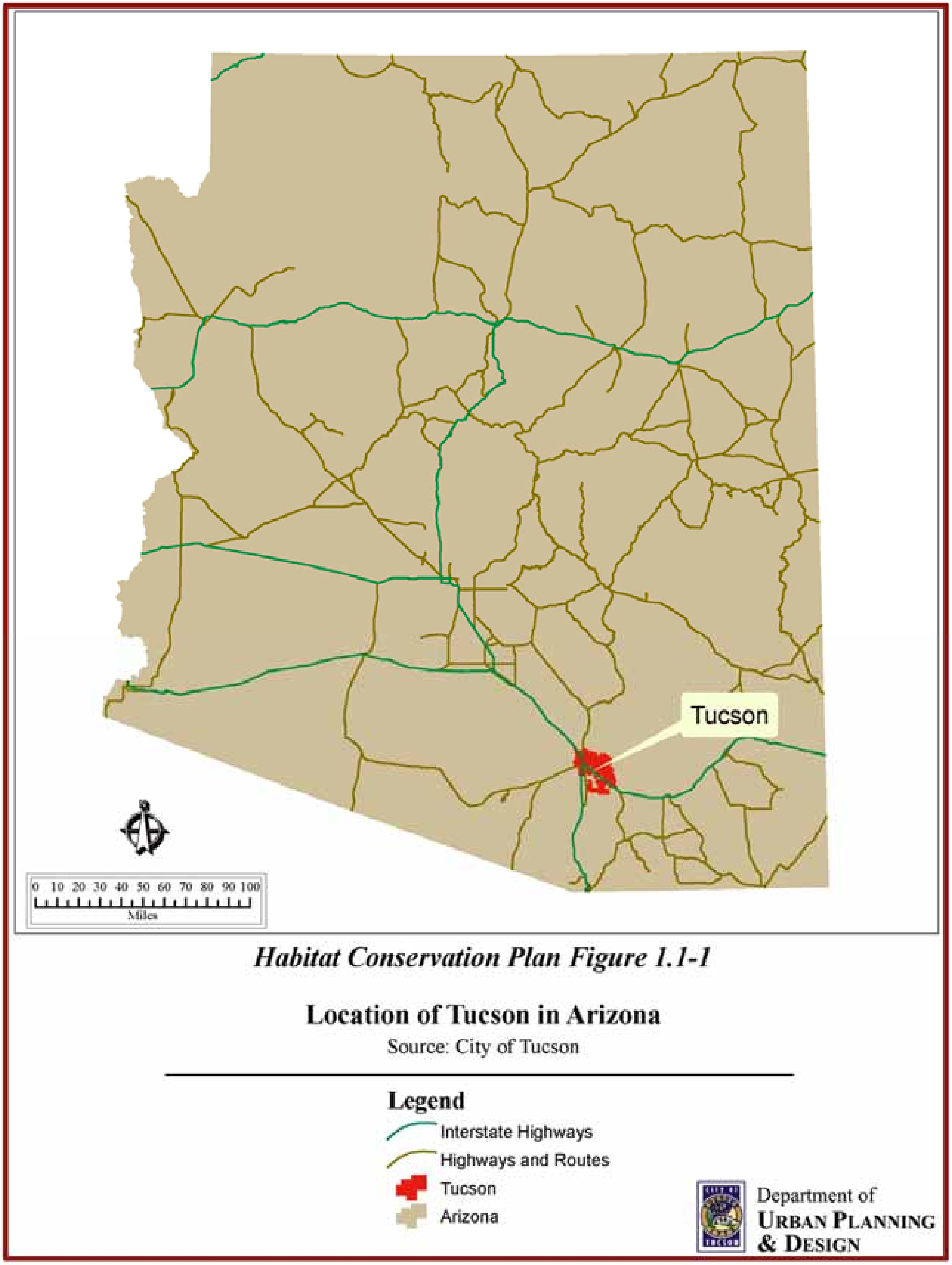

Figure 1.1-1. Location of Tucson in Arizona.

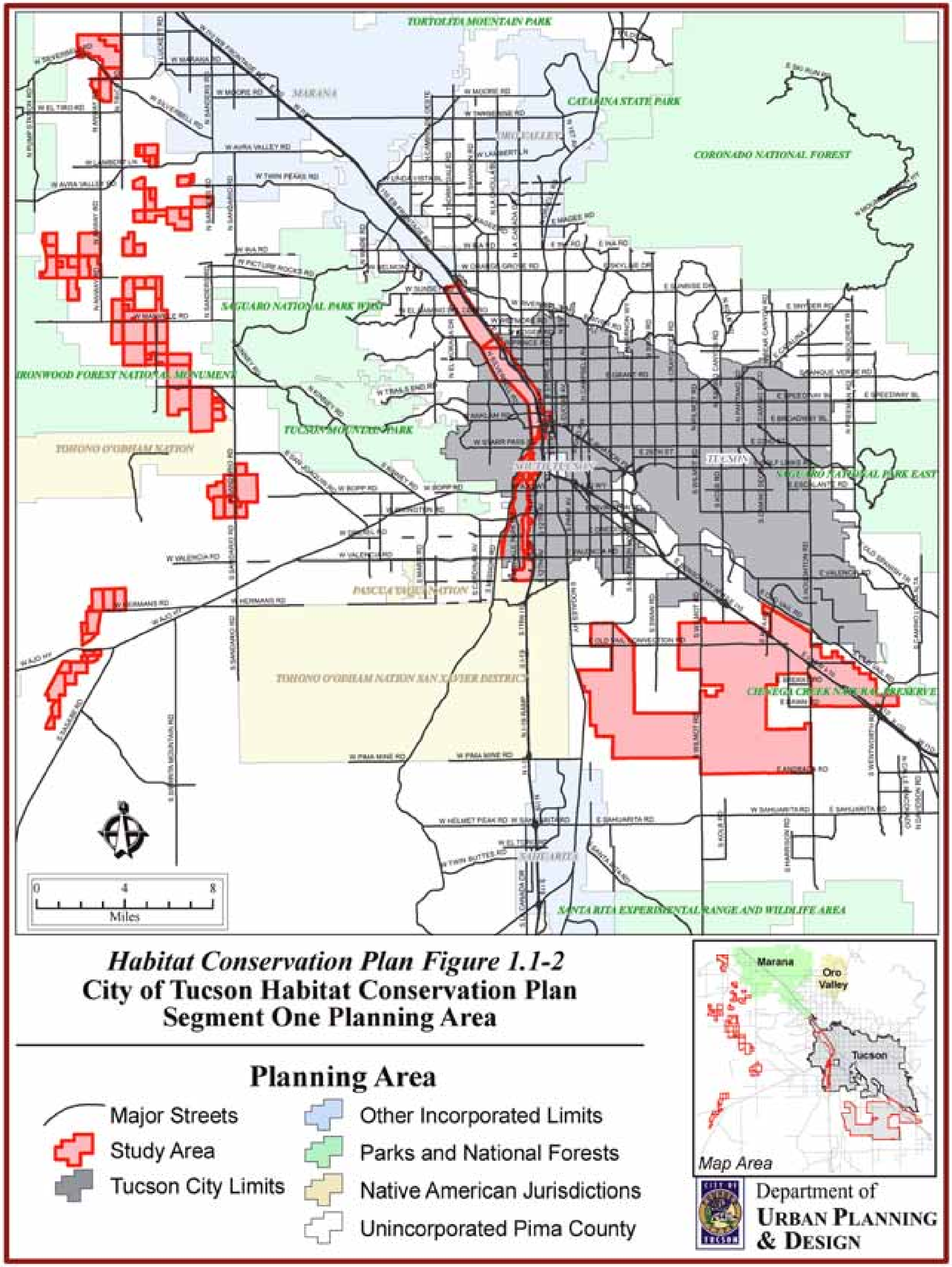

Figure 1.1-2. City of Tucson Habitat Conservation Plan Segment One Planning Area.

The Southlands planning sub-area includes 34,546 acres (13,981 hectares) of undeveloped land south of Interstate 10 (I-10) and north of the Santa Rita Mountains, east of Old Nogales Highway, and west of Wentworth Road. The majority of the Southlands planning sub-area (29,270 acres or 11,846 hectares) is trust land that is administered by the Arizona State Land Department (ASLD). In this area, vegetation is typical of the Arizona Upland Subdivision of the Sonoran Desertscrub biome (Brown 1994), which is characterized by the dominance of shrubs, small trees, and cacti. The abundance of cacti, trees, and shrubs and general absence of native grasses is typical of areas that have been subjected to intense livestock grazing over a period of many years. In addition to grazing, much of the land has been degraded or disturbed by past and present land uses including off-road vehicle (ORV) use, overhead utility line construction and maintenance, and illegal dumping. Xeroriparian[1] Mixed Scrub, consisting primarily of velvet mesquite (*Prosopis velutina*), is the characteristic riparian vegetation found along ephemeral washes in the area.

The Avra Valley planning sub-area consists of 21,596 acres (8,740 hectares) in unincorporated Pima County, west of the Tucson Mountains. Most of these parcels have been disturbed by agricultural activities, including irrigated farming that occurred before their purchase by the City. Vegetation communities include upland and riparian communities, both of which have been extensively modified by human activities. Upland vegetation communities on the City-owned properties include Scrub Grassland, Sonoran Desertscrub, and Sonoran Vacant or Fallow Land. Riparian vegetation communities include Sonoran Desertscrub Xeroriparian, Sonoran Riparian Deciduous Forest and Woodland (both mesquite and cottonwood-willow series), and Sonoran Deciduous Riparian Scrub.

The Santa Cruz River planning sub-area, which runs south to north through the west side of Tucson, includes 5,075 acres (2,054 hectares), along 14.5 river miles (23.3 kilometers) of highly degraded riparian lands. This historically perennial river is now ephemeral due to nearby groundwater pumping and has suffered significant vegetation loss associated with lowered groundwater tables, grazing, and development along its banks. The three USACE studies will determine the feasibility of restoring an approximately 29-mile (46.7-kilometer) section of the River, including the segment within the HCP planning sub-area, with native vegetation including cottonwood, willow, mesquite bosque, emergent marsh, and xeroriparian scrub shrub.

Through this HCP, the City aims to promote conservation of natural resources while providing for future growth. The City seeks to accomplish the following objectives with this HCP:

- Facilitate compliance with the ESA for planned urban development and capital improvement projects;
- Promote achievement of regional economic objectives including the orderly and efficient development of certain lands, while recognizing property rights, and legal and physical land use constraints;
- Complement other regional conservation planning efforts such as Pima County’s Sonoran Desert Conservation Plan (SDCP) and the Town of Marana HCP project.

The development of the Sonoran Desert Conservation Plan (SDCP) was initiated in 1998. Pima County, in consultation with several advisory committees and numerous technical experts, developed this land use plan that is, at its core, a scientifically based land conservation system. The County took a comprehensive approach to planning that focused on the preservation of ecosystems and biodiversity, rather than on species-specific conservation. This goal is captured in the overarching vision of the SDCP, which is:

[1] Associated with an ephemeral water supply and typically contains plant species also found in upland habitat, although riparian plants are commonly larger and occur at higher densities than those in adjacent uplands.

To ensure the long-term survival of the full spectrum of plants and animals that are indigenous to Pima County through maintaining or improving the habitat conditions and ecosystem functions necessary for their survival.

The entire county was addressed in this planning process, with nearly 6 million acres (2.5 million hectares) being considered in the development of a biological reserve system. Habitat for more than 50 vulnerable plant and animal species, and nearly 20 important vegetation communities or landscape features, were used as the basis for the reserves.

This process resulted in a map identifying lands of varying environmental sensitivity, known as the Conservation Land System (CLS), with associated development guidelines for each category of reserve land. Almost 3 million acres (1.2 million hectares) of land received some level of protection through one of four land-use designations. These categories and their associated development restrictions are:

- Important Riparian Areas – at least 95 percent of the land area should remain undisturbed
- Biological Core – at least 80 percent of the land area should remain undisturbed
- Special Species Management Areas – at least 80 percent of the land area should remain undisturbed
- Multiple Use Areas – at least 66-2/3 percent of the land area should remain undisturbed

The CLS has been formalized through the 2000 update of the County's Comprehensive Land Use Plan. All rezonings subdivision plats, development plans, conditional use permits, or any other projects subject to discretionary action by the County Board of Supervisors are required to comply with the guidance set forth in the CLS. All of the Avra Valley and Santa Cruz River planning sub-areas, and a small portion of the Southlands planning sub-area, fall within one or more of the four CLS reserve designations. The majority of the Southlands planning sub-area falls outside of the CLS and, as a result, has no associated conservation guidelines under the SDCP. Appropriate natural resource protection within the Southlands planning sub-area therefore requires the development of conservation measures independent of the SDCP. Consistency between the City HCP and the SDCP is an extremely important consideration. The City HCP addresses a subset of the more than 50 species considered in the SDCP, as many of the SDCP species are not found within the smaller City HCP planning area.

Another important consideration in the long-term success of the Tucson HCP is the presence of buffelgrass (*Pennisetum ciliare*) in the City HCP planning area. Buffelgrass, a drought-tolerant, perennial forage grass, was introduced into the Southwest from Africa in the late 19th century. It arrived in Tucson shortly before 1940 (Pima County 2006). Since that time it has spread rapidly in eastern Pima County, and is now abundant on Tumamoc Hill, the Tucson Mountains, Saguaro National Park, and Organ Pipe Cactus National Monument. It has also become established along roadsides, especially where runoff rainwater collects.

Buffelgrass poses a significant threat to the biodiversity of the Sonoran Desert region, not only because it can out-compete and displace native plant species, but also because it strongly modifies the communities it invades (TNC 2002). Buffelgrass re-sprouts vigorously after fire, thus is capable of causing more frequent and larger wildfires, decreasing both water infiltration to the soil and changing the way essential plant nutrients cycle in the desert (USGS 2002). Recurrent fires maintain buffelgrass populations, and the ecological result is the conversion of native desertscrub communities to African-type grassland with reduced biological diversity (TNC 2002). Native, long-lived plant species (e.g., saguaro [*Carnegiea gigantea*], ocotillo [*Fouquieria splendens*], and *Opuntia* cacti) are not adapted to these frequent fire cycles. In Organ Pipe Cactus National Monument, studies have determined that buffelgrass excludes native shrubs such as creosote bush (*Larrea tridentata*), saltbush (*Atriplex* sp.), bursage (*Ambrosia* sp.), and associated native grasses and forbs (TNC 2002). In addition to its effects on native plants, buffelgrass also can alter animal community structure (USGS 2002). For example, buffelgrass can reduce the open space required for some animals, like lizards, to escape predators, which can, in turn, lead to shifts in wildlife population abundance and species diversity. A map depicting the current range of buffelgrass in the Tucson area is provided as Figure 1.1-3.

There is no single approach to the successful control of buffelgrass in large areas (TNC 2002). For large infestations, management will likely be most effective through an integrated management approach. This includes removing standing biomass by application of herbicides, continued spraying of herbicides to control new seedlings or re-sprouts, followed by active restoration to create dense native vegetation. For small areas, control in disturbed, low-nutrient areas has been accomplished successfully by carefully pulling or digging out entire plants, followed in the second year, or in later years, by the pulling of new seedlings. There are no known biological controls of buffelgrass.

1.2 Permit Holder and Permit Duration

The City of Tucson will be the HCP permit holder and will be solely responsible for ensuring implementation of the HCP measures. The HCP addresses proposed development activities in three City HCP planning sub-areas: Southlands, Avra Valley, and Santa Cruz River. The proposed permit length will be tied to the major land use planning efforts for each of these areas. Water project development in the Avra Valley planning sub-area is projected through 2050 in the City of Tucson Water Department’s Water Plan: 2000-2050 (City Water Plan). Studies suggest that development in the Southlands planning sub-area may extend through 2078. Planning for the river restoration projects also follows a 50-year time horizon. Based on these time frames, the permit length will be between 50 and 75 years, depending on more refined estimates of anticipated buildout in the Southlands planning sub-area.

1.3 Permit Area

The City HCP permit area includes approximately 61,217 acres (24,774 hectares): with 34,546 acres (13,981 hectares) in the Southlands planning sub-area; 21,596 acres (8,740 hectares) in the Avra Valley planning sub-area; and 5,075 acres (2,054 hectares) along the Santa Cruz River planning sub-area. Figure 1.3-1 shows the HCP planning area relative to the incorporated portion of the City. The permit area does not include areas that may be annexed by the City in the future. Areas of possible future annexations will be addressed and incorporated into a future draft. Areas where mitigation lands may be located are identified in the conservation program (Section 5).

1.4 Species to be Covered by Permit

The City HCP covers the eight species listed Table 1.4-1. These species, referred to as “covered species,” will be included in the Incidental Take Permit if it is issued.

Figure 1.1-3.

Table 1.4-1. Species Included in the City of Tucson Habitat Conservation Plan

Species	Federal Status
Cactus ferruginous pygmy-owl (*Glaucidium brasilianum cactorum*)	Endangered
Pima pineapple cactus (*Coryphantha scheeri* var. *robustispina)*	Endangered
Western burrowing owl (*Athene cunicularia*)	Species of Concern
Tucson shovel-nosed snake (*Chionactis occiptalis klauberi*)	Petitioned
Ground snake (valley form) (*Sonora semiannulata*)	None
Needle-spined pineapple cactus (*Echinomastus erectocentrus* var. *erectocentrus)*	None
Pale Townsend's big-eared bat (*Corynorhinus townsendii pallenscens*)	Species of Concern
Western yellow-billed cuckoo *(Coccyzus americanus occidentalis)*	Candidate

1.5 Regulatory Framework

1.5.1 Federal Endangered Species Act

The ESA, and its implementing regulations, prohibit the take of any fish or wildlife species that are federally listed as threatened or endangered without prior approval pursuant to either Section 7 or Section 10(a)(1)(B) of the ESA. The ESA defines take as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. Federal regulation 50 CFR 17.3 further defines the term harm in the take definition to mean any act that actually kills or injures a federally listed species, including significant habitat modification or degradation.

Section 10(a) of the ESA establishes a process for obtaining an Incidental Take Permit, which authorizes nonfederal entities to incidentally take federally listed wildlife or fish subject to certain conditions. Incidental take is defined by ESA as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Preparation of a HCP is required for all Section 10(a) permit applications. The U.S. Fish and Wildlife Service (USFWS) and the National Oceanographic and Atmospheric Administration's Fisheries Service (NOAA Fisheries) have joint authority under the ESA for administering the incidental take program. NOAA Fisheries has jurisdiction over anadromous fish species, and USFWS has jurisdiction over all other fish and wildlife species.

Section 10(a) also was intended by Congress to authorize USFWS to approve HCPs for unlisted as well as listed species. Moreover, if an HCP treats an unlisted species as if it were already listed, additional mitigation will not be required within the area covered by the HCP upon the listing of that species. As stated by the Conference Committee when Section 10 was added to the ESA in 1982:

> "*The committee intends that the Secretary [of the Interior] may utilize this provision to approve conservation plans which provide long-term commitments regarding the conservation of listed as well as unlisted species and long-term assurances to the proponent of the conservation plan that the terms of the plan will be adhered to and that further mitigation requirements will only be imposed in accordance with the*

terms of the plan. In the event that an unlisted species addressed in an approved conservation plan is subsequently listed pursuant to the Act, no further mitigation requirements should be imposed if the conservation plan addressed the conservation of the species and its habitat as if the species were listed pursuant to the Act (House of Representatives Conference Report No. 97-835, 97th Congress, 2d Session, p. 30)."

The No Surprises policy, adopted by the U.S. Department of the Interior, provides that landowners who have habitat for listed species on their property and agree to a HCP under the ESA will not be subject to later demands for more land, water or financial commitment if the HCP is adhered to, even if the needs of the species changes over time (63 FR 8859).

Section 7 of the ESA requires all federal agencies to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any species listed under the ESA, or to result in the destruction, or adverse modification, of its habitat. Technically, the issuance of an Incidental Take Permit is an authorization for take by a Federal agency. Consequently, in conjunction with issuing a permit, USFWS must conduct an internal Section 7 consultation on the proposed HCP. The internal consultation is conducted after an HCP is developed by a nonfederal entity and submitted for formal processing and review. Provisions of Sections 7 and 10 of the ESA are similar, but Section 7 requires consideration of several factors not explicitly required by Section 10. Specifically, Section 7 requires consideration of the indirect effects of a project, effects on federally listed plants, and effects on critical habitat. (ESA requires that USFWS identify critical habitat to the maximum extent that it is prudent and determinable when a species is listed as threatened or endangered.) The internal consultation results in a Biological Opinion (BO) prepared by USFWS regarding whether implementation of the HCP will result in jeopardy to any listed species or will adversely modify critical habitat.

1.5.2 The Section 10 Process – Habitat Conservation Plan Requirements and Guidelines

The Section 10 process for obtaining an Incidental Take Permit has three primary phases: (1) HCP development; (2) formal permit processing; and (3) post-issuance.

During the HCP development phase, the project applicant prepares a plan that integrates the proposed project or activity with the protection of listed species. An HCP submitted in support of an Incidental Take Permit application must include the following information:

- Impacts likely to result from the proposed taking of the species for which permit coverage is requested;
- Measures that will be implemented to monitor, minimize, and mitigate impacts; funding that will be made available to undertake such measures; and procedures to deal with unforeseen circumstances;
- Alternative actions considered that would not result in take; and
- Additional measures USFWS may require as necessary or appropriate for purposes of the plan.

The HCP development phase concludes, and the permit-processing phase begins, when a complete application package is submitted to the appropriate permit-issuing office. A complete application package consists of (1) an HCP, (2) an Implementing Agreement (IA), (3) a permit application, and (4) a $25 fee from the applicant. USFWS must also publish a Notice of Availability of the HCP package in the Federal Register to allow for public comment. USFWS also prepares an Intra-Service Section 7 Biological Opinion; and prepares a Set of Findings, which evaluates the Section 10(a)(1)(B) permit application in the context of permit issuance criteria (see below). An Environmental Assessment (EA) or Environmental Impact Statement (EIS) serves as USFWS's record of compliance with the National Environmental Policy Act (NEPA) after a 60-day to 90-day public comment period on the document (see Section 1.5.3). No further NEPA review is required. An Implementing Agreement is required for HCPs unless the HCP qualifies as a low-effect HCP. A Section 10 incidental take permit is granted upon a determination by USFWS that all requirements for permit issuance have been met. Statutory criteria for issuance of the permit specify that:

- The taking will be incidental;
- The impacts of incidental take will be minimized and mitigated to the maximum extent practicable;
- Adequate funding for the HCP and procedures to handle unforeseen circumstances will be provided;
- The taking will not appreciably reduce the likelihood of survival and recovery of the species in the wild;
- The applicant will provide additional measures that USFWS requires as being necessary or appropriate; and
- USFWS has received assurances, as may be required, that the HCP will be implemented.

During the post-issuance phase, the Permittee and other responsible entities implement the HCP, and USFWS monitors the Permittee's compliance with the HCP as well as the long-term progress and success of the HCP. The public is notified of permit issuance by means of the Federal Register.

1.5.3 National Environmental Policy Act

The issuance of an Incidental Take Permit by USFWS constitutes a Federal action. The NEPA requires that Federal agencies analyze the environmental impacts of their actions (in this instance, issuance of an Incidental Take Permit) and include public participation in the planning and implementation of their actions. The NEPA process helps Federal agencies make informed decisions with respect to the environmental consequences of their actions and ensures that measures to protect, restore, and enhance the environment are included, as necessary, as a component of their actions. NEPA compliance is obtained through one of three actions: (1) preparation of an EIS; (2) preparation of an EA; or (3) a categorical exclusion (allowed for low-effect HCPs). An EA is typically prepared for a moderate-effect HCP with an EIS required for high-effect HCPs. Low-effect HCPs, as defined in the HCP Handbook, are categorically excluded under NEPA. Preparation of an EIS is anticipated for the City HCP.

SECTION 2

Activities Covered by Permit

Activities to be covered by the City of Tucson HCP Permit include any activities carried out by, or authorized by, the City on covered lands (i.e., the Permit Area identified in Section 1.3). These activities consist of residential, commercial, and industrial development within the City boundaries; Tucson Water Department development activities; capital improvement projects, including widening or resurfacing of existing roads; and construction of new roads, bridges, trails and parks. Maintenance activities associated with public infrastructure and HCP implementation activities also will be covered.

2.1 Development Projections

A range of development activities is planned in the three City of Tucson planning sub-areas over the next 50 years or more. In the Southlands planning sub-area, residential, commercial, and industrial development is anticipated. In the Avra Valley planning sub-area, portions of 21,596 acres (8,740 hectares) of City-owned lands will be used for future City water development projects. In the Santa Cruz River planning sub-area, the feasibility of restoration projects is currently being evaluated by the USACE and various local jurisdictions. These potential projects may impact species covered in this HCP. The regional context for these three planning sub-areas is provided in Figure 2.1-1.

The spatial distribution of these planned land uses is tied to current resource conditions. The resource conditions vary greatly within the different City HCP planning sub-areas. The Southlands planning sub-area includes large areas of undeveloped land with predominately native vegetation and ephemeral washes and areas of high sheet flow with associated xeroriparian habitat. The Avra Valley planning sub-area lands are largely disturbed former agricultural lands, ephemeral washes with associated xeroriparian habitat, and some undeveloped land with native vegetation. The Santa Cruz River planning sub-area lands include the channel and adjacent floodplain of the Santa Cruz River, much of which is highly degraded.

The City of Tucson General Plan identifies the Southlands planning sub-area as the Future City Growth Area, to be developed according to the Desert Village development model. The Desert Village model envisions the area to be developed with a series of large master planned communities. A master planned community typically consists of a cluster of villages with a sufficient population base to support community-scale civic and commercial services located within a town center. Each planned community should have a discreet identity defined by its context, a system of continuous open space, architectural design themes, or other distinguishing features. The land use mix within the overall planned community should promote a high degree of self-sufficiency.

The fundamental components of the Desert Village model are:

- A variety of housing types and densities, which offer both affordability and livability.
- A mix of uses within a compact development pattern, which integrates places for people to live, work, shop, and play within a cohesive system of neighborhoods and village and town centers.
- A transportation and circulation system that offers residents alternatives for mobility, giving high priority to pedestrian, bicycle, and transit modes.

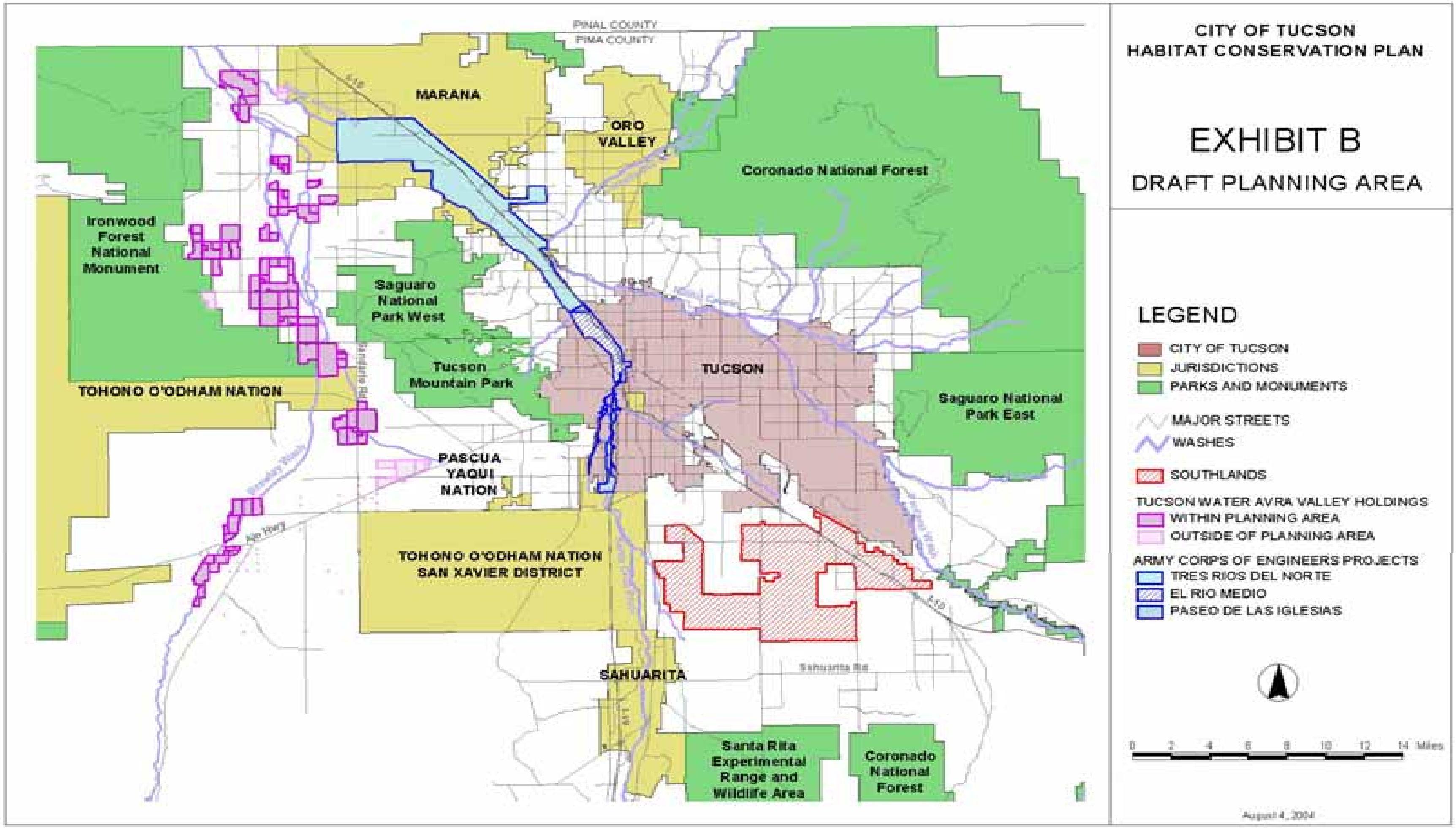

Figure 2.1-1. Context for the City of Tucson HCP Planning Sub-areas.

- A regional open space system that preserves washes and environmentally sensitive areas as passive open space amenities, and offers active recreational opportunities such as trails and developed parks.
- A long-term, phased approach to development, in order to provide for increased efficiency of infrastructure and services for residents.

The General Plan anticipates urban intensity development for the Southlands planning sub-area. Residential densities are projected to be at minimum four (4) residences per acre (RAC) for single-family neighborhoods. This can be characterized as moderate intensity development. Activity nodes— neighborhood centers, village centers and town centers—will incorporate a mix of commercial, office, service, and residential uses (minimum eight (8) RAC), and are considered to be high intensity use areas. Low intensity uses, such as less than one (1) RAC residential densities, may occur where localized environmental conditions warrant the lower intensity of use. Other low intensity land use categories include vacant/undeveloped properties, mitigation lands, natural resource parks, and floodplain zones.

A number of land use and infrastructure planning efforts will allow for the refinement of development projects for the Southlands.

The City is currently updating its Major Streets and Routes (MSR) Plan to include the Southlands planning sub-area. The Southlands arterial network has been conceptualized in the Southeast Area Arterial Study, completed under the umbrella of the Pima Association of Governments (PAG) in 2005.

The Pima County Regional Flood Control District (RFCD) will launch the Lee Moore Wash Basin Management Study in 2006. The study area includes all of the Southlands planning sub-area, plus a significant portion of the land adjacent to the sub-area. This study is designed to provide a comprehensive flood control program and a multi-objective approach to managing the watersheds, floodplains and other resources within the study area.

The Arizona State Land Department (ASLD), the principal land manager within the Southlands planning sub-area, is refining its development suitability analysis of the Southlands, completed in 2001, in preparation for developing a conceptual land use plan for its holdings. The ASLD, City, and Pima County are working toward a multi-jurisdictional land use planning process for an area that would include all of the Southlands and the area bordered by Interstate 19 (I-19) on the west, (I-10 on the north, State Route 83 on the east and the Santa Rita Experimental Range on the south.

This HCP covers all activities undertaken during the normal process of residential, commercial, and industrial land development. These activities include:

- Pre-construction clearance surveys for natural and cultural resources;
- Clearing, grubbing, grading, and other land disturbance activities necessary to construct buildings, parks, utilities, roads, trails, and all other associated infrastructure located within the Permit planning area;
- Noise and disturbance resulting from the construction of these structures or facilities; and
- Long-term indirect impacts to protected areas from urban development, including threats due to domestic animals and invasive species, habitat fragmentation, increased barriers to wildlife movement due to more roads and higher traffic volumes, and human intrusions (e.g., off-road vehicles).

2.2 Capital Improvement Projects

Growth in population, housing, and employment opportunities in the Southlands during the next 50 years will bring about the need for increased public infrastructure. City of Tucson will provide new roads, road improvements, and parks, trails, and other recreation opportunities necessary to support the growing community. Most utility services in the City are provided by other entities, with the exception of water, which is provided by Tucson Water Department. Sewer service is provided by Pima County, and power and gas by private companies. Future expansion of water services will be addressed in this HCP; however, the expansion of other utilities will not be covered in this HCP. Capital improvement projects that will be implemented by the City and covered by this HCP consist of:

- Road construction and improvement;
- Public water infrastructure;
- Parks and trails; and
- Maintenance of these facilities.

2.2.1 Road Construction and Improvement

The 2001–2025 Transportation Plan Update for the City of Tucson identifies 142 miles (229 kilometers) of public road projects planned for the next 20 years. In addition to the construction of new roads, these projects include improvements to existing roads. Table 2.2-1 lists the number and extent of anticipated road projects according to type. Major streets and routes in the Southlands are depicted in Figure 2.2-1. Descriptions of each of the road construction and improvement activities are provided below.

Road Resurfacing

Road resurfacing generally consists of milling the existing surface, adding a new asphalt driving surface, signing, and striping. Resurfacing projects can be accomplished at a rate of 0.1 miles (0.16 kilometers) per day with a crew of approximately six. All activities associated with road resurfacing are restricted to currently disturbed areas. Projects may include adding paved shoulders where none currently exist. If shoulders were added to an existing roadway, they would generally be from 5 to 8 feet (1.5 to 2.4 meters) in width. The shoulders would be added in existing graded areas so that no disturbance to potential habitat would occur.

Road Widening

Road widening generally consists of excavation and embankment creation, importing or exporting embankment material, minor changes in horizontal and vertical alignment, drainage improvements, asphalt surfacing, signing, and striping. Other possible improvements include street lighting, traffic signal installations, and landscaping. A 1-mile (1.6-kilometer) roadway-widening project takes about 9 to 12 months. Crew sizes range from 25 to 30 at any one time. Staging areas are approved by the City and generally are in currently disturbed locations.

New Road Construction

New road construction generally consists of excavation and embankment creation, importing or exporting embankment material, drainage improvements, asphalt surfacing, signing, and striping where an existing roadway does not currently exist. Other possible improvements include street lighting, traffic signal installations, and landscaping. A 1-mile (1.6-kilometer) section of new road requires about 6 to 9 months to construct. Crew sizes range from 25 to 30 at any one time. Staging areas are approved by the City and usually are in currently disturbed locations.

Table 2.2-1. Covered Activities, Southlands Planning Sub-area Major Street and Routes

ID#	Class	Street Name	Cross Street A	Cross Street B	Length (feet)
1	Parkway (300-foot ROW)	Andrada Rd	Rita Rd	Houghton Rd	15,905
2	Parkway (300-foot ROW)	Andrada Rd	Wilmot Rd	Rita Rd	10,878
3	Arterial (150-foot ROW)	Country Club Rd	Pima Mine Rd	Dawn Rd	11,836
4	Arterial (150-foot ROW)	Country Club Rd	Dawn Rd	Old Vail Connection Rd	16,450
5	Arterial (150-foot ROW)	Dawn Rd	Swan Rd	Wilmot Rd	9,230
6	Arterial (150-foot ROW)	Dawn Rd	Wilmot/Kolb & Kolb Rd	Rita Rd	14,072
7	Arterial (150-foot ROW)	Dawn Rd	Wilmot Rd	Wilmot/Kolb & Kolb Rd	4,374
8	Arterial (150-foot ROW)	Dawn Rd	Nogales Hwy	Country Club Rd	5,901
9	Arterial (150-foot ROW)	Dawn Rd	Country Club Rd	Swan Rd	10,818
10	Arterial (150-foot ROW)	Dawn Rd	Houghton Rd		10,011
11	Parkway (150-foot ROW)	Houghton Rd	Dawn Rd		11,560
12	Arterial (150-foot ROW)	Houghton Rd	Andrada Rd	Pima Mine Rd	6,397
13	Parkway (150-foot ROW)	Houghton Rd	Pima Mine Rd	Dawn Rd	6,228
14	Parkway (300-foot ROW)	Kolb Rd		Old Vail Connection Rd	5,866
15	Parkway (300-foot ROW)	Kolb Rd	Old Vail Connection Rd	Dawn Rd & Wilmot/Kolb	20,107
16	Parkway (150-foot ROW)	Nogales Hwy	Old Vail Connection Rd	Dawn Rd	5,972
17	Arterial (150-foot ROW)	Old Vail Connection Rd	Country Club Rd	Nogales Hwy	5,695
18	Arterial (150-foot ROW)	Old Vail Connection Rd	Swan Rd & Swan/Alvernon	Country Club Rd	6,121
19	Arterial (150-foot ROW)	Old Vail Connection Rd	Rita Rd	Kolb Rd	11,860
20	Arterial (150-foot ROW)	Old Vail Connection Rd	Kolb Rd	Wilmot Rd	3,617
21	Arterial (150-foot ROW)	Old Vail Connection Rd	Wilmot Rd	Swan Rd & Swan/Alvernon	5,927
22	Arterial (150-foot ROW)	Old Vail Connection Rd	Old Vail Connection Rd	Rita Rd	2,541
23	Arterial (150-foot ROW)	Pima Mine Rd	Houghton Rd	Rita Rd	12,187
24	Arterial (150-foot ROW)	Pima Mine Rd	Wilmot Rd & Wilmot/Kolb	Swan Rd	7,654
25	Arterial (150-foot ROW)	Pima Mine Rd	Rita Rd	Wilmot Rd & Wilmot/Kolb	14,677
26	Arterial (150-foot ROW)	Pima Mine Rd	Country Club Rd	Nogales Hwy	2,909
27	Arterial (150-foot ROW)	Rita Rd	Pima Mine Rd	Dawn Rd	10,800
28	Arterial (150-foot ROW)	Rita Rd	Dawn Rd	Old Vail Connection Rd	16,107
29	Arterial (150-foot ROW)	Rita Rd	Andrada Rd	Pima Mine Rd	6,628
30	Parkway (150-foot ROW)	Swan Rd	Pima Mine Rd	Dawn Rd	11,177
31	Arterial (150-foot ROW)	Wilmot Rd	Dawn Rd	Old Vail Connection Rd	17,368
32	Arterial (150-foot ROW)	Wilmot Rd	Old Vail Connection Rd		6,864
33	Parkway (300-foot ROW)	Wilmot Rd	Wilmot/Kolb & Pima Mine Rd	Andrada Rd	3,777
34	Parkway (300-foot ROW)	Wilmot/Kolb	Kolb Rd & Dawn Rd	Pima Mine Rd & Wilmot Rd	9,114

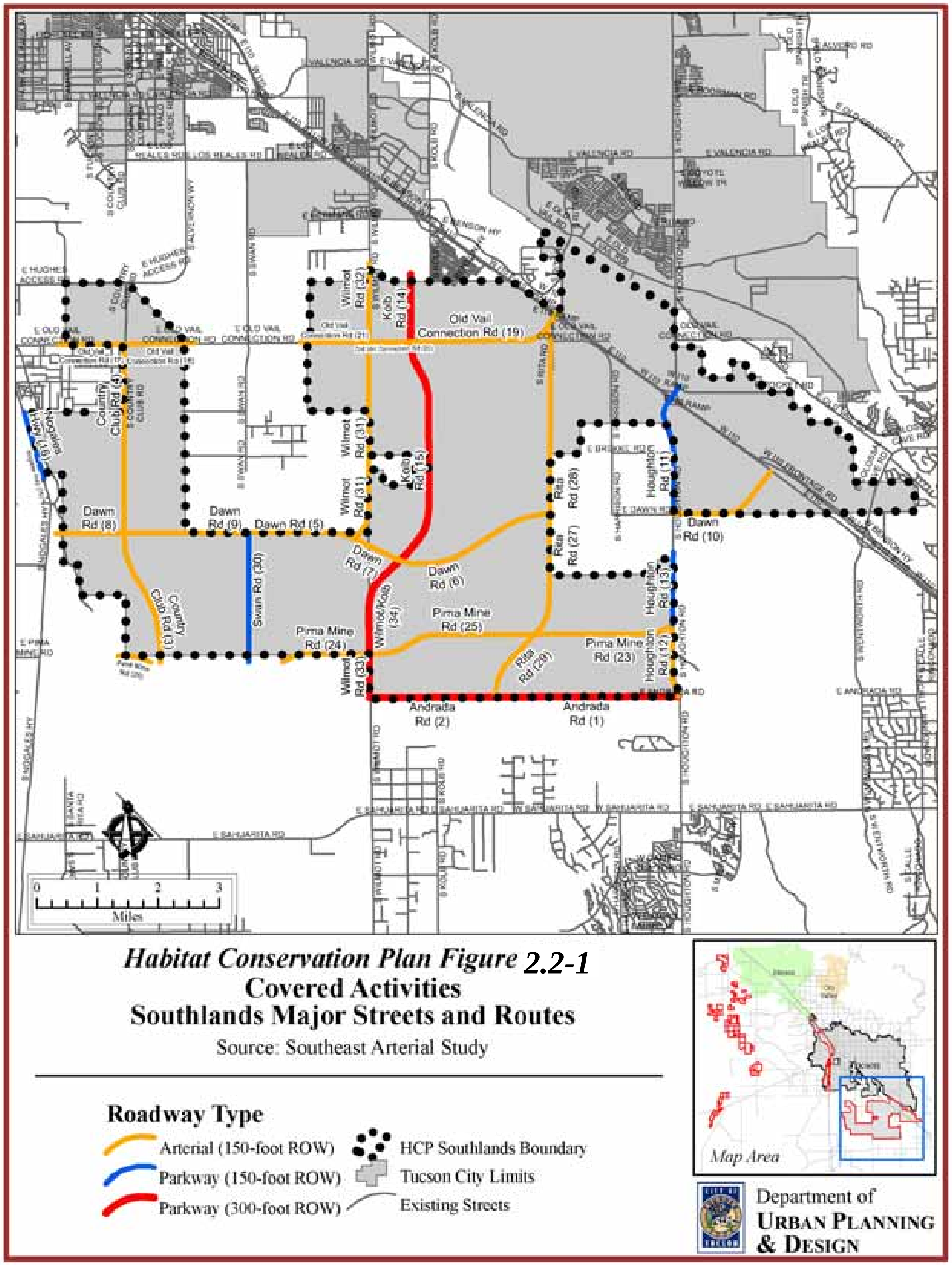

Figure 2.2-1. Covered Activities, Southlands Sub-area Major Streets and Routes.

Bridge Construction Over Water Ways

Bridge construction over waterways will occur where roadway widening, new road construction, railroad crossings, or pedestrian walk paths need to be constructed over existing or future drainage ways. Bridge construction generally consists of the sub-structure and the super-structure. The sub-structure is composed of abutments, piers, and girders. Piers are located in waterways and generally consist of several drilled shafts. The super-structure is composed of the bridge girders and deck. A new 500-foot (153-meter) bridge section takes about 6 to 9 months to construct. Crew sizes for a span of this size range from 25 to 30 at any one time. Staging areas are approved by the City and usually are in currently disturbed locations and out of water drainage areas.

Bridge Construction Over Transportation Ways

Bridge construction over transportation ways consists of grade-separated intersections, overpasses and underpasses. This construction generally is more complex than bridges over waterways due to factors such as traffic control and pedestrian safety. Bridge construction generally consists of the sub-structure and the super-structure. The sub-structure is composed of abutments and piers. The super-structure is composed of the bridge girders and deck. Construction generally takes about 9 to 12 months to complete. Crew sizes range from 25 to 30 at any one time. Staging areas are approved by the City and usually are in currently disturbed locations and away from traffic and pedestrian activities.

Bank Protection and Channel Modification

Bank protection consists of riverbank stabilization along the edges of rivers and washes to mitigate against soil erosion and scour. This consists of, but is not limited to, soil stabilization by compaction and soil-cement stabilized earth. Bank protection can also be accomplished with the use of geotextiles, gabions, riprap lined banks, and shotcrete protection. In environmentally sensitive areas, such as those covered by the HCP, bank protection is restricted to low impact methods by the City's Wash Ordinance, which strictly limits any use of concrete or shotcrete. Construction durations for bank protection varies according to the method implemented, and can take from 1 to 9 months for a 1-mile (1.6-kilometer) section. Crew sizes range from 5 to 15 at any given time. Staging areas will be approved by the City and generally will be at locations that are disturbed and out of the wash or river area.

Channel Creation

Locations and number of channels are unknown, but the channels will be located in existing agriculture or other disturbed areas.

2.2.2 Public Water Infrastructure Installation

The development of public water infrastructure on City-owned lands in Avra Valley and the Southlands will occur over the next 50 years. The Avra Valley planning sub-area includes lands acquired by Tucson Water Department for water rights. Many of these lands are former agriculture lands and have been highly degraded. The Avra Valley holdings are also the primary location for future water resources development project by Tucson Water Department. Tucson Water Department is currently in the process of updating its 50-year water resources plan (City Water Plan). Many of the future activities in Avra Valley are dependent on decisions still to be made by the community and the City's Mayor and Council regarding enhanced treatment for mineral content (salinity control) and the utilization of effluent. While the individual projects that will be required to implement these future decisions are not known with specificity, the listed activities below encompasses the range of projects anticipated.

The following list of activities is intended to be as inclusive as possible to accommodate future water resources development projects required to meet water demand associated with future urban growth; it includes construction and maintenance of typical water facilities including:

1. Wells
2. Treatment Plants
3. Reservoirs
4. Boosters
5. Transmission Mains
6. Pipelines
7. Recharge Basins
8. Evaporation Ponds
9. Wetlands
10. Flood Control projects such as berms and basins
11. Administrative buildings and facilities
12. Maintenance Yards
13. Access roads to all facilities

The Plan would allow for the possibility of brine disposal and related landfill activities encompassing up to 5,600 acres (2,266 hectares) in addition to the necessary pipelines to transport brine. The Plan would also allow for the possibility of expansion of existing and planned recharge facilities encompassing up to 1,000 acres (405 hectares). In addition, the Plan would allow for the possibility of a 100-acre (40.5 hectares) Treatment Plant and a well-field encompassing up to 600 acres (243 hectares). Additional recovery wells associated with recharge facilities may be required and would be anticipated to encompass up to 100 by 100 feet (30.5 by 30.5 meter) sites. Pipelines conveying recovered, treated or brine water will be required with determination of location and length dependent on future decisions of the community and Mayor and Council.

All construction projects are subject to Tucson Water Department's Design Standards and Tucson Water Department's Standard Specifications and Details (Construction Standards) as supplemented by the Pima County (County-City) Public Improvements Standard Specifications. Surface restoration is required on all construction projects including revegetation or mitigation of plants protected under the City Native Plant Protection Ordinance (NPPO).

2.2.3 Parks and Trails

The City of Tucson plans to develop several parks and trails as recreational opportunities in the Southlands and Santa Cruz River planning sub-areas. Neighborhood parks and trails are the responsibility of individual developers and are included in the impact footprint of private residential developments.

The following is a description of the parks and trails planned in the Southlands and Santa Cruz River planning sub-areas by the City during the next 50 years.

Parks

Parks and recreation facilities range from small, turf-covered neighborhood parks, to large regional parks that provide a wide range of uses, and may include both developed and undisturbed areas. Approximately 1,500 acres (607 hectares) of Metro and Regional parks would be developed in the Southlands planning sub-area during the permit period. Metro parks range in size from 40 to 200 acres (16 to 81 hectares), depending upon population and service area characteristics. Regional parks exceed 200 acres (81 hectares) in size. Metro and Regional parks are primarily designed to accommodate urban populations with a full range of active and passive recreational opportunities, including lighted athletic fields, outdoor performance areas, hiking and biking trails and facilities, as well as turf areas for play, relaxation and picnicking. Natural, undisturbed areas can also be included as components within these parks. For HCP purposes, Metro and Regional parks should be considered as 100 percent disturbance.

Trails

The Urban Pathways element of the Tucson Parks and Recreation Strategic Service Plan creates a classification system depicting the character and diversity of the trails system in Tucson. The following four classifications have been established. These are standard configurations, but they can be enhanced depending on the situation. Generally, divided urban pathways, urban pathways and potentially urban trails will feature restrooms, drinking fountains and storage buildings at 2 to 5 mile (3.2 to 8 kilometer) intervals. Such facilities can also be expected along the Pima County River Park Pathway system.

- The Divided Urban Pathway (50 feet [15 meters] of right-of-way) is the largest paved pathway within the City. This pathway consists of a separated, minimum 12 to 15 feet (3.6 to 4.6 meters), paved pathway and a minimum 8 to 10 feet (2.4 to 3 meters), stabilized, decomposed granite trail separated by landscaping. The path and trail have a minimum of 6 to 8 feet (1.8 to 2.4 meters) of landscaping on either side, however, the side furthest from the road or wash has a preferred minimum landscape buffer of 10 feet (3 meters). A Landscape buffer width should be developed to the maximum extent feasible, depending on the situation. Pathways and trails should meander whenever possible while still preserving sight lines.

- Similar to the Divided Urban Pathway, the Urban Pathway (minimum 24 feet [7.3 meter] of right-of-way) is a minimum 12 to 15 feet (3.6 to 4.6 meters) paved, shared-use trail shared by pedestrians and cyclists. The guidelines allocate a minimum of 6 to 8 feet (1.8 to 2.4 meters) of landscaping on both sides of the path. The landscape area adjacent to a wash is optional depending on right-of-way availability. This classification utilizes existing pathways to make important connections to park facilities, but in many cases recommends that the pathway be upgraded to 6 to 8 feet (1.8 to 2.4 meters) standard.

- The Urban Trail (minimum 13 feet [4 meters] of right-of-way) is a minimum 8 to 10 feet (2.4 to 3 meters) wide natural surface earthen trail with 5 feet (1.5 meters) of landscaping on one or both sides of the trail. A mountain bike could be used on these trails; however, they are designed primarily for pedestrian users. Urban Trails are intended for recreational use and to connect smaller neighborhood parks to larger community and metro parks via a pathway network. They may also provide connections to trail systems of other jurisdictions.

- The final City classification is the Enhanced Sidewalk (approximately 20 feet [6.1 meters]), which uses Mountain Avenue as a model. This classification is for urban areas where there is no watercourse or insufficient right-of-way or corridor to develop a separate trail. The enhanced sidewalk is a 6 to 12 feet (1.8 to 3.6 meters), concrete sidewalk with a minimum of 5 feet (1.5 meters) of landscaping on both sides. The sidewalk is for pedestrian use. Cyclists are accommodated by the existing bike routes; or when possible install a 3 feet (0.9 meters) buffer between the travel and bike lane. The buffer lane, as implemented on Mountain Avenue, is designed to visually separate the bike and vehicular lanes with a distinct material such as brick or bominite.

The River Park Pathway system is under development by Pima County. As the name suggests, the system consists of trails along the regions major waterways. Depending upon the outcome of the Lee Moore Wash Basin Management Study, there may be an opportunity to develop one or more River Park Pathways across the Southlands planning sub-area. The River trail consists of a 100-feet (30.5 meters) right-of-way with a separated, minimum 12 to 15 feet (3.6 to 4.6 meters), paved pathway and a minimum 8 to 10 feet (3 meters), stabilized, decomposed granite trail separated by a minimum of 5 feet (1.5 meters) of landscape buffer. The path and trail have a minimum of 15 to 40 feet (4.6 to 12.2 meters) of landscape buffer on either side. Landscape buffer width should be developed to the maximum extent feasible, depending on the situation. Pathways and trails should meander whenever possible while still preserving sight lines.

2.2.4 Regional Storm Water Facilities

Pima County is in the process of initiating a basin management study for the Lee Moore Watershed, located southeast of the City of Tucson core. This watershed extends from the Santa Rita Mountains north and west to the Santa Cruz River, and includes much of the City HCP Southlands planning sub-area. Sub-watersheds within the Lee Moore watershed include those associated with Gunnery Range Wash, Sycamore Canyon Wash, Fagan Wash, Petty Ranch Wash, Flato Wash, Summit Wash, and Franco Wash. The Fagan and Petty Ranch Washes comprise the priority conservation area in the Southlands as identified through the City's HCP planning process (see Section 5 and Figure 5.1-1).

The purpose of the Lee Moore study is to provide guidance and regulatory authority to discourage development in flood prone areas by managing encroachments into regional floodplains. The study will identify flood and erosion hazard areas and drainage problems, and identify cost-effective solutions to alleviate or manage floodwater in the Lee Moore Watershed. After an assessment of existing hydrologic and hydraulic conditions, floodplain delineations, future land use analysis, and the identification and evaluation of alternative flood and erosion hazard remediation solutions, a set of preliminary “Rules of Development” will be created to manage development in the Lee Moore Watershed.

Alternatives will include a “No Action” alternative and alternatives that take both a structural and non-structural approach to managing flood risks. The "Rules of Development" document will provide details of what can and cannot be constructed, ways to alleviate the impacts of construction on the watershed, and how to protect structures from flooding and erosion. Adoption of these development guidelines by all municipalities within the watershed is desired by Pima County.

Participants in the study include the Pima County Flood Control District, Pima County Department of Transportation, Pima County Planning and Development, Pima Association of Governments, Tucson Department of Urban Planning and Design, Tucson Department of Transportation, ASLD, Town of Sahuarita, and Union Pacific Railroad.

Once the study has been initiated, which is anticipated for early 2006, the existing conditions analysis is scheduled to be completed within 9 months; the floodplain delineations, future land use analysis, and the identification and evaluation of alternative flood and erosion hazard remediation solutions will take another 9 months; and a set of preliminary "Rules of Development" are anticipated for completion 2 years after the study begins.

It is anticipated that some of these regional flood management structures and activities will be located within the City HCP planning area and may be constructed and/or maintained by the City. The outcomes of the Lee Moore study will be used to refine the anticipated flood management activities to be covered under the City HCP.

2.2.5 Maintenance Activities

This HCP covers operation and maintenance activities carried out by the City. The City conducts maintenance activities on roads, water infrastructure and parks and trails as described below.

Road Maintenance

Road maintenance activities are required to keep roads and associated structures, such as rights-of-way, landscaping, signs, bridges, grade control structures, and bank protection in good repair and working condition. Covered maintenance activities include the following:

- Inspection;
- Pavement rehabilitation;
- Right-of-way maintenance, including sign installation, landscaping maintenance, trash pick-up, and grading of road shoulders; and
- Structure maintenance.

Each of these activities is described below.

Inspection Activities

The City continuously inspects its road system to determine where and when maintenance is required.

Pavement Rehabilitation

Pavement rehabilitation is limited to the existing roadbed, and includes sealing of cracks on the road surface, filling in potholes, and patching degraded portions of the road.

Right-of-Way Maintenance

The right-of-way for roads is generally 80 to 150 feet (24.4 to 45.7 meters) wide, depending on whether it is a major or minor route. Freeway segments may require 300 feet (91.5 meters) of right-of-way width. The rights-of-way may consist of a clear zone, signage and landscaping. Maintenance activities include sign installation, landscaping maintenance, trash pick-up, and grading of road shoulders.

Structure Maintenance

Aside from periodic maintenance of the road surface, regular activities are not undertaken to modify existing bridge pylons or other major infrastructure. Bridges rarely require structural repairs and may be replaced rather than repaired. No bridge repair is anticipated outside of the bridge replacement projects discussed in Section 2.2

Drainage System Maintenance

Drainage system maintenance includes vegetation management in public drainage channels and is performed under approved guidelines, which address precautionary measures to protect natural vegetation and habitat. Drainage system maintenance activity also includes debris removal from public drainage channels, erosion control and repair in public drainage channels, and cleaning and repair of public closed conduit. This includes maintenance activities within City owned parks and golf courses,

Park and Trail Maintenance

Maintenance activities required for the parks system include keeping existing irrigation, drainage, and related facilities in good repair and working condition. Minor improvements undertaken during the normal process of performing these activities also are included.

Other covered maintenance activities include management of open space and trail maintenance. Open space within park areas is maintained through irrigation, routine mowing of grass, and trash collection. Weeds in grassy open spaces of parks are controlled with herbicides. Maintenance of trails includes routine trash patrol along trail routes, sign mending, and repair of vandalized sites. Trail maintenance will occur on regional trails within the study areas.

Water Infrastructure Maintenance

Pipeline and Valve Maintenance

Maintenance activities associated with pipelines and valves include valve exercising, marking blue-stakes for main locations, routine hydrant and main flushing, chlorine residual and bacteriological testing, and routine inspections to ensure that the existing facilities are in good repair and in working condition. One or 2 person crews with light trucks, 1-ton or less, generally perform these activities quarterly.

Pipeline and Valve Repairs

Pipeline and valve repairs include repairing mainline breaks and the replacement of leaking and/or failing valves. The ground disturbance associated with these activities generally is limited by easement width or within public rights-of-way. These activities are not regularly scheduled and typically are performed on an emergency basis. Construction crews usually consist of 2 to 10 people. Project duration typically is less than one week but can be much longer in extreme cases. Repair or replacement can include aboveground installation of temporary pipelines to maintain service.

2.2.6 Santa Cruz River Restoration

The USACE, with local sponsorship from the City, Pima County and the Town of Marana, is leading an effort to study the feasibility of restoring vegetation along an approximately 29.5-mile (47.5 kilometers) section of the Santa Cruz River, including the entire 14.5-mile (23.3-kilometer) reach within the City. The three restoration feasibility studies, each of which is in a different stage of the planning process, are, from upstream to downstream, Paseo de las Iglesias, El Rio Medio and Tres Rios de Norte. Paseo de las Iglesias is furthest along in its planning, with a Final Environmental Impact Statement (EIS) and Feasibility Report issued in July 2005. Tres Rios de Norte will have a Draft EIS released early in 2006. El Rio Medio was kicked off in the summer of 2005, and is currently in the initial planning stages.

2.2.6.1 Paseo de las Iglesias

Paseo de las Iglesias, which encompasses approximately 5,005 acres (2,025 hectares), involves an approximately 7-mile (11.3 kilometer) stretch of the upstream Santa Cruz River between Los Reales Road and West Congress Road. Preliminary feasibility studies conducted by USACE identified various planning elements including habitat restoration, water supply and flood control, and recreation. The width of the project area varies between 0.5 and 1.6 miles (0.8 to 2.6 kilometers). Pima County Regional Flood Control District is the local sponsor of this project. Vegetation cover types within this restoration project area are provided in Table 2.2-2.

Table 2.2-2. Paseo de las Inglesias Cover Types and Acreages within the City of Tucson

Agriculuture / Developed / Water / Bare Ground	889.1198804
Agriculuture / Developed / Water / Bare Ground	41.07674619
Agriculuture / Developed / Water / Bare Ground	1084.532757
Agriculuture / Developed / Water / Bare Ground	12.99790499
Agriculuture / Developed / Water / Bare Ground	22.37191959
Agriculuture / Developed / Water / Bare Ground	40.59506938
Agriculuture / Developed / Water / Bare Ground	0.014031448
Agriculuture / Developed / Water / Bare Ground	0.754661172
Plant Association/Land Cover Type	**Acres**
Agriculture / Developed / Water / Bare Ground	448.5
Sonoran Desertscrub	0.167279421
Sonoran Desertscrub	4.595752707
Sonoran Desertscrub	1.624517658
Sonoran Desertscrub	4.616809567
Sonoran Desertscrub	7.083091766
Sonoran Desertscrub	0.062744225
Sonoran Desertscrub	23.07076335
Sonoran Desertscrub	0.792850207
Sonoran Desertscrub	0.211242513
Sonoran Desertscrub	0.706110607
Sonoran Desertscrub	0.818300863
Sonoran Desertscrub	0.015258019
Sonoran Desertscrub	3.726211872
Sonoran Desertscrub	24.23275563
Sonoran Desertscrub	0.028035347
Sonoran Desertscrub	1.447934804
Sonoran Desertscrub	0.043940654
Sonoran Desertscrub	0.265723769
Sonoran Desertscrub	1.756606455
Sonoran Desertscrub	63.2129424
Sonoran Desertscrub	3.64777159
Sonoran Desertscrub	49.77122618

Sonoran Desertscrub	0.144634549
Sonoran Desertscrub	4.685556975
Sonoran Desertscrub	2.061662447
Sonoran Desertscrub	1.831019502
Sonoran Desertscrub	4.429208493
Sonoran Desertscrub	0.523423722
Sonoran Desertscrub	0.038766865
Sonoran Desertscrub	0.021897086
Sonoran Desertscrub	1.980445238
Sonoran Desertscrub	1.561178519
Sonoran Desertscrub	0.097918758
Sonoran Desertscrub	0.609114661
Sonoran Desertscrub	1.643508646
Sonoran Desertscrub	10.39192815
Sonoran Desertscrub	2.458596464
Sonoran Desertscrub	1.751225524
Sonoran Desertscrub	558.8
Sonoran Interior Strand	241.3
Total Acreage	**1,248.6**

2.2.6.2 El Rio Medio

El Rio Medio involves an approximately 4.5-mile (7.2-kilometer) stretch of the Santa Cruz River, between Congress Street and Prince Road. The USACE El Rio Medio Feasibility Study is currently ongoing. The study will consider the following:(1) alternative means of structural stabilization to the river's banks between Prince Road (upstream) and West Congress Street (downstream); (2) opportunities to reclaim biotic properties of the Santa Cruz River near downtown Tucson, and elements of the riparian community on its banks; (3) modifications of upland surfaces adjacent to the incised banks to promote growth of appropriate native upland vegetation; (4) designs for recreational facilities that would feature prehistoric elements, historic properties, and biological traits of this portion of the Santa Cruz River; (5) integration of these recreational considerations into the Juan Bautista de Anza National Trail; and (6) the efficacy of recharging subsurface aquifers by means of water released into the river bottom downstream of West Congress Street. Pima County Flood Control District and City of Tucson are local sponsors of this project. Vegetation cover types within this restoration project area are provided in Table 2.2-3.

Table 2.2-3. El Rio Medio Cover Types and Acreages within the City of Tucson

Plant Association/Land Cover Type	Acres
Agriculuture / Developed / Water / Bare Ground	889.1198804
Agriculuture / Developed / Water / Bare Ground	41.07674619
Agriculuture / Developed / Water / Bare Ground	1084.532757
Agriculuture / Developed / Water / Bare Ground	12.99790499
Agriculuture / Developed / Water / Bare Ground	22.37191959

Agriculuture / Developed / Water / Bare Ground	40.59506938
Agriculuture / Developed / Water / Bare Ground	0.014031448
Agriculuture / Developed / Water / Bare Ground	0.754661172
Agriculture / Developed / Water / Bare Ground	2091.5
Sonoran Desertscrub	0.167279421
Sonoran Desertscrub	4.595752707
Sonoran Desertscrub	1.624517658
Sonoran Desertscrub	4.616809567
Sonoran Desertscrub	7.083091766
Sonoran Desertscrub	0.062744225
Sonoran Desertscrub	23.07076335
Sonoran Desertscrub	0.792850207
Sonoran Desertscrub	0.211242513
Sonoran Desertscrub	0.706110607
Sonoran Desertscrub	0.818300863
Sonoran Desertscrub	0.015258019
Sonoran Desertscrub	3.726211872
Sonoran Desertscrub	24.23275563
Sonoran Desertscrub	0.028035347
Sonoran Desertscrub	1.447934804
Sonoran Desertscrub	0.043940654
Sonoran Desertscrub	0.265723769
Sonoran Desertscrub	1.756606455
Sonoran Desertscrub	63.2129424
Sonoran Desertscrub	3.64777159
Sonoran Desertscrub	49.77122618
Sonoran Desertscrub	0.144634549
Sonoran Desertscrub	4.685556975
Sonoran Desertscrub	2.061662447
Sonoran Desertscrub	1.831019502
Sonoran Desertscrub	4.429208493
Sonoran Desertscrub	0.523423722
Sonoran Desertscrub	0.038766865
Sonoran Desertscrub	0.021897086
Sonoran Desertscrub	1.980445238
Sonoran Desertscrub	1.561178519
Sonoran Desertscrub	0.097918758
Sonoran Desertscrub	0.609114661
Sonoran Desertscrub	1.643508646
Sonoran Desertscrub	10.39192815
Sonoran Desertscrub	2.458596464
Sonoran Desertscrub	1.751225524

Sonoran Desertscrub	226.1
Sonoran Interior Strand	201.1
Total Acreage	**2,518.7**

2.2.6.3 Tres Rios de Norte

Tres Rios de Norte involves approximately 19,803 acres (8,014 hectares) along an 18-mile (29 kilometer) stretch of the Santa Cruz River between Prince Road and Sanders Road. Preliminary feasibility studies conducted by the USACE identify various issues including environmental degradation, habitat restoration, water supply and flood control issues, and recreation. The width of the project area varies between 2.2 and 6.9 miles (3.5 to 11.1 kilometers). Pima County Flood Control District, Town of Marana, and the City are local sponsors of this project. Vegetation cover types within this restoration project area are provided in Table 2.2-4.

Table 2.2-4. Tres Rios del Nortes Cover Types and Acreages within the City of Tucson

Plant Association/Land Cover Type	Acres
Agriculuture / Developed / Water / Bare Ground	889.1198804
Agriculuture / Developed / Water / Bare Ground	41.07674619
Agriculuture / Developed / Water / Bare Ground	1084.532757
Agriculuture / Developed / Water / Bare Ground	12.99790499
Agriculuture / Developed / Water / Bare Ground	22.37191959
Agriculuture / Developed / Water / Bare Ground	40.59506938
Agriculuture / Developed / Water / Bare Ground	0.014031448
Agriculuture / Developed / Water / Bare Ground	0.754661172
Agriculture / Developed / Water / Bare Ground	895.5
Sonoran Desertscrub	
Sonoran Desertscrub	
Sonoran Desertscrub	
Sonoran Desertscrub	
Sonoran Desertscrub	
Sonoran Desertscrub	
Sonoran Desertscrub	
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Sonoran Desertscrub	
Sonoran Desertscrub	
Sonoran Desertscrub	
Sonoran Desertscrub	
Sonoran Deciduous Swamp and Riparian Scrub	21.5
Sonoran Desertscrub	282.5
Sonoran Interior Strand	67.1
Sonoran Riparian and Oases Forests	40.9
Total Acreage	**1,307.5**

2.3 Activities Not Covered by the Permit

Activities carried out or authorized by public or private parties other than the City are not covered by this HCP and resulting Permit unless explicitly identified above. With respect to waters downstream and land outside of the City, covered activities will be specifically restricted to those impacts resulting from City operations and facilities on species using those sub-areas and covered in this HCP.

Activities within the Permit Area that are not covered by this HCP include those occurring on: (1) any properties that have received development permits in the form of an approved preliminary plat at the time the Permit is issued, and (2) properties that have completed or are in the process of completing a Section 7 or Section 10 consultation with USFWS at the time the Permit is issued.

Construction and maintenance of grade control structures and bank protection maintenance is performed by the Pima County Regional Flood Control District and therefore is not covered.

Covered activities do not include the operation and maintenance of facilities used to collect, treat, or release water or treated effluent. Activities that are not covered also include the impacts of increased, decreased, or otherwise altered water quality or availability except for those impacts directly resulting from activities carried out, or authorized, by the City and having all required federal permits.

2.4 Implementation of the HCP

Any incidental take of covered species that results from activities associated with the implementation of the mitigation measures and monitoring program associated with the HCP is covered under this HCP. These covered activities include management of habitat that is acquired, created, or restored in implementing the HCP as well as required surveys and monitoring activities. Mitigation, management and monitoring activities implemented by qualified third parties on behalf of the City for these purposes also are covered.

SECTION 3

Environmental Setting and Biological Resources

This section provides an overview of the environmental setting and biological resources in the City of Tucson and adjacent lands that are relevant to this HCP. Existing habitat conditions and population status for covered species is contained in Section 4: Covered Species.

The City HCP area can be viewed as encompassing three broad geographic planning sub-areas:

1. Southlands,
2. Avra Valley, and
3. Santa Cruz River.

The Southlands planning sub-area includes approximately 34,546 acres (13,981 hectares) of incorporated lands located east of Old Nogales Highway and south of I-10 that were annexed by the City between September 21, 1995 and February 7, 2002, as well as those incorporated lands extending north from I-10 to approximately 0.5 miles (0.8 kilometers) south of Old Vail Road. The ASLD administers a large percentage of this land, the majority of which is designated disposable State Trust land. City holdings include five parcels totaling about 1,260 acres (504 hectares), in addition to several scattered smaller parcels with well sites.

Avra Valley planning sub-area includes approximately 21,596 acres (8,740 hectares) of City-owned land located in unincorporated Pima County, between the Tucson Mountains to the east and the Waterman and Roskruge mountains on the west. This planning sub-area consists of largely noncontiguous agricultural properties, which the City purchased during the 1970s and 1980s for the purpose of acquiring those water rights tied to the lands.

The Santa Cruz River planning sub-area, which encompasses approximately 5,075 acres (2,054 hectares) of river corridor within the City limits, includes the river floodway and portions of the historic floodplain that have become spatially and hydrologically disconnected from the floodway due to river incision. The footprint of the Santa Cruz River planning sub-area equates to the cumulative footprint of the three USACE river restoration studies currently underway along the Santa Cruz River.

3.1 Physical Setting

The City is situated within the Basin and Range Physiographic province. This province is typified by broad alluvial basins lying between relatively isolated mountain ranges and dissected uplands. Within this province, sediments from the mountain ranges are slowing filling the intervening basins (Bates and Jackson 1997). Elevations within the City HCP planning area range from a low of 1,890 feet (576 meters) in the northern portion of Avra Valley planning sub-area, to a high of 3,200 feet (975 meters) above mean sea level in the eastern portion of the Southlands planning sub-area at the base of the Santa Rita Mountains. The Tucson Basin comprises a portion of the upper Santa Cruz River Basin, which encompasses approximately 750 square miles (1,943 square kilometers). The ephemeral Santa Cruz River parallels the mountain fronts and drains towards the northwest to its confluence with the Gila River. Mountains bordering the Tucson Basin include the Santa Catalina and Rincon mountains to the northeast and the Tucson Mountains on the west. The Santa Catalina and Rincon mountains reach a maximum elevation of approximately 9,100 feet (2,776 meters) while the Tucson Mountains reach approximately 4,700 feet (1,434 meters). The Rincon Mountains are composed of folded and foliated banded gneiss, schist, and granite of Precambrian age, overlain by Tertiary and younger alluvial and colluvial deposits. Often the colluvium forms a thin cover over pediment surfaces. In the Tucson Mountains, the dominant geologic formations include Permian and Cretaceous limestone, arkose, red beds, and Tertiary intrusives and volcanics. Quaternary gravels are also present and cover most of the pediments (Streitz 1962). The lower flanks of the Tucson and Rincon mountains are covered by terrace deposits or other alluvium ranging from 100 feet (30 meters) thick near the Rincon Mountains to approximately 400 feet (122 meters) thick near the Tucson Mountains (NPS 1995). The geologic pattern of the Santa Rita Mountains, with Mount Wrightson (9,453 feet [2,883 meters]) as the highest point, includes thrust faults with slices of Paleaozoic sedimentary rocks sitting astride or leaning up against a Precambrian core (Chronic 1983). An especially large alluvial fan, with numerous stream-cut channels, spreads out below the Santa Rita Mountains.

The Tucson Basin is filled with fluvial, lacustrine, and debris flow deposits derived from the erosion of the surrounding mountains farther up the drainage. At the center of the basin is a dissected graben structure where large accumulations of fine-grained sediments and evaporites are present (Leake and Hanson 1987). Alluvial fan deposits occur along the perimeter of the basin, while river channel and floodplain deposits are common on the basin floor and make up the larger proportion of the fill. Basin deposits are typically Tertiary and Quaternary in age, and may be as much as 8,000 feet (244 meters) thick (Streitz 1962). Geologic factors controlled the formation of the valley fill and determined the textural and structural relationships of the basin sediments. The characteristics of the sediments in turn control the occurrence and movement of surface and ground water in the basin (Kidwai 1957).

Soils in the Tucson Basin, which were formed by erosion of surrounding mountain ranges, are typically shallow, coarsely textured, and well-drained on the mountain slopes. Soils on the bajada are alluvial and contain sandy or rocky areas with distinct plant associations (NPS 1995). These soils lend themselves to rapid recharge, although recharge normally does not occur outside stream channels because antecedent soil moisture is usually very low, evaporation is very high, and rainfall amounts are insufficient to push the wetted front to ground water depths. An impermeable layer of caliche frequently forms at this depth, which can limit plant establishment and growth. Because alluvium within stream channels, fans, and bajadas is very permeable, streams spread out and rapidly lose flow as they leave the steep mountain gradients and enter the alluvial flats (Osterkamp 1973a).

The HCP planning area is located within the Tucson Active Management Area (Tucson AMA), which includes the Avra Valley Sub-basin and the Upper Santa Cruz Sub-basin north of the Pima/Santa Cruz County line. The Tucson AMA is one of five AMAs in the state established pursuant to the 1980 Groundwater Management Act. The Tucson AMA has a statutory goal of achieving safe-yield by 2025 and maintaining it thereafter. Safe-yield means that the amount of groundwater pumped from the AMA on an average annual basis does not exceed the amount that is naturally or artificially recharged. Ground water in the Tucson Basin occurs under confined or water table conditions. Permeability is greatest in the streambed of the Santa Cruz River; a perched sand and gravel aquifer is isolated from the underlying regional aquifer by a thick clay lens. Ground water depth in the planning area ranges from 70 to more than 200 feet (21 to 61 meters) below ground surface (bgs).

3.1.1 Southlands Planning Sub-area

Elevations in the Southlands planning sub-area range from approximately 2,600 feet (792 meters) in the western portion to about 3,200 feet (975 meters) at the eastern end. The Santa Cruz River is less than two miles from the western boundary of the sub-area. There are numerous washes that run east to west through the Southlands planning sub-area, all flowing into Lee Moore Wash. Lee Moore Wash, which has been channelized and redirected, runs through property owned by the Asarco Mining Company and the San Xavier District of the Tohono O'odham Nation. The southern two watersheds—Petty Ranch and Fagan—were identified by the Technical Advisory Committee (TAC) as being ecologically important. Consequently, they were located outside the main development footprint where there is the potential to preserve their hydrologic integrity. North of these two watersheds, washes run through areas of unincorporated Pima County that are currently developed, or will be developed in the future. The soils in the Southlands planning sub-area are generally shallow with little or no organic horizon and were formed in calcareous old alluvium derived from igneous and sedimentary rocks. There are no major visible rock outcrops in the area, and no caves or mine adits. No springs or other natural sources of water are known to occur within the planning area. Several stock tanks are located in the planning sub-area, and some may contain water year around. Water being pumped at one well location (Section 27, Township 16 South, Range 15 East) is currently overflowing the associated storage tank and is flowing aboveground for approximately 1.5 miles (2.4 kilometers). Whether or not this surface water is available year around is unknown.

Much of the Southlands planning sub-area has been degraded or disturbed by past and present land uses, particularly livestock grazing. Also responsible for vegetation/soil impacts are off-road vehicle (ORV) use, overhead utility line construction and maintenance, and illegal dumping. These uses have resulted in varying intensities and amounts of disturbance. For example, ORV use and illegal dumping have resulted in very intense disturbances to localized areas, whereas grazing has resulted in less intense disturbance to a much larger area. The Southlands Planning Sub-area is depicted in Figure 3.1-1.

3.1.2 Avra Valley Planning Sub-area

Elevations within the Avra Valley planning sub-area range from approximately 1,890 feet (576 meters) at the northernmost parcel to 2,650 feet (807 meters) at the southernmost parcel. There are few bedrock outcrops in Avra Valley, however none are located with the Avra Valley planning sub-area. The landform characteristic of the Avra Valley planning sub-area is deep valley fill, with materials derived from the Tucson Mountains to the east and the Waterman and Roskruge mountains to the west. Soils are deep alluvial and consist of varying proportions of sand, loam, and gravel.

The major drainage through Avra Valley is Brawley Wash, which is a complexly braided system with many small tributaries. Brawley Wash is the downstream continuation of Altar Wash, and is a major tributary of the Santa Cruz River. The Brawley Wash system is joined by two major washes: Black Wash from the Snyder Hill-Javier region and Blanco Wash from the Roskruge-Waterman mountains region. According to Rosen (2005), who conducted an ecological reconnaissance of Avra Valley, large portions of Brawley Wash are highly degraded barrens with adobe soils and low perennial plant diversity. Rosen suggests that Blanco Wash contains a higher proportion of relatively intact natural environments than Brawley Wash.

Because Avra Valley is generally flat, floodwater drainage throughout most of Avra Valley is by sheet flow, which collects in a few tributaries of Brawley Wash, or impounds behind man-made structures, such as roads and berms. Much of the Avra Valley planning sub-area is within the Federal Emergency Management Agency (FEMA) Designated 100-year floodplain. Major flood events occurred in this area in 1983 and 1993, with water remaining for several months on some of the Avra Valley planning sub-area parcels. Evidence of flooding in Avra Valley includes dead trees, bare ground, and deep silt deposits. Following the 1993 floods, some impediments to surface flow (i.e. berms) were removed and some drainage ditches were dug. These actions may reduce future flood impacts to the Avra Valley planning sub-area.

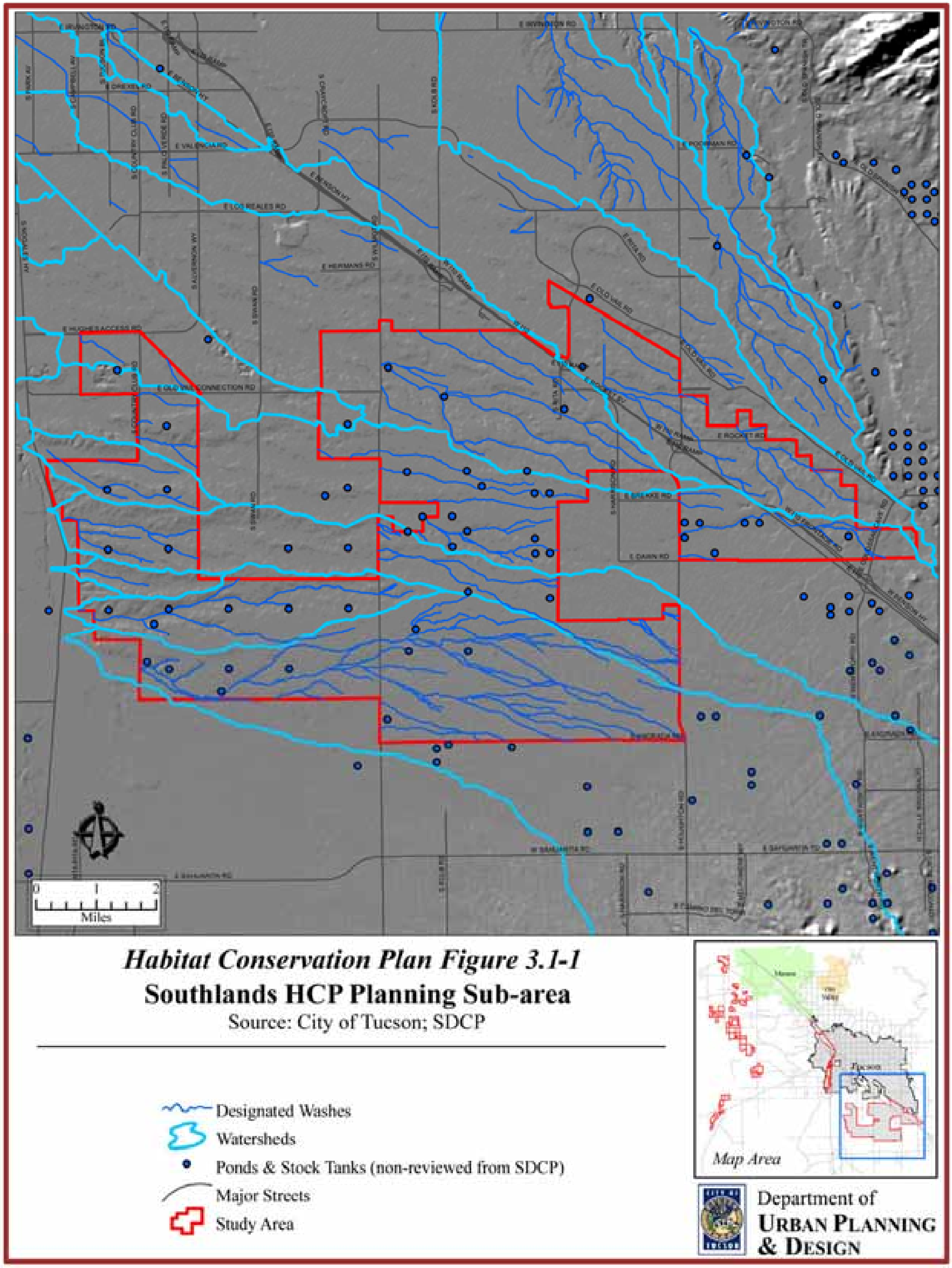

Figure 3.1-1. Southlands HCP Planning Sub-area.

There is no naturally occurring surface water within the Avra Valley planning sub-area, or elsewhere within Avra Valley. However, the Central Arizona Project (CAP) canal conveys Colorado River water north-to-south through Avra Valley and several CAP water recharge basins have been constructed on City land in Sections 5 and 8, Township 14 South, Range 11 East. The Santa Cruz River is an effluent-dominated stream. Approximately 70,000 acre-feet per year (af/yr) of wastewater is currently treated to the appropriate Surface Water Quality Standards by the two metropolitan treatment plants owned and operated by Pima County: Roger Road Wastewater Treatment Facility and Ina Road Water Pollution Control Facility. The majority of this water is discharged into the Santa Cruz River as effluent. The Santa Cruz River crosses the northern boundary of Avra Valley, intersecting three parcels within the Avra Valley planning sub-area discussed in this report (Simpson Farm North, Santa Cruz Farm, and Martin Farm). These parcels, and the other City-owned properties in Avra Valley, are described in detail in SWCA 2003a. The Avra Valley Planning Sub-area is depicted in Figure 3.1-2.

3.1.3 Santa Cruz River Planning Sub-area

The Santa Cruz River planning sub-area includes that portion of the river corridor within the City limits, roughly the reach of the river between Los Reales Road and Sunset Road. The width of the area varies. Elevations of the Santa Cruz River planning sub-area range from approximately 2,200 feet (671 meters) at the northernmost end to 2,550 feet (777 meters) at the southernmost end. Soils are deep alluvial, and consist of varying proportions of sand, loam, and gravel.

The headwaters of the Santa Cruz River begin in the San Rafael Valley southeast of Tucson. The river flows southwest into Mexico, and after 35 miles (56 kilometers) loops back and enters Arizona east of Nogales. Flowing northwest for approximately 40 miles (64 kilometers), the river crosses through Tucson and eventually intersects the Gila River 10 miles (16 kilometers) southwest of Phoenix. Several tributaries, including Sonoita Creek and the Rillito River, empty into the Santa Cruz River. After significant groundwater pumping for agriculture, mining, and municipal uses in the 20th century, the Santa Cruz River is now ephemeral, running only during periods of heavy rainfall. Due to the decrease in the groundwater table, the area around the streambed lacks significant stands of native riparian vegetation. Near Prince Road, at the north (downstream) end of the Santa Cruz River planning sub-area, wastewater effluent discharged into the streambed has created a unique riparian area. Major flood events occurred in this area in 1983 and 1993. Soil cement bank protection lines much of the Santa Cruz River through the City limits.

Three USACE restoration projects are in the planning phase along the Santa Cruz River within and outside City limits. The three plans are being developed to increase habitat values and the diversity of native wildlife species, with other benefits including recreation, environmental education, flood damage reduction, and water quality and supply. Current land uses along the Santa Cruz River through the City include residential, commercial, industrial, dedicated rights-of-way, and public open space (i.e. trails and parks). The Santa Cruz River Planning Sub-area is depicted in Figure 3.1-3.

3.2 Climate

The average precipitation at the Tucson International Airport (TIA) is between 11 and 12 inches (28 to 31 centimeters) per year. However, actual precipitation within the three HCP planning sub-areas varies as a result of elevation differences. TIA is located at an elevation of 2,643 feet (806 meters) above mean sea level. Lowe (1964) estimated that an increase in elevation of 1,000 feet (305 meters) results in an increase in annual precipitation of 4 to 5 inches (10 to 12 centimeters).

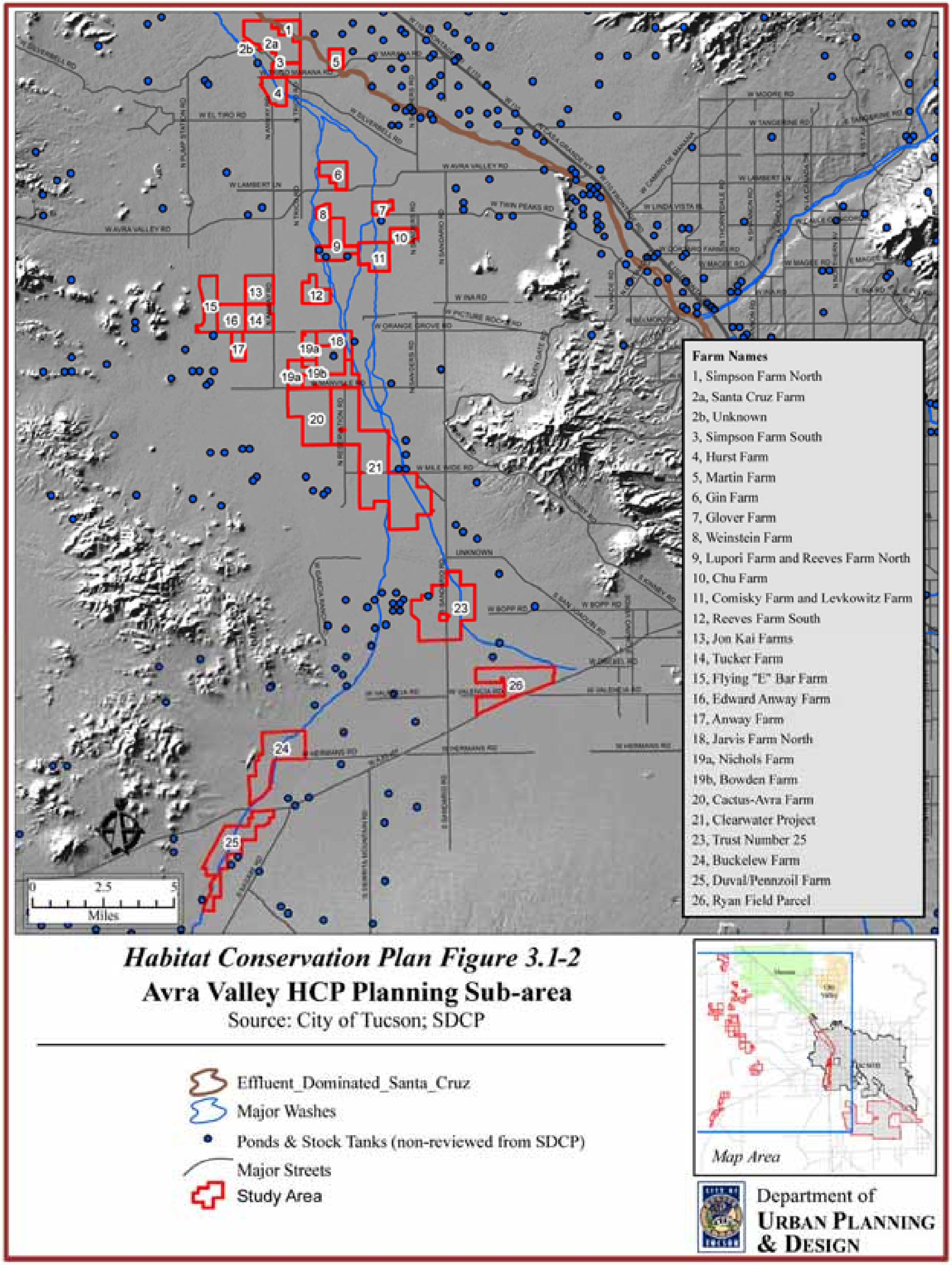

Figure 3.1-2. Avra Valley HCP Planning Sub-area.

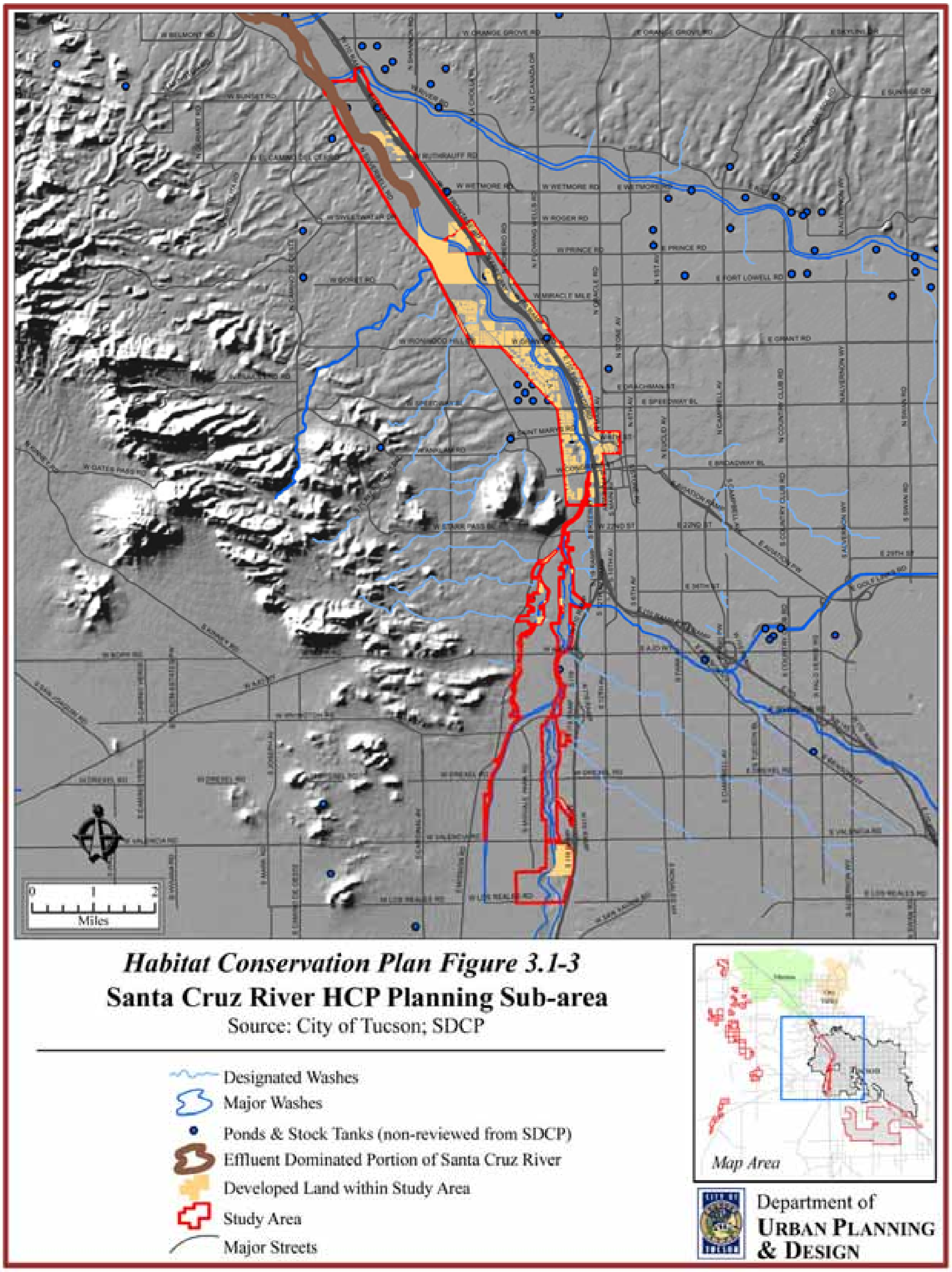

Figure 3.1-3. Santa Cruz River HCP Planning Sub-area.

Thus, the eastern area of the Southlands planning sub-area is likely to receive more precipitation than the northern portion of the Avra Valley planning sub-area. Precipitation occurs in a bi-seasonal pattern during summer monsoons and winter storms.

Winter temperatures in the Tucson Basin range from an average low of 38 degrees Fahrenheit (°F) (3 degrees Celsius [°C]) to an average high of 67 °F (19 °C). In the summer, the average low is 71 °F (22 °C), and the average high is 101 °F (38 °C). (NOAA 1997).

Southern Arizona has been experiencing drought conditions since 1996 (Jeff Phillips, U.S. Geological Survey water resources specialist, unpublished information). Due to record breaking dryness since fall of 2005, many areas in southern Arizona have deteriorated to severe drought classification (D2) with an area of extreme drought (D3) over eastern Pima County, all of Santa Cruz County, eastern Pinal County, and the eastern half of the Tohono O'odham Nation (National Weather Service Forecast Office website). For the Tucson area, the period between September 2005 and January 2006 was the driest ever, with just 0.01 inch (0.025 centimeters) of precipitation (Arizona Daily Star 2006). In addition, the NOAA Climate Prediction Center has identified cooler water temperatures in the central Pacific Ocean, which are consistent with the development of La Niña conditions. Such conditions usually foreshadow a decreased likelihood of winter storms in Arizona, and an increased chance of below average precipitation through May 2006 (NOAA website). In the City planning sub-areas, the absence of rainfall is stressing vegetation and wildlife populations and increasing the threat of wildfire; the presence of buffelgrass, a drought-tolerant forage grass, further exacerbates the threat of wildfire. The Arizona Republic (2005) reported that USFWS is concerned that the continued drought would further stress the cactus ferruginous pygmy-owl population through a decrease in prey that relies on lush plant growth.

3.3 Vegetation

3.3.1 Southlands Planning Sub-area

Both upland and riparian vegetation communities occur within the Southlands planning sub-area (Figure 3.3-1, Table 3.3-1). Upland vegetation communities include Sonoran Desertscrub and Semidesert Grassland (or Scrub Grassland). Riparian vegetation in the Southlands planning sub-area is limited to Sonoran Desertscrub Xeroriparian.

Semidesert Grassland is relatively uncommon in the Southlands planning sub-area and is confined to the easternmost portion of the sub-area (see SWCA 2003b). Grasses are locally uncommon to common, and are represented primarily by exotics of low forage value such as red brome (*Bromus rubens*), cheatgrass (*Bromus tectorum*), Lehmann lovegrass (*Eragrostis lehmanniana*), buffelgrass, and Bermuda grass (*Cynodon dactylon*). However, also present are scattered patches of native grasses that include several species of grama grass (*Bouteloua* spp.), three-awn (*Aristida* spp.), bush muhly (*Muhlenbergia porteri*), and curly-mesquite (*Hilaria belangeri*). Also present in this vegetation community is burroweed (*Isocoma tenuisecta*) and soaptree and banana yucca (*Yucca elata* and Y*ucca baccata*).

Sonoran Desertscrub vegetation, which is the dominant upland vegetation type in the planning sub-area, is relatively homogenous and is characterized by the presence of shrubs, the most abundant of which are creosote bush (*Larrea tridentata*), triangle-leaf bursage (*Ambrosia deltoidea*), burroweed, and desert zinnia (*Zinnia acerosa).* Tree species include velvet mesquite and foothill palo verde (*Cercidium microphylla*), which are relatively common and uncommon, respectively. Cholla (*Opuntia spinosior*, *O. fulgida*, *O. leptocaulis*, *O. arbuscula*) and prickly pear cactus (*O. englemannii*, *O. phaeacantha*) are common to abundant, candy barrel cactus (*Ferocactus wislizenii*), and

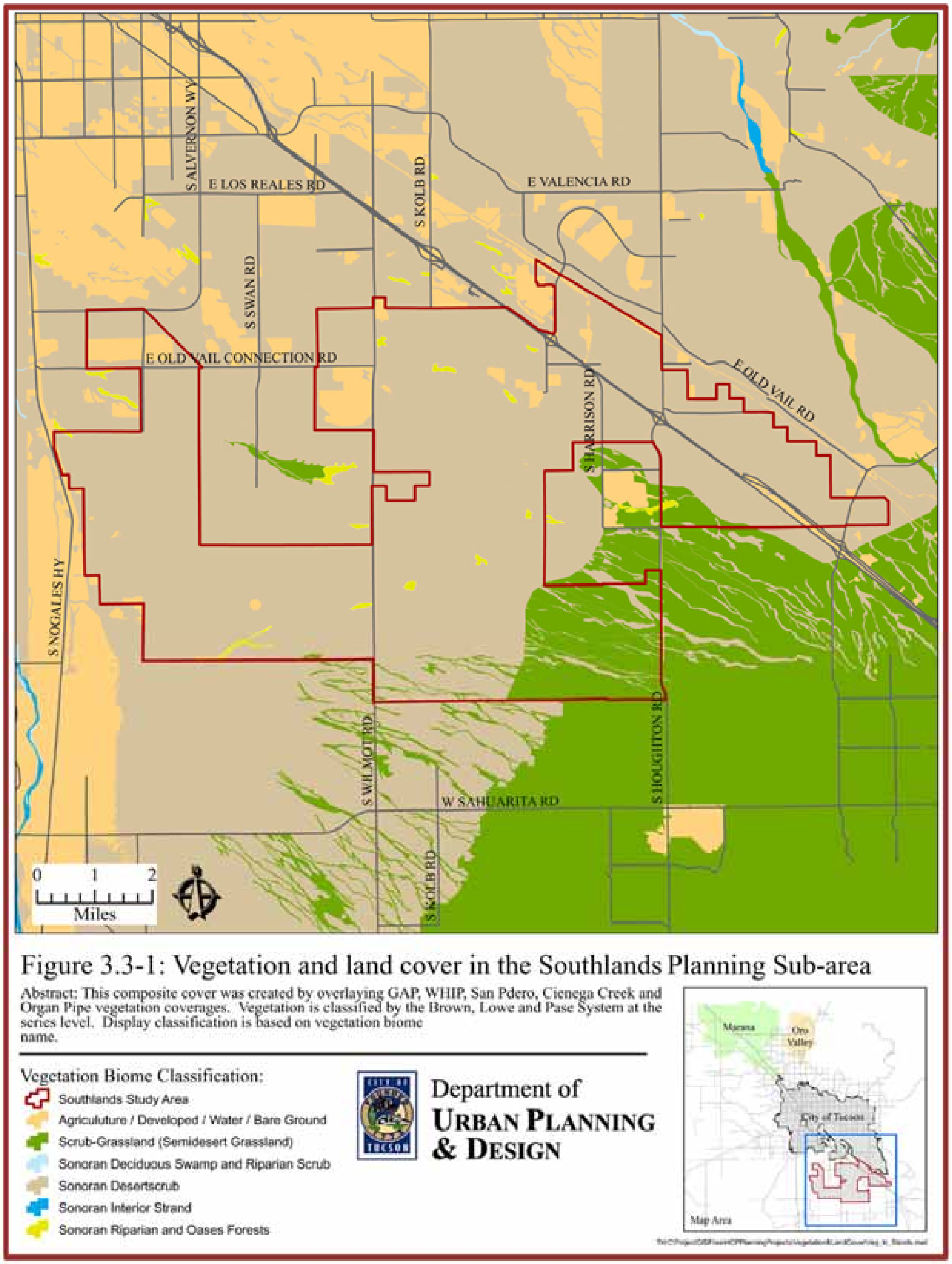

Figure 3.3-1. Vegetation and land cover in the Southlands Planning Sub-area.

pinkflower hedgehog cactus (*Echinocereus fendleri*) are uncommon to common, and saguaro (*Carnegia gigantea*) are rare to uncommon. Saguaros are regular (occurring at a density of approximately one per 2 to3 acres [0.8 to 1.2 hectares]) only in the southeastern portion of the Southlands planning sub-area. Pima pineapple cacti (*Coryphantha scheeri robustispina*) are rare and patchily distributed throughout the Southlands planning sub-area. In addition to the woody perennial species listed above, also common in the Southlands planning sub-area are whitethorn acacia (*Acacia constricta*), catclaw acacia (*Acacia greggii*), ocotillo, snakeweed (*Gutierrezia sarothrae*), and four-winged saltbush (*Atriplex canescens*).

Table 3.3-1. Plant Association/Land Cover Types in the Southlands Planning Sub-area

Plant Association/Land Cover Type	Acres	Percent
Sonoran Desertscrub	29,544	85.6
Agriculture/Urban/Water/Bare Ground	1,574	4.7
Sonoran Riparian and Oasis Forest	175	0.1
Semidesert Grassland	3,253	9.6
Total	**34,546**	**100.0**

The abundance of cacti and shrubs, and general absence of native grasses in the Southlands planning sub-area is typical of locations that have been subjected to intense livestock grazing over a period of many years.

Sonoran Desertscrub Xeroriparian consists primarily of mesquite. This vegetation type is the characteristic riparian vegetation found along washes and around stock tanks in the Southlands planning sub-area. Xeroriparian vegetation typically occurs as a linear corridor of sparse to dense shrubs and trees in areas with comparatively high soil moisture, such as washes and floodplains. Other plant species occurring in this community in the area are blue palo verde (*Parkinsonia florida*), catclaw acacia, seep willow (*Baccharis salicifolia*), tree tobacco (*Nicotiana glauca*), desert broom (*Baccharis sarothrae*), and desert hackberry (*Celtis pallida*). Density and height of riparian vegetation is largely dependent on local soil moisture, which varies within the Southlands planning sub-area.

Aquatic communities are temporarily present during the summer and winter rainy seasons at several stock tanks in the Southlands planning sub-area, and at some of these tanks the high soil moisture level supports riparian scrub vegetation.

3.3.2 Avra Valley Planning Sub-area

Vegetation communities within the Avra Valley planning sub-area include upland and riparian (Figure 3.3-2, Table 3.3-2), both of which have been extensively modified by human activities. Upland vegetation communities these include Semidesert Grassland, Sonoran Desertscrub, and Sonoran Vacant or Fallow Land. Riparian vegetation communities include Sonoran Desertscrub Xeroriparian and Sonoran Riparian Deciduous Woodland.

Semidesert Grassland is present at the south end of the Avra Valley planning sub-area (Buckelew Farm and Duval/ Pennzoil Farm parcels) at an elevation range of approximately 2,300 to 2,650 feet (701 to 808 meters). The dominant tree in this community is the velvet mesquite, and the dominant shrub is creosote bush. Additional shrub species include burroweed and snakeweed. Grass species

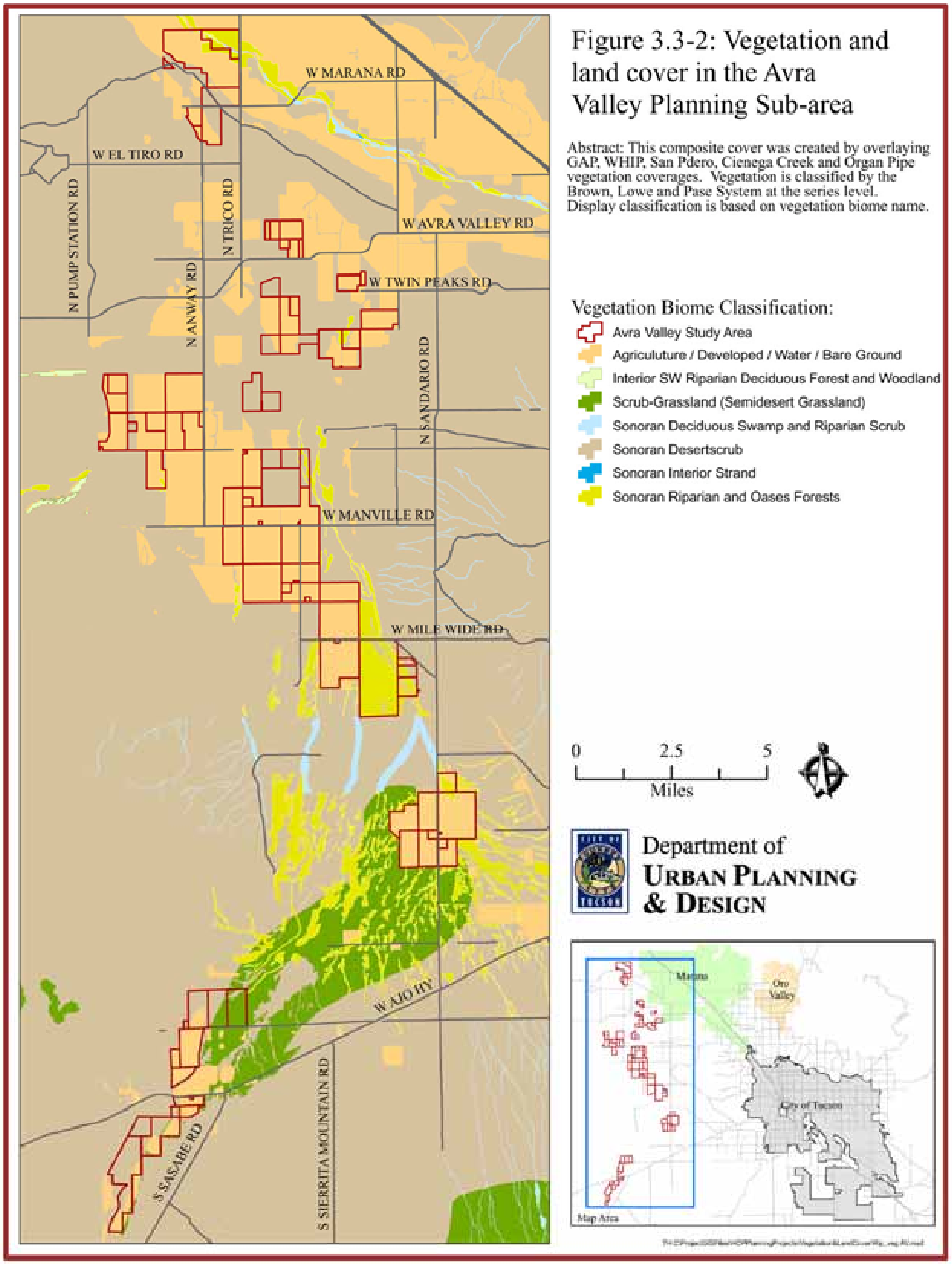

Figure 3.3-2. Vegetation and land cover in the Avra Valley Planning Sub-area.

Table 3.3-2. Plant Association/Land Cover Type in Avra Valley Planning Sub-area

Plant Association/Land Cover Type	Acres	Percent
Semidesert Grassland	521	2.4
Sonoran Desertscrub	2,102	9.7
Sonoran Vacant or Fallow Land	17,885	82.8
Sonoran Desertscrub Xeroriparian	811	3.8
Sonoran Riparian Deciduous Woodland	277	1.3
Total	**21,596**	**100.0**

include poverty threeawn (*Aristida ternipes*), purple threeawn (*A. purpurea*), needle grama (*Bouteloua aristidoides*), feather fingergrass (*Chloris crinita*), and Lehmann lovegrass, which may be the most abundant grass species in the Avra Valley planning sub-area. Another exotic grass, buffelgrass, is a major problem in the Avra Valley planning sub-area.

Sonoran Desertscrub is the most prevalent vegetation community within the Avra Valley planning sub-area. It occurs on portions of the Avra Valley planning sub-area that have not been used previously for agricultural production. The dominant vegetation in this community is dependent to a large degree on slope, soils, and exposure. Creosote bush and triangle-leaf bursage are dominant on lower elevation lands that are flat and generally have very deep, fine alluvial soil. The vast majority of the undisturbed upland vegetation within the Avra Valley planning sub-area is dominated by these two species. Higher elevation slopes at the edges of the Avra Valley and on rocky soils are dominated by foothill palo verde, triangle-leaf bursage, and cacti. Saguaros may be present, although there are few within the Avra Valley planning sub-area.

Sonoran Vacant or Fallow Land is the dominant vegetation community within the Avra Valley planning sub-area. This community consists of agricultural lands that are fallow and vacant lots within the urban setting. Rosen (2005) concluded that many or most former agricultural lands owned by the City are succeeding toward viable natural habitat conditions supporting diverse plant communities. Plants commonly established here include velvet mesquite, burroweed, desert broom, desert globe mallow (*Sphaeralcea ambigua*), prickly Russian thistle (*Salsola tragus*), silverleaf nightshade (*Solanum elaeagnifolium*), western tansymustard (*Descurainia pinnata*), shaggyfruit pepperweed (*Lepidium lasiocarpum*), and several species of grasses, mostly non-native. On some of the City-owned lands, non-native grasses were planted in the 1980s. Mowing of vegetation occurs periodically on many parcels within the Avra Valley planning sub-area. The goal of this management technique is to prevent weed growth, but it also has the consequence of preventing succession to a shrub or tree-dominated plant community.

Sonoran Desertscrub Xeroriparian is a shrub-dominated riparian community. Velvet mesquite, which can occur as a shrub or small tree is the most abundant species. Ironwood (*Olneya tesota*) may also be present. Other shrubs include desert broom, catclaw acacia, and burrobush (*Hymenoclea salsola*). This type of riparian vegetation is present on several of the parcels within the Avra Valley planning sub-area.

Sonoran Riparian Deciduous Woodland is a deciduous riparian community dominated either by velvet mesquite (as trees) or Fremont cottonwood (*Populus fremontii*) and/or Goodding willow (*Salix gooddingii*). Perennial or near-perennial streams or springs usually are necessary to provide water for the trees, although this is not always the case for mesquites.

This vegetation type is typically dominated by structurally diverse stands of velvet mesquite that range from open to dense. Mesquites sometimes have a large amount of mistletoe (*Phoradendron californicum*), a native parasite that may indicate stress to the trees. Other species commonly present in this vegetation type are catclaw acacia and blue palo verde. Midstory species include pitseed goosefoot (*Chenopodium berlanderi*), lotebush (*Zizyphus obtusifolia*), burrobrush, desert broom, and four-wing saltbush. Prickly Russian thistle, camphorweed (*Heterotheca subaxillaris*), and several species of grasses, vines and forbs are present in the understory. This vegetation series is present on the Simpson Farm North, Martin Farm, Comisky Farm, Levkowitz Farm, Anway Farm, Jarvis Farm North, and Buckelew Farm parcels. Much less common, in fact confined to Simpson Farm North, is the riparian vegetation type dominated by Fremont cottonwood and Goodding willow. Trees may be more than 50 feet (15 meters) tall and very dense. Other species commonly found in this community include velvet ash (*Fraxinus pennsylvannica* var. *velutina*), netleaf hackberry (*Celtis reticulata*), velvet mesquite, and saltcedar (*Tamarisk ramosissima*).

3.3.3 Santa Cruz River Planning Sub-area

The Santa Cruz River planning sub-area consists primarily of developed urban and vacant lands on either side of a frequently disturbed, deeply entrenched, ephemeral riverbed. Urban development and intensive alteration of natural landscapes have effectively isolated the river channel from natural communities. Historically, all but a few isolated sites within the floodplain were cultivated farmland. In addition to agricultural production, disturbances include channel bank erosion, urban development, landfills, ORV use, equestrian use, soil stabilization structures, wildcat dumping, and transient camps.

Both upland and riparian vegetation communities occur along the Santa Cruz River corridor (Table 3.3-3, Figure 3.3-3). Upland vegetation communities include Sonoran Desertscrub and Sonoran Vacant or Fallow Land. Riparian vegetation includes Sonoran Desertscrub Xeroriparian, Sonoran Riparian Deciduous Woodland, Sonoran Deciduous Riparian Scrub, and Sonoran Interior Strand. Sonoran Desertscrub is the characteristic upland vegetation type in the Santa Cruz River planning sub-area. It is typified by open to dense stands of drought and heat tolerant deciduous trees and shrubs that have small leaves and often have thorns. Vegetation density and diversity is often related to local edaphic conditions. Within the Santa Cruz River planning sub-area, vegetation is dominated either by creosote bush on gravely soils or four-wing saltbush on silty soils.

Table 3.3-3. Plant Association/Land Cover Type in the Santa Cruz River Planning Sub-area

Plant Association/Land Cover Type	Acres	Percent
Ag/Developed/Water/Bare Ground	3,436	67.8
Sonoran Deciduous Swamp and Riparian Scrub	21	0.4
Sonoran Desert Scrub	1067	21.0
Sonoran Interior Strand	510	10.0
Sonoran Riparian and Oases Forests	41	0.8
Total	**5,075**	**100.0**

Sonoran Vacant or Fallow Land consists of agricultural lands that are fallow and vacant lots within the urban setting. These lands were part of the upper terrace and/or floodplains of the Santa Cruz River. Plants commonly established here include velvet mesquite, Mexican palo verde (*Parkinsonia aculeata*), Athel tamarisk (*Tamarix aphylla*), burroweed, fiddleneck (*Amsinckia sp.*), globemallow

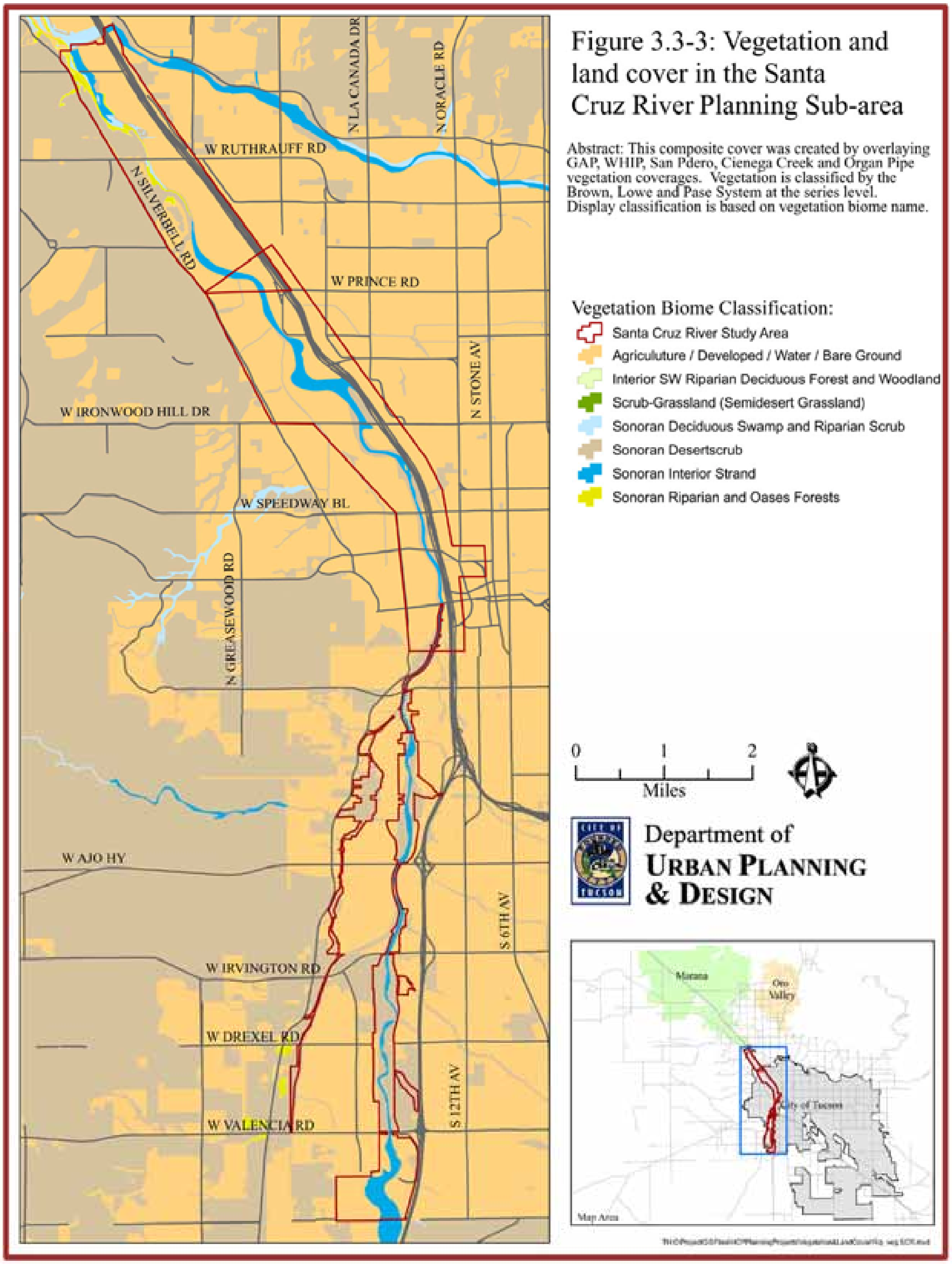

Figure 3.3-3. Vegetation and land cover in the Santa Cruz River Planning Sub-area.

(*Spharalcea* spp.), prickly Russian thistle, silverleaf nightshade, western tansymustard, shaggyfruit pepperweed, and several species of grasses, mostly non-native, including buffelgrass and fountaingrass.

Along natural drainages, Sonoran Desertscrub Xeroriparian vegetation usually forms more-or-less continuous corridors, consisting of velvet mesquite, blue palo verde, and catclaw acacia. Water is seldom present in drainages, except briefly following rainfall. These drainages usually have braided channels that can be substantially rearranged with surface flow events. Within the Santa Cruz River planning sub-area, most of the drainages have been highly modified by human activities.

The Sonoran Riparian Deciduous Woodland community occurs in the Santa Cruz River planning sub-area at locations influenced by the presence of effluent discharge. Two major vegetation types occur within this community: Cottonwood-Willow and Mesquite. The natural cottonwood-willow community was entirely eliminated many decades ago. Mesquite-dominated communities were formerly widespread along the Santa Cruz River adjacent to cottonwood-willow vegetation but farther from the general stream course. Historically these communities were generally restricted to perennial or near perennial streams and springs, and surrounded by Sonoran Desertscrub communities. In the Santa Cruz River corridor, stands of velvet mesquite range from open to dense. Some of these trees are relatively large, but do not reach the stature of the forests that existed pre-settlement. Other plant species commonly present with mesquite are catclaw acacia, blue palo verde, pitseed goosefoot, lotebush, four-wing saltbush, and various species of forbs, grasses, and vines.

The Sonoran Deciduous Riparian Scrub occurs adjacent to washes on benches above the river channel. This community, which has largely replaced much of the formerly occurring Sonoran Riparian Deciduous Woodland, has limited structural diversity and is dominated by plant species that are adapted to xeric conditions including several non-native invasive species. Athel tamarisk and saltcedar dominate and form open to dense stands. Other species present include Bermuda grass, camphorweed (*Heterotheca subaxillaris*), western tansymustard, and Mexican palo verde. Typically, trees in this plant community are less than 20 feet (6.1 meters) tall and are regularly subjected to intensive flood events.

Sonoran Interior Strand is found within river and wash channels that are subject to seasonal flooding and scouring. Strand habitats typically include sparsely distributed clusters of vegetation that are separated by areas devoid of vegetation. Vegetation is primarily a mixture of shrubs. Soils are typically sand and gravel, with small silt deposits and very low organic content. Common species include burrobrush and desert broom. Many of the species that make up the vegetative community are annuals, short-lived perennials, and invasive species, such as Adonis blazingstar (*Mentzelia multiflora*), camphorweed, Canadian horseweed (*Conyza canadensis*), common sunflower (*Helianthus annuus*), desert horse-purselane (*Trianthema porulacastrum*), western tansymustard, and buffelgrass.

3.4 Wildlife

Wildlife habitat for any given species can be best described as a combination of vegetation and landform. Landform, in turn, reflects topography, soil, and other habitat features. The Southlands, Avra Valley, and Santa Cruz River planning sub-areas all contain areas that have been extensively modified by ranching, agriculture, floodplain modifications, ORVs, wildcat dumping, and other human activities. Human activity in some cases extends back more than 12,000 years. The wildlife communities present in the two areas reflect these differences in the level of human activity.

3.4.1 Southlands Planning Sub-area

Wildlife in upland areas (mountains, fans, and bajadas) of the Southlands planning sub-area is characteristic of the Arizona Upland Subdivision of the Sonoran Desertscrub and Semidesert Grassland biomes. The creosote bush-mixed shrub vegetation association, which dominates most of the sub-area, does not support a great variety or abundance of mammals or nesting bird species and is not a particularly important resource for migrating birds. Mammals common to the creosote bush-mixed shrub and grassland associations found in the Southlands planning sub-area include round-tailed ground squirrel (*Spermophilus tereticaudus*), kangaroo rat (*Dipodomys* spp.) and a variety of other rodents, desertcottontail rabbit (*Syvilagus auduboni*), black-tailed jackrabbit (*Lepus californicus*), and coyote (*Canis latrans*). Birds found in these associations include a number of wintering and breeding sparrows, including rufous-winged sparrow (*Aimophila carpalis*).

Xeroriparian vegetation is found along washes and around stock tanks. This vegetation type is an important habitat for many species of wildlife by providing relatively more food and cover than the adjacent upland areas. These washes also represent habitat linkages because they provide areas of nearly continuous cover that can support wildlife movement within and among habitat patches. In addition, the washes provide shade and cover where wildlife can escape temperature extremes.

There are several stock tanks in the Southlands planning sub-area, and aquatic communities are temporarily present at these tanks during the summer and winter rainy seasons. Game birds, such as mourning dove (*Zenaida macroura*) and Gambel's quail (*Callipepla gambelii*), are observed commonly at tanks. White-winged doves (*Zenaida asiatica*) are also likely abundant around these tanks during the summer months, and ducks and shorebirds visit these tanks during migration. Numerous mammals, including bobcat (*Lynx rufus*), mule deer (*Odocoileus hemionus*), and a variety of bats also visit these tanks regularly during the rainy season.

3.4.2 Avra Valley Planning Sub-area

Areas of valley bottom with intact native vegetation support wildlife characteristic of the Lower Colorado River Valley Subdivision of the Sonoran Desertscrub biome. These areas are important to some species of wildlife, notably western burrowing owl (*Athene cunicularia*), ground snake (*Sonora semiannulata*), and the Tucson shovel-nosed snake (*Chionactis occipitalis klauberi*). Soil conditions, rather than vegetation, are a key habitat feature for many fossorial species in the uplands of the Avra Valley. Rosen (2005) found that mammal burrows were abundant and diverse in size at several of the former agricultural fields within the Avra Valley planning sub-area.

Xeroriparian vegetation, associated with Brawley Wash and Black Wash, is present on several parcels within the Avra Valley planning sub-area. These wash corridors support a higher density and diversity of birds and mammals than do adjacent uplands. They also provide important habitat linkages for a variety of species, including cactus ferruginous pygmy-owl, that move between habitat patches.

The Avra Valley planning sub-area supports a wide variety of reptiles, including sidewinder (*Crotalus cerastes*), western diamondback rattlesnake (*Crotalus atrox*), common gopher snake (*Pituophus melanoleucus*), western whiptail (*Cnemidophorus tigris*), desert iguana (*Dipsosaurus dorsalis*), zebra-tailed lizard (*Callisaurus draconoides*), and tree lizard (*Urosaurus ornatus*). Notable and common breeding bird species include rufous-winged sparrow, Swainson's hawk (*Buteo swainsonii*), western kingbird (*Tyrannus verticalis*), curve-billed thrasher (*Toxostoma curvirostre*), verdin (*Auriparus flaviceps*), ash-throated flycatcher (*Myiarchus cinerascens*), cactus wren (*Campylorhynchus brunnei-capillus*), northern mockingbird (*Mimus polyglottos*), greater roadrunner (*Geococcyx californianus*), white-winged dove, and mourning dove. Mammals common to the area include the round-tailed ground squirrel, white-throated woodrat (*Neotoma albigula*), kangaroo rat, pocket mouse (*Perognathus* spp.), desert cottontail rabbit, black-tailed jackrabbit, and coyote. Rosen (2005) found antelope jackrabbit (*Lepus alleni*), a southwestern endemic species, to be abundant on City-owned properties south of Ajo Way at Three Points.

3.4.3 Santa Cruz River Planning Sub-area

Riparian habitats in the Sonoran Desert have the potential to support a diverse assemblage of wildlife, and are regionally important for maintaining biological diversity. However, because habitat patches in the Santa Cruz River floodplain are relatively narrow and isolated within an urban mosaic, they do not support the full assemblage of wildlife typically associated with many riparian systems that receive perennial water flow. Nevertheless, the diversity of vegetation and presence of open water provides habitat for a large assemblage of wintering, migratory, and breeding bird species. Especially important habitats for bird species are the Sonoran Riparian Deciduous Woodland (composed of willow and cottonwood trees) and Mesquite Woodland. These vegetation types in particular support a large variety of raptors, woodpeckers, flycatchers, warblers, sparrows, and finches. A common nest parasite occurring in this area is brown-headed cowbird (*Molothrus ater*).

Reptiles and amphibians observed within the Santa Cruz River planning sub-area include common gopher snake, western diamondback rattlesnake, western-banded gecko (*Coleonyx variegates*), western whiptail lizard, tree lizard, zebra-tailed lizard, Couch's spadefoot (*Spea couchii*), Arizona spadefoot (*Spea multiplicata*), Sonoran mud turtle (*Kinosternon sonoriensis*), and bullfrog (*Rana catesbeiana*).

Mammals known to occur in riparian habitats along the Santa Cruz River include black-tailed jackrabbit, cactus mouse (*Peromyscus eremicus*), desert pocket mouse (*Chaetodipus penicillatus*), cotton rat (*Sigmodon arizonae*), rock squirrel (*Spermophilus variegatus*), round-tailed ground squirrel, and desert cottontail rabbit. Riparian areas along the Santa Cruz River planning sub-area also provide food and cover for large mammals, and can function as movement corridors for some species, such as the coyote. Due to poor water quality, the area no longer provides habitat for native fish species.

SECTION 4

Covered Species

4.1 Introduction

The City of Tucson is covering eight species in its HCP:

- Cactus ferruginous pygmy-owl,
- Pima pineapple cactus,
- Western burrowing owl,
- Tucson shovel-nosed snake,
- Ground snake (valley form),
- Needle-spined pineapple cactus,
- Pale Townsend's big-eared bat, and
- Western yellow-billed cuckoo.

The purpose of the habitat conservation planning process and subsequent issuance of Incidental Take Permits is to authorize the incidental take of threatened or endangered species. Generally, Permit applicants include all Federally listed wildlife species likely to be incidentally taken during the life of the Permit. It is also advised to address unlisted species in the HCP permit area that are likely to be listed within the foreseeable future or within the life of the Permit. The Permit applicant usually wants to consider including Federally listed plants in the HCP to avoid jeopardizing these species, as prohibited in section 7(a)(2). This section presents the species-specific baseline conditions in the City HCP planning area. Each species is individually addressed. For each species, baseline information is presented on the species' status and distribution, life history and habitat requirements, existing population status and habitat conditions in the HCP planning area, and potential impacts to the species from the proposed covered activities. In consideration of this information, Section 5 will list biological goals and objectives for each species and describe the conservation program intended to minimize and mitigate impacts of covered activities pursuant to those goals and objectives. Section 6 provides an evaluation of the effects on each species of implementing the HCP.

To facilitate the development of a conservation program for the City HCP, the existing habitat models for all target species were evaluated with respect to perceived accuracy of extent and distribution within the City's HCP planning area. For seven of the eight target species, the City's Technical Advisory Committee recommended that the Pima County's SDCP habitat models did not provide a sufficient level of detail and should be replaced or revised. For two of these seven species, the ground snake and Tucson shovel-nosed snake, an alternative habitat model developed for the Town of Marana HCP was used. For the remaining five species, a new habitat model was developed based on input from the Technical Advisory Committee and other local species experts.

4.2 Cactus Ferruginous Pygmy-owl (*Glaucidium brasilianum cactorum*)

4.2.1 Population Status and Ecology

4.2.1.1 Range and Distribution

The ferruginous pygmy-owl (*Glaucidium brasilianum*) has a range that extends from the southern United States (Arizona and Texas) south to central Argentina (Cartron et al. 2000a). The cactus ferruginous pygmy-owl (CFPO; *Glaucidium brasilianum cactorum*) is the northernmost occurring of several subspecies of the ferruginous pygmy-owl (Cartron et al. 2000a).

The current distribution of CFPOs within Arizona is poorly understood. Historically, CFPOs occupied areas of south-central Arizona from New River (approximately 35 miles or 56 kilometers north of Phoenix), south to the U.S./Mexico border, west to southern Yuma County, and east to the San Pedro River and the confluence of the Gila and San Francisco rivers (approximately 100 miles or 161 kilometers northeast of Tucson) (USFWS 2003b; Cartron et al. 2000a; Figure 4.2-1). Currently, the Arizona population appears to have a patchy distribution, with most CFPOs located in one of four general areas: northwest Tucson and southern Pinal County, Organ Pipe Cactus National Monument, the Tohono O'odham Nation, and Alter Valley (Richardson et al. 2000). The species may be extirpated from portions of its historic range, including the lower and middle Gila River, the Santa Cruz River near Tucson, the Rillito Creek, and the Salt River near Phoenix (Cartron et al. 2000c). The patchy, dispersed nature of the CFPO population in Arizona suggests that the overall population may function as a metapopulation, with local groups of owls functioning as subpopulations (USFWS 2003b).

4.2.1.2 Taxonomic Uniqueness

The ferruginous pygmy-owl is divided into four distinct population segments: Texas, eastern Mexico, Arizona, and western Mexico (USFWS 1997). The eastern (Texas and east Mexico) and western (Arizona and west Mexico) populations are separated by the basins and mountain ranges of the Chihuahuan Desert in the United States, and by the Sierra Madre Occidental and Oriental ranges and the Mexican Plateau in Mexico (Cartron et al. 2000a). The non-migratory nature of the CFPO subspecies suggests that genetic mixing across these barriers is infrequent. In addition to the likely geographic isolation of the eastern and western populations, the two populations utilize floristically dissimilar habitats. Finally, significant morphological differences have been identified between Arizona and Texas owls, further supporting the genetic distinctness of the two populations (USFWS 1997). A recent genetic study provides strong evidence that the eastern and western populations of ferruginous pygmy-owl are genetically distinct units (Proudfoot and Slack 2001).

The further separation of the two populations into northern and southern segments is less certain. The genetic distinction between the Arizona and western Mexico populations (and the Texas and eastern Mexico populations) is the subject of substantial and ongoing controversy. Proudfoot and Slack (2001) did not find any evidence of genetic isolation between distinct populations in the U.S. and those immediately across the border in northwestern or northeastern Mexico. Furthermore, the low haplotypic diversity and distinct clade occurring in Northwest Tucson suggests current separation between populations in Northwest Tucson and populations in the Altar Valley, Sonora, and Sinaloa.

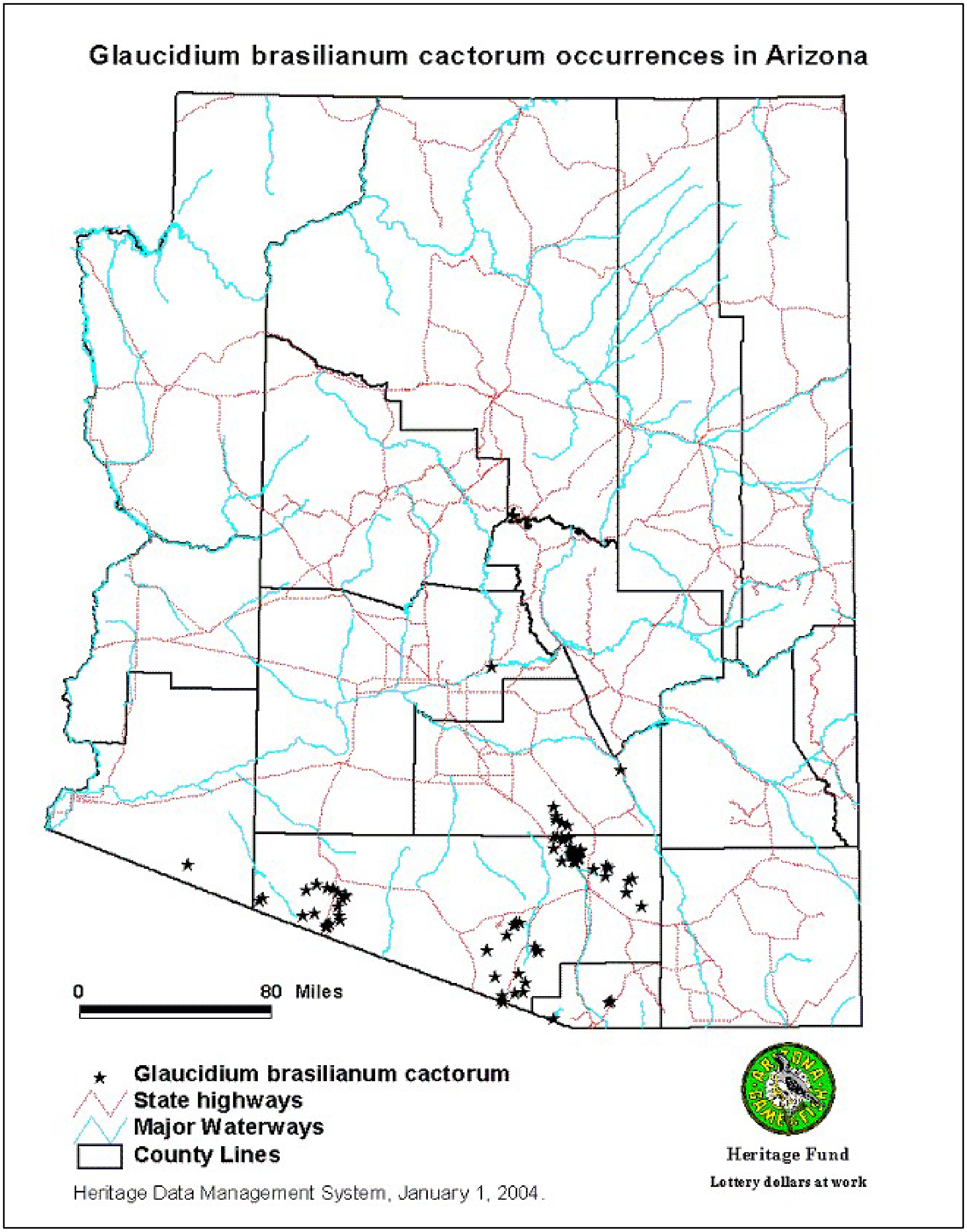

Figure 4.2-1. Distribution Map of Cactus Ferruginous Pygmy-owls in Arizona; Based on Locations Reported in the Heritage Data Management System (HDMS). Source: Arizona Game and Fish Department Website (http://www.gf.state.az.us/w_c/edits/images/glaubrca.gif).

4.2.1.3 Population Status and Threats

Federal Status. The endangered status of the CFPO has been controversial and subject to years of litigation. In March 1997, the Arizona population of the CFPO was Federally listed as endangered and as a distinct population segment (DPS) (USFWS 1997). In January 2001, the National Association of Homebuilders (Homebuilders) sued to vacate the listing on the basis that the DPS designation for the Arizona population was not valid. The District Court, in September 2001, found that the DPS designation, and as a result the listing, was consistent with USFWS policies. Then, in March 2003, the Homebuilders appealed the District Court decision to the Ninth Circuit Court. Five months later, the Ninth Circuit Court declared that the USFWS was arbitrary and capricious in listing the Arizona population of the CFPO and remanded the listing back to the District Court for further proceedings (NAHB 2003). In June 2004, the District Court left the listing in place and referred the listing back to the USFWS for further review based on information gathered since 1997. In August 2004, the Homebuilders appealed the District Court's June order to the Ninth Circuit Court of Appeals. The USFWS provided an update of their reconsideration at the end of January 2005 (NAHB 2004). In September 2005, the USFWS announced its proposed rule to remove the Arizona DPS of CFPO from the Federal List of Endangered and Threatened Wildlife (USFWS 2005a). The legal status of the CFPO continues to be uncertain.

In July 1999, USFWS designated approximately 740,000 acres of Critical Habitat in Arizona. This designation, along with the listing itself, was challenged in the January 2001 lawsuit described above. In September 2001, a Federal judge vacated the Critical Habitat and remanded the designation back to USFWS for a new analysis of economic impacts. In 2003, USFWS re-proposed 1.2 million acres of Critical Habitat (USFWS 2002b). The USFWS also announced in 2005 its intention to eliminate its currently designated Critical Habitat Critical and withdraw its proposed new Critical Habitat (USFWS 2005a).

Texas Population and Status. Although threatened status was proposed for the Texas population of CFPOs, this population was determined to be stable and have a lower level of threat than the Arizona population. Therefore, listing of the Texas population was not found to be warranted (USFWS 1997). One estimate of the CFPO population in Texas suggests that, across Brooks, Kenedy, and Willacy counties, there are 1,308 owls occurring in live oak-mesquite habitat (Wauer et al. 1993). Another study estimates that between 745 and 1,823 individuals occur in Kenedy County alone (Mays 1996).

Mexico Population and Status. At the time of the listing, the USFWS noted that it would continue to review the status of CFPO populations in Mexico and evaluate whether one or more of these populations should be proposed for listing (USFWS 1997). There is limited information about the population status of CFPOs in Mexico. Russell and Monson (1998) suggested that, based on their personal observations and anecdotal information, populations in Sonora, Mexico had not declined. Currently, the CFPO is thought to be relatively abundant in northern Sonora. Flesch and Steidl (2000) looked at CFPO populations just south of the U.S. border throughout Sonora, Mexico. They observed 240 owls (208 males and 32 females) on 191 transects surveyed between February and March 2000, the early part of the breeding season. Another 22 possible detections were made during the surveys. Presence of a pair was documented at only 12 sites, with evidence of pair occupancy at another five sites. In all, only four occupied nest cavities were recorded. In addition to the survey results, another 39 incidental CFPOs detections were recorded. Eight of these owls were female and 31 were male. Three sites had confirmed pair occupancy, with two of these sites having occupied nest cavities. The densities of owls recorded during the survey ranged from 1.80 owls per 10,000 hectares (61,000 acres) to 0 owls per 10,000 hectares (61,000 acres), with an average of 0.17 owls per 10,000 hectares (61,000 acres) (Flesch and Steidl 2000).

Arizona Population Status and Threats. There has been a historical decline in the species' range in Arizona (Pima County 2001). The extent of this population decrease is unknown, in part due to the lack of quantified historical records. Historically, CFPOs in Arizona were most commonly reported in cottonwood-mesquite forest and mesquite woodlands. In recent years, CFPOs have been observed primarily in the Arizona Upland Subdivision of the Sonoran Desertscrub biome (USFWS 2003b).

The general understanding is that CFPO populations in Arizona began to decline after about 1950, possibly as a result of the increasing loss of riparian habitat caused by lowered water tables, loss of perennial flows in many streams and rivers, invasion of exotic vegetation such as tamarisk (*Tamarix* spp.), and physical changes to river channels, banks, and floodplains. Many riparian areas, however, had not been surveyed prior to being impacted by human activities, so it is possible that the population decline started much earlier in the 20th Century (Johnson et al. 2000).

Formal surveys for the CFPO did not begin in Arizona until 1993. Although CFPO records in Tucson and Organ Pipe Cactus National Monument date back to 1872 and 1949, respectively, for many other areas, such as on the Tohono O'odham Nation, little or no historical data exists (Johnson et al. 2000). Even after formal surveys began, the intensity of those efforts was insufficient to provide a good estimate of the number of CFPOs in Arizona. Only after the listing in 1997 did survey efforts increase to the point that a better picture of the population status begin to emerge (Richardson et al. 2000).

The total number of CFPOs in Arizona is still unknown. Survey and monitoring documented 37 adult CFPOs in 1999, 30 in 2000, 36 in 2001, 29 in 2002, 21 in 2003, 20 in 2004, and 20 in 2005 (USFWS 2003b; S. Richardson, USFWS, pers. com.; D. Abbate, AGFD Research Branch, pers. com.). It is probable that there are more CFPOs in Arizona, as large tracts of potentially suitable CFPO habitat have not been surveyed (USFWS 2002b; Richardson et al. 2000). In 1999, the last year for which CFPO survey data was published, 28 owl territories were identified in Pinal and Pima counties. Eleven of these territories had documented breeding activity, with all nests successfully fledging young (although one nest failed after fledging). In total, 32 young successfully fledged in 1999, with 16 known to survive through dispersal (Abbate et al. 2000). Surveys indicate that there are fewer than 50 territories in the State (outside of Tribal lands) (S. Richardson, USFWS, pers. comm.).

Three general factors were identified as the basis for the listing of the Arizona population segment: (1) present or threatened destruction, modification, or curtailment of the species habitat or range; (2) inadequacy of existing regulatory mechanisms; and (3) other natural or man-made factors affecting its continued existence. Regardless of uncertainty related to habitat use by the CFPO in Arizona, loss of habitat is generally regarded as the single largest contributor to the decline in owl populations. Anecdotal evidence from both Arizona and Texas indicates that population declines in both locations coincided with the loss of habitat. Relatively large populations of CFPOs can still be found in Texas where owl habitat has been preserved (Johnson et al. 2000).

Although loss of riparian habitat may have been the primary threat to CFPOs in Arizona, the recent loss and fragmentation of upland vegetation from large-scale residential and commercial developments has also been identified as an important threat (USFWS 2003b). Development pressure is seen as the primary threat to conservation of habitat for this species in Northwest Tucson (USFWS 2002b). Activities that may affect habitat include: clearing vegetation, indirect effects of urbanization, agricultural encroachment, road-building, high-impact recreation, water diversion or impoundment, channelization of drainages, groundwater pumping, livestock grazing, and hydrologic changes resulting from various land use practices (USFWS 2003b).

CFPOs are susceptible to predation from a variety of species, such as great horned owls, Harris' hawks (*Parabuteo unicinctus*), Cooper's hawks (*Accipiter cooperi*), screech-owls (*Otus* sp.), and domestic cats (USFWS 2002b, USFWS 2003b). Other threats include direct and indirect human-caused mortalities, such as collisions with cars, glass windows, fences, and power lines; illegal dumping of toxic waste; and wildfire (USFWS 2003b). Additional natural and human induced factors that could affect the subspecies include low levels of genetic variation, possible contamination from pesticides, potential competition with other birds for nesting cavities, concentration of recreational birding activities at remaining known locations, disease (e.g. *Trichomoniasis*), and nest predation (USFWS 2002b, USFWS 2003b). Human activities near nest sites at critical periods of the nesting cycle also can cause CFPOs to abandon their nests (USFWS 2003b). CFPO habitat also can be compromised by the presence of barriers to movement, including roads, interstates, canals, certain types of fencing, and alterations of functional drainages (Pima County 2001).

4.2.2 Ecology

4.2.2.1 Life History

CFPOs are primarily diurnal with crepuscular tendencies, i.e. most activity occurs during daylight hours, with peaks at dawn and dusk (USFWS 2003b). A CFPO typically flies in quick bursts, moving only a short distance from one lookout point to another (Cartron et al. 2000b). CFPOs typically hunt from perches in trees with dense foliage using a perch-and-wait strategy. They also hunt by inspecting tree and saguaro cavities for other nesting birds, and possibly bats. Their diverse diet includes birds, lizards, insects, and small mammals; however, the owls do utilize different groups of prey species on a seasonal basis (USFWS 2002b). CFPOs have never been observed directly drinking water; it is likely they meet much of their biological water requirements through the prey they consume (USFWS 2003b).

CFPOs are considered non-migratory throughout their range (USFWS 2002b). They are highly territorial with territory sizes between three and 57 acres (1.2 to 23.1 hectares) during the breeding season and winter home ranges as large as 279 acres (113 hectares) (Pima County 2001, USFWS 2003b). A 280-acre (112-hectare) home range is currently considered necessary for CFPOs to meet their life history requirements on an annual basis (USFWS 2003b). Based on telemetry data, it appears that the larger winter range of CFPOs represents an expansion of the breeding territory and does not involve a seasonal shift of territory from one location to another (S. Richardson, USFWS, pers. comm.).

CFPOs typically nest as yearlings and both sexes breed annually thereafter. Territories normally contain several nest-roost cavities from which a responding female selects a nest. Hence, cavity density could be a fundamental criterion for habitat selection (USFWS 2003b).

In Arizona, the courtship and nesting period runs from February to May (USFWS 2003b; USFWS 2003b). Clutch sizes range from 3 to 7 eggs (Pima County 2001). One clutch per year is typical (USFWS 2003b); however, a second clutch may be laid if the first one fails (Pima County, 2001). Juveniles typically disperse from natal areas between July and August and do not appear to defend a territory until September. Direction of dispersal appears to be random (USFWS 2003b) and a juvenile CFPO has been documented dispersing over 100 miles (161 kilometers) (D. Abbate, AGFD, pers. comm.). Once dispersing male CFPOs settle in a territory, they rarely move out of their home range. Unpaired females may continue to move until the subsequent breeding season (USFWS 2002b). CFPOs exhibit a high degree of site fidelity once territories and home ranges have been established (USFWS 2002b). Behaviorally, the option to seek alternative areas outside of the home range appears limited, particularly for males (USFWS 2003b).

Little is known about the rate or causes of mortality in CFPOs or their life expectancy. The average or maximum life span of a CFPO is not known; however, the longest an owl has been tracked in Arizona is five years. Glen Proudfoot suspects there is a CFPO in Texas that could be as much as seven years old, but the longest documented life span in that state is five years old (S. Richardson, USFWS, pers. comm). In 1999, AGFD reported three instances of adult mortality and 11 instances of actual or presumed juvenile mortality. One adult owl appeared to have broken its neck in a collision with a fence and the other two adults were suspected victims of predation (Abbate et al. 2000). The five confirmed juvenile deaths were from predation (1 juvenile), injuries resulting from wind damage to the nest saguaro (3 juveniles), and unknown causes (1 juvenile) (Abbate et al. 2000).

4.4.2.2 Habitat Requirements

The habitat requirements of the CFPO are not fully understood. Habitat use by the CFPO varies from Arizona to Texas to Mexico. In Texas, they are typically found in coastal-plain oak associations, mesquite bosques, and Tamaulipan thornscrub. In eastern Mexico, they occur in lowland thickets, thornscrub associations, riparian woodlands, and second-growth forests. In western Mexico, the CFPO is commonly found in Sonoran desertscrub, Sinaloan thornscrub, Sinaloan deciduous forest, riverbottom woodland, cactus forests, and thornforests. As discussed below, in Arizona habitat use has included cottonwood and mesquite riparian woodlands, upland Sonoran desertscrub, and Semidesert Grasslands.

Although the plant communities in Texas and Arizona differ, their similarities may help identify those characteristics most significant for the CFPO. The ferruginous pygmy-owl is often associated with thickets and thicket edges in Texas and densely foliated non-native landscape vegetation in Arizona. Another similarity between these diverse communities is the presence of thorny bushes (Cartron et al. 2000a). These similarities may indicate that vegetation structure, rather than composition, is a critical factor in determining the preferred habitat of the owl.

In Arizona, CFPOs historically were most commonly reported in cottonwood-mesquite forest and mesquite woodlands. These mesic riparian forests and associated mesquite woodlands have been nearly eliminated in southern Arizona over the last 100 years, and the reduction of these habitats is thought to have caused a decline in CFPOs over that period (USFWS 2002b). There is some question as to whether the CFPO was exclusively associated with riparian habitat. Early naturalists in Arizona tended to focus their efforts along rivers, so it is possible that the tendency for CFPOs to be documented in riparian areas is primarily an artifact of where survey and collection work took place (Johnson et al. 2003). Advocates for this historic CFPO-riparian association note that numerous expeditions crossed the south and central portions of Arizona without reporting the presence of CFPOs. In the late 1800s, noted ornithologists Charles Bendire and George Breninger made a distinction between elf owl nesting habitat (in upland saguaros) and CFPO nesting habitat (in riparian cottonwoods and mesquites). There are, however, published historic records (1920s to 1950s) of CFPOs in areas with no permanent water source (Johnson et al. 2003). The lack of extensive and quantified historical records makes it unlikely that the debate will ever be fully settled (S. Richardson, USFWS, pers. comm.).

In recent years, CFPOs have been primarily found in the Arizona Upland Subdivision of the Sonoran Desertscrub biome. The Arizona Upland Subdivision is described as low woodlands of leguminous trees with an overstory of columnar cacti and with one or more layers of shrubs and perennial succulents. Over the past several years, owls also have been observed in riparian and xeroriparian (dry washes) areas and in Semidesert Grasslands (USFWS 2003b).

The primary constituent elements of CFPO habitat have been identified as USFWS 2002b):

1) Below 4,000 feet within the following biotic communities: Sonoran riparian deciduous woodlands; Sonoran riparian scrubland; mesquite bosques; xeroriparian communities; tree-lined drainages in Semidesert Grassland, Sonoran savanna, and mesquite grasslands; and the Arizona Upland and Lower Colorado River subdivisions of the Sonoran desertscrub.

2) Nesting cavities in trees including, but not limited to, cottonwood, willow, ash, mesquite, palo verde, ironwood, and hackberry with a trunk diameter of 6 inches (15.2 centimeters) or greater (measured at 4.5 feet [1.4 meters] above ground), or large columnar cactus such as saguaro or organ pipe greater than 8 feet (2.4 meters) tall;

3) Multi-layered vegetation (presence of canopy, mid-story, and ground cover) provided by trees and cacti in association with shrubs such as acacia, prickly pear, desert hackberry, graythorn, etc., and ground cover such as triangle-leaf bursage, burroweed, grasses, or annual plants;

4) Vegetation providing mid-story and canopy-level cover in a configuration and density compatible with CFPO flight and dispersal behaviors; and

5) Habitat elements configured and human activity levels minimized so that unimpeded use, based on CFPO behavioral patterns, can occur during dispersal and within home ranges.

Studies of habitat use in Texas suggest that important habitat characteristics include moderate to dense understory cover (anywhere from 50 percent to 100 percent), the presence of trees large enough to provide cavities, and fewer small trees (Proudfoot et al. 2000). In Arizona, nest sites tend to have a higher degree of canopy cover and higher vegetation diversity than random sites (USFWS 2003b). Relatively dense understory cover could be important for foraging and survival of fledglings (Cartron et al. 2000a) as well as providing protection from extreme climatic conditions (Cartron et al. 2000b).

Preliminary studies suggest that CFPOs in Northwest Tucson use areas with relatively high levels of structural diversity in the suburban/urban interface. Areas of highest concentration of CFPOs are commonly characterized by semi-open or open woodlands, often in proximity to forests or patches of forest. Although CFPOs occupy the same general area year-round, the size of the area used and the composition of vegetation may vary among seasons (USFWS 2003b).

CFPOs are obligate cavity nesters, meaning that they almost exclusively utilize natural cavities or cavities created by other species (Cartron et al. 2000b). Historically, CFPOs in Arizona used cavities in cottonwood, mesquite, ash (*Fraxinus* sp.), and saguaro cacti for nest sites (USFWS 2002b); although some evidence suggests that mesquite (a hardwood species) is less readily excavated and, therefore, is less frequently used in riparian areas than softwood trees (Cartron et al. 2000b). Recently (1996 to 2002) all but two known nest sites were in saguaro cacti. Of the two non-saguaro nests, one was in an ash tree and the other in a eucalyptus tree.

The general conclusion from these studies is that, in order to support successful reproduction and rearing of young, home ranges should include trees and cacti of adequate size to provide cavities for nest sites and that are in proximity to foraging, roosting, sheltering, and dispersal habitats. Further, adequate cover is needed for protection from climate and predators, and in an appropriate configuration in relation to the nest site.

Some preliminary investigations have been done to determine the degree of development within the home ranges and/or breeding territories of CFPOs. In 2001, 83 percent of known CFPO sites were in undeveloped areas with very little human activity and 17 percent of sites were in areas with some level of low-density development. No CFPOs have been documented in high-density commercial or residential developments. CFPO experts on the Recovery Team calculated the level of vegetation disturbance within the estimated home range (280 acres or 113 hectares) at each nest site. The average percent disturbance was calculated to be 23 percent. More recent information from an analysis completed by the AGFD showed an overall disturbance of 33 percent within breeding home ranges. There appears to be a difference in the tolerance of breeding versus non-breeding CFPOs to the level of vegetation disturbance (S. Richardson, USFWS, pers. comm.).

CFPOs require habitat linkages, within and among territories, for movement and dispersal. Habitat linkages consist of continuous cover or patches of trees and large shrubs spaced at regular intervals, to provide concealment and protection from predators and mobbing. These areas also provide shade and cover to moderate temperature extremes (USFWS 2003c).

In their search for mates, food, or territories, dispersing CFPOs may stop temporarily in appropriate over-wintering habitats. For CFPOs, over-wintering habitats are defined as riparian areas that are more extensive in size and support higher vegetation densities, thereby providing greater cover and prey densities, than dispersal habitats. Although saguaros may be present in the vicinity, the presence of saguaros is not a requirement of either over-wintering or dispersal habitats (S. Richardson, USFWS, pers. comm.).

4.2.3 Baseline Conditions

4.2.3.1 City of Tucson Population Status

While the total number of CFPOs in southern Arizona is unknown, CFPOs have been detected in the following areas (Pima County 2001; S. Richardson, USFWS, pers. comm.; D. Abbate, AGFD Research Branch, pers. comm.):

- Tortolita Fan, northwest of Tucson (documented annually since 1993, with nesting observed from 1995 to 2002; 3 owls observed in 2004; 2 owls observed in 2005, and 1 owl observed in 2006);
- Tucson Mountains (1 owl documented in 1998) and just east of this range;
- Organ Pipe Cactus National Monument (documented annually since 1993, with nesting documented from 1998 through 2001; no nesting documented from 2002 to 2005; 1 pair and at least 2 individuals observed in 2006);
- Tohono O'odham Nation (several owls), and;
- Altar Valley (nesting documented annually since at least 1999; 4 pairs observed in 2003 and 2004; 5 pairs observed in 2005)

AGFD Research Branch has conducted radio-tracking studies on selected CFPOs since 1998. In 2003-2004, a female CFPO was tracked crossing Avra Valley, starting in the vicinity of Green Valley, crossing Ajo Highway, and continuing north into Pinal County (S. Richardson, USFWS, pers. comm.; D. Abbate, AGFD, pers. comm.). During the 2004–2005 tracking period, AGFD monitored the movements of a female CFPO that fledged from a nest on ASLD land, in the central portion of the Altar Valley, east of Highway 286. Consistent with other female CFPO, this individual moved relatively long distances in search of a mate. Movements were tracked from the onset of dispersal (late July 2004), until December 2004 when the transmitter failed. This female initially moved southeast, passing by the Cerro Colorado Mountains, then briefly south across Arivaca Road and into the canyon-foothill areas of the Tumacacori Mountains. It then headed northeast until reaching an area within two miles of its natal territory, where it spent the late summer, fall and winter of 2004. This disperser was recaptured in March 2005 and equipped with a new transmitter. In late March, it began moving north again and eventually crossed to the west side of Highway 286, in the north section of the Altar Valley, during 10 and 11 April. After this road crossing, AGFD used a triangulation estimate to determine the CFPO's location within a City-owned parcel (Duval/Pennzoil Farm) in Section 7 of Township 16 South, Range 10 East. To AGFD's knowledge, this location is the first confirmed detection of a CFPO on City property since CFPO was Federally listed in 1997.

This individual continued its dispersal east, spending some time near Green Valley, and eventually moved west onto the Tohono O'odham Nation, where it was last detected during aerial tracking on June 11, 2005.

4.2.3.2 Habitat in and Near the City of Tucson

Four different approaches have been used to delineate potential habitat for CFPO:

- Critical Habitat,
- Draft recovery areas,
- The Sonoran Desert Conservation Plan habitat model
- The City of Tucson Habitat Conservation Plan CFPO habitat model.

Proposed Critical Habitat. The areas proposed as Critical Habitat are intended to:

- Protect known locations of CFPOs,
- Include habitat linkages that allow movement and dispersal among the areas supporting CFPOs, and
- Maintain habitat through which CFPOs can move between Mexico and the northern portion of the Arizona range.

Critical Habitat was developed to include the following: recent (since 1997) verified CFPO sites; areas below 4,000 feet (1,220 meters) elevation that include one or more primary constituent elements related to vegetation; areas included in the average straight-line dispersal distance (5 miles or 8 kilometers) from nest sites; and 4 of the 5 Special Management Areas identified in the draft Recovery Plan (described below). All areas of proposed Critical Habitat fall within the maximum dispersal distance (21.8 miles or 35.1 kilometers) from recent, verified owl locations, are below 4,000 feet (1,220 meters) elevation, and include one or more primary constituent element (USFWS 2003c). The City HCP planning area encompasses 8,419 acres (3,368 hectares) of proposed Critical Habitat for CFPO (Figure 4.2-2).

Draft Recovery Plan. The draft Recovery Plan identifies eight Recovery Areas (RAs) for CFPO. These areas represent an interconnected system of habitat based on:

- Recent, verified locations of CFPOs,
- More recent historical locations, and
- Habitat with the best chance of supporting breeding CFPO and dispersal (specifically, Arizona Upland Desertscrub, xeroriparian wash vegetation communities, and where appropriate, mesic riparian vegetation).

The RAs include some areas that are not considered currently occupied (i.e. areas more than 21.8 miles [35.1 kilometers] from recent, verified locations). Within some RAs, Special Management Areas (SMAs) were identified that need special management because of current or potential threats to the recovery of the CFPO (USFWS 2003c). There are 8,427 acres (3,371 hectares) of recovery areas in the City HCP planning area (Figure 4.2-3).

Sonoran Desert Conservation Plan Habitat Model. The SDCP habitat model for CFPO was based on four primary components:

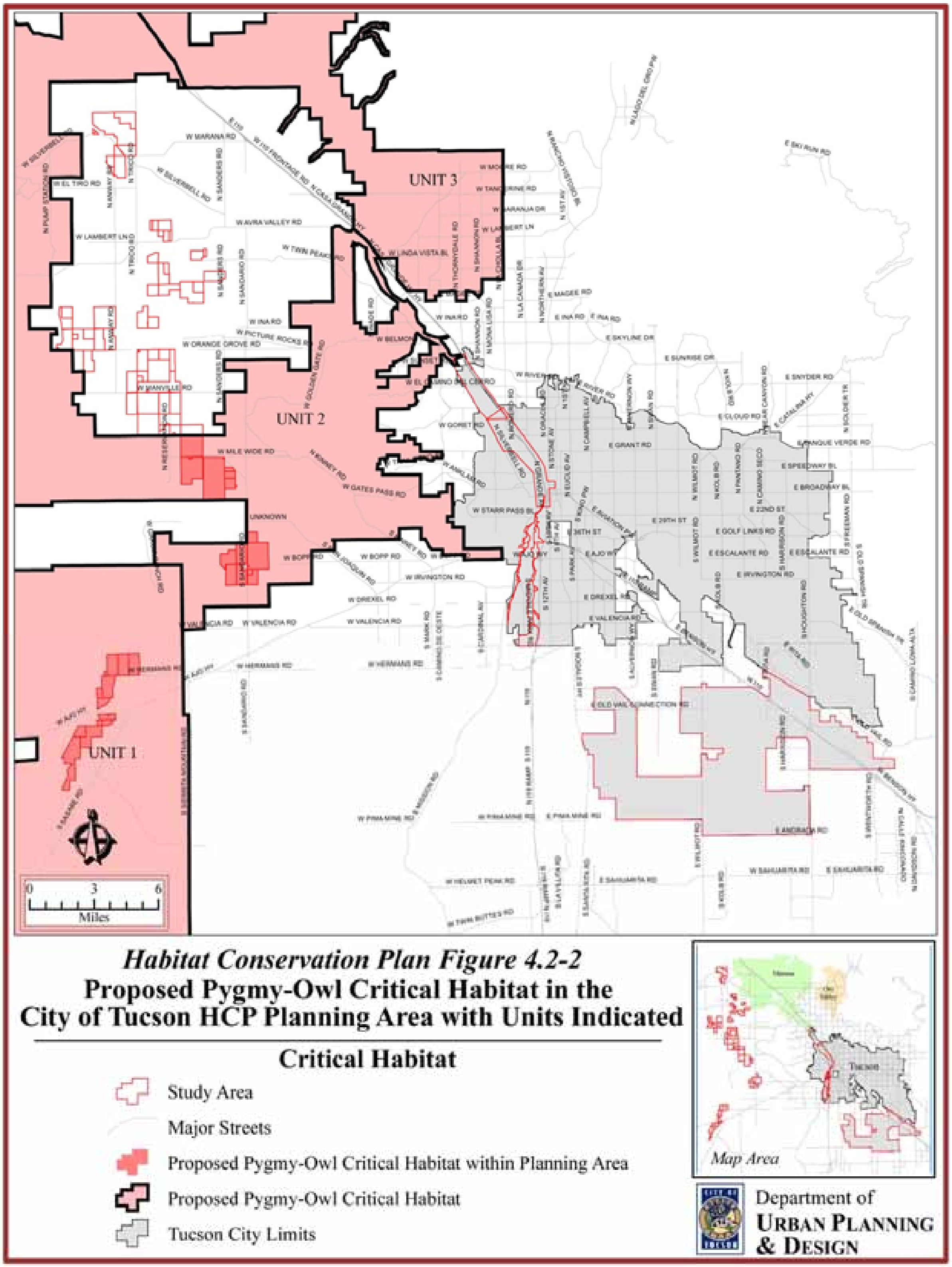

Figure 4.2-2. Proposed CFPO Critical Habitat in the City of Tucson HCP Planning Area (with units indicated).

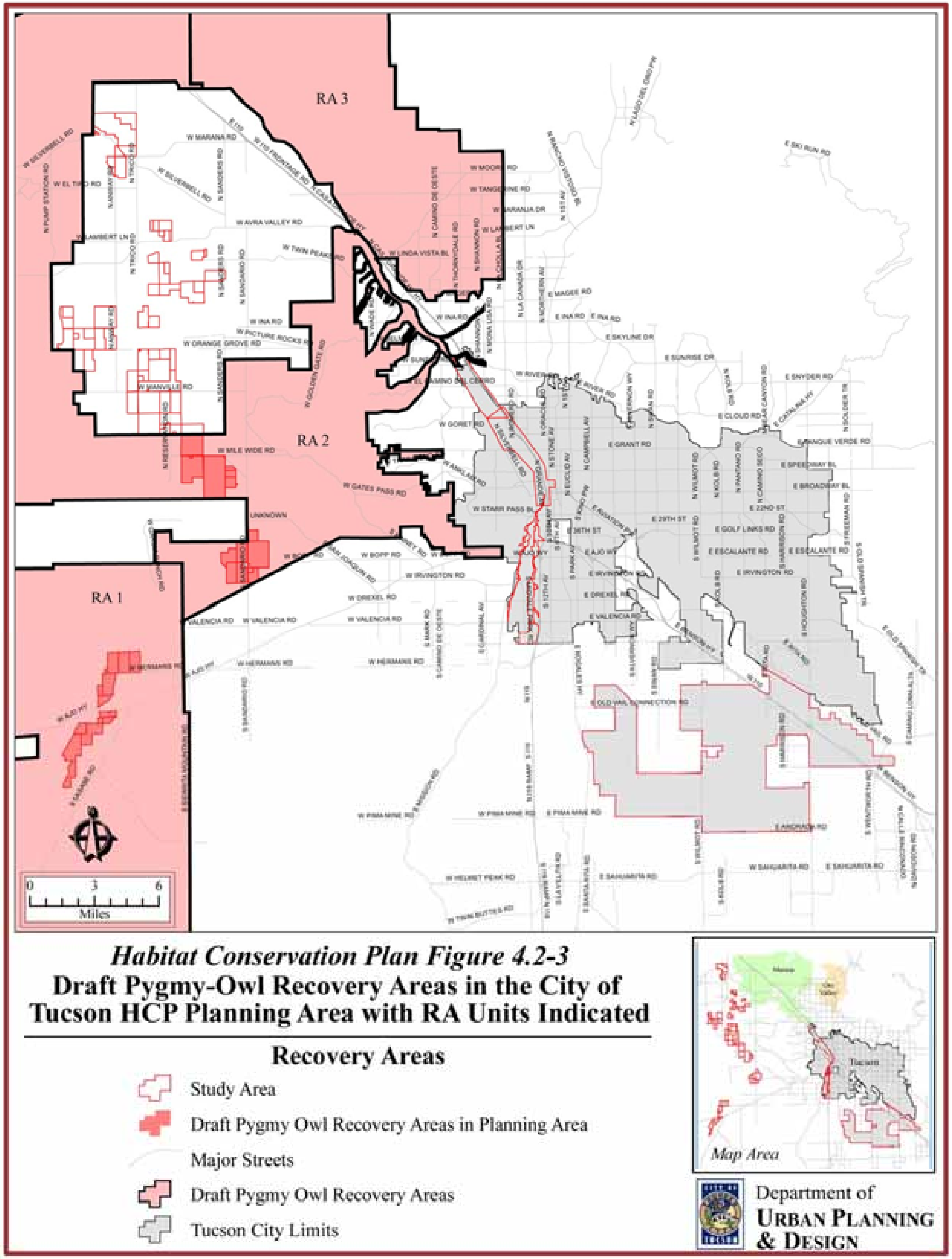

Figure 4.2-3. Draft CFPO Recovery Areas in the City of Tucson HCP Planning Area

- Elevation,
- Vegetation,
- Presence of perennial or intermittent streams, and
- Landform characteristics (Pima County 2001).

A series of categories was then assigned to each of these components, and each category was ranked as 0, 1, 2, and 3, with 0 indicating that the category provides no habitat value and 3 indicating that the category provides high habitat value. The four variables were then combined to provide an overall habitat value (Table 4.2-1).

Table 4.2-1. Value Ratings for Characteristics of the Variables Used in the SDCP CFPO Habitat Model

Variable/Category	Value Rating
Hydrology	
Intermittent stream	2
Adjacent habitat within 1/2 mile of intermittent stream	1
Perennial stream	2
Vegetation	
Sonoran Riparian Woodland Xero-riparian mesquite (124.7)	3
Scrub-Grassland Mixed grass-scrub (143.15)	1
Scrub-Grassland Xero-riparian biome (143.10.XR)	1
Sonoran Desertscrub Upland Paloverde-mixed cacti (154.12)	3
Sonoran Desertscrub Xero-riparian Paloverde-mixed cacti (154.12XR)	3
Sonoran Desertscrub Urban Paloverde-mixed cacti (154.12U)	2
Interior Southwestern Riparian Deciduous Forest and Woodland Meso-riparian biome (223.20)	3
Interior Southwestern Riparian Deciduous Forest and Woodland Meso-riparian cottonwood-willow (223.21)	3
Interior Southwestern Riparian Deciduous Forest and Woodland Meso-riparian mixed broadleaf (223.22)	3
Interior Southwestern Riparian Deciduous Forest and Woodland Urban biome (223.20U)	2
Sonoran Riparian and Oasis Forests Meso-riparian mesquite (224.52)	3
Sonoran Riparian and Oasis Forests Meso-riparian cottonwood-willow (224.53)	3
Sonoran Riparian and Oasis Forests Urban mesquite (224.52U)	2
Sonoran Riparian and Oasis Forests Meso-riparian cottonwood-willow (224.53U)	2
Sonoran Deciduous Swamp and Riparian Scrub Meso-riparian biome (234.70)	1
Sonoran Deciduous Swamp and Riparian Scrub Meso-riparian mixed scrub (234.71)	1
Sonoran Deciduous Swamp and Riparian Scrub Meso-riparian saltcedar disclimax (234.72)	1
Slope	
0–2%	1
2–5%	1

Table 4.2-1. Value Ratings for Characteristics of the Variables Used in the SDCP CFPO Habitat Model, continued

Variable/Category	Value Rating
Elevation	
195–400 meters	1
401–600 meters	2
601– 800 meters	2
801–1,000 meters	2
1,001–1,200 meters	2
Land Form	
Drainage ways	2
Floodplains	2
Terraces	2

Source: Recon (2002) Priority Vulnerable Species Analysis and Review of Species Proposed for Coverage by the Multiple Species Conservation Plan.

Using this habitat model, 27,991 acres (11,328 hectares) of high potential habitat and 18,978 acres (7,680 hectares) of medium potential habitat for CFPO are predicted to occur in the City HCP planning area (Figure 4.2-4).

City of Tucson Habitat Conservation Plan CFPO Habitat Model. The City of Tucson HCP CFPO habitat model was developed through discussions with members of the CFPO Recovery Team and other experts, including representatives of USFWS, AGFD, and University of Arizona. Proposed Critical Habitat and mapped RAs do not capture all potentially suitable habitats within the City HCP planning areas, but, on the other hand, the degraded state of the land within the Avra Valley planning sub-area that falls within these designations should be recognized.

To create this habitat model, the team of experts visually identified areas on orthophotos that: (1) are currently suitable as overwintering habitat for CFPOs, (2) are currently suitable as dispersal habitat for CFPOs, and (3) are not currently suitable habitat but constitute critical connections between existing over-wintering or dispersal habitat and therefore needed to be considered in the habitat conservation planning process. The model recognizes the value of the Avra Valley planning sub-areas to provide connectivity between CFPO populations on the Tohono O'odham Nation and Avra Valley, and Critical Habitat in southern Pinal County and the Northwest Tucson and Tortolita Fan area. Also captured within the model are areas with sufficient vegetation density to offer potential over-wintering habitat for dispersing CFPOs. This over-wintering habitat was identified as areas with characteristics similar to those existing in areas of suitable breeding habitat. As a result, these areas present potential, although highly unlikely, breeding opportunities for the owl.

Based on this habitat model, 1,588 acres (2,100 hectares) of potential over-wintering habitat, 6,513 acres (2,636 hectares) of potential dispersal habitat, and 677 acres (274 hectares) of habitat with potential for dispersal with restoration is predicted to occur in the City HCP planning area (Table 4.2-2, see Figure 4.2-4).

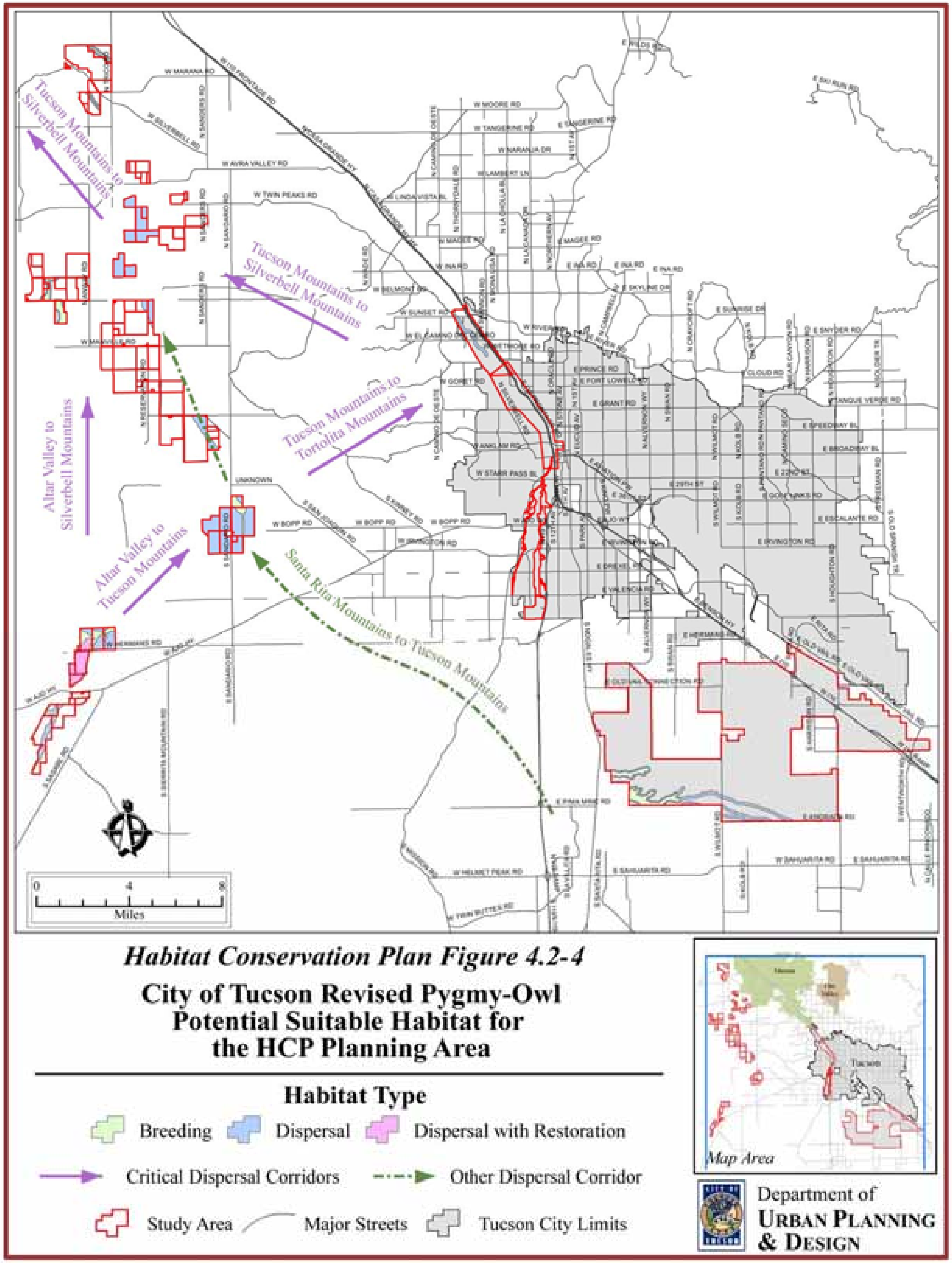

Figure 4.2-4. City of Tucson Revised CFPO Potential Suitable Habitat for the HCP Planning Area. Parcels within the Avra Valley Planning Sub-area Also Fall Within Recovery Areas 1 and 2. Duval/Pennzoil and Buckelew Farms are Located on the Very Northern End of the Altar Valley Recovery Area (USFWS 2003c).

Table 4.2-2. Acreage of Each Type of Potential CFPO Habitat by City of Tucson HCP Planning Sub-area

Habitat Type	Avra Valley (acres)	Santa Cruz River Corridor (acres)	Southlands (acres)	Total Acres
Over-wintering	975	9	604	1,588
Dispersal	5,290	175	1,048	6,513
Dispersal with Restoration	677	0	0	677
Total Acres of Habitat, all Classes	**6,942**	**184**	**1,652**	**8,778**
Total Planning Area Acres	**21,596**	**5,075**	**34,546**	**61,217**

4.2.3.3 Importance of City of Tucson in Species' Range and Ecology

There have been no CFPO breeding or over-wintering territories documented within the City HCP planning area. The only recorded use of the planning area has been an AGFD record of an unmated dispersing female on Duval/Pennzoil Farm parcel in the Avra Valley planning sub-area in 2005. Historically, the Santa Cruz River was the site of numerous CFPO records; in recent years there has not been any documented use of this corridor by CFPOs. With restoration, the value of the river as potential breeding and dispersal habitat will increase. The Southlands planning sub-area is not considered to be a significant potential dispersal corridor for CFPO unless the CFPO population naturally recovers or is artificially augmented.

The Duval/Pennzoil and Buckelew Farm properties, the SAVSARP site, and portions of the CAVSARP property fall within Unit 2 of proposed Critical Habitat for CFPO. When proposing the newest Critical Habitat designations, USFWS indicated that Unit 2 consisted of a "strip of potential habitat" that provided connectivity, and the potential for movement of CFPOs, between the Tohono O'odham Nation, Saguaro National Park – West, and southern Pinal County (USFWS 2002b). According to USFWS, the value of Unit 2 lies in the connectivity it provides between other units of Critical Habitat. The proposed rule recognized that much of this area, including City-owned property, have been heavily impacted by grazing, agriculture, mining, and other uses. Retired agricultural lands in the Avra Valley are considered by USFWS as providing habitat connectivity and potential dispersal corridors for CFPOs (USFWS 2002b). The USFWS expects Unit 2 to be utilized for breeding only if the CFPO population was to expand (USFWS 2002b).

Parcels within the Avra Valley planning sub-area also fall within RAs 1 and 2. The Duval/Pennzoil and Buckelew Farms are also located on the very northern end of the Altar Valley RA 1 (USFWS 2003c). Although this RA does contain suitable breeding habitat for CFPOs and has accounted for approximately 43 percent of documented owls, most of those records come from farther south in the Altar Valley. The Recovery Team recognized that some portions of the RAs were subject to greater threats and these areas were therefore identified as SMAs. Just east of the City parcels, the Altar Valley SMA was designated as such due to the increasing development of this area and its impact on available breeding habitat and dispersal corridors (USWFS 2003a). The two former farm holdings are not called out as either historically productive areas for CFPOs or SMAs, probably due to they're past use for agricultural production and current "recovering" status. If allowed to recover from past farming activities, the two properties represent a significant potential linkage between CFPO populations in Altar Valley and the Tohono O'odham Nation.

The SAVSARP and CAVSARP sites lie in the southern portion of RA 2, which extends from the Tohono O'odham Nation, east to City of Tucson and Town of Marana, and north to southern Pinal County, including Saguaro National Park – West and Ironwood Forest National Monument (USFWS

2003c). Like Unit 2 of proposed Critical Habitat, this RA was designated primarily as potential dispersal habitat and a movement corridor for CFPO in Altar Valley (RA 1), southern Pinal County (RA 2 and 3), and the Tortolita Fan (RA 3). Only a single confirmed CFPO record exists for this RA; however, vegetation suitable for nesting habitat does exist in some areas (USFWS 2003c).

4.2.4 Threats and Management Needs

4.2.4.1 Potential Threats and Stressors

Although loss of riparian habitat may have been the primary threat to CFPOs historically in Arizona, the recent loss and fragmentation of upland vegetation from large-scale residential and commercial developments has also been identified as an important threat (USFWS 2003b). Development pressure is seen as the primary threat to habitat for this species in Northwest Tucson (USFWS 2002b).

Mortality of CFPOs has resulted from a variety of natural (predation by raptors) and human causes (collisions with automobiles, glass windows, fences, and power lines). Human activities near nest sites at critical periods of the nesting cycle can impact CFPOs indirectly by causing them to abandon their nests. CFPO habitat also can be compromised by the presence of barriers to movement, including roads and agricultural fields. There is concern that the recent drought in southern Arizona is further stressing the CFPO population through a reduction in plant growth and associated prey populations. See Table 4.2-3 for a complete list and discussion of stressors and threats to CFPO.

Table 4.2-3. Potential and Current Threats and Stressors for CFPO

Stressor/Threat	Relevance to Species
Habitat Loss	
Breeding	Historically, many records were from riparian areas, but current and recent records are mostly from uplands. Historic loss of breeding habitat is deemed a major factor in the decline of CFPO. This owl breeds in areas with fairly dense and diverse native vegetation, but may include some non-natives plant species as well. It requires cavities, mostly in saguaros, for nest sites, and diverse and abundant food. It also requires a home range of approximately 35 acres during the breeding season.
Dispersal	Females disperse over a long distance in search of males. Males disperse from natal area to new suitable territory, usually close to natal areas. Dispersal occurs during July to November. Loss of vegetation diversity and structure, especially tree species, results in disruption of connectivity and may impede dispersal.
Foraging	Size of foraging area is unknown, but may be related to available food supplies and therefore differs seasonally and based on the life cycle of species. Diversity of resources is important to CFPO.
Wintering	CFPOs over-winter in the Tucson area and need foraging and roosting sites. Winter food supply may be critically important. Evidence suggests that females may over-winter in dense mesquite.
Migratory stops	The CFPO apparently does not migrate, but does need suitable wintering areas and places to rest during periods of dispersal.
Fire threat	Fire may result in loss of habitat, especially nest sites.
Habitat Alteration	
Prey	Consumes diverse prey: insects, lizards, rodents, small birds. Habitat diversity provides for a variety of prey items; therefore, anything that reduces diversity is detrimental to this species.

Table 4.2-3. Potential and Current Threats and Stressors for CFPO, continued

Stressor/Threat	Relevance to Species
Habitat Alteration, continued	
Nest sites	Uses woodpecker holes in saguaros and (rarely) other trees as nest sites; therefore, loss of mature saguaros and/or decline in woodpecker populations would render areas potentially unsuitable.
Vegetation composition/density	The CFPO prefers high vegetation density and multiple vegetation layers. Loss of one or more layers, by fire, grazing, flood, or mechanical impacts would be detrimental to this species.
Habitat conversion	Conversion of vegetation community to annual or invasive grassland reduces plant species diversity and increases fire potential.
Escape cover	CFPO needs some protection from other raptor species, usually in the form of dense vegetation.
Fragmentation	Fragmentation of historic habitat may have led or contributed to the decline of this species. Habitat connectivity benefits this species during dispersal.
Invasive plant species	Invasion by mesquite and buffelgrass is probably bad for this species because it reduces vegetation diversity and can lead to fires.
Habitat rehabilitation potential	Anything that enhances vegetation diversity is probably beneficial to this owl. Habitat rehabilitation to enhance connectivity for dispersing owls is probably a practical approach.
Water accessibility	The CFPO is loosely associated with water, perhaps because the presence of water enhances owl escape cover and increases prey abundance.
Drought	There is concern that recent drought conditions are further stressing the cactus ferruginous CFPO population through a decrease in plant growth and associated prey populations.
Groundwater depletion	May have led to the loss of suitable habitat in the past, and may impede restoration of potential habitat in the future.
Artificial water sources	May be beneficial by enhancing prey abundance and cover.
Edge effects	May increase predation by cats, dogs, and humans.
Land use history	CFPO prefers areas of dense vegetation with saguaros and high vegetation diversity; anything that lowers density or diversity of vegetation, such as grazing, mining, land development, fire, etc. is considered detrimental to this species.
Species Characteristics	
Dispersal mechanism	Females disperse over long distances in search of males. Males disperse from natal areas to new suitable territories, usually close to natal areas. Birds fly short distances between trees. Dispersal occurs during July to November. Loss of vegetation diversity, especially trees, results in disruption of connectivity and potential dispersal corridors. Intense human activity, such as from construction and maintenance activities, may impede or influence dispersal and may make it difficult for females to locate males.
Habitat rehabilitation potential	It may be fairly easy to increase and/or improve connectivity by managing vegetation, and it may be possible to increase or improve breeding habitat by undertaking projects that maximize vegetation diversity and thereby increase the prey base.
Colonization potential	The potential for this owl to colonize new area is unknown, but probably very limited due to loss of connectivity and suitable breeding habitat.
Fecundity	Although fecundity is not considered a problem, small population size limits potential for long-term survival.
Seasonal specialization	Winter availability of prey may be important.

Table 4.2-3. Potential and Current Threats and Stressors for CFPO, continued

Stressor/Threat	Relevance to Species
Species Characteristics, continued	
Captive breeding/ translocation potential	Captive breeding and translocation may be a useful approach to reestablishing viable populations in some areas.
Sensitivity to disturbance	Considered sensitive to disturbance, although some individuals habituate to frequent predictable disturbance.
Interspecific Factors	
Predation	CFPO is highly susceptible to predation by raptors, and therefore does not appear to thrive in areas with high raptor concentrations or in areas with an abundance of potential raptor perches.
Competition	The extent of competition for nest cavities and prey is currently unknown.
Domestic/feral animals	Known to be preyed on by cats and may be harassed by dogs.
Invasive species	Effects unknown, invasive plants alter habitat structure and prey diversity adversely.
Anthropogenic Factors	
Edge effect	May increase susceptibility to predation, automobile collisions, and shooting.
Fire threat	Fire may cause loss of habitat, especially potential nest sites.
Off-road vehicles	ORV disturbance may be a problem if frequent, and may increase fire frequency.
Passive recreation	Not considered a problem except that bird watchers may harass this species if nesting locations are published.
Grazing	Grazing may be harmful if it reduces vegetation diversity.
Collection/hunting	Illegal collection of this species is not considered a problem. Illegal shooting, as by children with pellet guns, may be a problem in some urban locations.
Pesticides - impacts to prey	Insecticides, especially rodenticides, may reduce the prey base for this species.
Direct take/mortality	Direct take is not considered a problem.
Noise	Noise may be a problem if disturbance is frequent and/or unpredictable, particularly during the nesting cycle.
Light	The effects of light are unknown; however, high intensity lights, such as those used by the U.S. Border Patrol, may be disruptive.
Movement	Movement may be a problem if the disturbance is frequent and/or unpredictable.
Landscaping	Could be beneficial if high-density vegetation with structural diversity.
Undocumented immigrants	Undocumented immigrants may cause fires that result in habitat loss, and may cause repeated disturbance in nesting areas.
Connectivity	
Fragmentation	To facilitate dispersal, CFPO apparently needs a high degree of habitat connectivity and a high density of trees.
Barriers	Wide roads, unvegetated washes, and tall fences may act as barriers to the movement of this owl.
Wash incision	Wash incision may be beneficial if it results in the creation of new habitat for owls and prey.
Habitat patchiness	Habitat connectivity is considered crucial to this species.
Roads	Road crossings may be hazardous due to the tendency for this owl to fly low to the ground. Vegetation next to roads may be a problem if it increases the potential risk of vehicular collisions.

4.2.4.2 Current Management Recommendations

The Recovery Team has recommended general guidelines for activities within RAs in order to reduce potential development impacts to CFPO. The recommendations include:

- No development activities allowed within a quarter-mile of an active nest during the breeding season (February 1 to July 31);
- Year-round restrictions on any activities within 330 feet (100 meters) of a nest site;
- Configuration of development in a manner that preserves the highest quality habitat and maintains connectivity to adjacent habitat; considerations should be given to the spatial needs of the species, breeding requirements, dispersal patterns and landscape-scale movement needs, habitat conditions, and home range requirements;
- Land acquisition and other management and conservation efforts that focus on the SMAs.

4.2.5 Potential Impacts of City of Tucson's Proposed Activities

4.2.5.1 Direct Effects

Construction activities for new residential, commercial, and industrial development; Tucson Water Department water development projects; and supporting infrastructure have the potential for take of CFPOs, either through direct mortality or by harassing or harming. These covered activities would cause temporary and permanent habitat loss and fragmentation. In addition, construction activities would result in short-term noise disturbance during construction, and in long-term disturbance from continued use of the project area (road or development). Short-term construction disturbances would include noise, dust, traffic, and other human activities that could result in owls leaving established territories or abandoning nest sites. Habitat impacts also could affect future use of the area by owls.

4.2.5.2 Indirect Effects

CFPOs have rarely been documented making flights greater than 100 feet (30.5 meters), and they appear to avoid large open areas such as golf courses (USFWS 2003c). Therefore, roads and other developments can act as impediments to CFPO movement (USFWS 2003c). Wide roadways and associated clear zones also can result in owls flying directly into the path of oncoming vehicles, significantly increasing the threat of an owl being struck by a vehicle (USFWS 2003c).

The introduction of exotic plant species, such as fountaingrass, buffelgrass, Lehman's lovegrass, and red brome, which accompanies urbanization and grazing, can increase the risk of wildfires in CFPO habitat (USFWS 2003c). Disturbance, such as ORVs and target shooting, which often accompanies urban development, could cause CFPO to abandon their nest sites. CFPOs also are vulnerable to predation from domestic cats, whose numbers increase in association with urban development. Non-native cavity-nesting birds, such as starlings, tend to be found in greater numbers in disturbed areas and may compete with CFPOs for nesting cavities. An influx of starlings and other cavity nesters, associated with future urban development, could cause a shortage of available nesting sites and reduce the suitability of nearby areas as breeding habitat.

4.2.5.3 Potential Habitat Changes in the City of Tucson

Based on discussions with USFWS, for the purposes of the analysis of impacts to CFPOs in this HCP, the City of Tucson HCP CFPO Habitat Model is used to identify potential habitat within the HCP planning area. However, impacts to proposed Critical Habitat also are considered when the two differ. The bulk of the CFPO habitat in the HCP planning area occurs in the Avra Valley planning sub-area.

Due to the vast difference in acreage and the differences in development threats between Avra Valley, Santa Cruz River, and the Southlands, effects to CFPO from development in these three planning sub-areas are discussed separately.

Impacts to Potential CFPO Habitat in the Southlands Planning Sub-area

Planned residential and commercial development and capital improvement projects could directly impact all suitable CFPO habitat in the Southlands planning sub-area. Suitable habitat for CFPO in this area consists of riparian habitat along some of the major washes.

Pending the outcome of land use planning for ASLD land and regional stormwater management through the Lee Moore Watershed Basin Management Study, some or all of the washes in this area may be channelized to manage storm flows. This would result in the removal of riparian vegetation and some disturbance to the natural hydrologic regime, which will impact the long-term persistence of remaining riparian habitat.

Previous land use concepts, although not currently supported, have called for high intensity development through out the Southlands planning sub-area in conjunction with complete wash channelization. This level of high intensity use would result in additional loss of riparian vegetation and promote long-term and frequent disturbance of any remaining habitat as a result of the proximity to an urban environment.

The City's Environmental Resource Zone (ERZ) wash ordinance requires developers to minimize disturbance to the 100-year floodplain of all ERZ designated washes. However, since the protections on ERZ washes are tied to 100-year floodplains, which are not mapped until the land is proposed for development, it is impossible to ascertain at this point in time the extent of riparian habitat within the Southlands planning sub-area that would be protected under the ERZ ordinance. In addition, it is possible to receive an exception to the regulation that will allow greater disturbance to the riparian habitat within the 100-year floodplain of ERZ washes. Finally, ERZ regulations do not prohibit high intensity development immediately proximate to riparian habitat protected under the ERZ. Given the sensitivity of the CFPO to human disturbance, this situation would likely render any protected riparian areas unsuitable as CFPO over-wintering or dispersal habitat.

As a result, for purposes of the impact analysis in the HCP, we are assuming a worst-case scenario and, at this point in time, it is possible for urban development under the current regulatory environment to impact 100 percent of the modeled potential CFPO habitat within the Southlands planning sub-area.

Impacts to Potential CFPO Habitat in the Avra Valley Planning Sub-area

As proposed in the City Water Plan, planned public water infrastructure projects could directly impact all suitable CFPO habitat in the Avra Valley planning sub-area. Given the uncertainty in the Plan regarding the types and scope of projects that may be constructed within the Avra Valley planning sub-area, we are assuming a worst-case scenario. The total footprint of covered activities in Avra Valley, e.g., recharge basins, evaporation ponds, treatment plant, etc., may require almost 7,500 acres (3,035 hectares). Construction of these projects will create impacts outside of the project footprints, long-term disturbance to habitat may result from operation of these facilities, and the covered activities may, depending on their location and configuration, result in fragmentation of the remaining habitat within these properties. Without knowing the final location and design of any of these facilities, we cannot say that any habitat in the Avra Valley planning sub-area will not be impacted in some fashion by these covered activities.

Impacts to Proposed CFPO Critical Habitat

There is no proposed Critical Habitat for CFPO in the Southlands or Santa Cruz River planning sub-areas.

As proposed in the City of Tucson's long-range 50-year plan, planned public water infrastructure projects could directly impact all proposed Critical Habitat in the Avra Valley planning sub-area. Much of this area, however, is retired agricultural land and as such does not contain the constituent elements necessary to support CFPOs.

4.2.5.4 Population Level Effects

The City HCP planning area is subject to ongoing residential and commercial development pressures, capital improvements, and State, local, and private actions. Many individual developments will occur on parcels with no federal nexus and, consequently, will not require Section 7 ESA consultations. Within City of Tucson, the proposed covered activities would contribute to an overall loss of CFPO habitat (up to 8,594 acres [3,478 hectares], or 98 percent of suitable habitat, not including any net increases in habitat along the Santa Cruz River) and could lead to further fragmentation of movement corridors. Though most of the proposed residential development in the Southlands would probably be medium to high intensity (at least 4 homes per acre), this level of development would likely not result in population level impacts to CFPO given the absence of breeding habitat in that area and limited current use of the area for dispersal.

It is unlikely that there would be direct take of a CFPO due to implementation of covered activities in the City HCP planning area. However, the potential loss of all Critical Habitat and modeled suitable habitat within the Avra Valley planning sub-area could reduce the maximum number of breeding pairs in southern Arizona primarily through fragmentation of potential dispersal habitat. Habitat on lands in the Avra Valley planning sub-area and Santa Cruz River planning sub-area provides connectivity between breeding areas.

City land holdings within proposed Critical Habitat in the southern Avra Valley are located in the Black and Brawley washes floodplains, which are considered potential habitat connectivity corridors for CFPO. If water development projects on these properties occur in a manner that is not conducive to CFPO movement, the linkage between habitat to the north and south could be impaired. There is evidence, though limited, that CFPO periodically move through Avra Valley, though not necessarily on City of Tucson lands.

4.3 Pima Pineapple Cactus (*Coryphantha scheeri* var. *robustispina*)

4.3.1 Population Status And Ecology

4.3.1.1 Range And Distribution

The Pima pineapple cactus is one of several named varieties of *Coryphantha scheeri* or *C. robustispina,* not all of which are currently recognized. Taxonomy of the entity variously known as *Coryphantha scheeri* or *C. robustispina* and all of its varieties is in a state of uncertainty at present. In this document, the name "*Coryphantha scheeri* var. *robustispina*" and Pima pineapple cactus (PPC) will be used, and the entity will be treated herein as a distinct variety.

The species occurs from the southwestern United States (Arizona, New Mexico, and Texas) into central Mexico (Sonora and Chihuahua, and possibly Coahuila and Nuevo León), with the putative varieties allegedly having distinct but partially overlapping distributions (RECON 2002, Schmalzel et al. 2004). PPC is found primarily in southeastern Arizona, but is also known to occur in north-central Sonora, Mexico (AGFD 2001, USFWS 1993). Within Arizona, PPC is found in Pima and Santa Cruz counties (Figure 4.3-1). The distribution of PPC is roughly horseshoe-shaped; extending from the Arizona/Mexico border north through Altar Valley to the south end of the Avra Valley, across the San Xavier District of the Tohono O'odham Nation and the Southlands planning sub-area, and then south down the Santa Cruz Valley, through the Santa Rita Experimental Range and the communities of Sahuarita, Green Valley, Amado, and Tubac (see Figure 4.3-1).

4.3.1.2 Taxonomic Distinctness

PPC is currently undergoing a status review based on taxonomic issues. Most recent authors agree that the correct species name should be *Coryphantha robustispina*, and the controversy lies in the number of varieties of the species. There are two opposite opinions that have been advanced by different authors recently. Baker (2004) reviewed and evaluated the taxonomic relationships within the putative entity, and stated (p.1): "Nomenclature within *Coryphantha* (Engelm.) Lemaire, section *Robustispina* Dicht & A. Luuthy is confusing." He included a table (reproduced here as Table 4.3-1) that illustrates the state of confusion.

Baker (2004) conducted a phenetic analysis, measuring and comparing ten stem characteristics in 447 individuals of four entities in 14 populations. His conclusion was that "data indicated that populations of *C. robustispina* ssp. *scheeri* represent a separate taxon and possibly a distinct species." He presented a great deal of data and statistical analysis that support this conclusion (Baker 2004, 2005b).

The opposite view is taken by Schmalzel et al. (2004). They assessed the infraspecific taxa of the species based on analysis of 16 morphological vegetative characteristics measured from 67 herbarium specimens, 279 live specimens from Pima and Santa Cruz counties, and small numbers of other live individuals from other locations. They found a great deal of variation in characters, some suggesting clinal variations. They concluded (p. 553): "morphological intergadation occurs across the east-west range of this species, indicating that neither varietal nor subspecific divisions are warranted at this time." Their data and analysis lead to the conclusion that the PPC is not a valid taxonomic entity and does not meet the definition of "species" as defined in the ESA. They encourage USFWS to reconsider the listing status of the cactus. The matter is currently under review, and the outcome is uncertain.

4.3.1.2 Population Status And Threats

Population Status. PPC is difficult to locate except through intensive foot surveys and, as a result, the number of individuals in Arizona in not known. Surveys of PPC in Arizona occurred as early as 1935; however, more intensive survey efforts did not begin until 1991 (USFWS 2004b). To date, the number of PPC located through surveys has been conservatively estimated to be approximately 3,800 individuals. Of this number, 58 percent (2,203 individuals) are known to have either been removed and transplanted to a new site or lost through observed or authorized mortality. This figure, however, does not include an estimate of the number of individuals removed from private land or lost as a result of projects that were not subject to Section 7 ESA consultation (USFWS 2004b).

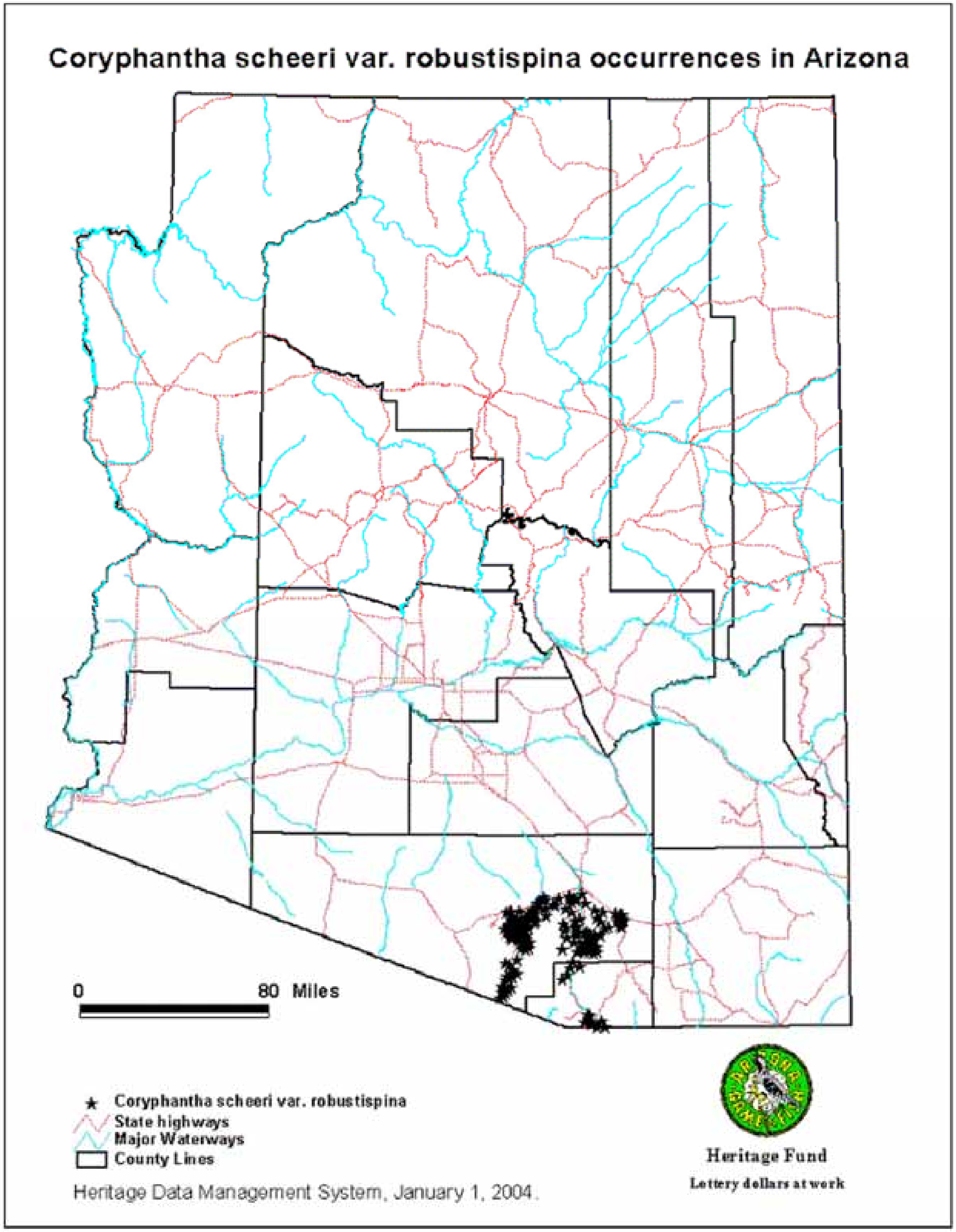

Figure 4.3-1. Distribution Map of Pima Pineapple Cactus in Arizona; Based on Locations Reported in the Heritage Data Management System. Source: Arizona Game and Fish Department website (http://www.gf.state.az.us/w_c/edits/images/glaubrca.gif).

Table 4.3-1 Cross-Reference of Classifications for *Coryphantha robustispina* (from Baker 2004)

Taylor (1998)	C. robustispina ssp. robustispina	*C. robustispina* ssp. *uncinata*	*C. robustispina* ssp. *scheeri*
Anderson (2001)	Same as Taylor	Same as Taylor but defines this ssp. as having only "strongly curved or hooked spines"	Same as Taylor
Benson (1982), Bravo-Hollis (1991)	*C. scheeri* var. *robustispina*	*C. scheeri* var. *valida* and *C. scheeri* var. *uncinata*	C. scheeri var. scheeri
Dicht & Lüüthy (2001)	Same as Taylor	*C. robustispina* ssp. *scheeri*	C. robustispina ssp. scheeri
Britton & Rose (1920)	*C. robustispina*	*C. muehlenpfordtii*	*C. muehlenpfordtii*
New Mexico Rare Plant Technical Council (1999)	Not discussed	*C. scheeri* var. *valida*	*C. scheeri* var. *scheeri*

The range of PPC in Arizona is approximately 45 miles (72 kilometers) east to west and 50 miles (80 kilometers) north to south. This 2,250-square-mile (5,828-square-kilometer) area, however, includes extensive areas that are not suitable habitat for the cactus, such as locations above 4,700 feet (1,433 meters) elevation, riparian areas, and lands that have been heavily impacted by humans (USFWS 1993; USFWS 2004b). The total area of suitable habitat is thought to be between 280,000 and 570,000 acres (113,312 and 230,671 hectares), of which 56,730 acres (22,958 hectares, from 10 to 20 percent) has been surveyed for PPC (USFWS 2004b).

Although a portion of this surveyed area involved 100 percent pedestrian coverage, some locations were only partially surveyed and this sub-sample was used to estimate PPC densities over the entire property (USFWS 2004b). Across its range, PPC has a clumped and widely dispersed pattern of distribution, with observed densities ranging from 0.05 to 3 plants per acre (0.02 to 1.2 per hectare). As a result, it is not possible to estimate the current population size using density estimates.

Arizona Population and Threats. PPC was listed as endangered in 1993. The threats noted as the basis of the listing included illegal collection, habitat degradation due to recreation, historical and present overuse of habitat by livestock, and habitat loss and fragmentation due to mining, agriculture, road construction, urbanization, and range management practices to increase livestock forage (USFWS 1993). Critical Habitat has not been designated for this species (USFWS 2004a).

Ninety percent of potential PPC habitat is Tribal, State, or privately owned. Only 10 percent of potential habitat is held in Federal ownership, and these lands tend to occur as scattered parcels or along the periphery of the cactus' range (USFWS 2004b). Between 1987 and 2000, nearly 43 percent (approximately 24,429 acres or 9,886 hectares) of known PPC habitat, i.e., habitat that has been surveyed for PPC, was lost to projects that underwent Section 7 ESA review. A number of other housing developments have occurred in Pima County, south of Tucson, that were not evaluated under Section 7 ESA but were known to have impacted several hundred acres of PPC habitat (USFWS 2004b). The majority of documented habitat loss has occurred within the Santa Cruz Valley from south of Tucson to Amado. It is estimated that as much as 75 percent of the species' range is threatened by urban development (USFWS 1993).

In addition to urban development, PPC habitat has been lost to mining and agriculture. Although conversion of habitat for agriculture is probably no longer a significant threat, mining expansion continues to result in the loss of known habitat and PPC individuals.

All currently undisturbed PPC habitats are subject to livestock grazing with many areas experiencing severe grazing, especially during the 1980s (USFWS 1993). Severe grazing can damage PPC habitat through accelerated erosion; impacts to local hydrology and microclimate; exotic species invasion; and changes in the density, relative abundance, and vigor of native species, including shifts toward higher densities or abundances of woody perennials. There is some indication that livestock grazing can also impact PPC through trampling of individuals. Range management practices such as ripping, imprinting, and seeding of exotic species are detrimental to PPC (USFWS 1993).

4.3.2 Ecology

4.3.2.1 Life History

PPC is a succulent perennial. Flower buds appear on plants during mid-May (RECON 2002). The flowers bloom during the summer monsoon season, with rains of as little as 3 millimeters (0.12 inches) triggering the onset of flowering, typically in early July (USFWS 2004a, USFWS 1993). Flowering begins within five to seven days after the first monsoon rains, with individual flowers blooming for single-day periods once to three times during each year. Flowering typically ends by late August (USFWS 2004a).

PPC have been successfully self-pollinated in the laboratory; however, significantly more seeds are produced from cross-pollination. Self-pollination is unlikely *in situ* (USFWS 2004a), to the extent that the species could be considered an obligate outcrosser (AGFD 2001). It is speculated that at least some seeds drop from the mother plant, land at the plant base, and then germinate, forming clusters of smaller PPC (RECON 2005). Potential pollinators of PPC include ground-nesting native bees (*Diadasia* spp.), European honeybees (USFWS 2004a), and other native invertebrates (RECON 2005). Recent research indicates that *Diadasia* bees are the most important pollinators of the plant. These bees, which are known to nest in urban areas, pollinate a diverse range of cacti species (barrel cactus, cholla, and prickly pear). Although specific soil requirements for the bees are not known, it is believed that widespread use of diverse cactus species within urban landscaping could help maintain the corridor between PPC individuals and known populations (RECON 2005).

Following successful pollination, fruits mature within two weeks. Germination has been observed during the summer rainy season (USFWS 2004a). Fruits are succulent and sweet and consumption of the fruit by ground squirrels, jackrabbits, and some birds has been documented (USFWS 1993). These and other species may distribute the relatively large, up to 2 millimeter (0.08 inch), seeds in their droppings (RECON 2005). However, it is not currently known what the long-distance dispersal mechanisms are for this species (Desert Botanical Garden 1999, RECON 2002). Specific corridor needs are also unknown, but dispersal corridors may be needed for the species to establish new populations. Clusters of cacti indicate that some seeds may fall from and germinate at the base of the mother plant (RECON 2002).

Roller (1996) found that the PPC sampled in her study produced an average of seven flowers per year. Between 41 and 82 percent of flowers achieved fruit set (mean is 71 percent), with an average of 5 fruits and 89 seeds (range of 24 to 131) per plant (Roller 1996).

The survival rates of naturally occurring PPC are not well known. Roller (1996) found that, in laboratory and shade house experiments, nearly 90 percent of 160 planted seeds germinated, with about two-thirds of the total plantings becoming established, and a combined 47 percent remaining viable at the end of the first year.

4.3.2.2 Habitat Requirements

In general, the vegetation communities that provide PPC habitat are Semidesert Grassland, Arizona Upland Subdivision of the Sonoran Desertscrub, and the ecotone between the two. The cactus occurs at elevations between 2,360 and 4,700 feet (720 and 1,434 meters), along the ridges of alluvial bajadas and on slopes of less than 10 percent (USFWS 2004c). PPC prefers deep, rocky loam alluvial soils, but occurs on a wide range of soil types from shallow to deep soils and from silty to rocky soils (USFWS 2004c, USFWS 1993). On a smaller scale, the cactus prefers relatively flat and sparsely vegetated areas (USFWS 1993).

The cactus is typically found in areas that are dominated by whitethorn acacia, velvet mesquite, snakeweed (*Gutierrezia microcephala*), triangle-leaf bursage, other cacti, and various grass species. Although PPC prefers open grassland areas, it is not found in association with dense grass cover (RECON 2002).

PPC have been found in a wide variety of environments, occurring fairly regularly even in those areas considered marginal for the species. It can be found in areas of disturbance such as overgrazed grasslands in association with kangaroo rat mounds (RECON 2002). Although riparian areas are considered unsuitable for PPC, it regularly occurs along wash edges and has even occasionally been found in areas of significant sheet flow (M. Falk, USFWS, pers. comm.).

4.3.3 Baseline Conditions

4.3.3.1 City of Tucson Population Status

The population status within the City HCP planning area is unknown. A range of estimates exists for the entire population of the species, but few areas, including the City's planning area, have been intensively surveyed. Results from surveys in the vicinity of the City's planning area provide some indication of the relative densities at which PPC may occur in the area.

In 2000, the Arizona Department of Administration (ADA) underwent a Section 7 ESA consultation with the USFWS regarding potential impacts of a prison expansion on PPC. The prison expansion occurred on land in unincorporated Pima County, immediately adjacent to the Southlands planning sub-area. In the Biological Opinion for this project, it was noted that the 1,920-acre (777-hectare) project area contained an estimated 1,295 acres (524 hectares) of suitable habitat, about two-thirds of the overall site. Surveys of the project area found 68 PPC, a density of approximately one cactus per 19 acres (7.7 hectares) of suitable habitat, or 0.05 cacti per acre (USFWS 2000b).

Another project, the New Tucson development located approximately two miles south of the Southlands planning sub-area in Corona de Tucson, resulted in the loss of 50 acres (20.2 hectares) of suitable habitat. A total of 272 cacti were found in pre-construction surveys, which equates to a density of 5.4 plants per acre (2.2 per hectare) in the impacted area. Another 191 PPC were found within 16 acres (6.5 hectares) of suitable habitat that is on the Corona de Tucson site, but outside of the proposed project impact area. These cacti, which may be negatively impacted by the adjacent development, occurred at a density of 11.9 cacti per acre (4.8 per hectare). The overall density of PPC within the project area, both developed and undeveloped portions, was slightly more than seven per acre (USFWS 2004c). At the time of the Biological Opinion, this was the highest known density of PPC, exceeding the previous highest density of 3.5 per acre (1.4 per hectare) found in a site less than 0.5 miles north of the New Tucson project (USFWS 2004c). Since then, the Mirasol development, which impacted 128 acres (52 hectares), an unknown amount of which was suitable PPC habitat, has resulted in a higher density estimate. Attempts to identify suitable habitat based on surficial geology led to an estimation of 3.2 acres (1.3 hectares) of suitable habitat, 2.5 percent of the overall project area. Based on this estimation, suitable habitat on the site contained 19 cacti per acre (7.6 per hectare) (USFWS 2004a).

Another project, located two miles south of the Southlands planning sub-area and several miles west of Corona de Tucson, is the Santa Rita Mountain Ranch development. A total of 268 PPC were detected during surveys of the 1,597-acre (646-hectare) property, for a density of approximately one cactus per six acres (USFWS 2003c). According to USFWS, this density is considered moderate for the species, with densities less than 0.09 plants per acre (about 1 PPC per 11 acres) being considered low. Densities above 0.31 per acre (about 1 cactus per 3 acres [1.2 hectares]) are considered high for this species (USFWS 2003c).

The Asarco Mine complex is located nearly a mile west of the Southlands planning sub-area, west of I-19. Between 1998 and 2002, Asarco initiated projects that resulted in the loss of almost 950 acres (384.5 hectares) of potentially suitable PPC habitat. A survey of the combined project areas resulted in the detection of 306 live and 61 dead PPC, for a moderate density of 0.22 plants per acre (one plant per 4.5 acres or 1.8 hectares) (USFWS 2002a). On the east side of the interstate, about four miles west of the Southlands planning sub-area, 41 cacti were located on an 80-acre (32-hectare) property. This site, at more than two cacti per acre, had a relatively high density of plants (USFWS 2000a).

4.3.3.2 Habitat in and Near the City of Tucson

Two different approaches have been used to delineate potential habitat for PPC:

- The Sonoran Desert Conservation Plan habitat model, and
- The City of Tucson Habitat Conservation Plan PPC habitat model.

Sonoran Desert Conservation Plan Habitat Model. A habitat model for the PPC was developed as part of the SDCP (RECON 2002). This habitat model consisted of the following four primary variables:

- Vegetation
- Slope
- Elevation
- Landform

The habitat potential of the categories of each variable were ranked as 0, 1, 2, and 3, with 0 indicating that the category provided no habitat and 3 indicating that the category provided high potential habitat. The four variables were combined to provide an overall habitat potential. Table 4.3-2 shows the specific categories of the variables considered to provide habitat for the PPC and their habitat potential ratings. Using this habitat model, the City HCP planning area supports about 881 acres (357 hectares) of high potential habitat and 32,890 acres (13,310 hectares) of medium potential habitat for PPC, all located within the Southlands planning sub-area (Figure 4.3-2).

City of Tucson Habitat Model. The SDCP model did not differentiate between riparian and upland areas in assessing suitability for PPC, even though the cactus is a recognized upland species. As a result, 100 percent of the Southlands planning sub-area was mapped as potential habitat under the SDCP. A more refined model would allow the City to better set priorities for conservation by distinguishing between areas or better and poorer quality within the planning area. A revised potential habitat model for PPC was developed in coordination with Mima Falk (plant ecologist, USFWS) and consisted of differentiating between potentially suitable upland habitat and areas where PPC are

Table 4.3-2. Value Ratings for Characteristics of the Variables Used in the SDCP Pima Pineapple Cactus Habitat Model

Variable/Category	Value Rating
Vegetation	
Madrean Evergreen Forest and Woodland Encinal (oak) (123.31)	1
Madrean Evergreen Forest and Woodland Xero-riparian Encinal (oak) (123.31XR)	1
Interior Chaparral Mixed Evergreen Sclerophyll (133.36)	1
Scrub-Grassland (Semidesert Grassland) Mixed Grass-Scrub (143.15)	3
Scrub-Grassland (Semidesert Grassland) Scrub-Shrub Disclimax (143.16)	1
Scrub-Grassland (Semidesert Grassland) Xero-riparian biome (143.10XR)	3
Scrub-Grassland (Semidesert Grassland) Xero-riparian Scrub-Shrub Disclimax (143.16XR)	2
Scrub-Grassland (Semidesert Grassland) Urban Mixed Grass-Scrub (143.15U)	2
Chihuahuan Desertscrub Mixed-Scrub (152.26)	2
Sonoran Desertscrub Creosote-Bursage (154.11)	2
Sonoran Desertscrub Paloverde-Mixed Cacti (154.12)	2
Sonoran Desertscrub Agave-Bursage (154.15)	2
Sonoran Desertscrub Xero-riparian biome (154.10XR)	2
Sonoran Desertscrub Xero-riparian Creosote-Bursage (154.11XR)	2
Sonoran Desertscrub Xero-riparian Paloverde-Mixed Cacti (154.12XR)	2
Sonoran Desertscrub Urban Paloverde-Mixed Cacti (154.12U)	1
Sonoran Riparian and Oasis Forests Mesquite (224.52)	2
Sonoran Riparian and Oasis Forests Urban Mesquite (224.52U)	1
Slope	
0–2 %	3
2–5 %	3
5–10 %	1
10–15 %	1
Elevation	
601–800 m	2
801–1,000 m	2
1,001–1,200 m	2
1,201–1,400 m	2
1,401 m and above	MASK
Land Form	
Non-dissected bajadas and fans	2
Hills with low relief	2

Source: Recon (2002) Priority Vulnerable Species Analysis and Review of Species Proposed for Coverage by the Multiple Species Conservation Plan.

unlikely to occur. These areas delineated as unsuitable were derived from the Harris Riparian Vegetation map developed as part of the SDCP. All areas identified as riparian in the Harris data set, with the exception of large areas of potential sheet flow indicated as Sonoran Desertscrub. To verify the Harris Riparian Vegetation map, it was compared with the composite vegetation layer developed by Pima County, also as part of the SDCP. Areas that were considered riparian in the Harris model, but were not categorized as such in the composite vegetation map were field verified to determine whether they should be included in as riparian habitat.

The areas mapped as riparian in Harris, but not in the SDCP vegetation composite layer, included areas of both suitable and unsuitable habitat. There also does appear to be some areas of unsuitable habitat that are not captured by the riparian map. Given the difficulty of delineating areas from the field or using orthophotos, the Harris vegetation layer was used without modification. Based on this model, 25,598 acres (10,359 hectares) of potential PPC habitat is predicted to occur in the Tucson planning area; all of it within the Southlands sub-area.

2005 PPC Surveys. During the summer of 2005, Dr. Marc Baker conducted PPC surveys in the Southlands planning sub-area using random, or semi-random, transects (Baker 2005a). The results were used to validate and/or refine the PPC potential habitat model. The primary objective of his study was to estimate the geographic distribution and relative density of PPC within the Southlands planning sub-area, which is approximately 34,546 acres (13,818 hectares) or 54 square miles (140 square kilometers) in size. Prior to surveys, Baker delineated “higher density” habitat polygons based on known occurrences and similarity of habitat to that at occupied sites. These polygons were intended to capture those areas with conditions likely to promote higher densities of PPC than in surrounding potential habitat. Known occurrences were taken from the AGFD Heritage Data Management System and from a previous study for AGFD (Baker 2005a). These polygons encompassed 34 percent (11,569 acres or 4,682 hectares) of the Southlands planning sub-area. Half of the survey transects were located within these polygons, the other half were outside but in close proximity to the polygons. Transects averaged slightly more than one kilometer long and approximately 20 meters (66 feet) wide. The transects were designed to maximize the chance of locating populations, but were not intended to locate 100 percent of the individuals that might occur within a given area. In addition to conducting pedestrian transects, Baker recorded all individuals seen along vehicle transect routes. All individuals were recorded as a GPS point (waypoint) using UTM coordinates (NAD27, zone 12).

Baker recorded a total of 92 PPC. Thirty-five individuals were recorded along PPC pedestrian transects, 19 along PPC vehicle transects, and 38 along pedestrian routes surveyed primarily for needle-spined pineapple cactus (NSPC). Of the 35 individuals recorded along PPC pedestrian transects, 30 (86 percent) occurred within predicted “higher density” PPC habitat; the remaining five (14 percent) occurred outside of predicted “higher density” habitat. Similarly, of the 19 individuals recorded along vehicle routes, 16 (84 percent) occurred within predicted “higher density” PPC habitat and three (16 percent) occurred outside of predicted “higher density” PPC habitat. A greater percentage (37 percent) of the individuals recorded along other pedestrian routes occurred outside of predicted “higher density” PPC habitat. All individuals with the exception of two were within 300 meters (984 feet) of predicted “higher density” PPC habitat (Baker 2005a).

Baker’s results suggest that more densely populated areas of PPC habitat can be predicted with a fair level of accuracy, except in the southeastern portion of the Southlands planning sub-area in the vicinity of NSPC transects. Based on data from Baker’s surveys, an additional 4,356 acres (1,763 hectares) of potential “higher density” PPC habitat were added to the original 11,569 acres (4,682 hectares) of potential “higher density” PPC habitat originally delineated in the Southlands. As a result of the study, Baker predicted that approximately 15,616 acres (6,320 hectares, 61 percent) of the potential PPC habitat in the Southlands planning sub-area should be modeled as potential “higher density” habitat (Baker 2005a). Of the total Southlands planning sub-area, three-quarters of modeled potential PPC habitat and approximately 46 percent exhibits some indication of supporting higher PPC densities. Figure 4.3-2 shows the refined PPC habitat model for the Southlands.

4.3.3.3 Importance of Tucson In Species' Range And Ecology

The Green Valley area is the center of the PPC's distribution and is known to support the highest densities of cacti. Two other significant population centers are Altar valley and the Southlands planning sub-area. Only about 10 percent of the species' distribution occurs on Federal land, with the largest contiguous area being the Buenos Aires National Wildlife Refuge, an area that is on the fringe of the species' range and has lower plant densities (USFWS 2004b).

The natural distribution of this species has been fragmented as a result of land clearing for urban and suburban development and associated infrastructure, including roads, powerline rights-of-way, etc. The extent of habitat fragmentation has been poorly documented, in part because the historic and current distributions of the species have been poorly documented. The majority of documented PPC habitat loss has occurred in the Santa Cruz Valley, from south of Tucson through Amado. This area, which also includes the rapidly developing communities of Sahuarita and Green Valley and the Asarco Mine complex, still contains areas of suitable habitat that supports dense populations and evidence of recruitment (USFWS 2004b). As a result of past habitat loss and the continuing threat of urban development and mine expansion, this area appears to be critically important to the conservation of the species. Also, because the mechanisms of pollination and seed distribution are not well known, it is uncertain whether these activities may disrupt gene flow and long-term population survival.

The Southlands planning sub-area represents an important segment of the overall range of PPC in Arizona. Therefore, loss of the Southlands population could result in reduced pollination rates, lower reproductive output, and a decrease in gene flow among other populations, which could have a significant long-term effect on the species survival.

4.3.4 Threats and Management Needs

4.3.4.1 Potential Threats and Stressors

It is estimated that as much as 75 percent of the species' range is threatened by urban development (USFWS 1993). In addition to urban development, PPC habitat has been lost to mining and agriculture. Although conversion of habitat for agriculture is probably no longer a significant threat, mining expansion continues to result in the loss of known habitat and PPC individuals. Severe grazing can damage PPC habitat through accelerated erosion; impacts to local hydrology and microclimate; exotic species invasion; and changes in the density, relative abundance, and vigor of native species, including shifts toward higher densities or abundances of woody perennials. There also is some indication that livestock grazing can impact PPC through trampling of individuals.

The Southlands planning sub-area is one of three existing population centers for this species; the other two are Altar Valley and the area along Ajo Road southwest of Tucson. Genetic isolation of these populations, resulting from increased fragmentation and a reduction in pollinator visits, is considered a serious threat to this species. See Table 4.3-3 for a complete list and discussion of stressors and threats to Pima pineapple cactus.

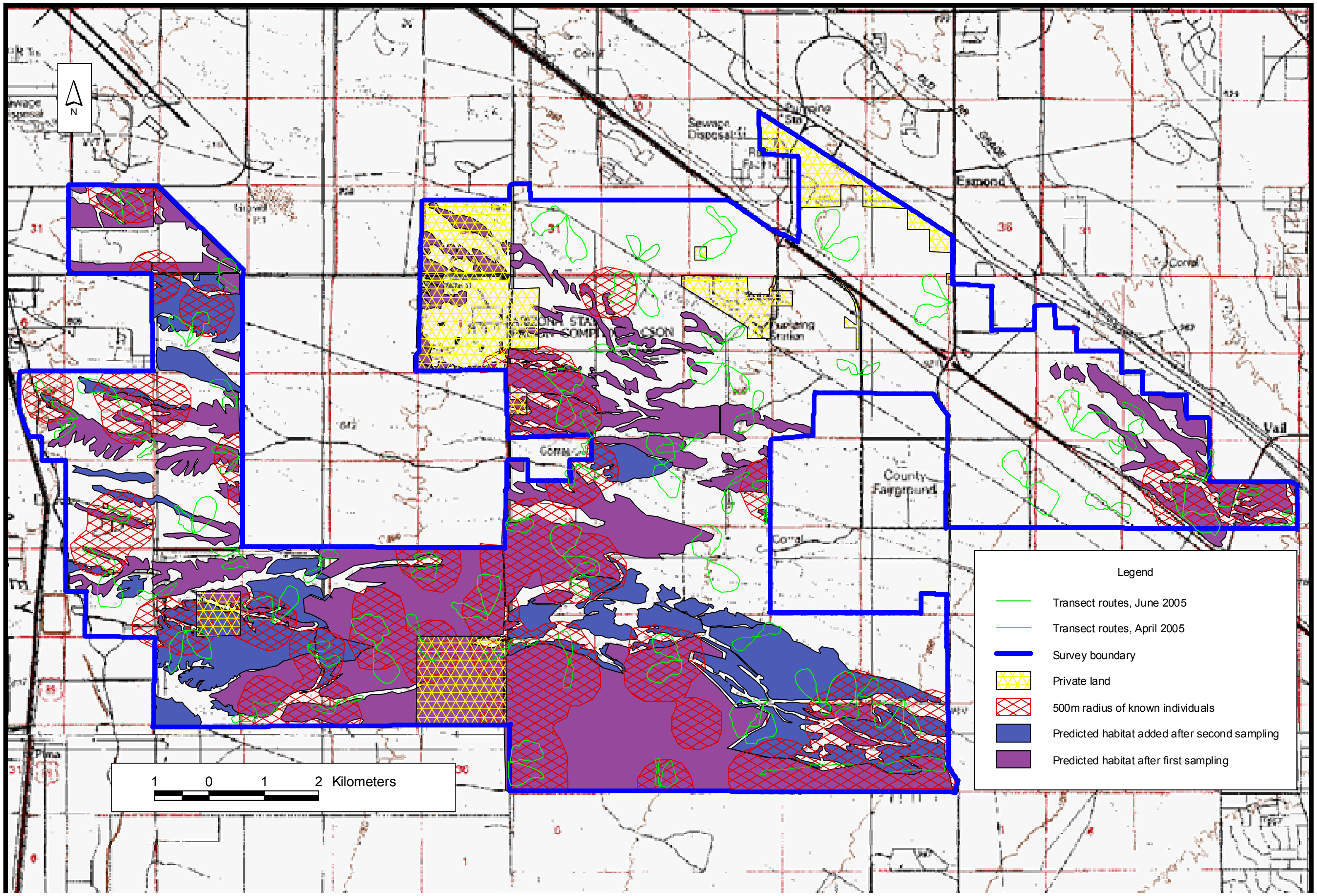

Figure 4.3-2. City of Tucson "high density" Pima Pineapple Cactus Potential Suitable habitat for the Southlands Planning Sub-area including Original and Revised Polygons of Predicted Occurrence, Transect Tracks, and Areas within 500 Meters (1,640 feet) of Recorded Individuals (Baker 2005a).

Table 4.3-3. Potential and Current Threats and Stressors for Pima Pineapple Cactus

Stressor/Threat	Relevance to Species
Habitat Loss	
Urban Growth	Loss of habitat through urbanization is the primary threat to this species. Suitable habitat consists of more than just the areas inhabited by individual plants; it also includes sufficient areas of suitable habitat for the species to expand or shift in response to environmental factors. It may be possible, based on habitat preferences and historic distribution, to rate areas based on potential to support future populations, including presence of oxidized or gravelly soils, absence of rocky soils and outcrops, elevation, distance to nearest known or historic population, and presence of other cactus species. The Southlands planning sub-area is one of three existing population centers for this species; the other two being Altar Valley and the area along Ajo Road southwest of Tucson.
Fire threat	The impacts of fire on this species are not well understood, but thought to be negative. Fire loads in the Southlands planning sub-area are fairly low and, thus, this threat is not as significant as in Altar Valley.
Habitat Alteration	
Vegetation composition/density	Natural succession of vegetation communities toward higher grass and shrub densities could reduce cactus densities.
Nurse plant availability	Not known to be associated with nurse plants; 10 percent or fewer of individuals are found in the shade of other plants.
Invasive plant species	Non-native grasses (e.g., buffelgrass), particularly at high densities, are thought to reduce plant densities. Invasives may also increase risk of fire, which may be detrimental to individual cacti.
Invasive animal species	Individual plants may be trampled by cows and horses.
Habitat rehabilitation potential	Habitat rehabilitation potential is considered high for this cactus; however, critical factors to restore or enhance to increase suitability for cactus are unknown.
Drought	Can have a negative, and potentially severe, impact on cactus populations.
Flood	Inundation can result in mortality of cacti. Floodplains are poor habitat, although areas of sheet flow are not entirely unsuitable.
Artificial water sources	Irrigation could provide a real benefit to cactus, especially during droughts. Water should be supplemented during rainy season and only when rain is limited.
Edge effects	There is anecdotal evidence that this cactus does well along roadsides. Although the reasons for this are unclear, it may be linked to potential deterrence of predators or increased water availability. This species also seems to do fairly well in areas with limited disturbance, which may be related to reduced competition with other plants. Roads, however, encourage invasive plant species that may have negative impact on cactus.
Land use history	The significance of land use history for this cactus relates to whether the seed bank is still present in the soil. Grazing may potentially have some benefit to the extent that grass and shrub densities are reduced. Cactus can recover from the impacts of prior land uses, but only over very long periods of time.
Species Characteristics	
Colonization potential	The presence of a seed bank is critical for colonization by this species.
Captive breeding/ translocation potential	Although transplantation of this cactus has been done, the success of these transplantations has not been adequately evaluated and is questionable.
Genetic isolation	Genetic isolation is considered a serious issue in some portions of the species range: north of Ajo between Three Points and Casino del Sol and south of the Southlands planning sub-area. The population along the I-19 corridor is considered the most imperiled.

Table 4.3-3. Potential and Current Threats and Stressors for Pima Pineapple Cactus, continued

Stressor/Threat	Relevance to Species
Species Characteristics, continued	
Inbreeding	Does not appear to self-pollinate.
Breadth of resource use	This can be found in a wide range of areas, including many that would seem to unsuitable, albeit at very low densities.
Interspecific Factors	
Predation	Rodents, grasshoppers, and the larvae of several insect species, are known to feed on this cactus. Areas with high densities of cacti may be especially susceptible.
Disease	This cactus is susceptible to infection. Although the source of the infection is unknown, it could be bacterial or related to larval invasion.
Pollinators/seed dispersers	Seed dispersers are not known, but may include jackrabbits and birds. Not highly specialized with respect to pollinators. Pollinator visits decrease dramatically as distance between cacti exceeds 1 km.
Competition	This cactus is found at lower densities in areas with dense grasses.
Anthropogenic Factors	
Off-road vehicles	PPC are run over fairly frequently by ORVs. ORV disturbance may also encourage invasive plant species, which may have negative impact on cactus.
Mining	Copper mining as resulted in the direct loss of large numbers of plants, and in serious impacts to the seed bank.
Passive recreation	People moving off of trails may expose cacti to potential disturbance, trampling, or risk of collection.
Collection/hunting	Collection of this cactus is a problem; it is highly valued by collectors in Germany and Japan.
Insecticides	Not highly specialized with respect to pollinators. Non-target insecticides may be a problem.
Direct take/mortality	Mortality is primarily associated with loss of habitat and collection.
Landscaping	The impact on this cactus of using non-native species as landscaping is unknown, but generally is thought to be a risk. Although this cactus can be used in landscaping, this is not a replacement for preservation of the species in its native habitat. Use for landscaping, however, could provide connectivity between isolated reserves for pollinators, which tend to be limited to distances of no more than 1 km between plants.
Increased road density	Results in loss of habitat.
Connectivity	
Fragmentation	Fragmentation of habitat at a relatively large scale (> 1 kilometer or 0.6 mile gaps) is thought to dramatically reduce the ability of pollinators to reach these cacti. Reduced pollination rates impact reproductive output and decrease gene flow between populations. Patch size is also important to allow for shifts in location of cacti in response to environmental factors.
Wash incision	If gradual, was incision may provide habitat for this cactus; typically headcuts result in loss of habitat.
Habitat patchiness	From a landscape perspective, a mosaic of habitat types and locations is desirable, as long as individual reserves are not isolated. Minimum patch size is not known.

4.3.4.2 Current Management Recommendations

A preliminary Recovery Plan for PPC was drafted in March 2001, but has not yet been released for public review (RECON 2002). AGFD (2001) included the following management recommendations in an abstract on the species:

- Improved livestock management;
- Education regarding Arizona Native Plant Law and cacti theft;
- Surveys to better delineate the range, particularly in Mexico;
- Studies to determine if transplantation as a mitigation measure is successful;
- Demographic monitoring to determine if “populations” are stable; and
- Identification and establishment of preserves large enough to sustain viable populations.

4.3.5 Potential Impacts of Tucson’s Proposed Activities

4.3.5.1 Direct Effects

Construction activities (e.g., grading and other land disturbance) for new residential, commercial, and industrial development and supporting infrastructure would result in the direct loss of PPC. Some cacti may be preserved in place within developments; however, biologists question the value of protecting individual plants in small areas isolated from one another because there is little opportunity for gene flow. Transplantation of cacti is also a questionable strategy. Transplanted individuals exhibit low survival rates, in those rare instances where survival has been monitored, and successful reproduction in transplanted cacti has not been documented, although it may occur. Even though data are limited, transplantation does not appear to contribute to the long-term conservation of the species (USFWS 2004b).

4.3.5.2 Indirect Effects

Urban development in and around PPC habitat also results in greater human access to plants, increasing the threat of collection, unintentional disturbance, and vandalism. The introduction of exotic plant species, such as fountain grass, buffelgrass, Lehman’s lovegrass, and red brome, which often accompanies urbanization, can increase the risk of wildfires and interspecific competition. Invasive species may out compete PPC for space and resources or may render open areas vulnerable to wildfires that could potentially result in mortality of cacti. Urban development may also adversely impact pollinators and seed dispersers either by removing the resources needed for their survival or by supporting introduced competitors, predators, parasites, and diseases.

4.3.5.3 Potential Habitat Changes in Tucson

Planned residential and commercial development and capital improvement projects could directly impact all suitable habitat in the Southlands planning sub-area, through permanent habitat loss and fragmentation.

Previous land use concepts, although not currently supported, have called for high intensity development through out the Southlands planning sub-area. This level of high intensity use would result in loss of upland vegetation and promote long-term and frequent disturbance of any remaining habitat as a result of the proximity to an urban environment.

The City's NPPO requires developers to preserve on site a certain percentage of individual plants of specific species. Currently, the NPPO requires on-site protection, either through preservation-in-place or transplanting-on-site, of 100 percent of PPC, 50 percent of saguaros, and 30 percent of other cacti.

As an alternate approach, developers can leave undisturbed 30 percent of the site as compliance with the NPPO, although 100 percent preservation of PPC on-site is still required. Many developers choose the later route, especially when riparian habitat is present on site. Since the NPPO provides only broad guidance as to which 30 percent of a site should be protected, and since PPC can be "preserved" through transplanting, developers can technically move all PPC on a site into wash areas that will protected as open space. This scenario presents several problems with respect to long-term preservation of PPC within developments. First, as noted above, transplantation of cacti is also a questionable strategy. Transplanted individuals exhibit low survival rates, in those rare instances where survival has been monitored, and successful reproduction in transplanted cacti has not been documented, although it may occur. Even though data are limited, transplantation does not appear to contribute to the long-term conservation of the species. Second, as PPC is an upland species, transplanting individuals into wash areas can greatly reduce the potential for long-term survival of those plants. Finally, the NPPO does not regulate the size, placement, or configuration of open space. PPC are obligate out-crossers that rely on pollination by bee species that are thought to travel no more than 2,000 or 2,500 feet (610 or 762 meters) between plants. If transplanted cacti are located in small, isolated patches, it can greatly reduce the likelihood of visitation by pollinators.

Another complication is that developers get double credit for each PPC measuring four inches (10 centimeters) or greater in height or diameter that is preserved-in-place. In this scenario, one-half of the PPC could be preserved-in-place, but there are no guidelines in the NPPO regarding the size and quality of the area in which they are preserved. Technically, just the individual plants can be preserved, with no protection of surrounding vegetation, and their location can end up being integrated into resident's yards, public spaces, or anywhere else within the development. As noted above, long-term persistence of plants is likely to be negatively impacts if cacti are preserved in isolation from each other and other cacti. Preserving cacti in place, but allowing them to be interspersed within the development also increases the likelihood that they will be damaged or destroyed at a later time through collection, unintentional disturbance, or vandalism.

As a result, for purposes of the impact analysis in the HCP, we are assuming a worst-case scenario and, at this point in time, it is possible for urban development under the current regulatory environment to impact 100 percent of the modeled potential PPC habitat within the Southlands.

4.3.5.4 Population Level Effects

The Southlands planning sub-area represents an important portion of the roughly horseshoe-shaped range of the species in Arizona. The loss of this population could impede gene flow to adjacent populations, which could have significant long-term effects on the species' continued survival. These effects may take several generations to appear.

4.4 Western Burrowing Owl (*Athene cunicularia hypugaea*)

4.4.1 Population Distribution, Taxonomy, and Status

4.4.1.1 Range and Distribution

Breeding. The western burrowing owl (*Athene cunicularia hypugaea*) has a breeding range that extends from southern Canada, east to western Minnesota and eastern Texas, and south into Baja California and central Mexico. All of Arizona is considered to be within the current breeding range for the western burrowing owl (burrowing owl). The historical breeding range includes portions or all of 19 western states, although Minnesota and Iowa are no longer considered to fall within the current breeding range of this owl. It has been extirpated from approximately eight percent of its historical breeding range over the past 10 to 15 years (Klute et al. 2003).

Burrowing owls have been reported from 14 of 15 Arizona counties with breeding confirmed in 12 counties (Brown 2001b). Currently, the two major breeding populations in Arizona are in the Tucson area and Yuma areas (Brown 2001a). In Pima County, burrowing owls were reported in five USGS quadrangles between 1993 and 1999: Childs Mountain, Cat Mountain, Palo Verde Camp, Tucson SW, and West of Marana (Arizona Breeding Bird Atlas 2000). Within Tucson, most burrowing owls are concentrated at Davis-Monthan Air Force Base (AFB) and along the west branch of the Santa Cruz River (Estabrook and Mannan 1998).

Wintering. Arizona also supports wintering burrowing owls (deVos 1998). Little is known about the winter range of the subspecies due to a limited number of banding recoveries. The species regularly winters in Mexico, including Baja California, and Central America south to El Salvador, and may occasionally occur as far south as western Panama. Christmas Bird Counts in the U.S. have reported wintering owls in Arizona, California, New Mexico, Oregon, and Texas. The subspecies is also known to winter in more northern states, including Oklahoma, Kansas, and Nevada, although in low abundance (Klute et al. 2003).

Migration. The routes and timing of burrowing owl migration are not well known. The owls head north during March and April, appearing in Canada during the first week in May. Most of the owls that breed in Canada and the northern U.S. are thought to migrate south between September and October. Banded owls have been tracked from British Columbia, Washington, Oregon, and California south along the Pacific coast. Owls breeding in Alberta, Saskatchewan, Manitoba, Montana, and North Dakota have been tracked moving through Nebraska and Kansas and then settling in Texas. Banded owls from Wyoming, South Dakota, Nebraska Colorado, Kansas, and Oklahoma wintered in Arkansas, Oklahoma, Texas, and Mexico. It is thought that birds from North and South Dakota migrate to Texas for the winter (Klute et al. 2003).

Seasonal movements by burrowing owls that breed or winter in Arizona are unclear. Owls from Canada and the northern United States may winter in southern Arizona or migrate through this area on their way to over-wintering areas in Mexico (James and Ethier 1989). Owls that breed in northern Arizona are thought to migrate in winter, while in other portions of the state, owls may be year-round residents (Phillips et al. 1964, Brown 2001b). In the Tucson area, it appears that some burrowing owls are year-round residents while others are migratory (Estabrook and Mannan 1998). Ellis et al. (2004) concluded that year-round residents compose a relatively large portion of the burrowing owls breeding in urban Tucson. Recent studies indicate that less than 40 percent of the burrowing owls present in Arizona during the summer spend the winter in Arizona (Brown and Mannan 2002). Following two years of surveys, Conway and Ellis (2004) found that 12 to 15 percent of juveniles and 28 to 40 percent of adults (40 to 56 percent of males and 17 to 29 percent of females) that lived on Davis-Monthan AFB were non-migratory. Of adults occupying habitat along washes, fewer were migratory, with 54 to 61 percent of adults (39 to 56 percent of males and 55 to 81 percent of females) that were found during the breeding season also detected during the winter. The percentage of juveniles occupying wash habitat that were migratory (2.5 to 20 percent) was similar to that for Davis-Monthan AFB (Conway and Ellis 2004a). This study did not document any movement of birds between Tucson and agricultural areas near Casa Grande and Coolidge (Conway and Ellis 2004a). Ellis et al. (2004) did not find any evidence to suggest that migratory owls arrive from elsewhere and spend the winter in Tucson. Mark Ogonowski (University of Arizona) is currently conducting a study to determine the migratory status of burrowing owls in southern Arizona and to evaluate factors that my influence winter residency.

4.4.1.2 Taxonomic Uniqueness

Two subspecies of burrowing owl are currently recognized in North America by the American Ornithologists' Union, the western burrowing owl and the Florida burrowing owl *(Athene cunicularia floridana)* (AOU 1957). *S. c. hypugaea* is the only subspecies of burrowing owl found in Arizona. The second subspecies, *S. c. floridana*, inhabits prairies of central and southern Florida. In this document, burrowing owl refers to the western burrowing owl only.

4.4.1.3 Population Status and Threats

Range-wide Population Status and Threats. The burrowing owl has declined in abundance throughout most of its range (Haug et al. 1993). In the western states, 54 percent of 24 jurisdictions reported decreasing burrowing owl populations; there were no reported increases (Haug et al. 1993, James and Espie 1997). Local populations of this species are especially prone to extinction (Haug et al. 1993). Only limited data exists on population sizes and trends in the United States. Based on surveys of state biologists, James and Espie (1997) estimated that there are between 20,000 and 200,000 western burrowing owls in the U.S.

A large proportion of the western population of burrowing owl occurs in California (TNC 1999), which is also the state for which the owl population status and trend is best known. DeSante et al. (In Press) estimated that there are 9,266 pairs of burrowing owls in California, 95 percent of which live in the Imperial and Central valleys (Klute et al. 2003). Surveys conducted over the past 15 years show that the number of breeding groups in California has decreased by 23 to 52 percent and the number of breeding pairs has fallen by 12 to 27 percent (DeSante et al. 1997 *in* Klute et al. 2003). During the 1980s and 1990s, 60 percent of the known breeding groups in the Imperial Valley disappeared (Barclay et al. 1998, DeSante et al. 1997), and surveys in the Central Valley and the San Francisco area show a decline of 52 percent in the number of breeding groups (DeSante et al. 1997). Santa Clara County has seen a loss of 60 percent of known owl locations due to development. The owl has also been extirpated in four coastal counties (DeSante et al. 1997) and is expected to be extirpated in some areas of central California in the near future (Holroyd and Wellicome 1997).

Of the 19 U.S. states in which the western burrowing owl occurs, it is listed as Threatened or Endangered in two states, as a Species of Concern in seven states, and as vulnerable in an additional seven states.The burrowing owl has been petitioned for state listing in California, where it is currently considered a Species of Concern. The subspecies is also listed as threatened or endangered in four provinces in Canada and is listed as a federally threatened species in Mexico. Throughout its range, the owl is considered secure in only three U.S. states (Klute et al. 2003).

Burrowing owls have declined through much of their range because of habitat loss associated with urbanization, agricultural conversion, and rodent control programs (Johnsgard 1988). Fragmentation of existing habitat also poses a risk to owl populations. Fragmentation of habitat may result in reduced opportunities for unpaired owls to find mates, increased predator populations and vulnerability to predation, higher mortality rates among dispersing fledglings, and increased home range sizes (Klute et al. 2003; TNC 1999). When there is a shortage of suitable habitat, owls may occupy the highest quality sites rather than the largest and least fragmented sites. This can lead to crowding at smaller sites, which results in increased foraging competition, reduced reproduction, and higher rates of nest abandonment (TNC 1999).

Rodent control programs have resulted in the incidental poisoning of burrowing owls as well as the direct destruction of their burrows (Collins 1979, Zarn 1974). Eradication efforts on black-tailed prairie dogs (*Cynomys ludovicianus*) have also resulted in the loss of burrowing owls, as well as having created a level of fragmentation and colony isolation that hampers recolonization of eradicated areas (Benedict et al. 1996, Desmond et al. 2000 *in* Klute et al. 2003). Within one to three years of being abandoned, prairie dog colonies cease to provide suitable habitat for burrowing owls (Butts 1973 *in* Klute et al. 2003). Survival and reproductive success can also be adversely affected if insecticides are sprayed at or near nesting colonies (James and Fox 1987).

Although burrowing owls are relatively tolerant of human activity, there are human-related impacts, such as shooting and burrow destruction, that adversely affect the owls (Zarn 1974, Haug et al. 1993). The tendency of these owls to fly low to the ground makes vehicle strikes a significant threat to the species (Klute et al. 2003). Other human activities, such as grazing, mowing, and burning, however, can improve the quality of existing habitat or create new burrowing owl habitat (Klute et al. 2003). The species is also adversely affected by the artificial enhancement (e.g., availability of artificial food sources and shelter) of native predator populations, species such as gray foxes (*Urocyon cinereoargenteus*) and coyotes, and by the introduction of non-native predators, such as red foxes (*Vulpes vulpes*), domestic cats (*Felis domesticus*), and dogs (*Canis lupus*), near burrowing owl colonies (see e.g. Milsap 2002). Although there are no known significant direct threats to burrowing owls from diseases, outbreaks of sylvatic plague among prairie dog colonies can reduce the available habitat for burrowing owls (Kulte et al. 2003).

Arizona Population Status and Threats. The burrowing owl is widely distributed but generally uncommon in Arizona (Brown 2001b) (Figure 4.4-1). Population data appear to be inconsistent and unreliable, with widely different estimates being made by different investigators at different times and using different techniques. James and Espie (1997) estimated the burrowing owl population in Arizona at between 100 and 1,000 birds, although this estimate was based on questionnaires rather than a systematic survey. In 1998, an effort was undertaken to create a statewide database of known burrowing owl locations based on interviews with wildlife biologists and birders (Brown 2001b). According to these interviews, a total of 206 reported sites, representing 281 owl locations, were identified in Arizona; 164 of which were later visually surveyed (Brown and Mannan 2002). Breeding-season surveys in 2001 resulted in the detection of burrowing owls at 17.7 percent (29 locations) of the surveyed sites. Burrowing owls were found at an additional four locations outside of the established survey sites. Thirty-two of the resulting 33 occupied sites were resurveyed the following winter (Brown and Mannan 2002). Statewide, only 89 adults and 19 young were found during the breeding season and 16 owls were located when the 164 sites were resurveyed the following winter.

The breeding range of the burrowing owl in Arizona appears to be have been relatively stable in the 1990s (Arizona Breeding Bird Atlas 2000). Currently, there are two major breeding populations in Arizona, one in the Tucson area at Davis-Monthan AFB and along the floodplain of the Santa Cruz River West Branch (Estabrook and Mannan 1998) and one in the Yuma area where high numbers of burrowing owls have been reported along the irrigation canals. Casa Grande Ruins National Monument and surrounding agricultural areas support a small population of burrowing owls (Conway and Ellis 2004b). The breeding population in Tucson typically supports 80 to 110 active burrows with the numbers varying seasonally and annually (Estabrook and Mannan 1998). The size of the population in Yuma has not been estimated. Six nests were reported in the Phoenix Metropolitan Area in 1994, three in 1995, and five to six in 1996 (Brown 2001a). Dozens of burrowing owls have been relocated to the Tucson area from urban development sites around Phoenix. AGFD surveys for burrowing owls in 2003 and 2004 found 1,072 burrowing owls (including dispersal locations) and 58 active burrows in the Tucson basin (Figure 4.4-2). These surveys have been restricted primarily to Davis-Monthan AFB, portions of the main channel and west branch of the Santa Cruz River, and in and around Marana, primarily west of I-10. The location of artificial burrow installations and owl relocations is shown in Figure 4.4-3 and the number of artificial burrows installed and number of owls released at each site is presented in Table 4.4-1. These artificial burrows were installed between January 2004 and January 2005 and owls were released between March and September 2004.

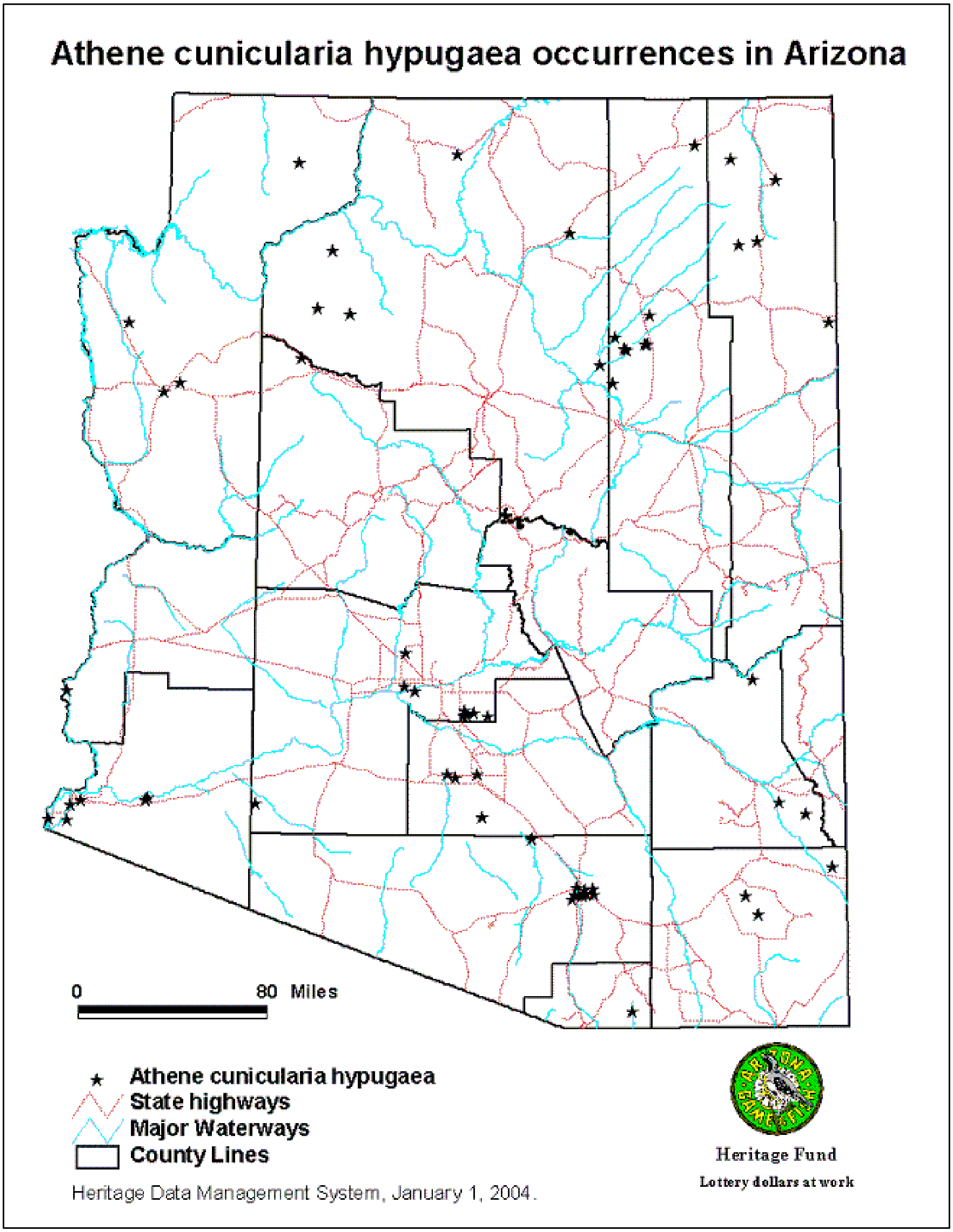

Figure 4.4-1. Distribution Map of Burrowing Owls in Arizona; Based on Locations Reported in the Heritage Data Management System. Source: Arizona Game and Fish Department Website (http://www.gf.state.az.us/ w_c/edits/images/athecuhy.gif)

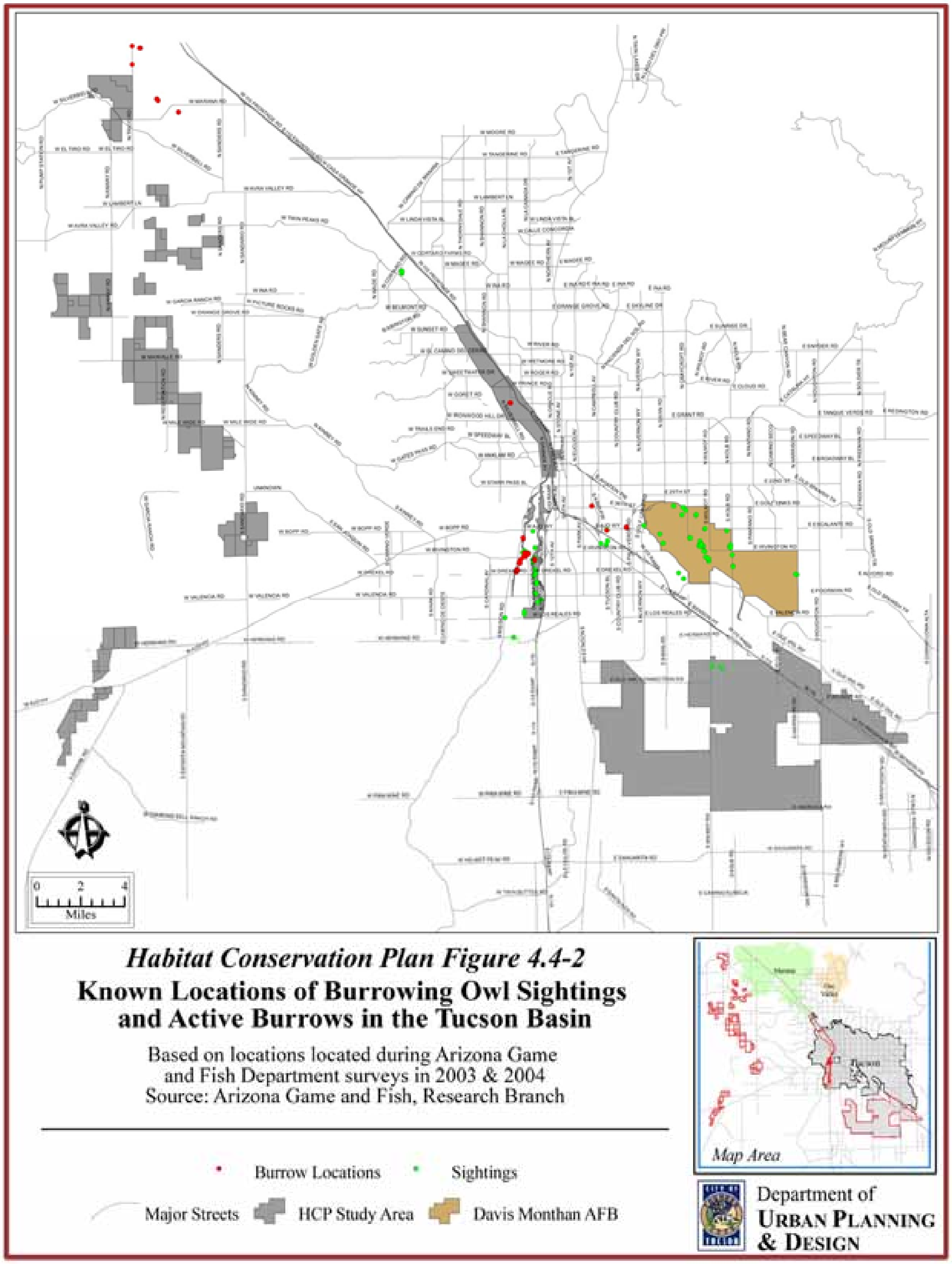

Figure 4.4-2. Known Locations of Burrowing Owl Sightings and Active Burrows in the Tucson Basin; Based on Sites Located during Arizona Game and Fish Department Surveys in 2003 and 2004. Source: Arizona Game and Fish Department, Research Branch.

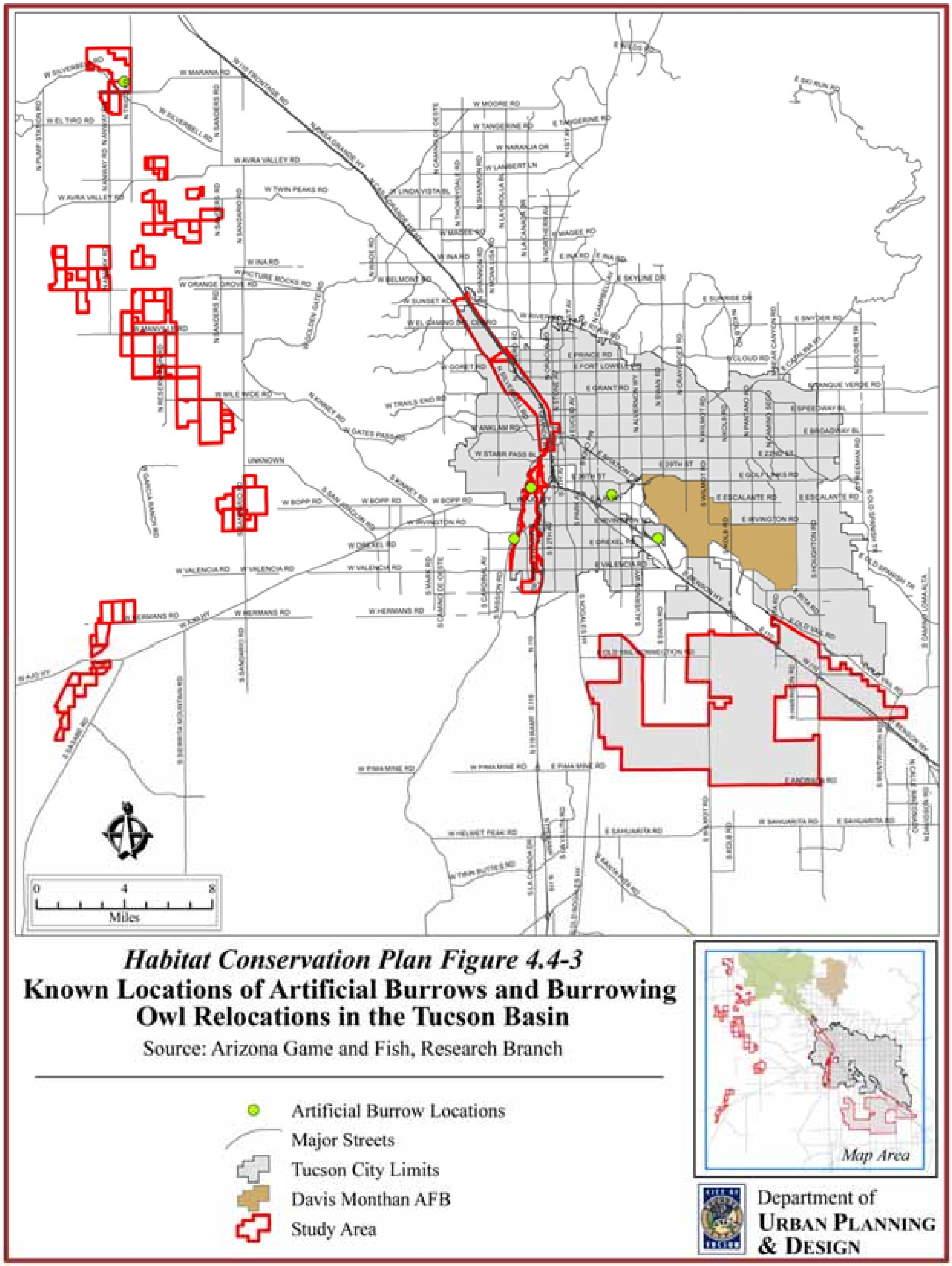

Figure 4.4-3. Known Locations of Artificial Burrows and Burrowing Owl Relocations in the Tucson Basin. Source: Arizona Game and Fish Department, Research Branch.

Table 4.4-1. Number of Artificial Burrows Installed and Number of Burrowing Owls Released at Each Artificial Burrow Site in the Tucson Area

Site Name	Number of Artificial Burrows	Numbers of Owls Released
Santa Cruz West Branch – Mission Road	4	0
Simpson Farm	32	6
Ajo Retention Basin	32	16
Cottonwood Lane	32	20
Tucson Electric Power-Irvington	64	52
Cochise AEPCO	32	0
Total	**196**	**94**

Source: Arizona Game and Fish Department, Research Branch

No data are available yet on the number of owls that stayed and wintered at the release sites or returned after wintering elsewhere.

Burrowing owls are believed to have declined in abundance in Arizona (Brown 2001b, James and Espie 1997) principally as a result of the decline in the population of Gunnison's prairie dog (*Cynomys gunnisoni*) in northern Arizona and the extirpation of black-tailed prairie dog in southeastern Arizona (Brown 2001a). Loss of habitat resulting from shrub encroachment also has contributed to declines in parts of Arizona (Brown 2001a). Grazing practices and prairie dog control programs likely have encouraged shrub encroachment (Brown 2001a).

Brown (2001a) identified the following threats to burrowing owls in Arizona:

- Reduced habitat availability because of prairie dog and ground squirrel control programs,
- Bubonic plague indirectly limiting habitat availability through effects to prairie dogs and ground squirrels,
- Conversion and urban development of natural habitat and agricultural lands,
- Overgrazing of rangelands resulting in a more woody species composition and destruction of burrows,
- Reduction of prey,
- Maintenance programs of agricultural irrigation and water resources canals destroying burrows,
- Urbanization increasing the risk of contracting *Trichomoniasis* from doves,
- Urbanization increasing predation by domestic and/or feral animals and the potential for vehicle strikes,
- Reduction in prairie dog and ground squirrel populations may increase predation on burrowing owls, and
- Agricultural pesticides.

4.4.2 Ecology

4.4.2.1 Life History

Breeding and Reproductive Success. The burrowing owl often lives in colonies with many pairs nesting in close proximity. They are monogamous and generally produce one brood per season. Not all individuals capable of breeding do so every year. Breeding is initiated in early March (Terres 1980), although in California courtship may begin as early as late December (Thomsen 1971 in Klute et al. 2003). Eggs are laid from late March to July (Terres 1980) and clutch size averages 6.5 eggs, with a range of 4 to 12 eggs (Haug et al. 1993 in Klute et al. 2003). In Tucson, nests on Davis-Monthan AFB had an average clutch size of 7.6 eggs and nests along washes averaged 6.6 eggs. Nests in agricultural areas near Casa Grande and Coolidge had mean clutch sizes of 8.8 eggs (Conway and Ellis 2004a). If a female's first clutch is lost, she may re-nest, although this has not often been documented (Haug et al. 1993).

Young are born altricial and fledge in late summer to fall (Coulombe 1971). Young owls are capable of running and foraging at four weeks and can make sustained flights by six weeks of age. Beginning when the chicks are 3 to 4 weeks of age, burrowing owl families often change burrows every 10 to 15 days until the young begin to disperse in early fall, usually moving to nearby burrows (Klute et al. 2003). Moving the chicks to satellite burrows and the use of dung, in some areas, to line burrow entrances are both thought to reduce the risk of predation (TNC 1999).

Hatching success has been reported to range from about 90 percent in Idaho to about 55 percent in California. Fledging success has ranged from 2.9 to 4.9 young per successful nest (Haug et al. 1993). Reproductive success can differ depending on the nesting location and environment and, in particular, may be reduced by limited prey availability (CDOW 2003). Burrowing owls in New Mexico that nested in human-altered environments produced an average of 3.3 nestlings and 2.6 fledglings, while nests in natural environments resulted in an average of 1.1 nestlings and 0.7 fledglings (Bothelo and Arrowood 1996 in Klute et al. 2003).

In Tucson, Estabrook and Mannan (1998) found that 62.5 percent of 72 nests studied were successful and 16.7 percent failed. The outcome of the remaining 20.1 percent was unknown. Between these 72 nests, a total of 67 nestlings were produced, 57 of which survived past fledging. This study found that nests in open areas on Davis-Monthan AFB averaged three nestlings and 2.4 fledglings per nest, compared to 2.4 nestlings and 2.1 fledglings per nest from burrows along the main channel and West Branch of the Santa Cruz River (Estabrook and Mannan 1998).

In 2002 and 2003, Conway and Ellis (2004a) surveyed burrowing owl nests on the Davis-Monthan AFB, along several washes in Tucson, including the Santa Cruz River, and in agricultural fields near Casa Grande and Coolidge. This study found that 49.5 percent of 208 established nest sites produced one or more offspring. Success rates were highest in wash areas (67 percent), lowest on Davis-Monthan AFB (40 percent), and intermediate in agricultural areas (55 percent). Among nests in open flat areas on Davis-Monthan AFB, 41.7 percent of nests that produced young had at least one confirmed fledgling disperse. Although fledgling dispersals could not be confirmed at most of the nests along washes and in agricultural areas, the two nests at each site for which data could be collected had at least one confirmed fledgling dispersal. The minimum confirmed fledging rates at Davis-Monthan AFB, along washes, and in agricultural areas averaged 3.0, 2.2, and 3.0 young per nest, respectively (Conway and Ellis 2004a).

Nest failures on Davis-Monthan AFB were attributed to predation (31 percent), abandonment with no evidence of adult mortality (31 percent), burrow collapse (11.9 percent), vehicle-caused collapse (2.4 percent; 1 nest), and unknown causes (23.8 percent). Of the three nests that were confirmed as failing along surveyed washes, the failures were attributed, one in each case, to monsoon flooding, nest abandonment with no observed adult mortality, and unknown reasons. Nest failures in agricultural areas were found to be caused by predation (40 percent), burrow collapse due to vehicles (40 percent), and abandonment (10 percent) (Conway and Ellis 2004a).

Diet and Foraging. Burrowing owls are opportunistic feeders whose diets largely reflect prey availability (CDOW 2003). They primarily eat arthropods, small mammals, birds, amphibians, and reptiles, with seasonal shifts in the relative amounts of each type of item consumed. Owls typically consume more vertebrate prey during the winter, with arthropods, especially large insects like beetles, grasshoppers, and crickets, playing a larger role in their diet during summer (Haug et al. 1993, Johnsgard 1988). Among the mammals eaten by burrowing owls are mice, rats, ground squirrels, gophers, young prairie dogs, cottontails, and even bats. Birds are sometimes taken (Johnsgard 1988). During the summer in Arizona, predominant prey items in pellets from burrowing owls were scorpion, beetles, locusts, and small rodents (Haug et al. 1993).

Burrowing owls have been reported foraging in agricultural areas (both active and fallow fields), along roads and ditches, and in native grassland and pastures (Gervais et al. 2000, CDOW 2003). Burrowing owls, when suitable alternatives are present, seem to limit their utilization of cultivated areas for foraging (Haug and Oliphant 1990). Owls also seem to prefer foraging where vegetation heights are greater than one meter, avoiding areas with vegetation less than one meter tall (Wellicome 1994, CDOW 2003). During the breeding season, owls actively forage for invertebrates during the day and for rodents at night (CDOW 2003). When foraging for invertebrates, burrowing owls tend to remain near the nest burrow (TNC 1999).

Mortality and Predation. Little is know about the average life span or rates of mortality among burrowing owls. The longest documented life span for a burrowing owl was 8 years, 8 months (Anderson et al. 2001 *in* CDOW 2003). Annual survival rates, calculated based on return rates of adult banded birds to breeding sites, were estimated to be at least 29 to 58 percent (Haug et al. 1993). Annual survival rates for a non-migratory population in California were 81 percent for adult owls and 30 percent for juveniles (Thomsen 1971 *in* CDOW 2003). In Oklahoma, annual mortality rates have been estimated at 62 percent (Butts 1973 *in* Klute et al. 2003). Adult females in Saskatchewan were found to have a higher annual survival rate (62 percent) than adult males and juveniles, 48 and 45 percent respectively (Clayton and Schmutz 1997 *in* CDOW 2003). Common predators of burrowing owls are badgers, bobcats, weasels, skunks, coyotes, domestic cats and dogs, snakes, and raptors such as Swainson's, ferruginous (*Buteo regalis*), Cooper's, and red-tailed hawks (*Buteo jamaicensis*), northern harriers (*Circus cyaneus*), merlins (*Falco columbarius*), prairie (*Falco mexicanus*) and peregrine falcons (*Falco peregrinus*), great horned owls (*Bubo virginianus*), and American crows (*Corvus brachyrhynchos*) (Haug et al. 1993, Leupin and Low 2001 *in* Klute et al. 2003).

As part of a burrowing owl nest success study in Tucson, 17 dead adult owls were found during site surveys. On Davis-Monthan AFB, a car hit one owl, airplanes struck another three, a raptor killed one, and unknown causes were responsible for the death of two. Three dead owls were found along surveyed washes. Causes of mortality were from a vehicle strike, drowning, and unknown causes. In agricultural areas, mortality was documented from predation (two owls), collision with a vehicle (one owl), and unknown causes (one owl) (Conway and Ellis 2004a).

Site Fidelity and Juvenile Recruitment. This species exhibits moderate to high levels of site fidelity to general breeding locations, to specific nest sites (i.e. a prairie dog colony), and to particular nest burrows (Klute et al. 2003). Males are nearly three times as likely to return to a nest site than females and individuals are more than five times more likely to return if the previous year's nest was successful than if it was not (Pezzolesi 1994 *in* CDOW 2003). One study found that every male owl re-used the burrow it had occupied in the previous year, moving to a nearby burrow only if the original nest was destroyed (Martin 1973 *in* CDOW 2003). For adult owls in Colorado, the return rate to previously occupied burrows was 39 percent, with 66 percent returning to the overall breeding site (Plumpton and Lutz 1993 *in* CDOW 2003). In Idaho, burrows in rock outcrops were re-used more frequently than those in soil mounds (48.9 percent compared to 31.4 percent) and were more likely to be re-used in consecutive breeding seasons (31 percent were occupied in at least two consecutive years, versus 13.2 percent for burrows in soil mounds). The authors suggest that the greater re-use rates for burrows in rock outcrops may be tied to the greater stability of these sites and a lower likelihood of collapse than for soil burrows (Rich 1984 *in* Klute et al. 2003). Burrow re-occupancy rates range from 90 percent in Colorado to 17 percent in east Wyoming (Klute et al. 2003).

In Tucson, Conway and Ellis (2004a) found that 63 percent of banded adult burrowing owls found on Davis-Monthan AFB were re-sighted the next year and 77 percent of birds that nested along surveyed washes returned in the following year. One hundred percent of the owls identified in 2002 that returned to Tucson in 2003, returned to the same environment (Davis-Monthan AFB versus Tucson washes) they had occupied the previous year. Fifty-one percent of those birds returned to the same burrow they had used in the previous year, with burrow fidelity the same at Davis-Monthan AFB (50 percent) and along washes (51 percent) (Conway and Ellis 2004a). Return rates for males was the same for surveyed washes and Davis-Monthan AFB (80 and 81 percent, respectively), but females were much more likely to return for a second year along the washes (73 percent) than to Davis-Monthan AFB (47 percent).

Conway and Ellis (2004a) found that 17 percent of Davis-Monthan AFB juveniles and 28 percent of young from burrows along washes returned in 2003 to the site they had occupied during the previous breeding season.

4.4.2.2 Habitat Requirements

Breeding Habitat. Burrowing owls inhabit open areas, such as grasslands, pastures, coastal dunes, desert scrub, and the edges of agricultural fields. They also inhabit golf courses, airports, cemeteries, vacant lots, and road embankments (Haug et al. 1993). Habitat preferences include soils that are well drained and slightly sloping, a predominance of bare ground or sparse vegetation, and presence of mammal burrows or natural or man-made cavities (Klute et al. 2003). In Arizona, burrowing owls have been documented in Great Basin, Semidesert, and Plains Grasslands; Sonoran and Mojave Desertscrub; pinyon and Ponderosa pine habitats; riparian woodlands in the Lower Colorado River Valley; and urban, agricultural, rangeland, and vacant/barren areas (Klute et al. 2003).

Burrows are a critical habitat requirement for burrowing owls. Owls use burrows for nesting and also require access to alternate burrows to provide escape cover for adults and fledglings. Because they do not excavate their own burrows, burrowing owls are dependent on fossorial mammals such as badgers (*Taxidea taxus*), ground squirrels, and prairie dogs to create burrows. Owls have also been reported to use coyote, fox, woodchuck (*Marmota monax*), and tortoise burrows. Some of them have been listed previously, like the coyote I think, but not all of them) (TNC 1999). In Arizona, burrowing owls often inhabit areas supporting prairie dog (*Cynomys gunnisoni*) and round-tailed ground squirrel (*Spermophilus tereticaudus*) populations (deVos 1998, Brown 2001b). Burrowing owls on Casa Grande Ruins National Monument mostly were nesting in old ground squirrel burrows, followed by coyote burrows, badger burrows, and burrows of unknown origin (Conway and Ellis 2004b). These burrowing mammals usually inhabit open environments and create the burrows that the owls require as well as maintain vegetation at a short height (deVos 1998). If the number of natural burrows is limiting, owls may instead use natural cavities, such as rock and lava cavities (Klute et al. 2003), and man-made features, including drainage tiles, culverts, and rock piles. Conway and Ellis (2004b), for example, found that owls nesting in agricultural fields surrounding Casa Grande Ruins National Monument used primarily man-made structures (39 percent, n=56). At Davis-Monthan

AFB, owls typically nest in ground squirrel burrows or coyote dens (Ellis et al. 2004). Estabrook and Mannan (1998) stated that the burrowing owl distribution in Tucson is limited, at least in part, by insufficient burrow availability.

In the Tucson area, nearly all (97 percent) of the burrows used for breeding were in undeveloped areas that had been cleared of native vegetation (Estabrook and Mannan 1998). At 87.7 percent of these active burrows, bare ground was the predominant cover type. The dominant cover surrounding the remaining burrows was grass (62.5 percent), forbs (20.1 percent), shrubs (11.4 percent), and litter (6.0 percent). Overall, active burrow sites had significantly less visual obstruction by vegetation than nearby burrows that, although inactive, appeared to be potential nest sites (Estabrook and Mannan 1998).

In a statewide survey of known burrowing owl locations, Brown and Mannan (2002) identified micro-habitat and macro-habitat features surrounding active nesting sites. Active breeding burrows were predominately found in agricultural areas, particularly along irrigation canals, and among prairie dog towns (Tables 4.4-2 and 4.4-3).

Table 4.4-2. Percentage of Adult Burrowing Owls and Owl Pairs Found in Various Macro-habitat Types in Arizona

Habitat Type	Percent of Adult Owls	Percent of Owl Pairs
Agricultural	50.6	50.0
Great Basin Desertscrub	12.4	19.2
Semidesert Grassland	11.2	11.5
Urban	6.7	3.8
Rural	7.9	7.7
Residential	5.6	3.8
Plains Grassland	2.2	none
Pasture	2.2	3.8
Great Basin Grassland	1.1	none

Source: Brown and Mannan 2002

Table 4.4-3 Percentage of Adult Burrowing Owls and Owl Pairs Found in Various Micro-habitat Types in Arizona

Habitat Type	Percent of Adult Owls	Percent of Owl Pairs
Irrigation canal	42.7	53.8
Prairie dog town	20.2	26.9
Creosote/Sonoran Desertscrub	11.2	11.5
Canal/levee	6.7	3.8
Pasture	3.4	none
Great Basin Desertscrub	3.4	3.8
Nestbox/agricultural	3.4	3.8
Old prairie dog town	3.4	3.8
Plowed area (culvert)	2.2	none
Plains Grassland	1.1	none
Fallow field	1.1	none

Source: Brown and Mannan 2002

Another important factor in nest site suitability is the density of unoccupied burrows in the area. Nest burrows in central Saskatchewan had an average of six unoccupied burrows within 30 meters (98 feet) (Haug and Oliphant 1990). In western North Dakota, there were available burrows within 7.8 meters (25.6 feet), on average, of all nest burrows studied (Stockrahm 1995 *in* Dechant et al. 1999). Desmond and Savidge (1999) found that there were more available burrows within 75 meters (246 feet) of successful nests than around unsuccessful nest burrows. Burrowing owl families have been documented using up to ten satellite burrows (Dechant et al. 1999). Estabrook and Mannan (1998) found that, in Tucson, areas with many large burrows supported more owls than areas with fewer and/or smaller burrows.

Wintering Habitat. Less is known about the habitats utilized by burrowing owls for wintering. Some authors have reported that agricultural fields with culverts are used more heavily in some locations (Haug et al. 1993). Owls in Louisiana have been found to winter in dunes and beaches, in or near vegetation and woody debris, and in pastures and agricultural fields (Klute et al. 2003). In Nevada and Arizona, a large percentage of owls are non-migratory and use the same sites, and even the same burrows, in winter that they use during the breeding season (Hall et al. in review *in* Klute et al. 2003, Conway and Ellis 2004a).

Territory Size. Burrowing owl nesting densities appear to be affected by local burrow distribution, site size, and foraging habitat quality. Reported nesting densities are highly variable, ranging from one pair per 3.1 acres (1.25 ha) to one pair per 11,366 acres (4,546 ha) (Table 4.4-4).

Table 4.4-4. Density of Burrowing Owls in Various Areas

Location	Density (Acres/pair)	Reference
Lower Colorado River	3.1	Brown 1998 (in TNC 1999)
Bay Area, California	5.9	Trulio 1997
Oklahoma[a]	10.0	Zarn 1974
Minnesota	14.0	Grant 1965 (in Milsap and Bear 2000)
Imperial Valley, California	30.0	Rosenberg and Haley 2001
Florida	36.0	Milsap and Bear 2000
Imperial Valley, California	29.0–53.0	Coulombe 1971
Oklahoma[b]	11,366.0	Zarn 1974

[a] In prairie dog towns
[b] More than 1 mile from a prairie dog town

Burrowing owls maintain an exclusive area around their nest burrows (Haug et al 1993). Reported nearest neighbor distances are more consistent than nesting densities and range from 45 feet (14 meters) to 2,950 feet (900 meters) (Table 4.4-5). Assuming a circular nesting territory, reported nearest neighbor distances translate into nesting territories ranging from 0.04 acres to 156.8 acres (0.02 to 63.5 hectares) (see Table 4.4-5).

During the day, burrowing owls typically remain close to their burrows, foraging farther from the nest at night. Wellicome suggests that diurnal ranges can be used to estimate nesting area requirements and nocturnal activity provides a basis for determining foraging activity (pers. comm. *in* Dechant et al. 1999). Owls were found to have 8.6-acre (3.5 hectares) diurnal ranges in Wyoming (Thompson 1984 *in* CDOW 2003), 11.9 and 15.8-acre (4.8 and 6.4 hectares) ranges in Minnesota, and nest areas between 10 and 15 acres (4 to 6 hectares) in North Dakota (Grant 1965 *in* Denchant et al. 1990).

Table 4.4-5. Nearest Neighbor Distances between Burrowing Owl Nests

Location	Distance Feet (Meters)	Acres[d]	Reference
Texas	45 ft (14 m)	0.04	Ross 1974 (in CDOW 2003)
Oakland, California	197 ft (60 m)	0.7	Thomsen 1971
Nebraska	344 ft (105 m)[a]	2.1	Desmond et al. 1995
Oregon	361 ft (110 m)	2.3	Green and Anthony 1989
Nebraska	410 ft (125 m)[b]	3.0	Desmond et al. 1995
Saskatchewan	525 ft (160 m)	5.0	Haug 1985 (in Desmond et al. 1995)
New Mexico	545 ft (166 m)	5.4	Martin 1973
Imperial Valley, California	545 ft (166 m)	5.4	Rosenberg and Haley 2001
Florida	577 ft (176 m)	6.0	Milsap and Bear 2000
Nebraska	787 ft (240 m)[c]	11.1	Desmond et al. 1995
Idaho	2,950 ft (900 m)	156.8	Gleason 1978 (in CDOW 2003)
Median	**525 ft (160 m)**	**5.0**	

[a] Large prairie dog towns (≥35 ha)
[b] Small prairie dog towns (<35 ha)
[c] Badger burrows not in prairie dog towns
[d] Based on a circle with radius one-half the nearest neighbor distance

Nearest neighbor distances differ between successful and unsuccessful nests. Green and Anthony (1989 *in* CDOW 2003) found that if two active nests were within 60 meters (197 feet) of each other, both nests ended up being abandoned. In nearly half of the nest pairs, one nest was abandoned if the pair of nests was 60 to 110 meters (197 to 361 feet) apart. If the nests were more than 110 meters (361 feet) apart, one or more of the pair were abandoned in only 14 percent of cases (Green and Anthony 1989). On the other hand, colonial nesting among owls (i.e. nesting in clusters) has been documented (Ehrlich et al. 1988 *in* CDOW 2003). It is unknown whether owls become less territorial as a way of reducing the risk of predation (Anderson et al. 2001), or if this is simply a response to nest scarcity (Jones 1998). Desmond and Savidge (1996) found that in prairie dog colonies greater than 86 acres (35 hectares) in size, owls nested in clusters with burrows located, on average, 410 feet (125 meters) apart. Owl nests in smaller colonies (less than 86 acres in size) were randomly distributed throughout the colony at an average distance of 345 feet (105 meters) between burrows (Desmond and Savidge 1996).

Home range and foraging area may overlap between different pairs, with only the burrow being actively defended (Coulombe 1971, Johnsgard 1988). Little information is available on home range size and foraging distances for burrowing owls. Rosenberg and Haley (2001) found that burrowing owls typically foraged in areas close to burrows, with more than 80 percent of observations within 1,968 feet (600 meters) of burrows. This finding is similar to that of Haug and Oliphant (1990) who found 95 percent of telemetry points within this distance of a burrow. Depending on the method used to estimate home range size, average home range sizes range from 83 acres to 595 acres (33 to 238 hectares) (Table 4.4-6). Rosenberg and Haley (2001) reported that home ranges overlapped by about 30 percent.

Table 4.4-6. Home Range Sizes (Mean ± 1 Standard Deviation) of Burrowing Owls

Location	Size (acres)	Method	Reference
Imperial Valley, California	112±45	Fixed kernel	Rosenberg and Haley 2001
Imperial Valley, California	454±161	Adaptive kernel	Rosenberg and Haley 2001
Imperial Valley, California	281±75	MCP[a]	Rosenberg and Haley 2001
Saskatchewan	83±21	MCP	Sissons and Scalisi 2001
Saskatchewan	123±34	Adaptive kernel	Sissons and Scalisi 2001
Saskatchewan	595±170	MCP	Haug and Oliphant 1990
Imperial Valley, California	452	MCP	Gervais et al. 2000

[a] MCP – minimum convex polygon

4.4.3 Baseline Conditions

4.4.3.1 City of Tucson Population Status

Only a small portion of the City HCP planning area has been systematically surveyed for burrowing owls, although survey data exists for other areas in the Tucson Basin. Based on 1998 interviews of wildlife biologists and birders, a total of 206 burrowing owl locations were identified statewide; 164 were later visually surveyed (Brown and Mannan 2002). In Pima County, 35 burrowing owl locations were identified based on the interview information. Of these sites, 28 were surveyed in 2001, four only partially. A total of six owls were found at two sites during the breeding season and no owls were found at these locations during the winter survey (Brown and Mannan 2002). Of the two sites with documented owls, one was located inside the City limits; the second site was near the Pima/Pinal County line.

Estabrook and Mannan (1998) reported a 1997 survey of suitable habitat on and around Davis-Monthan AFB and a section of the Santa Cruz River and West Branch of the Santa Cruz River (the survey area extended from 36th Street and Golf Links Road south to Irvington Road and Valencia Road, and from Mission Road east to Camino Seco and Kolb Road). Additional surveys were conducted at the Tucson International Airport (TIA) and along the Santa Cruz River from Silverlake Road to the Rillito Creek confluence, the Rillito Creek east to 1st Avenue, and an undeveloped area located along Rillito Creek near the southeast corner of the Swan Road Bridge. A total of 67 active winter burrows and 72 active breeding burrows were found within the primary survey area. Thirty-nine percent of active burrows (both breeding and wintering) were found on Davis-Monthan AFB and 61 percent were located along the West Branch of the Santa Cruz River. Another three burrows were located at TIA and two burrows were found along the Santa Cruz River, one near ‘A’ Mountain and the other near the Silverbell Golf Course (Estabrook and Mannan 1998). Based on these surveys, Estabrook and Mannan (1998) estimated that, within the urbanized portion of the Tucson basin, there are 80 to 110 active burrows in any given year. The authors suggest that most of the active burrows in Tucson can be found either on Davis-Monthan AFB (30 to 40 burrows) or between the main channel and West Branch of the Santa Cruz River (50 to 60 burrows). Only 10 to 20 active burrows are thought to occur outside of the two primary areas, with these additional sites scattered throughout Tucson (Estabrook and Mannan 1998).

Conway and Ellis (2004a) conducted surveys for burrowing owls in 2002 and 2003 on Davis-Monthan AFB and along several washes in Tucson, including the Santa Cruz River. Forty-two and 74 burrowing owl nests were located on Davis-Monthan AFB in 2002 and 2003, respectively. In both years, 18 nests were found along surveyed portions of Tucson washes. At the Davis-Monthan AFB nest sites, 83 adults and 53 juveniles were located during the survey during 2002 and 148 adults and 180 young were found in 2003. Thirty-six adult owls were found along the surveyed washes in both years, with 38 juveniles located in 2002 and 55 young found in 2003. The total number of adult and juvenile birds found in the Tucson Basin during the breeding season was 210 (2002) and 419 (2003). Follow-up surveys during the winter found 37 and 83 owls on Davis-Monthan AFB during the 2002–2003 and 2003–2004 winters, respectively. During those same two time periods, 18 and 43 owls were located along surveyed washes (Conway and Ellis 2004a).

AGFD Research Branch conducted annual surveys for burrowing owls in 2003, 2004, and 2005. These surveys were conducted, for the most part, outside of the City HCP planning area. The 2003 surveys took place in and around the Town of Marana, and the 2004 surveys focused primarily on Davis-Monthan AFB and the main channel and west branch of the Santa Cruz River. The results of these surveys, relative to the City HCP planning sub-areas, are shown in Table 4.4-7. AGFD found 138 owls within the HCP planning area; 129 along the Santa Cruz River and 9 on the northern end of the Southlands planning sub-area. Within the planning sub-area, AGFD also found 22 active burrows, all along the Santa Cruz River (AGFD Research Branch pers. comm.). Excluding locations south of Sahuarita, the Southlands planning sub-area contains 12.9 percent of the owl locations and 37.9 percent of active burrows documented during AGFD's surveys.

Table 4.4-7. Known Locations of Burrowing Owl Sightings and Active Burrows in the Tucson Basin; Based on AGFD Surveys in 2003 and 2004

Location	Owl Records within the Specified Area	Owl Records Outside, but Adjacent to the Specified Area	Burrows within the Specified Area	Burrows Outside, but Adjacent to the Specified Area
Avra Valley planning sub-area	0	40	0	11
Santa Cruz River planning sub-area	129	137	22	20
Southlands planning sub-area	9	0	0	0
Davis-Monthan AFB[2]	63	28[1]	5	0
All records south of Sahuarita[2]	5	n/a	0	n/a
			Total owl records inside HCP planning area	**138**
			Total owl records outside HCP planning area	*934*
			Total active burrows inside HCP planning area	**22**
			Total active burrows outside HCP planning area	*36*

Source: AGFD, Research Branch
[1] Area roughly bounded by 36th Street (north), Irvington (south), Kino Parkway (west), and Palo Verde (west)
[2] Outside of City HCP planning area

Surveys in 2005 were again conducted at Davis-Monthan AFB. Results were reported as follows: 298 burrows and 119 owl detections (D. Grandmaison, AGFD, email). Burrow numbers are based on the number of burrows potentially suitable for use by burrowing owls based on size and depth. Owl detections are not intended to imply absolute numbers of individuals because the some individuals may have been detected at more than one burrow.

In 2006, AGFD Research Branch initiated systematic surveys of parcels within the Avra Valley planning sub-area. Beginning in January, researchers searched of properties along the Santa Cruz River in the northern portion of Avra Valley. The following information is being recorded during these searches: the locations (i.e., the UTM coordinate) of all burrows that could potentially provide a nest site for a burrowing owl (i.e., a burrow that is at least 8 centimeter [3.2 inches] in diameter and

1 meter [3.3 feet] in depth), and any sign of burrow excavating mammals (e.g., ground squirrels, badgers, coyotes, etc). At each potential burrow, biologists are recording any sign of burrowing owl activity and placing the burrow into one of the following three categories: (1) no evidence of previous use; (2) evidence of previous use, but use is not recent (e.g., old traces of feces and pellets, cobwebs or debris at tunnel entrance); (3) evidence of recent use (e.g., fresh feces, pellets, feathers, or nest decorations); and (4) owl observed.

Initial survey results within the Avra Valley planning sub-area suggest that some City-owned lands are more important to burrowing owls than previously thought (D. Abbate, AGFD Research Branch, pers. comm.). A total of 797 suitable burrows and 17 owls were detected as of January 19, 2006 (D. Grandmaison, AGFD, email). Of the 797 burrows, 120 (15 percent) showed evidence of previous use (Category 2), 35 (4 percent) showed evidence of recent use (Category 3), and owls were observed (Category 4) at 17 burrows (2 percent). During spring 2006, all burrows considered potentially suitable will be revisited by AGFD to determine how many of the sites are being use by burrowing owl for breeding. According to AGFD, the vast majority of burrows and owl detections on parcels within the Avra Valley planning sub-area, as of January 19, 2006, were from the Santa Cruz Farm property. Coyotes appear to have been the source of most of the suitable burrows recorded.

4.4.3.2 Habitat in and near the City of Tucson

Two different approaches have been used to delineate potential habitat for burrowing owl:

- The Sonoran Desert Conservation Plan habitat model, and
- The City of Tucson Habitat Conservation Plan burrowing owl habitat model.

Sonoran Desert Conservation Plan Habitat Model. A habitat model for the burrowing owl was developed as part of the SDCP (RECON 2002). This habitat model consisted of the following four primary variables:

- Vegetation
- Slope
- Elevation
- Landform

The habitat potential of the categories of each variable were ranked as 0, 1, 2, and 3, with 0 indicating that the category provided no habitat and 3 indicating that the category provided high potential habitat. The four variables were combined to provide an overall habitat potential. Table 4.4-8 shows the specific categories of the variables considered to provide habitat for the burrowing owl and their habitat potential ratings. Using this habitat model, the City HCP planning area supports about 44,688 acres (18,085 hectares) of high potential habitat and 15,759 acres (6,377 hectares) of medium potential habitat for burrowing owl (Figure 4.4-4).

Tucson Conservation Plan Burrowing Owl Habitat Model. Pima County did not differentiate between breeding and dispersal habitat in developing the SDCP suitable burrowing owl habitat model, even the owl has very specific and narrow breeding habitat requirements, but can make use of almost any habitat for dispersal. By capturing dispersal and breeding habitat in a single model, wide areas are viewed as "suitable" for burrowing owls, even though only a small fraction of that area may be suitable for breeding versus dispersal. As a result, almost all of the City HCP planning area was mapped as potential habitat under the SDCP. Since breeding habitat appears to be, by far, the more limiting factor, it was decided that the City burrowing owl habitat model would focus on breeding quality habitat, with the assumption that all other areas could be utilized by dispersing owls.

A more refined model would allow the City to appropriately focus their conservation efforts on the more limited breeding habitat for this species.

Table 4.4-8. Value Ratings for Characteristics of the Variables Used in the SDCP Burrowing Owl Habitat Model

Variable/Category	Value Rating
Vegetation	
Scrub-Grassland (Semidesert Grassland) Sacaton-Scrub (143.14)	1
Scrub-Grassland (Semidesert Grassland) Mixed Grass-Scrub (143.15)	1
Scrub-Grassland (Semidesert Grassland) Scrub-Shrub Disclimax (143.16)	1
Scrub-Grassland (Semidesert Grassland) Xero-riparian biome (143.10XR)	1
Scrub-Grassland (Semidesert Grassland) Xero-riparian Scrub-Shrub Disclimax (143.16XR)	1
Chihuahuan Desertscrub Mixed-Scrub (152.26)	1
Sonoran Desertscrub Creosote-Bursage (154.11)	1
Sonoran Desertscrub Agave-Bursage (154.15)	1
Sonoran Desertscrub Xero-riparian biome (154.10XR)	1
Sonoran Desertscrub Xero-riparian Creosote-Bursage (154.11XR)	1
Active Agriculture (999.11)	3
Abandoned Agriculture (999.12)	3
Slope	
0–2 %	3
Elevation	
195–400 m	2
401–600 m	2
601–800 m	2
801–1,000 m	2
Land Form	
Non-dissected alluvial plains	3
Dissected alluvial plains	3
Non-dissected pediments	MASK
Dissected pediments	MASK

Source: Recon (2002) Priority Vulnerable Species Analysis and Review of Species Proposed for Coverage by the Multiple Species Conservation Plan.

All three City HCP planning sub-areas have suitable habitat for burrowing owls. Burrowing owl habitat can be differentiated into breeding/wintering habitat and dispersal/migration habitat. The difference between these two types of habitat has to do with how long owls will reside in the area and the types of habitat that the owl will utilize. Breeding/wintering habitat corresponds to the habitat descriptions provided in previous sections of this document: they consist of open, sparsely vegetated areas, with mammal burrows or other features that can be modified to provide burrows. Dispersal or migration stopovers, on the other hand, are almost unlimited in variety. Dispersing owls can be found in areas typical of breeding habitat, but they will also utilize areas of dense mesquite vegetation (Urreiztieta, pers comm.) or temporary man-made features such as post-holes (Abbate, pers comm.). In Tucson, burrowing owls have been documented using dispersal stopover locations for at little as one day and as long as two weeks. The environments in which these dispersing owls were found

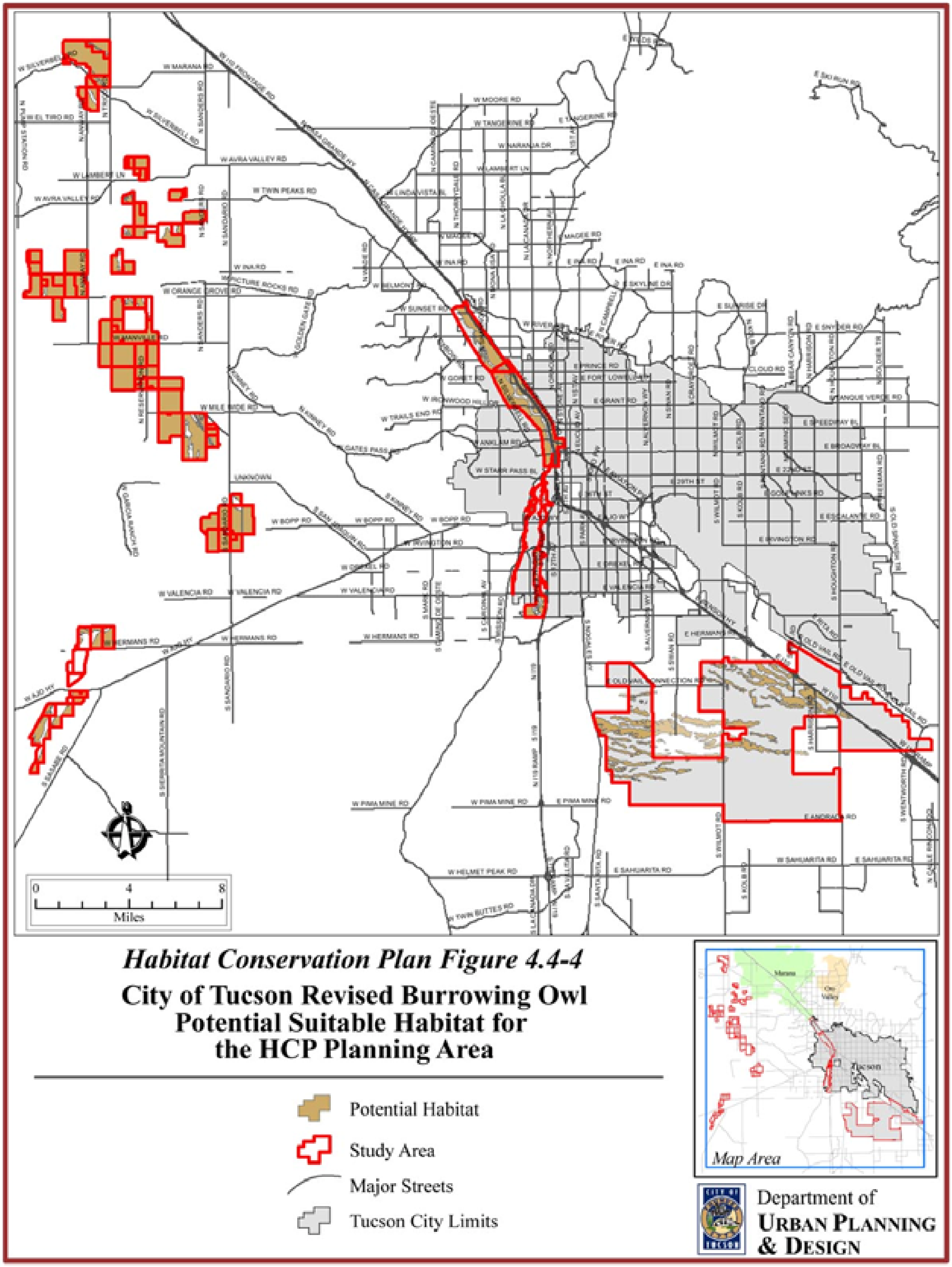

Figure 4.4-4. City of Tucson Revised Burrowing Owl Potential Suitable Habitat for the HCP planning area.

include: Sonoran Desertscrub, creosote, thornscrub, grassland, urban landscaping, xeroriparian, and fallow fields. The types of burrows documented as dispersal stopover locations include: coyote, badger, round-tailed ground squirrel, rock squirrel, tortoise, erosion burrows, and culverts (Urreiztieta, email). Since burrowing owls only remain in these stopover locations for a short time period, there is no specific information available on the range of habitat use or the relative preference of migrating birds for different types of habitat. Dispersing birds are assumed to utilize areas similar to breeding habitat (CDOW 2003).

Santa Cruz River Planning Sub-area

The entire Santa Cruz River planning sub-area is considered to be suitable breeding habitat for burrowing owls. This area, especially south of Silverlake Road, has historically been used by owls for nesting and wintering. In areas where there is no bank protection present, the owls will use erosion features along the banks as burrows, in addition to any mammal burrows that might be present. Along stretches of the river where there is bank protection, owls can use spots where the soil has eroded under the soil cement as burrow locations.

Avra Valley Planning Sub-area

The City-owned parcels within the Avra Valley planning sub-area seem to offer potentially suitable breeding habitat for burrowing owls. The majority of these parcels are retired farmlands and, as such, have the sparse, short vegetation and open areas that is predominant in breeding habitat for this species. The one uncertainty regarding the potential of the Avra Valley planning sub-area as breeding habitat is whether burrows are present, and at what densities, on the properties. Pre-existing burrows are a critical habitat element, since the owl does not excavate burrows itself, and number of burrows may be the factor most limiting to owl populations in the region. The entire Avra Valley planning sub-area can be considered potential breeding habitat, with the caveat that site-specific surveys may be necessary to confirm suitable vegetation characteristics and/or presence or density of suitable burrows.

Southlands Planning Sub-area

The type of areas in the Southlands planning sub-area with potential breeding habitat were identified by Michael Ingraldi (Arizona Game and Fish Department, Research Branch,) and other AGFD staff based on the location of few owl records from this area and the known habitat preferences of the species. All of the owls that have been documented in the Southlands planning sub-area have been dispersing/migrating; no breeding territories have been identified. The areas that owls have been utilizing for dispersal stopovers, however, do have potential as breeding habitat.

Any areas identified as potential breeding habitat would have the following characteristics.

- They are ridge top areas that are distinguished from the surrounding low-lying areas by a lack of signs of sheet flow, water ponding, differences in soil type, changes in vegetation composition, or other factors that indicate that they are not regularly inundated with stormwater runoff.
- Vegetation is sufficiently sparse to provide suitable line-of-sight views around potential nest sites.
- There is some evidence of burrowing mammal presence, including unoccupied and possibly abandoned burrows.

Areas that were not considered potential breeding habitat had the following features.

- Evidence of regular sheet flow and/or ponding of water; evidence that burrows in that area would be subject to inundation.
- Fine, silty or clayey soils that are less likely to support stable burrows.
- Dense vegetation with only a few small open areas that are typical of the habitat surrounding burrowing owl nests.
- Few or no mammal burrows evident.

A digital elevation model (DEM) was developed to identify areas of potential breeding habitat. The DEM was built from 2-foot (0.6-meter) contours for the area and used to create a hillshade map. Possible ridges were identified and hand digitized. Random points were selected within some of these possible ridge polygons, especially in areas where the topography was uncertain or the model was unclear. AGFD and SWCA staff visited 12 of these random points to determine whether or not they were ridge-top locations. All of these points proved to be unsuitable because they were in relatively low-lying areas that had either excessively dense vegetation or silty soils with few or no burrows and evidence of water ponding. Using field observations and GPS data, the ridge polygons were adjusted to remove these unsuitable areas from the potential burrowing owl breeding habitat model. The resulting fine-tuned model appears to be successful in delineating potentially suitable habitat. Potential breeding habitat for all three City HCP planning sub-areas is shown in Figure 4.4-4.

4.4.3.3 Importance of City of Tucson in Species' Range and Ecology

Local and regional movements of burrowing owls are largely unknown. For example, it is unknown whether owls move between areas in Tucson and Phoenix. However, given the City's location and the apparent availability of suitable habitat for burrowing owls, part of the City might serve as a corridor for movement between these two populations as well as for seasonal migrations by owls between breeding and over-wintering grounds. Habitat in the City potentially could be important to burrowing owls from Canada and the northern United States that may winter in or migrate through southern Arizona, but the extent of use of the City area by wintering and migrating burrowing owls is unclear. As discussed earlier, Ellis et al. (2004) did not find any evidence to suggest that migratory owls arrive from elsewhere and spend the winter in Tucson.

4.4.4 Threats and Management Needs

4.4.4.1 Potential Threats and Stressors

Burrowing owls have been severely impacted by the historic loss of prairie dogs throughout their range (Johnsgard 2006). Prairie dogs were not known to have been present in Tucson, but Pima County is considered one of four counties to have comprised the historic range of black-tailed prairie dogs in Arizona (Ellis et al. 2004). Black-tailed prairie dogs were eradicated from Arizona in the 1930s (Ellis et al. 2004). Today the primary threat to the burrowing owl is from urban development in areas that were agricultural or vacant land. Translocation of birds to new areas with artificial burrows is the standard mitigation method, but the results of this procedure have not been studied adequately.

Burrowing owls appear to be sensitive to direct disturbance from people passing near their burrows, but they are not especially sensitive to traffic noise, although they are occasionally hit by cars. Burrowing owls are said to be susceptible to West Nile Virus, but there is little information available on susceptibility to other diseases. Overall, very little is known about their population biology and the effects of various anthropogenic factors. See Table 4.4-9 for a complete list and discussion of stressors and threats to burrowing owls.

Table 4.4-9. Potential and Current Threats and Stressors for Burrowing Owls

Stressor/Threat	Relevance to Species
Habitat Loss	
Breeding	Historic breeding areas were largely associated with prairie dog towns, and burrowing owls have lost habitat with the widespread eradication of prairie dogs and other burrowing rodents. Loss of breeding habitat is considered to be the most critically important threat, as areas that support burrowing owls in Arizona are largely private lands that are being developed.
Dispersal	Loss of dispersal habitat not seen as a significant threat, in part due to the wide variety of environments that the burrowing owl uses during dispersal and the relatively short time period that owls are thought to stay at any stopover location. Loss of areas with suitable holes for roosting is a concern.
Foraging	Average foraging area size is unknown, but may be related to available food supply, and likely differs seasonally and according to life cycle of species. Areas with sufficient prey may be limiting within the Tucson area; however the factors leading to a limited prey base are unknown
Wintering	This species does winter in the Tucson area and needs foraging and roosting sites. Known wintering locations are usually the same areas as breeding sites, although it is possible that owls will use areas outside of known breeding habitat.
Habitat Alteration	
Prey	Although this species is a diet generalist, prey availability may be limiting in areas that may otherwise be suitable for breeding or foraging habitat. Habitat diversity provides for a variety of prey items, and anything that reduces the diversity of native vegetation will likely have a detrimental affect on prey availability.
Nest sites	Natural burrows may be limiting in some areas of otherwise suitable habitat; however, no information on burrow densities in the Tucson area is currently available. Use of artificial burrows is a common tool for improving nest site availability, but the value of artificial burrows has not been well researched.
Vegetation composition/ density	The burrowing owl prefers low-density vegetation surrounding burrows, but some structural diversity is necessary to support prey diversity and abundance, serve as lookout perches near burrows, and provide escape cover for males. Natural successional changes, such as mesquite invasion, may reduce the suitability of breeding habitat.
Fragmentation	This species appears to adapt well to a fragmented environment, and is capable of finding suitable patches of habitat that are scattered across the landscape. The extent and degree of fragmentation that this species can tolerate is not known.
Invasive species	Invasion by mesquite and bufflegrass is probably bad for this species. There have apparently been losses of burrowing owls in the Avra Valley that are contemporary with mesquite and bufflegrass invasion of inactive agricultural fields.
Habitat rehabilitation potential	The burrowing owl uses a variety of developed areas, but the widespread use of artificial burrows has not been studied over time; control of invasive plants may be beneficial.
Hydrologic changes	Drought may result in reduction of prey populations. Flooding may have adverse effects on burrows and prey.
Edge effects	Edges are not considered beneficial; this bird prefers large blocks of open habitat with few perches for larger raptors.
Species Characteristics	
Sensitivity to disturbance	Owls are considered sensitive to disturbance, although some individuals habituate to frequent disturbance.

Table 4.4-9. Potential and Current Threats and Stressors for Burrowing Owls, continued

Stressor/Threat	Relevance to Species
Interspecific Factors	
Predation	Owls are highly susceptible to predation by raptors, and does not thrive in areas with high raptor concentrations or perches for raptors
Disease	Burrowing owls are susceptible to West Nile Virus and known to be killed by it, but the effects of WNV and other diseases on individuals and populations are unknown at present.
Competition	Burrowing owls may be subject to competition for burrows from rock squirrels and snakes.
Domestic/feral animals	This species may be preyed on by cats and harassed by dogs.
Anthropogenic Factors	
Edge effect	Large blocks of relatively barren soil or low vegetation is preferred; does not benefit from edges, and may be harmed if edges attract raptors.
Fire threat	Fire may improve habitat by clearing vegetation; unintended fires may result in loss of habitat.
Off-road vehicles	ORVs possibly may result in habitat loss, crushing of burrows or impacts to prey. Such disturbance may be a problem if frequent.
Grazing	Grazing may be beneficial if it prevents growth of new vegetation.
Collection/ hunting	Collection and hunting are not considered a problem, except illegal target shooting.
Pesticides - impacts to prey	Insecticides may reduce prey base; historic use of rodenticides led to loss of prairie dogs and decline of this species; present use of rodenticides may be a serious problem for this species.
Direct take/mortality	Direct take is not considered a problem.
Noise	Noise may be a problem depending on frequency and duration.
Movement	Movement of people may be a problem depending on frequency and duration.
Landscaping	Artificial landscaping could be beneficial if low-density vegetation and minimal potential raptor perches are part of the landscaping of large sites; owls are known to do well in some parks, parkways, and golf courses.
Invasives	Buffelgrass invasion may be detrimental; mesquite invasion is almost certainly a negative impact.
Automobile collisions	Automobile collisions may be a problem, but frequency is not well documented
Connectivity	
Fragmentation	Burrowing owls live in a fragmented landscape, but prefer fairly large blocks of open country.
Wash incision	Wash incision is beneficial if it results in the creation of new habitat, and harmful if burrows are lost.
Habitat patchiness	Large patches of habitat with minimal vegetation are preferred by burrowing owls.
Riparian/upland connection	The riparian/upland interface is not considered a problem, except if "restoration" projects are done in a way that causes loss of burrows and habitat

4.4.4.2 Current Management Recommendations

Burrowing owls nesting along washes in Tucson lay fewer eggs per clutch, but have both higher rates of nest site fidelity and nesting success, than those that nest on Davis-Monthan AFB or in agricultural areas near Casa Grande and Coolidge (Conway and Ellis 2004a). Given the relatively high rates of burrow fidelity and the large number of non-migratory owls in the Tucson area, Conway and Ellis

(2004a) recommend that protection of active nest burrows, particularly those along washes, which are both more productive and in shorter supply, be given a high priority. Other recommendations include: protection and enhancement of existing owl populations, protection/maintenance of fossorial mammal populations, consideration to owl needs during wash maintenance activities, and education and outreach to the community.

Conway and Ellis (2004a) caution that urban environments may act as ecological traps due to higher mortality from vehicle collisions, predation by domestic cats and dogs, or other human-related impacts. They suggest that additional information is needed on the health and stability of urban owl populations before too much emphasis is placed on maintaining or enhancing urban populations. On the other hand, they note that wash-associated burrows may leave owls more vulnerable to flooding and nest collapse, while agricultural populations may face reduced reproductive success due to pesticide exposure and mortality from plowing and irrigation canal maintenance.

The USFWS produced a technical publication, *Status Assessment and Conservation Plan for the Western Burrowing Owl in the United States* (Klute et al. 2003), which includes the following recommendations:

- Maintain continuous, large tracts of treeless, native grasslands;
- Implement protocols to minimize impacts from development and other land uses;
- Use fire, mowing, and/or grazing, as necessary and appropriate, to maintain suitable habitat;
- Maintain and enhance fossorial mammal populations;
- Construct artificial burrows to reduce limitations on nesting sites and provide replacement burrows for owls evicted due to development, and relocate owls as near to the site of eviction as possible, ideally within 100 meters;
- Reduce/restrict use of pesticides and use pesticides with lower toxicities, and do not spray pesticides on or near burrows during the breeding season; and
- Educate landowners and the public.

According to Trulio (1997), there are five standard approaches for maintaining breeding opportunities for burrowing owls:

- Protect habitat in place – This approach allows burrowing owls to remain at and, in subsequent years, return to the site and specific burrows that they prefer. On the other hand, existing burrow sites may become increasingly isolated and subject to effects of urbanization as surrounding areas are developed.
- Passively relocate owls – Passive relocation allows burrowing owls to select replacement burrows when their chosen sites are lost to development. Passive relocation seems to work best when alternative sites are provided within 75 meters of the eviction site.
- Create new habitat – The creation of additional patches of habitat increases nesting opportunities for burrowing owls within an area. A new habitat patch created in Palo Alto, California, was successfully colonized by burrowing owls. This new habitat is located about one kilometer from existing occupied habitat.
- Actively relocate owls – This approach involves the capture and relocation of burrowing owls to replacement burrows outside the original home range, but within the local range, of the owls. The effectiveness of this approach is uncertain, but preliminary results from a project in California show that 63 percent of 27 relocated birds disappeared within 12 months after

release; 26 percent of birds returned to the original nest site, reflecting the strong site fidelity of the owls. Only two out of 27 birds bred successfully, another two bred unsuccessfully, one was killed by a predator, and one owl remained on the site through two breeding seasons.

- Reintroduce owls – In this approach, owls are relocated to areas from which they were previously extirpated. None of the three large-scale reintroductions attempted in the past (in Manitoba, Minnesota, and British Columbia) have been successful.

The Grassland Ecosystem Initiative (Dechant et al. 1999) provides a number of specific management recommendations for burrowing owls. Although these recommendations focused on protecting owls and owl habitat in the Great Plains, many of the concepts remain relevant in the discussion of Tucson-area burrowing owl management.

- Educate the public, especially private landowners, about the status of burrowing owls, the benefits of protecting habitat for the species and for burrowing mammals, and the negative effects of insecticides.
- Work to improve the image of prairie dogs (and other fossorial mammals).
- Enlist landowner's help in protecting burrows.
- Obtain easements or purchase land in prime burrowing owl habitat.
- Encourage municipal governments and agricultural representatives to reduce or restrict the use of pesticides, and to use pesticides of low toxicity to non-target species.
- Preserve traditional nesting sites.
- Create a patchwork of reserves with sustainable land uses in surrounding buffer areas. Because owls forage over tall grass and nest and roost in short grass, a mosaic of habitats may be important in conserving habitat.
- Provide fresh horse or cow manure near nesting areas if none is available. Burrowing owls use shredded manure to line their nests, possibly to mask odors as a predator-avoidance strategy.
- Install artificial burrows where natural burrows are scarce.
- Provide supplemental food during the nestling stage as a short-term solution if food seems limiting; take care not to overfeed as excessive food caching may attract predators.
- Provide observation perches where vegetation is tall.
- Allow heavy grazing on saline, gravelly, stony, or sandy areas; allow moderate to intense grazing on good soils that otherwise would support tall vegetation.
- Do not spray pesticides within 400 to 600 meters (1,312 to 1,969 feet) of burrowing owl nests during the breeding season.
- If lethal control of burrowing mammals is necessary, restrict the timing of control activities to avoid the period when burrowing owls choose nest sites or are nesting.
- Protect colonies and increase populations of burrowing mammals.
- Maintain abandoned prairie dog colonies at an early successional stage, with short (<8 centimeters [3.2 inches]) vegetation.

- Preserve, restore, or enhance prey habitat such as road rights-of-way, haylands, and uncultivated areas of dense, tall vegetation within a 1-kilometer (0.6-mile) radius of nesting areas.

4.4.5 Potential Impacts of the City of Tucson's Proposed Activities

4.4.5.1 Direct Effects

Construction activities for new residential, commercial, and industrial development and supporting infrastructure have the potential to directly kill or injure owls by filling in or collapsing burrows. The number of owls potentially impacted in this manner is unclear. To date, the majority of burrowing owls located in the City HCP planning area have been along the Santa Cruz River floodplain. These owls would likely not be directly affected by development, but may be impacted by the construction of restoration projects along the river. The EIS for the Paseo de las Iglesias restoration project states that:

> *The riverbank protection with soil cement may negatively affect habitat suitable for burrowing owl under each of the action alternatives due to the re-grading of the currently steep eroded riverbanks. Ultimately, stabilization of these banks may provide greater protection for nest sites as the erodability of the unprotected banks leads to destruction of nest sites during floods.*

It is likely that the other two restoration projects (El Rio Medio and Tres Rios del Norte) will present similar concerns. The number of pairs of owls present on agricultural lands in the Avra Valley area is unknown. Any owls found in such habitats would potentially be vulnerable to construction activities related to water infrastructure projects. The extent to which dispersing burrowing owls winter in the Tucson area also is unknown. Depending on the timing of construction, wintering birds could be vulnerable to construction activities. No information is available to estimate the number of wintering birds that could potentially be impacted.

4.4.5.2 Indirect Effects

The burrowing owl population could be adversely affected through indirect mechanisms facilitated by, or resulting from, urban development. Burrowing owls are vulnerable to predation by domestic and feral cats whose numbers often increase in association with urban development. Other potential indirect adverse effects to burrowing owls from urban development include increased use of pesticides, increased disturbance from maintenance activities associated with drainage ways, disturbance, injury or mortality from shooting or rock throwing, and increased exposure to *Trichomoniasis*. Vehicle strikes also can cause mortality of owls. Thus, the construction of new roads, widening of existing roads, increased speed limits, and increased population expected in the City could contribute to mortality of resident and over-wintering burrowing owls.

4.4.5.3 Potential Habitat Changes in the City of Tucson

Impacts to Potential Burrowing Owl Habitat in the Southlands Planning Sub-area

Planned residential and commercial development and capital improvement projects could directly impact all suitable habitat in the Southlands planning sub-area. Suitable habitat for burrowing owl in this area consists of upland ridges that are not subject to significant sheet flow.

Previous land use concepts, although not currently supported, have called for high intensity development through out the Southlands planning sub-area. This level of high intensity use would result in loss of burrowing owl habitat and promote long-term and frequent disturbance of any remaining habitat as a result of the proximity to an urban environment.

As a result, for purposes of the impact analysis in the City HCP, we are assuming a worst-case scenario and, at this point in time, it is possible for urban development under the current regulatory environment to impact 100 percent of the modeled potential burrowing owl habitat within the Southlands planning sub-area.

Because burrowing owls are tolerant of some types of human activity, owls may continue to occupy suitable habitat patches within areas proposed for low intensity development, and parks and school grounds associated with high intensity development. The City at this time, however, does not have policies of regulations in place to encourage or require integration of burrowing owl habitat onto planned parks.

Impacts to Potential Burrowing Owl Habitat in the Avra Valley Planning Sub-area

As proposed in the City Water Plan, planned public water infrastructure projects could directly impact all suitable burrowing owl habitat in the Avra Valley planning sub-area. Given the uncertainty in the City Water Plan regarding the types and scope of projects that may be constructed within the Avra Valley planning sub-area, we are assuming a worst-case scenario. The total footprint of covered activities in Avra Valley, e.g., recharge basins, evaporation ponds, treatment plant, etc., may require almost 7,500 acres (3,035 hectares). Construction of these projects will create impacts outside of the project footprints, long-term disturbance to habitat may result from operation of these facilities, and the covered activities may, depending on their location and configuration, result in additional habitat loss or degradation within these properties. Without knowing the final location and design of any of these facilities, we cannot say that any habitat within the Avra Valley planning sub-area will not be impacted in some fashion by these covered activities.

4.4.5.4 Population Level Effects

Development could result in a direct reduction in the local burrowing owl population in the Tucson planning area, although the extent of that reduction is unclear. For burrowing owls that occur along the Santa Cruz River floodplain, the impacts could be significant owl habitat enhancement measures can be integrated into the river restoration project designs. Burrowing owl use of other areas (i.e. agricultural properties within the Avra Valley planning sub-area) is poorly understood at present, so it unclear as to what might be the effect of habitat loss in this area. The lack of known nest sites in the Southlands planning sub-area, the limited records of use by dispersing owls, and the marginal status of the area as breeding habitat means that there is unlikely to be a significant impact to local and regional populations from loss of habitat in this area.

The level of use of habitats in the City HCP planning area by wintering and migratory owls is currently unclear, although initial survey results indicate that a number of owls winter at potential breeding sites along the Santa Cruz River planning sub-area. For those lands within the City HCP planning area that are currently being used as nesting/wintering habitat by burrowing owls from within and outside of Arizona, urban development could contribute to reductions in the number of owls nesting/wintering or using City lands for migratory stopovers, and increase mortality from vehicle collisions, predation, and exposure to disease. While it is conceivable that these types of impacts would result from future urban development, the number of owls affected and the impact on local and regional populations of burrowing owls is unclear.

4.5 Tucson Shovel-nosed Snake (*Chionactis occipitalis klauberi*)

4.5.1 Population Distribution, Taxonomy, and Status

4.5.1.1 Range and Distribution

The range of the western shovel-nosed snake (*Chionactis occipitalis*) encompasses most of the Mohave and Sonoran desert regions of the southwestern United States and a small portion of contiguous Mexico. This species' range extends from below sea level to about 4,700 feet (1,430 meters) (Stebbins 1985). In Arizona, it is associated with valley floors below 2,000 feet (610 meters) (Lowe 1964). Rosen (2003b) described shovel-nosed snakes as being abundant in the great dunes of the Gran Desierto, Lower Colorado River Valley, and Mohave Desert.

Four subspecies of shovel-nosed snake have been described. The historical range of the Tucson shovel-nosed snake (*C. o. klauberi*) is believed to have extended in a narrow band from southeastern Maricopa County through southwestern Pinal County to northern Pima County inclusive of the City of Tucson (RECON 2002) (Figure 4.5-1). As currently mapped, this range encompasses the margin of the Arizona Upland Subdivision of the Sonoran Desert biome, which includes portions of Scottsdale, Florence, Casa Grande, Avra Valley, and the City (Rosen 2003b). Snakes with characteristics considered intermediate between Colorado Desert shovel-nosed snake (*C. o. annulata*) and Tucson shovel-nosed snake may occupy the northeastern edge of the Tohono O'odham Nation, Sonoran Desert National Monument near Mobile, and the vicinity of Ajo (Rosen 2003b).

4.5.1.2 Taxonomic Distinctness

Three of the four subspecies of the western shovel-nosed snake occur in Arizona: Colorado Desert shovel-nosed snake (*C. o. annulata*), Tucson shovel-nosed snake, and Mojave shovel-nosed snake (*C. o. occipitalis*) (AHA 2005). The Colorado Desert shovel-nosed snake and Tucson shovel-nosed snake populations intergrade over much of their ranges (CBD 2004). The portion of the Colorado Desert shovel-nosed snake range that does not overlap with the range of the Tucson shovel-nosed snake covers most of La Paz and Yuma Counties. The intergrade range for these two subspecies has been defined broadly as extending from eastern Yuma and La Paz counties east to central Maricopa and Pima Counties, and covering most of Yavapai County (AZ PARC 2005). Klauber (1951 *in* CBD 2004) described a narrower intergrade zone from Gila Bend east to Casa Grande, and Ajo north to Aguila. The Arizona population of the Mojave shovel-nosed snake has a range that primarily covers southern Mohave County and, although it is adjacent to the Colorado Desert-Tucson shovel-nosed snake intergrade zone, is geographically disjunct from the unique range of the Tucson shovel-nosed snake (AZ PARC 2005).

The taxonomy of the Western shovel-nosed snake is not well understood and has not been recently addressed in the published literature. The current taxonomy of the three Arizona subspecies is based on differences in color patterns and, as a result, may not reflect evolutionary divergence among the species (Mahrdt et al. 2001 *in* NatureServe 2005). The Colorado Desert shovel-nosed snake is differentiated by having black bands that are narrower, less densely spaced, and more cleanly distributed than the Tucson shovel-nosed snake (AZ PARC 2005). In addition, the Tucson shovel-nosed snake has black, brown, or purplish secondary bands, i.e. bands that do not contact the ventral surface, as opposed to the Colorado Desert subspecies, which has red secondary bands (CBD 2004). The Mojave shovel-nosed snake typically lacks the narrow orange-red saddles that occur between the black bands in the Colorado Desert and Tucson shovel-nosed snake subspecies. Although there is

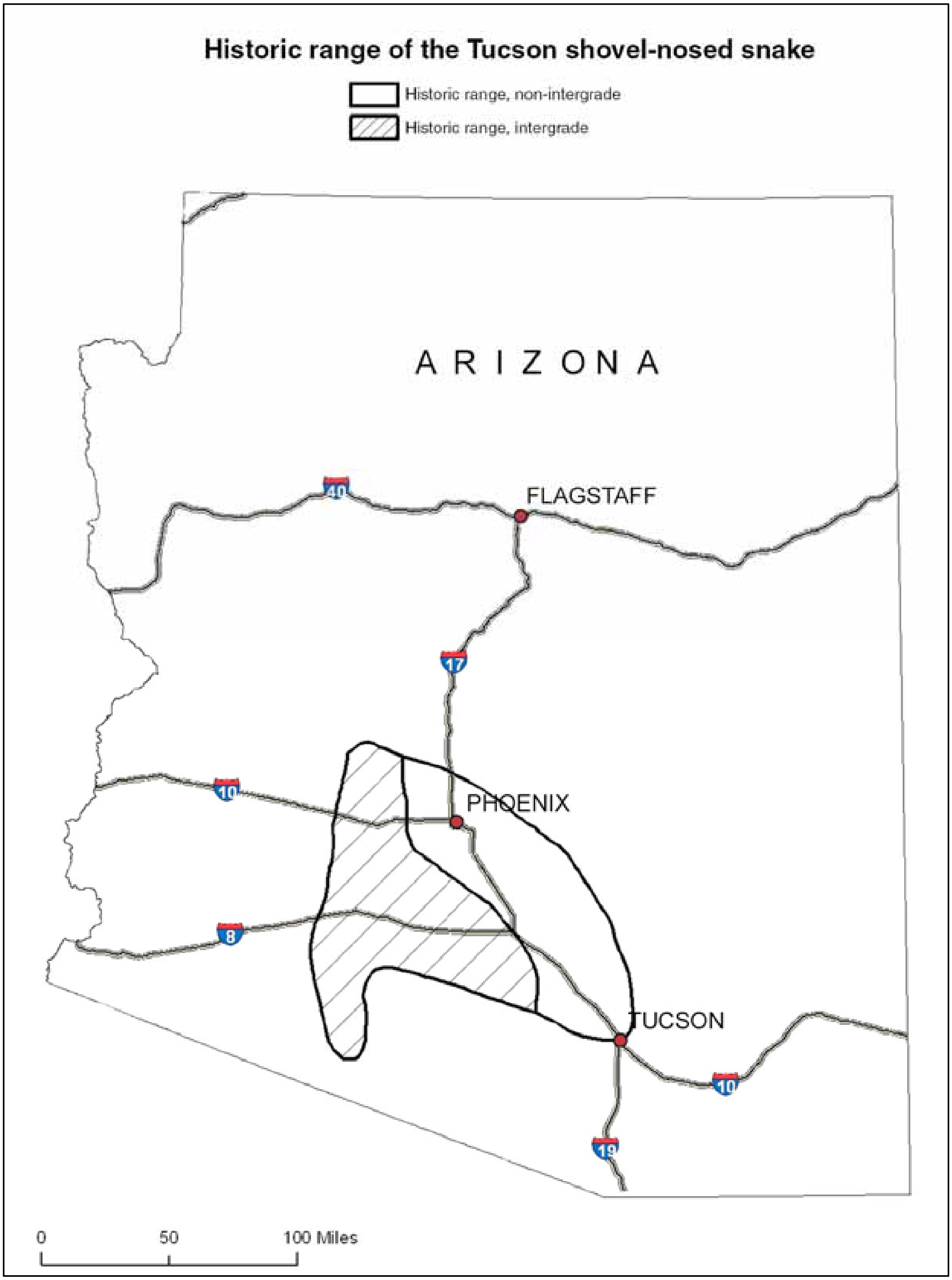

Figure 4.5-1. Historic range of the Tucson shovel-nosed snake.

some question regarding the subspecific taxonomy of the Western shovel-nosed snake, Rosen (2003b) indicated that there is evidence of significant local adaptation that does not appear to be subject to full genetic mixing among the subspecies. He supports the current taxonomic classification of the snake and suggests that even smaller valid taxonomic units that may be "evolutionary significant units" could exist (Rosen 2003b).

4.5.1.3 Population Status and Threats

A petition was filed in December 2004, requesting that the Tucson shovel-nosed snake be considered for listing under the ESA (Center for Biological Diversity [CBD] 2004). The listing petition includes both the intergrade and non-intergrade portions of the Tucson shovel-nosed snake populations (CBD 2004).

Rosen (2003a) speculates that populations in the area of Scottsdale, Florence, and Casa Grande have been severely impacted or extirpated. Systematic surveys have not been conducted in these areas and, therefore, the status of the species across its entire range is imperfectly known. Northern Avra Valley is one of the few areas that have been extensively surveyed. As late as the mid-1970s, surveyors were observing Tucson shovel-nosed snake as many as 2 to 3 times per night (CBD 2004). Rosen (2003b) surveyed for the subspecies in and around Marana in 2003. He failed to detect any shovel-nosed snakes and, given the absence of records since 1979, concluded that the Tucson shovel-nosed snake population has severely declined in the Avra Valley since the 1960s and 1970s, and may now be extirpated from the area. In 2004, however, Rosen (2004) reported that a Tucson shovel-nosed snake was observed near Picacho. Western shovel-nosed snakes have also been recorded in the Sonoran Desert National Monument near Mobile. However, the subspecific identity of these individuals has not been verified. The specimens appear to range in character from similar to Colorado Desert shovel-nosed snakes to "somewhat to strongly resembling" Tucson shovel-nosed snakes (Rosen 2003b).

The primary threat to the Tucson shovel-nosed snake, and likely cause of the subspecies' presumed decline, is the loss of habitat through agricultural and urban development (CBD 2004). Grading and farming of former habitat alters soil conditions and removes native vegetation, thereby eliminating essential habitat components for this species. It is unknown whether natural recovery or restoration of degraded soils to a condition that is suitable for re-colonization by Tucson shovel-nosed snakes is possible (CBD 2004).

Identified threats to the subspecies include:

- Agricultural development,
- Urban development,
- New road construction,
- Increased traffic on new and existing roads,
- Off road vehicle activity, and
- Possibly scientific and commercial collection of the subspecies.

Another potential factor in the decline of Tucson shovel-nosed snake populations may be competition from the morphologically, ecologically, and behaviorally similar banded sand snake (*Chilomeniscus cintus*) (Rosen 2003b). The banded sand snake is thought to prefer a "richer" or less arid desert environment than the shovel-nosed snake. It is assumed to have historically occupied areas adjacent to shovel-nosed snake habitat, on bajadas along the Santa Cruz River east of the Tucson Mountains and along a sandy ridge that separates the Santa Cruz River floodplain from the combined floodplains of the Brawley, Los Robles, and Blanco washes (Rosen 2003b). Drawing an analogy from the relationship between desert horned lizards and regal horned lizards, Rosen suggests (2003b) that the banded sand snake population and distribution may be expanding at the expense of shovel-nosed snakes. The banded sand snake was not recorded on the floor of Avra Valley until 1983, after which time it appears to have increased in abundance. This time frame coincides with the marked decline in shovel-nosed snakes, from reasonably abundant during the 1970s to undocumented after 1979. Whether the sand snake is contributing to the decline of the shovel-nosed snake or simply invading altered habitat following extirpation of the shovel-nosed snake is uncertain.

4.5.2 Ecology

4.5.2.1 Life History

The shovel-nosed snake is adapted to moving quickly through loose sand and loamy soils. This movement has been described as sand swimming (Stebbins 1985, Rosen 2003b). This small (250 to 425 millimeters) coral snake mimic uses venom to subdue its prey, which includes insects, scorpions, spiders and centipedes (Stebbins 1985, Rosen 2003b). The shovel-nosed snake feeds frequently and, as a result, is thought to actively forage from at least April through October (Rosen et al. 1996 *in* CBD 2004).

The shovel-nosed snake is thought to breed in May and June. Only a quarter of females surveyed during the breeding season were found to be reproductively active, indicating that all females do not breed each year (Goldberg 1997 *in* CBD 2004). The species is oviparous and has a clutch of 2 to 4 eggs in the summer (Stebbins 1985).

Western shovel-nosed snakes are primarily nocturnal (Stebbins 1985) although on cool days they may also be active in the late and early evening (Warren 1953 *in* RECON 2002). Daily activity seems to peak from dusk until just after dark, roughly from 19:00 to 21:00 hours (Rosen et al. 1996 *in* CBD 2004). Shovel-nosed snakes spend the daytime under the surface of the soil beneath a creosote bush or under objects, such as boards (CBD 2004). Rosen (2003b) researched the seasonal activity cycle of the Tucson shovel-nosed snake as part of a recent survey effort. He discovered that activity peaks during May and decreases rapidly through late June. There is residual activity in early July and almost no observed activity after that. Shovel-nosed snakes also appear to be more active after warm summer or hot spring days and on days with higher relative humidity (Rosen et al. 1996 *in* CBD 2004). During the winter, the snake will often hibernate in small, enclosed burrows beneath but near the surface of the soil (CBD 2004).

4.5.2.2 Habitat Requirements

The western shovel-nosed snake is known from the Lower Sonoran life zone primarily on valley bottoms with sand dunes or soft sandy loams. More detailed habitat preferences of the species have not been systematically examined (CBD 2004). Rosen (2003b) suggests that populations in Avra Valley centered on the valley floor, with only fringes of the distribution extending into adjacent bajadas. He also notes that the species appears to prefer productive creosote-mesquite floodplains, but also may occur in areas of open upland creosote (Rosen 2003b). The species prefers soils containing small amounts of gravel (Rosen 2003a).

4.5.3 Baseline Conditions

4.5.3.1 City of Tucson Population Status

The last known record of the Tucson shovel-nosed snake in the vicinity of the City was at Sanders Road and Avra Valley Road in 1979. It is unknown whether the species persists within the City HCP planning area. It was not observed during species-specific surveys conducted in and around Marana in

2003. However, these surveys were initiated during the latter half of the seasonal activity cycle when the snake was much less active (Rosen 2003b). The previously mentioned record of a Tucson shovel-nosed snake observed near Picacho in 2004 demonstrates that the species is not regionally extinct, and may still inhabit the Avra Valley (Rosen 2004).

Previous survey work concentrated along Avra Valley Road and Mile Wide Road. Although many Tucson shovel-nosed snakes were observed in the 1960s and early 1970s, none have ever been found west of Pump Station Road or along the portion of Avra Valley Road that is within three miles of I-10. In addition, no shovel-nosed snakes have been observed along Mile Wide Road. This recorded distribution led Rosen (2003b) to conclude that most of the original population occurred north of Mile Wide Road, and likely north of Manville Road. There are few records from the area where Avra Valley Road crosses Brawley Wash, specifically between Sanders Road and Trico Road. This dearth of records is thought to be due to the presence of adobe-like soils near Brawley Wash that are too hard to be suitable for shovel-nosed snakes (Rosen 2003b).

4.5.3.2 Habitat in and Near the City of Tucson

Two different models have been developed to delineate potential habitat for the TSS:

- The Sonoran Desert Conservation Plan habitat model; and
- A habitat model developed by Dr. Phil Rosen for the Town of Marana HCP.

Sonoran Desert Conservation Plan Habitat Model. A habitat model for the Tucson shovel-nosed snake was developed as part of the SDCP (RECON 2002). This habitat model consisted of the following four primary variables:

- Vegetation
- Slope
- Elevation
- Landform

The habitat potential of the categories of each variable were ranked as 0, 1, 2, and 3, with 0 indicating that the category provided no habitat and 3 indicating that the category provided high potential habitat. The four variables were combined to provide an overall habitat potential. Table 4.5-1 shows the specific categories of the variables considered to provide habitat for the Tucson shovel-nosed snake and their habitat potential ratings. Using this habitat model, the City HCP planning area supports about 3,403 acres (1,377 hectares) of high potential habitat and 56,557 acres (22,888 hectares) of medium potential habitat for Tucson shovel-nosed snake, all located within the Avra Valley planning sub-area (Figure 4.5-2).

City of Tucson Habitat Model. When developing the Tucson shovel-nosed snake habitat model for the Town of Marana HCP, Dr. Rosen concluded that elevation and soil taxonomy and condition provide the best overall predictors of potential habitat for this species. Elevations greater than 2,300 feet (700 meters) were eliminated because existing records do not include observations of the species above that elevational limit. Active agricultural lands and developed areas were eliminated as potential habitat because soils in these areas are no longer suitable for use by this species.

This model was considered to be as accurate and appropriate for identifying habitat within the City of Tucson planning area as it had been for use in the Town of Marana HCP planning area, with one exception. Although agriculture has been prevalent in both Marana and the City's Avra Valley

Table 4.5-1. Value Ratings for Characteristics of the Variables Used in the SDCP Tucson Shovel-nosed Snake Habitat Model

Variable/Category	Value Rating
Vegetation	
Scrub-Grassland (Semidesert Grassland) Scrub-Shrub Disclimax (143.16)	1
Scrub-Grassland (Semidesert Grassland) Xero-riparian Scrub-Shrub Disclimax (143.16XR)	1
Sonoran Desertscrub Creosote-Bursage (154.11)	3
Sonoran Desertscrub Paloverde-Mixed Cacti (154.12)	1
Sonoran Desertscrub Agave-Bursage (154.15)	3
Sonoran Desertscrub Saltbush (154.17)	2
Sonoran Desertscrub Xero-riparian biome (154.10XR)	3
Sonoran Desertscrub Xero-riparian Creosote-Bursage (154.11XR)	3
Sonoran Desertscrub Xero-riparian Paloverde-Mixed Cacti (154.12XR)	3
Slope	
0–2 %	1
2–5 %	1
5 % and above	MASK
Elevation	
401–600 m	3
601–800 m	1
801 m and above	MASK
Land Form	
Drainageways	3
Streambeds	3
Floodplains	3
Terraces	3
Non-dissected alluvial plains	3
Dissected alluvial plains	3

planning sub-area for decades, and continues to be practiced in Marana, all of the City's lands within the Avra Valley planning sub-area were retired from farming between 20 and 30 years ago. Although farming dramatically reduces the suitability of the land for this species, as these lands recover from cultivation however, it is plausible that they may return to being suitable habitat. The City's former agricultural lands therefore cannot be ruled out as future snake habitat as long as they have appropriate soil types and occur within the elevational range of the species. Due to the potential recovery of snake habitat in these areas, these former farmlands are considered as possible restoration areas for the species in the City of Tucson Tucson shovel-nosed snake habitat model. It must be noted, however, that it is currently unknown how long these lands must remain fallow for natural processes to restore them to suitable Tucson shovel-nosed snake habitat.

The combination of soil type, elevation range, and past land use (cultivated or not cultivated) results in a possible 12 habitat suitability classes for this species with the City HCP planning area. In order to simplify conservation planning for this species, these 12 classes were aggregated into low, medium,

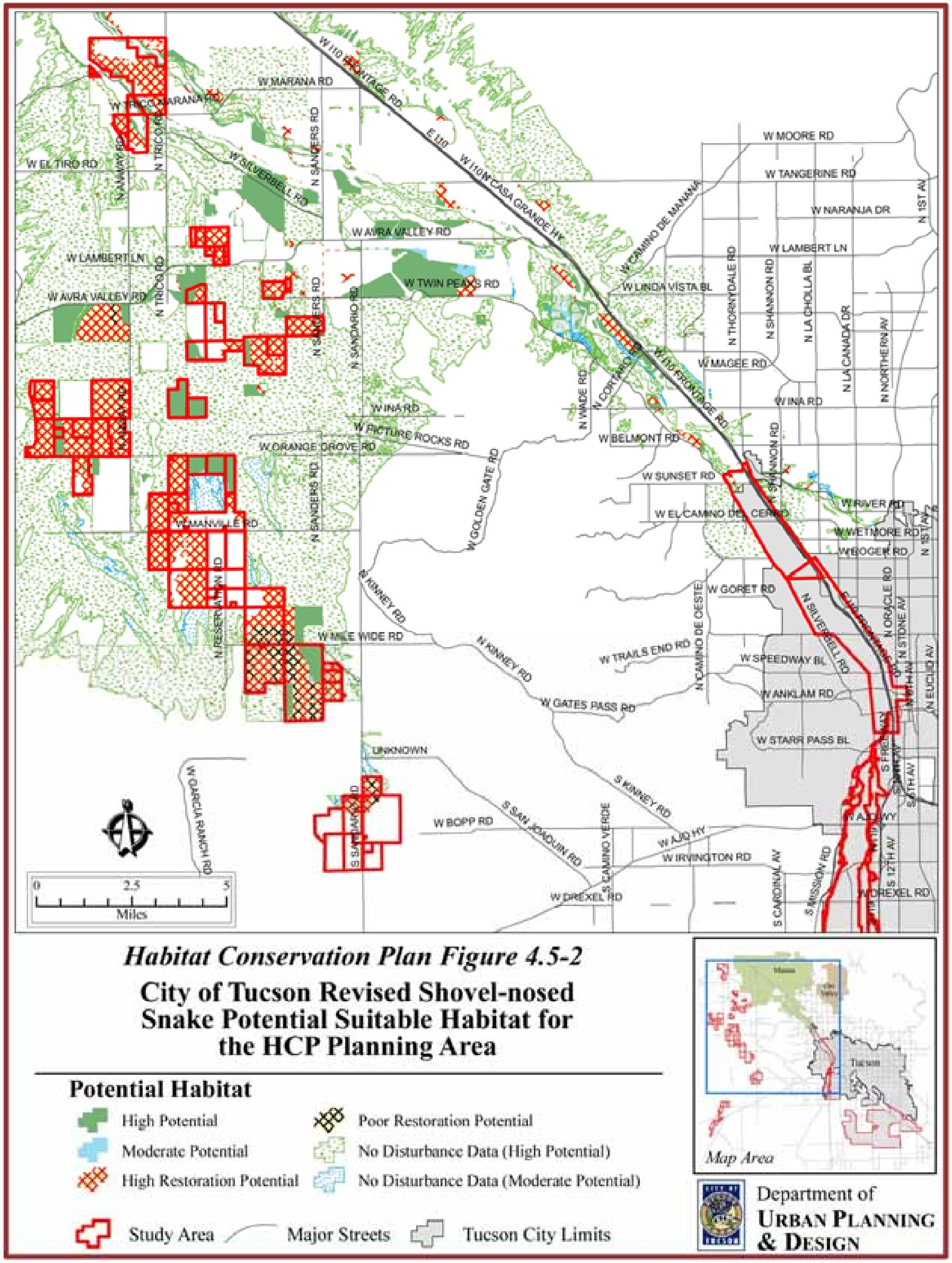

Figure 4.5-2. City of Tucson revised shovel-nosed snake potential suitable habitat for the HCP Planning Area.

and high potential habitat based on the input of Dr. Rosen. According to Dr. Rosen, soil type takes precedence over elevation and any properties with good soils should be "high" potential in a 3-tiered system. Marginal soils, regardless of elevational suitability, do not provide "high" potential habitat. The overall suitability for each soil type and elevation combination is presented in Table 4.5-2, for uncultivated land, and Table 4.5-3, for previously farmed properties. The output of the habitat suitability model for the Tucson shovel-nosed snake is shown in Figure 4.5-2 and Table 4.5-4.

Table 4.5-2. Habitat Suitability Classes for Non-cultivated Lands. Overall Ratings Recommended by Dr. Phil Rosen

Soil Type Suitability Rating	Elevation Suitability Rating	Overall Habitat Potential Rating
3	3	High
3	2	High
3	1	High
2	3	High
2	2	Moderate
2	1	Moderate
1	3	Moderate
1	2	Moderate
1	1	Low

Table 4.5-3. Habitat Suitability Classes for Non-cultivated Lands. Overall Ratings Recommended by Dr. Phil Rosen

Soil Type Suitability Rating	Elevation Suitability Rating	Overall Habitat Potential Rating
3	3	High Restoration Potential
3	2	High Restoration Potential
3	1	High Restoration Potential
2	3	High Restoration Potential
2	2	High Restoration Potential
2	1	Poor Restoration Potential
1	3	Poor Restoration Potential
1	2	Poor Restoration Potential
1	1	Poor Restoration Potential

Table 4.5-4. Acreage of Potential Tucson Shovel-nosed Snake Habitat for Each Suitability Class by City HCP Planning Sub-area

Habitat Suitability Class	Avra Valley (acres)	Santa Cruz River (acres)	Total Acres
High	2,197	197	2,394
Moderate	68	27	95
Low	0	0	0
High Restoration Potential	9,575	113	9,688
Poor Restoration Potential	890	0	890
Total Acres	**12,729**	**337**	**13,066**

4.5.3.3 Importance of City of Tucson in Species' Range and Ecology

The City and vicinity represent a small and likely inconsequential portion of the range of this widely distributed species (i.e., most of the Mohave and Sonoran deserts). The range of the subspecies under consideration here extends from southeastern Maricopa County through southwestern Pinal County to northern Pima County, inclusive of a portion of the Avra Valley planning sub-area. It is possible that the Tucson shovel-nosed snake genotype might only be available for long-term conservation in the area of Mobile, Arizona (Rosen 2003b).

4.5.4 Threats and Management Needs

4.5.4.1 Potential Threats and Stressors

The primary threat to the Tucson shovel-nosed snake, and likely cause of its presumed decline, is the loss of habitat through agricultural and urban development (CBD 2004). Grading and farming of former habitat alters soil conditions and removes native vegetation, thereby eliminating essential habitat components for this species. It is unknown whether natural recovery or restoration of degraded soils to a condition that is suitable for re-colonization by Tucson shovel-nosed snakes is possible (CBD 2004). Another potential factor in the decline of Tucson shovel-nosed snake populations may be competition from the morphologically, ecologically, and behaviorally similar banded sand snake (Rosen 2003b).

Essentially nothing is known about the demographics or population dynamics of this snake. Habitat requirements also are not well known, except that this snake requires undisturbed desert vegetation communities. Vehicle collisions are a serious problem, and were almost certainly more of a problem historically. See Table 4.5-5 for a complete list and discussion of stressors and threats to Tucson shovel-nosed snake.

Table 4.5-5. Potential and Current Threats and Stressors for Tucson Shovel-nosed Snake

Stressor/Threat	Relevance to Species
Habitat Loss	
Breeding	Loss of habitat to agricultural and urban development is regarded as the most serious historic threat to this species. Loss continues today, to a lesser degree, as urban development occurs in previously undeveloped land that may still support this species.
Dispersal	Dispersal is limited for a small snake. The ability to disperse has been compromised by roads, developed areas, irrigation and drainage ditches, and areas with impacted soils.
Foraging	Size of foraging area is unknown, but is almost certainly related to available food supply and available suitable soils; diversity of resources is important.
Habitat preferences	This snake uses rodent burrows and litter (e.g., boards) as shelter for unknown periods of time; rodents have largely been eradicated as a result of agricultural and urban development from areas where this snake once lived.
Habitat Alteration	
Prey	This snake consumes a diversity of invertebrate prey; loss or reduction in populations of suitable prey species through habitat loss and invasive competitors is probably a significant threat, but further research is needed.
Vegetation composition/density	The loss of native desert vegetation by conversion to agricultural fields was an important cause of population loss.

Table 4.5-5. Potential and Current Threats and Stressors for Tucson Shovel-nosed Snake, continued

Stressor/Threat	Relevance to Species
Habitat Alteration, continued	
Fragmentation	Fragmentation of historic habitat may have led or contributed to endangerment of this species; remaining potentially suitable areas are isolated by barriers.
Invasive plant species	Invasion by mesquite, bufflegrass, and red brome reduces vegetation diversity and can lead to fires, changes in soil characteristics, and reduced prey availability.
Invasive animal species	Effects are unknown, but concern has been expressed about invasive non-native insects, such as cockroaches, that out-compete native food animals.
Habitat rehabilitation potential	Restoration of native vegetation communities and enhancement of connectivity would improve long-term survival opportunities for this species.
Edge effects	Edge habitats may contribute to isolation and increased predation on this snake.
Water quality	Water quality may result in changes in soil texture and the invertebrate community.
Land use history	Historic agriculture likely rendered areas unsuitable for use by this species; the long-term effects of agriculture are unknown.
Roads	Dispersal by this snake may be impacted adversely by roads, ditches, and areas with unsuitable soils.
Species Characteristics	
Dispersal mechanism	Habitat and the potential for dispersal by this snake may have been altered in important ways we do not understand. The goal of restoration would likely require the creation of functioning desert ecosystems with soils and vegetation communities historically available to this species.
Life history/ Population data	Essentially nothing is known about the demographics or population dynamics of this species. Habitat requirements are not known, except that this snake requires undisturbed desert communities.
Seasonal specialization	The prey animals of this species are clearly seasonal in abundance, so the snake must have the ability to switch prey as necessary.
Captive breeding/ translocation potential	Although a potentially useful approach, the potential for successful captive breeding and restoration is unknown.
Breadth of resource use	This snake appears to specialize in a narrow range of resources, but this is not well understood.
Adaptability	Habitat selection apparently is limited by available soils.
Predation	The effects of predation on this snake are unknown.
Disease	The effects of disease are unknown.
Competition	A potential factor in the decline of this snake may be competition from the morphologically, ecologically, and behaviorally similar banded sand snake (*Chilomeniscus cintus*), which appears to have moved into the area occupied previously by shovel-nosed snake.
Domestic/feral animals	Not likely to be a problem.
Anthropogenic Factors	
Fire threat	Fires may negatively impact this species by resulting in loss or conversion of vegetation.
Off-road vehicles	ORVs may impact snakes directly, or indirectly through impacts to soils.
Grazing	Grazing may be harmful if it reduces vegetation diversity or compacts soils.
Collection/hunting	Collection of snakes may have been a problem historically, but is no longer considered a problem because snakes have not recently been found in area.

Table 4.5-5. Potential and Current Threats and Stressors for Tucson Shovel-nosed Snake, continued

Stressor/Threat	Relevance to Species
Anthropogenic Factors, continued	
Insecticides	Insecticides are not thought to be a problem, except to the extent that affect prey base for this species.
Direct take/mortality	Direct take of this snake is not considered a problem.
Dumping	Illegal dumping may actually benefit this species by providing cover.
Increased road density	Increased road density results in loss of habitat, barriers to dispersal, and direct mortality.
Connectivity	
Fragmentation	Fragmentation is probably a significant problem for this snake because the only remaining habitat is isolated.
Barriers	Potential barriers to dispersal by this snake include roads, ditches, agricultural fields, urban development, and other unsuitable habitats.
Traffic volumes	Vehicular collisions are a serious problem, at least historically.
Habitat patchiness	Connectivity is considered crucial for the long-term maintenance of viable populations.

4.5.4.2 Current Management Recommendations

Rosen (2004) suggests that the persistence of this species in Avra Valley requires that most, or all, of the few remaining areas of "relatively undisturbed creosotebush and creosotebush-mesquite upland desertscrub" be preserved.

Among the areas Rosen (2003b) recommends for conservation are (also see Figure 4.5-3)

- **Site 2:** Brawley Flats – The least-disturbed remaining patch of desert within the local distribution of the Tucson shovel-nosed snake. Much of the area has been heavily damaged by past land uses and parcels are in various stages of recovery. Several City-owned parcels, including the Weinstein, Lupori, and Reeves Farms (north and south) parcels, include portions of or are adjacent to the Brawley Flats.
- **Site 3:** Magee-Avra Roads Desert Flats – Adjacent to the Brawley Flats, this area also includes tracts of relatively undisturbed desert within the local distribution of the snake. Impacts in this area include wildcat development and overgrazing. A few City-owned parcels, including Lupori, Reeves (north), Comisky, and Levokitz Farms parcels, include or are adjacent to portions of the flats.
- **Site 4:** Trico-Brawley Flats and North Silverbell Ridge – Patches of high quality mesquite and creosotebush habitat can be found in this area. This area has been impacted by past land uses and continues to be affected by urban sprawl. Several City-owned parcels are located in the general vicinity, including the former Gin, Hurst, and Simpson Farms south.

4.5.5 Potential Impacts of City of Tucson's Proposed Activities

4.5.5.1 Direct Effects

Urban development, including construction of water projects, can cause direct mortality or injury to Tucson shovel-nosed snakes.

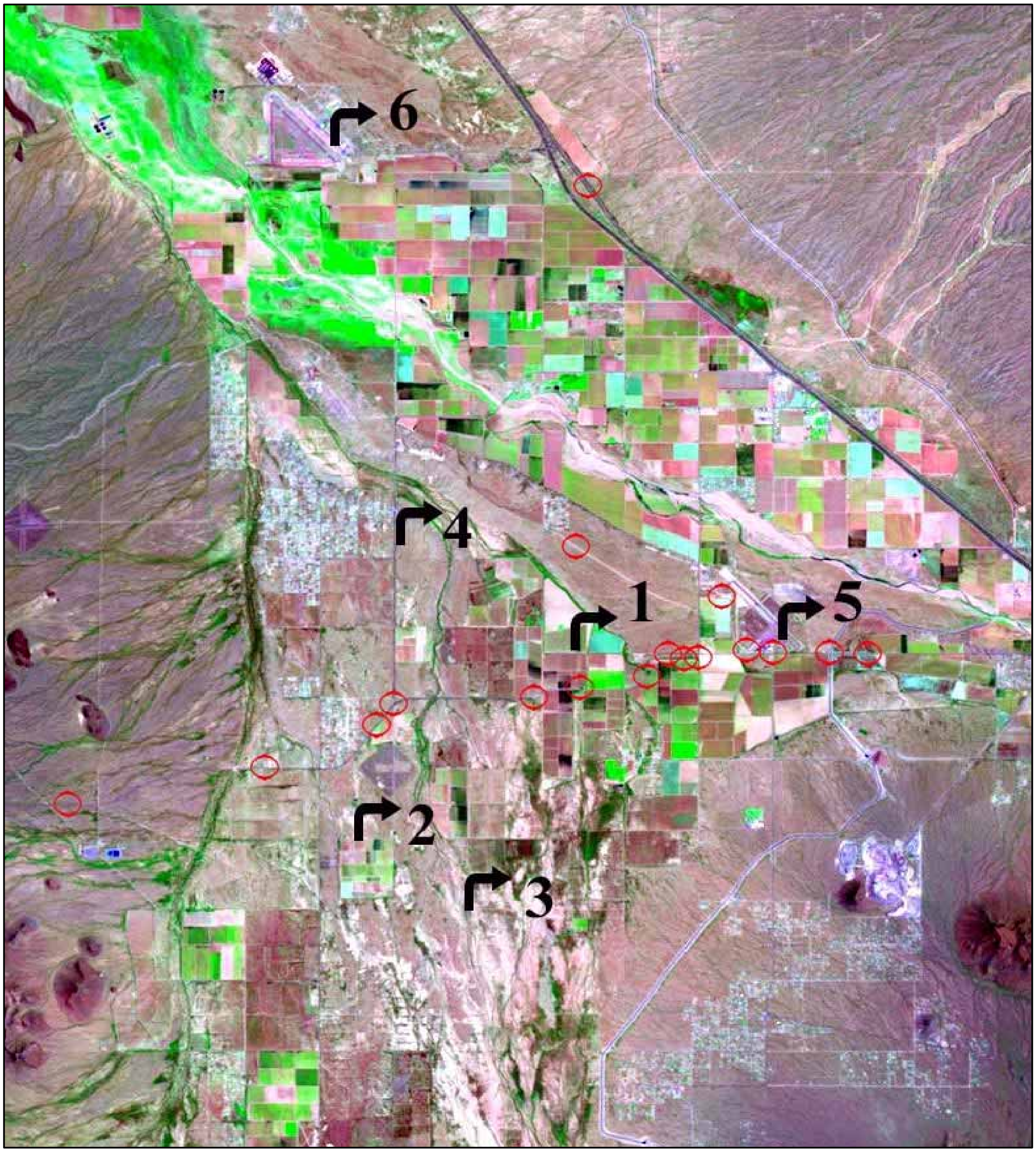

Figure 4.5-3. Museum records and potential conservation areas mapped onto a 1993 aerial image of the northern Avra Valley. The habitat associations at museum localities for the Tucson shovel-nosed snake (red ovals) may be inferred, although agricultural expansion (green–active; reddish–recovering) has obliterated desert habitat formerly occupied by snakes. Arrows point toward potential conservation areas, with numbers corresponding to discussion in the text. Base image source: University of Arizona A.R.T. lab, School of Renewable Natural Resources.Source: Rosen 2003b.

4.5.5.2 Indirect Effects

Tucson shovel-nosed snakes that are displaced by construction activities could experience higher mortality while searching for suitable, unoccupied habitat. Roads and increased traffic on roads can increase mortality of snakes from vehicle strikes. Over the long term, conversion of suitable habitat to urban uses could result in take of snakes through a variety of mechanisms, including reduced foraging opportunities, reduced or degraded denning opportunities, and increased predation.

4.5.5.3 Potential Habitat Changes in City of Tucson

Once suitable habitat with relatively undisturbed soil conditions is graded for development its potential value to this species is lost. As proposed in the City Water Plan, planned public water infrastructure projects could directly impact all suitable Tucson shovel-nosed snake habitat in the Avra Valley planning sub-area. Given the uncertainty in the City Water Plan regarding the types and scope of projects that may be constructed within the Avra Valley planning sub-area, we are assuming a worst-case scenario. The total footprint of covered activities in Avra Valley, e.g., recharge basins, evaporation ponds, treatment plant, etc., may require almost 7,500 acres (3,035 hectares). Construction of these projects will create impacts outside of the project footprints, long-term disturbance to habitat may result from operation of these facilities, and the covered activities may, depending on their location and configuration, result in additional habitat loss or fragmentation within these properties. Without knowing the final location and design of any of these facilities, we cannot say that any habitat in Avra Valley will not be impacted in some fashion by these covered activities.

4.5.5.4 Population Level Effects

Because it is not known whether this species persists in the City HCP planning area, the population effects of the City’s proposed activities are unknown.

4.6 Ground Snake (Valley Form) (*Sonora semiannulata*)

4.6.1 Population Distribution, Taxonomy, and Status

4.6.1.1 Range and Distribution

This range of the ground snake (*Sonora semiannulata*) extends from southwestern Idaho south through western and southern Arizona; eastward through much of west and central Texas including nearly all of Oklahoma; and south through north-central Mexico. Rosen (2004) provides a map (Figure 4.6-1) of the species’ known distribution in Pima County and adjoining areas. The ground snake is found from sea level to around 6,000 feet (1,830 meters) (Stebbins 1985).

4.6.1.2 Taxonomic Uniqueness

Current taxonomy recognizes only one species with no subspecies. The ground snake, however, has distinctive and potentially isolated forms throughout its range. RECON (2002) describes three forms as occurring within Pima County, but the degree of genetic separation among these forms is unknown. The ground snakes in the Tucson area are described as the “valley form”; Rosen (2003a) uses the term “population segment” in referring to this population. He notes that color pattern phases tend to differentiate the mountain and valley forms of the snake, but not with complete certainty (Rosen 2004).

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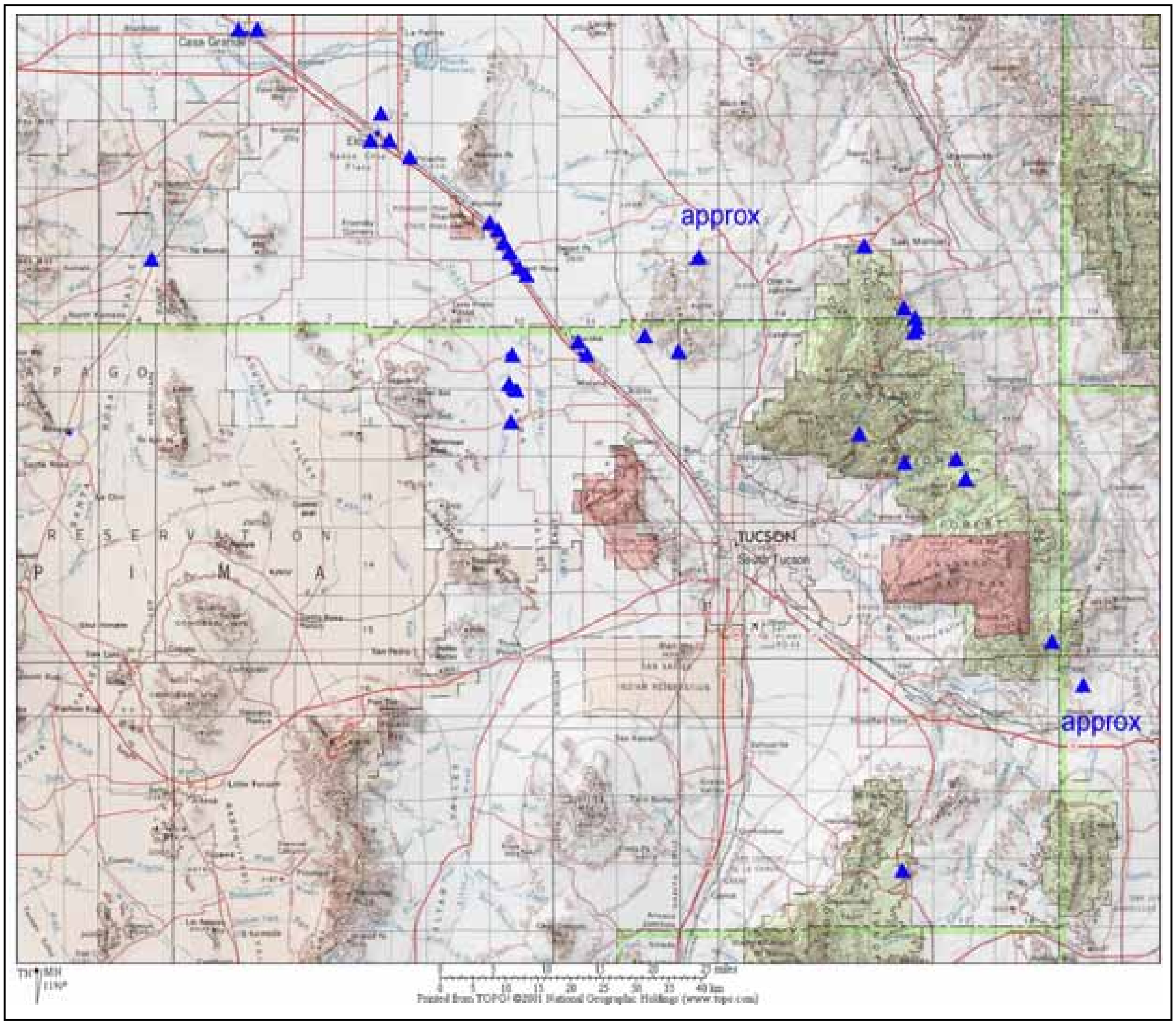

Figure 4.6-1. Distribution of ground snake (*Sonora semiannulata*, valley form) in eastern Pima County and adjoining areas, Arizona, based on plotable museum records, 1900–2004, and observations and reliable records obtained by the author. Records occur in two environments: valley flats (mesquite- and grass-dominated desertscrub) and lower mountain slopes (Semidesert Grassland and upper edge of Arizona Upland Desertscrub). Base image from TOPO! digital mapware. (Reproduced from Rosen 2004)

4.6.1.3 Population Status and Threats

The population status of this species in Arizona and Pima County is unknown. This species is not tracked by the AGFD Heritage Data Management System. Although recent surveys have confirmed that ground snakes persist within the range of the valley form (Rosen 2004), the population status is unknown.

Rosen (2003a) believes that habitat destruction, particularly in Pinal County, could be adversely affecting the local population. Other threats are likely to be similar to those for other snakes, and include:

- Agriculture and urban development,
- New road construction,
- Increased traffic on new and existing roads,
- Off road vehicle activity, and
- Scientific and commercial collection.

The snake has also been observed trapped in cattle guards (BISON-M 2004a).

4.6.2 Ecology

4.6.2.1 Life History

The ground snake is a small, secretive, nocturnal snake whose prey includes insects, scorpions, centipedes, crickets, and grasshoppers (Rosen 2003a, Stebbins 1985). Unlike other closely related snakes, the ground snake is not morphologically adapted to digging (Rosen 2004). Clutches of four to six eggs are laid in June through August. This species is active during April through October and hibernates in underground dens during the winter (Stebbins 1985).

4.6.2.2 Habitat Requirements

The ground snake occupies desert valleys on hard clays and silts that digging snakes, such as shovel-nosed snakes, do not usually occupy (Rosen 2003a). Ground snakes are known from fine soils on flats and from very coarse, gravelly soils on lower rock slopes in desert grassland. Over its range, the species occurs in river bottoms, desert flats, sand hummocks, and rocky hillsides where there are pockets of loose soil. Vegetation in these areas is typically sparse (e.g., creosote bush desertscrub), but along the lower Colorado River this snake occurs in thickets of mesquite (Stebbins 1985). Rosen (2004) recently described the valley form's habitats as valley flats of mesquite and grass-dominated desertscrub, and lower mountain slopes of Semidesert Grassland and Arizona Upland Desertscrub.

Small snakes, including members of the Colubrid family, tend to have fairly small home ranges. Data for related species indicate that home ranges for colubrid snakes are ususally significantly less than one hectare (2.5 acres) in size (NatureServe 2005). These snakes are still capable of moving relatively large distances, with reports of some individuals dispersing as far as 1.7 kilometers (1.1 miles) (NatureServe 2005).

In the Phoenix metropolitan area, ground snakes are known to occupy urban environments. The population does best in open areas with established vegetation, including landscaped areas that are untended by typical landscape management practices (P. Rosen, pers. comm.). However, there is no evidence that the valley form of this species occupies urban environments in Pima County (RECON 2002).

4.6.3 Baseline Conditions

4.6.3.1 City of Tucson Population Status

There are no known observations of ground snakes within the City's HCP planning area. Four historic records of the ground snake show that it occurs along the Blanco Wash, from the confluence with the Santa Cruz River south to Avra Valley Road. Although these three observations serve to confirm the presence of this snake in the vicinity of the City's HCP planning area, they are not sufficient to determine the local abundance or population status of the species.

4.6.3.2 Habitat in and near the City of Tucson

Two different models have been developed to delineate potential habitat for the ground snake:

- The Sonoran Desert Conservation Plan habitat model and
- A habitat model developed by Dr. Rosen for the Town of Marana HCP.

Sonoran Desert Conservation Plan Habitat Model. A habitat model for the ground snake was developed as part of the SDCP (RECON 2002). This habitat model consisted of the following four primary variables:

- Vegetation
- Slope
- Elevation
- Landform

The habitat potential of the categories of each variable were ranked as 0, 1, 2, and 3, with 0 indicating that the category provided no habitat and 3 indicating that the category provided high potential habitat. The four variables were combined to provide an overall habitat potential. Table 4.6-1 shows the specific categories of the variables considered to provide habitat for the ground snake and their habitat potential ratings. Using this habitat model, the City HCP planning area supports about 9,617 acres (3,892 hectares) acres of high potential habitat and 15,827 acres (6,405 hectares) of medium potential habitat for ground snakes, all located within the Avra Valley planning sub-area (Figure 4.6-2).

Table 4.6-1. Value Ratings for Characteristics of the Variables Used in the SDCP Ground Snake Habitat Model

Variable/Category	Value Rating
Vegetation	
Great Basin Conifer Woodland Pinyon-Juniper (122.41)	1
Madrean Evergreen Forest and Woodland Encineal (Oak) (122.31)	1
Madrean Evergreen Forest and Woodland Xero-riparian Encineal (Oak) (122.31XR)	1
Sonoran Riparian Woodland Xero-riparian Mesquite (124.71XR)	2
Interior Chaparral Manzanita (133.32)	1
Interior Chaparral Mixed Evergreen Sclerophyll (133.36)	1
Scrub-Grassland (Semidesert Grassland) Sacaton-Scrub (143.14)	2
Scrub-Grassland (Semidesert Grassland) Mixed Grass-Scrub (143.15)	2
Scrub-Grassland (Semidesert Grassland) Scrub-Shrub Disclimax (143.16)	1
Scrub-Grassland (Semidesert Grassland) Xero-riparian biome (143.10XR)	2
Scrub-Grassland (Semidesert Grassland) Xero-riparian Scrub-Shrub Disclimax (143.16XR)	1
Scrub-Grassland (Semidesert Grassland) Urban Mixed Grass-Scrub (143.15U)	1
Sonoran Desertscrub Saltbush (154.17)	1
Interior Southwestern Riparian Deciduous Forest and Woodland Cottonwood-Willow (223.21)	1
Sonoran Riparian and Oasis Forests Mesquite (224.52)	1
Sonoran Riparian and Oasis Forests Cottonwood-Willow (224.53)	2
Sonoran Riparian and Oasis Forests Urban Cottonwood-Willow (224.53U)	1

Table 4.6-1. Value Ratings for Characteristics of the Variables Used in the SDCP Ground Snake Habitat Model, continued

Variable/Category	Value Rating
Vegetation, continued	
Sonoran Deciduous Swamp and Riparian Scrub Meso-riparian biome (234.70)	2
Sonoran Deciduous Swamp and Riparian Scrub Mixed Scrub (234.71)	2
Sonoran Deciduous Swamp and Riparian Scrub Saltcedar Disclimax (234.72)	2
Sonoran Deciduous Swamp and Riparian Scrub Urban biome (234.70U)	1
Slope	
0–2 %	1
2–5 %	1
5–10 %	1
10–15 %	1
Elevation	
195–400 m	1
401–600 m	3
601–800 m	3
801–1,000 m	2
1,001–1,200 m	2
1,201–1,400 m	2
1,401–1,600 m	2
1,601–1,800 m	1
1,801–2,000 m	1
2,000 m and above	MASK
Land Form	
Drainageways	3
Streambeds	3
Floodplains	3
Terraces	3
Non-dissected alluvial plains	2
Dissected alluvial plains	2
Non-dissected bajadas and fans	1
Dissected bajadas and fans	1
Non-dissected pediments	1
Dissected pediments	1
Hills with low relief	1

Source: Recon (2002) Priority Vulnerable Species Analysis and Review of Species Proposed for Coverage by the Multiple Species Conservation Plan.

Town of Marana Habitat Conservation Plan Habitat Model. Rosen (2004) recently concluded that ground snakes formerly occupied narrow bands of habitat on the periphery of the valley center where bajada washes discharged water and fine sediment onto dense xeroriparian plains. He speculated that the ground snake’s preferred habitat is the denser soils of the Brawley Wash floodplain (Rosen 2004). Potential habitat, and possibly former habitat, extends as far south as Avra

Valley Road and includes several City-owned parcels. The heavy soils of the valley bottom in the City have the required soil conditions favored by the ground snake (Rosen 2003a).

A habitat model for this snake, developed by Dr. Rosen for the Town of Marana HCP, consisted of three primary variables: 1) land use, 2) elevation, and 3) soils. A series of categories was then assigned to each of these variables, and each category was ranked as 0, 1, 2, and 3, with 0 indicating that the category provides no habitat value and 3 indicating that the category provides high habitat value. The three variables were combined to provide an overall habitat value for a given area (Table 4.6-2).

Table 4.6-2 Habitat Model for the Ground Snake (Valley Form)

Variable/Category	Value Rating[1]
Soils	
Silty clay loam	3
Gila loam	3
Gravelly loam	1
Slope (applies only to gravelly loam soils)	
0 to 3 degrees (about 6.5%)	Mask
> 3 degrees	1
Vegetation	
Active agriculture	Mask*

[1] Value ratings recommended by Dr. Phil Rosen.
* Active agriculture does not constitute potential habitat in its current state. These areas can be managed in the future, however, in a manner that improves their potential as ground snake habitat.

Dr. Rosen concluded that soils provide the best overall predictor of habitat for ground snakes. Potential habitat identified by the presence of gravelly soils was further refined using slope. Vegetation and landform characteristics, however, did not appear to improve the predictive value of the model. Active agricultural land was identified as having zero habitat potential.

The Tucson shovel-nosed snake habitat model developed for the Town of Marana HCP by Dr. Rosen was considered to be as accurate and appropriate for identifying habitat within the City HCP planning area as it had been for use in the Town of Marana HCP planning area. The Marana model was therefore used in the City of Tucson HCP process without revision.

The output of the habitat suitability model for the ground snake is shown in Figure 4.6-2. Based on this habitat model, 5,193 acres (2,077 hectares) of potential ground snake habitat is predicted to occur in the Tucson planning area (Table 4.6-3).

Table 4.6-3. Acreage of Potential Ground Snake Habitat for Each Suitability Class [1]

Habitat Suitability Class	Avra Valley (acres)
High potential	1,501
Low Potential	3,692
Total Acres of Habitat, all classes	**5,193**
Total Planning Area Acres	**21,596**

[1]Avra Valley is the only planning sub-area with potential habitat

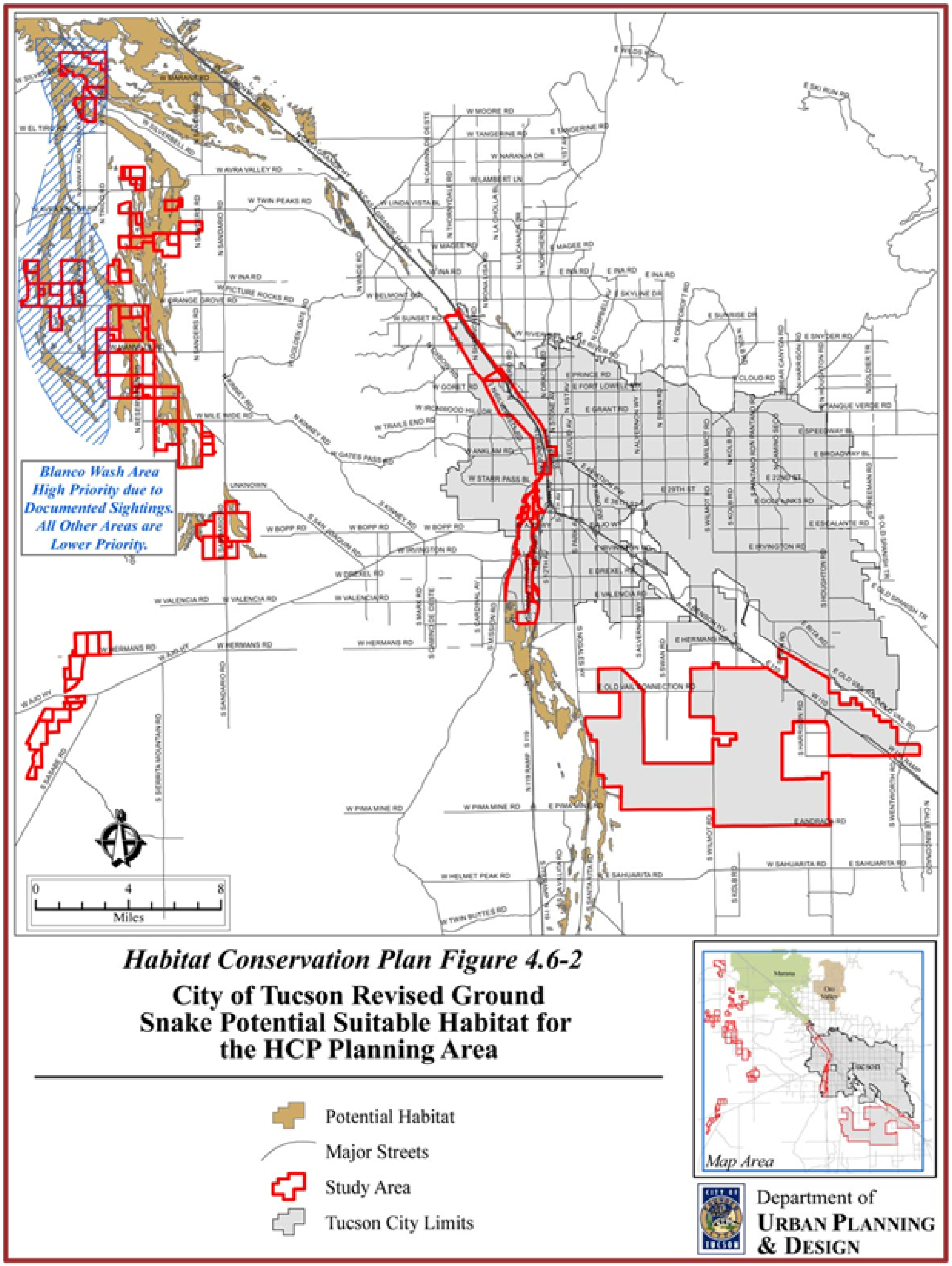

Figure 4.6-2. Habitat Suitability Model for the Ground Snake in Eastern Pima County, Arizona, Based on Soil Type Determined from Pre-2003 Records (Rosen 2004).

4.6.3.3 Importance of City of Tucson in Species' Range and Ecology

The Blanco Wash, which at its northern end runs near several parcels within the Avra Valley planning sub-area, supports the only known population of the valley form of the ground snake in Avra Valley. Rosen (2004) states that the persistence of the species from Silverbell Road south to at least halfway between Silverbell Road and Avra Valley Road has been adequately confirmed. The Brawley flats, which cover portions of a number of additional City-owned lands, also provide potential habitat for the ground snake; however, no individuals have been recorded in this area and restoration may be needed to enhance the potential of these lands to support snakes (Rosen 2004).

4.6.4 Threats and Management Needs

4.6.4.1 Potential Threats and Stressors

Loss of habitat to agricultural and urban development is regarded as the most serious threat to ground snake. Fragmentation of habitat may have contributed to the decline of this species, and various barriers, including agricultural field, residential developments, and roads, may isolate remaining potentially suitable habitat. Other serious threats identified for this snake include vehicular collisions and scientific and commercial collection, though the latter is probably no longer a serious threat given the small size of the population. See Table 4.6-4 for a complete list and discussion of stressors and threats to ground snake.

Table 4.6-4. Potential and Current Threats and Stressors for Ground Snake

Stressor/Threat	Relevance to Species
Habitat Loss	
Breeding	Loss of habitat to agricultural and urban development is regarded as most serious historic threat to the species. Loss continues today, to a lesser degree, as urban development occurs in previously undeveloped land that may still support this species.
Dispersal	Dispersal is limited for a small snake. The ability to disperse has been compromised by roads, developed areas, irrigation and drainage ditches, and areas with impacted soils.
Foraging	Size of foraging area is unknown, may be related to available food supply and available suitable soils; diversity of resources is important.
Diurnal shelter	Uses rodent burrows and litter (e.g., boards) as shelter for unknown periods of time; rodents have largely been eradicated as a result of agricultural and urban development from areas where this snake once lived.
Fire threat	May be a threat if it results in loss or conversion of vegetation; direct effects of fire on snake are unknown, probably lethal under some circumstances, not under others.
Habitat Alteration	
Prey	Consumes diverse invertebrate prey; loss or reduction of populations of suitable prey species through habitat loss and invasive competitors is probably a significant threat, but needs further research.
Vegetation composition/density	Loss of native floodplain vegetation by conversion to agricultural fields was important cause of population loss.
Habitat conversion	Loss of native floodplain vegetation by conversion to agricultural fields was important cause of population loss.
Fragmentation	Fragmentation of historic habitat may have led or contributed to endangerment of this species; remaining potentially suitable areas are isolated by various barriers.

Table 4.6-4. Potential and Current Threats and Stressors for Ground Snake, continued

Stressor/Threat	Relevance to Species
Habitat Alteration, continued	
Invasive plant species	Invasion by mesquite, buffelgrass, and red brome reduces vegetation diversity and can lead to fires, changes in soil characteristics, and prey availability.
Invasive animal species	Effects are unknown, but concern has been expressed about invasive non-native insects such as cockroaches out-competing native food animals.
Habitat rehabilitation potential	Anything that restores native vegetation is beneficial; habitat rehabilitation to enhance connectivity may improve long-term survival if the species is present or reintroduced.
Flood	May result in loss of individuals and/or areas that were formerly inhabited; much of this species' natural habitat gets flooded occasionally, and under natural conditions snakes survive, but flood regime has been altered by human activities so that floodplains in part of the historic range may remain under water for longer periods than before alteration and effect on snakes is unknown.
Groundwater depletion	May have led to loss of suitable habitat in the past, and may impede restoration of suitable habitat.
Edge effects	Unknown, but may contribute to isolation and predation on snake.
Fire threat	May be a threat if it results in loss or conversion of vegetation; direct effects of fire on snake unknown, probably lethal under some circumstances, not under others.
Water quality	Water quality is probably irrelevant, but may result in changes in soils and invertebrate community.
Land use history	Historic agricultural use may render land unsuitable for this species; long-term effects are unknown.
Species Characteristics	
Dispersal mechanism	Moves overland, apparently preferring certain types of soil; dispersal may be impacted adversely by roads, ditches, and unsuitable areas.
Habitat rehabilitation potential	Habitat rehabilitation potential for this snake is unknown. Its habitat may have been altered in important ways that we do not understand. Because the goal of rehabilitation for this species would be to restore fully functioning floodplain environments to historically suitable habitat, the potential for success is unknown.
Life history/population information	Essentially nothing is known about demographics or population dynamics of this snake; Other than its preference for undisturbed floodplain communities, specific habitat requirements are not known.
Seasonal specialization	Unknown, prey animals are clearly seasonal in abundance and life cycle, so snake must have the ability to switch prey.
Breadth of resource use	Appears to specialize in a narrow range of resources, but this is not well understood.
Adaptability	Fairly limited in habitat selection to specific soil types.
Interspecific Factors	
Invasive species	The effects of invasive species are unknown; however, invasive plants alter habitat adversely and invasive insects may alter the snake's prey base.
Anthropogenic Factors	
Fire threat	May be a threat if it results in loss or conversion of vegetation; direct effects of fire on snake are unknown, probably lethal under some circumstances, not under others.
Off-road vehicles	ORVs may impact snakes directly or indirectly through compaction of soil and/or potential burrows.
Grazing	Grazing may be harmful if it reduces vegetation diversity.
Collection/hunting	Collection may have been a problem historically, but is no longer considered a problem because snakes have not been found recently in the area.

Table 4.6-4. Potential and Current Threats and Stressors for Ground Snake, continued

Stressor/Threat	Relevance to Species
Anthropogenic Factors, continued	
Pesticides – impacts to prey	Pesticides may affect the prey base for this species.
Direct take/mortality	Direct take is not considered a problem.
Increased road density	An increase in number of roads results in loss of habitat, barriers to dispersal, and direct mortality. Mortality from vehicles is a serious problem, at least historically.
Connectivity	
Fragmentation	This is probably a significant problem because the only remaining habitat is isolated.
Barriers	Effective barriers to the movement of snakes include roads, ditches, agricultural fields, urban development, and patches of unsuitable habitat.
Habitat patchiness	Connectivity of suitable habitats is considered crucial to this species.

4.6.4.2 Current Management Recommendations

Rosen (2004) notes that, in Phoenix, the ground snake does occur in residential developments, using gardens, lawns, and mesic landscaping, especially those with native plants such as mesquite or riparian species. The biggest hurdle to maintaining ground snake populations in areas that are being developed for residential use is the high potential mortality rate resulting from grading or other surface disturbance activities (Rosen 2004). In order to minimize impacts of development on the snake, Rosen (2004) recommends that areas intended for open space, landscaping, or other less intensive uses should not be bladed. Areas with mesquite should be preserved on site.

4.6.5 Potential Impacts of City of Tucson's Proposed Activities

The City and vicinity represent a small and likely inconsequential portion of this widely distributed range of this species (i.e., much of the western United States and north-central Mexico). The range of the "valley form" of the ground snake under consideration here extends north to Eloy and the snake is likely most abundant around Red Rock (see Figure 4.6-1).

4.6.5.1 Direct Effects

Urban development, including construction of water projects, can cause direct mortality or injury to snakes.

4.6.5.2 Indirect Effects

Snakes that are displaced by construction activities could experience higher mortality while searching for suitable, unoccupied habitat. Roads and increased traffic on roads can increase mortality of snakes from vehicle strikes. Over the long term, conversion of suitable habitat to urban uses could result in take of snakes through a variety of mechanisms, including reduced foraging opportunities, reduced or degraded denning opportunities, and increased predation.

4.6.5.3 Potential Habitat Changes in City of Tucson

Conversion of existing undeveloped potential habitat to development would have an adverse effect on the snake, but the effect on this species of converting agricultural lands to development is unclear.

In the Phoenix metropolitan area, ground snakes are known to occupy urban environments. The population does best in open areas with established vegetation, including landscaped areas that are untended by typical landscape management practices (P. Rosen, pers. comm.). However, there is no evidence that the valley form of this species occupies urban environments in Pima County (RECON 2002), so it is unclear as to what extent the conversion of agricultural fields to water development projects might render existing habitat unsuitable for ground snakes. We are assuming, for purposes of this analysis, that the construction of water development projects would render the entire parcel unsuitable for the snake.

As proposed in the City Water Plan, planned public water infrastructure projects could directly impact all suitable ground snake habitat in the Avra Valley planning sub-area. Given the uncertainty in the City Water Plan regarding the types and scope of projects that may be constructed within the Avra Valley planning sub-area, we are assuming a worst-case scenario. The total footprint of covered activities in Avra Valley, e.g., recharge basins, evaporation ponds, treatment plant, etc., may require almost 7,500 acres (3,035 hectares). Construction of these projects will create impacts outside of the project footprints, long-term disturbance to habitat may result from operation of these facilities, and the covered activities may, depending on their location and configuration, result in additional habitat loss or degradation within these properties. Without knowing the final location and design of any of these facilities, we cannot say that any habitat within the Avra Valley planning sub-area will not be impacted in some fashion by these covered activities.

4.6.5.4 Population Level Effects

The potential effect of covered activities on the ground snake is uncertain because the current distribution and abundance of the species in the planning area is unknown. In the Phoenix area, the species is known to persist in urban and modified environments, and in New Mexico the species has been reported to tolerate or benefit from human developments including farm outbuildings (barns, silos, and sheds), and abandoned buildings (BISON-M 2000 *in* RECON 2002). Based on these observations, ground snakes could persist in portions of the City HCP planning area following development. However, no specific information is available with respect to the tolerance of the ground snake to human development and activity (RECON 2002).

4.7 Needle-spined Pineapple Cactus (*Echinomastus erectocentrus* var. *erectocentrus)*

4.7.1 Population Status and Ecology

4.7.1.1 Range And Distribution

The needle-spined pineapple cactus (NSPC) is one of two named varieties of *Echinomastus erectocentrus*. The species occurs from northern Sonora, Mexico north to south-central Arizona (USFWS 2005b). Within Arizona, the NSPC is found from eastern Pinal County south through eastern Pima County and Cochise County (RECON 2002) (Figure 4.7-1). The other variety, *Echinomastus erectocentrus* var. *acuñensis* or Acuña cactus, has a range that overlaps that of the NSPC within Sonora, Mexico; but the two varieties have disjunct populations in Arizona (AGFD 2003a). The putative NSPC variety is found in southeast Pima County and western Cochise County, generally along the county line. Known locations include the Rincon Valley, Little Rincon Mountains, Santa Rita Mountains, San Pedro River, near and within Cienega Creek County Preserve, in the Empire Mountains, and in the Little Dragoon Mountains (AGFD 2003a). Within that range, individuals are found in widely scattered clusters, generally on light colored, well-drained soils on fairly level or gently rolling ground. The known distribution includes the City HCP planning area on the extreme east side of the Southlands planning sub-area.

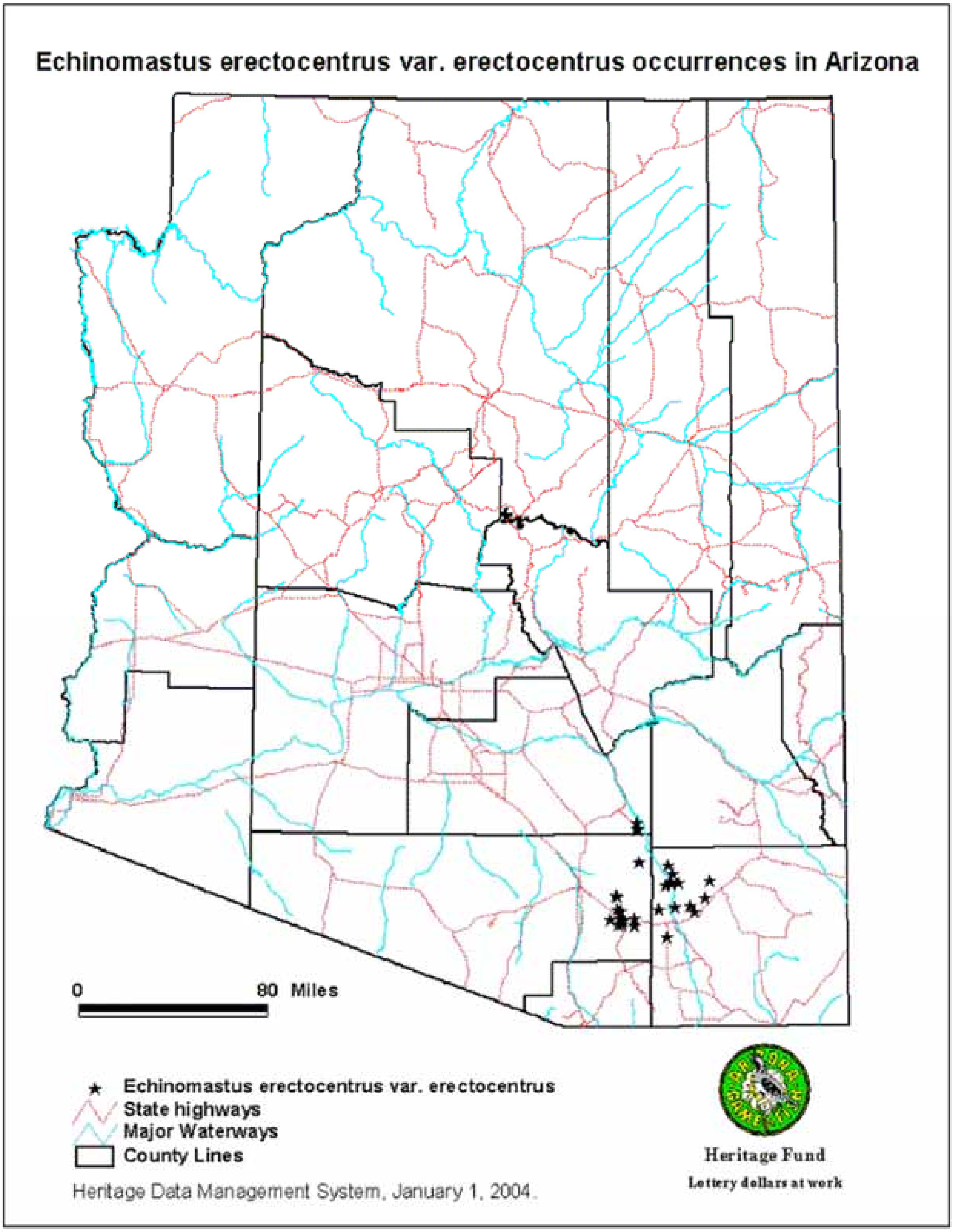

Figure 4.7-1. Distribution Map of Needle-spined Pineapple Cactus in Arizona; Based on Locations Reported in the Heritage Data Management System. Source: Arizona Game and Fish Department Website (http://www.gf.state.az.us/w_c/edits/images/echierer.gif).

4.7.1.2 Taxonomic Distinctness

The taxonomic status of this cactus is unclear to taxonomists. Synonyms include:

- *Echinocactus horripilus* Lemaire var. *erectocentrus* Weber
- *Echinomastus erectocentrus* Britton and Rose
- *Thelocactus erectocentrus* W. T. Marshall
- *Mammillaria Childsii* Blanc
- *Echinocactus Krausei* Hildmann
- *Theocactus Drausei* Kelsey and Dayton
- *Neolloydia erectocentra erectocentra* (Coulter) L. Benson
- *Sclerocactus erectocentrus* (Coulter) N.P. Taylor

The status of the two named varieties is uncertain, because they have partially overlapping ranges (in Sonora) and nearly identical morphology. In this document, NSPC will be referred to as *Echinomastus erectocentrus* var. *erectocentrus*, but readers should be aware that the accepted generic name might become *Sclerocactus*, and that this variety may be sunk.

4.7.1.3 Population Status And Threats

The population size of this species is not known. The species is uncommon, patchily distributed, and most of the known range has not been adequately surveyed. Because distribution is clustered, the species may be subject to significant loss by habitat destruction of a few small areas. Population trends are unknown, but there has been some development, including an interstate highway, paved and dirt roads, a railroad, housing, mining, and other infrastructure in the known range in Pima County (RECON 2002). Identified threats include collection for sale, habitat degradation due to urbanization, and trampling (AGFD 2003a, RECON 2002). The magnitude of these threats has not been documented.

4.7.2 Ecology

4.7.2.1 Life History

The NSPC is a succulent perennial, single-stemmed cactus with dense spines. It generally grows to a height of approximately six inches to almost 12 inches (30.5 centimeters) and a diameter of 3 to 5 inches (7.6 to 12.7 centimeters). The general appearance is of a very densely spined cactus, with many of the reddish spines pointing straight up. Flowering is known to occur in April (RECON 2002). The flowers are pink, approximately 1.5 inches (3.8 centimeters) long and 1.5 to 1.8 inches (3.8 to 4.6 centimeters) wide, with bright red stigma lobes (AGFD 2003a). Pollinators and seed distributors are not known. No additional information is available on the biology of this species.

4.7.2.2 Habitat Requirements

The NSPC is generally found in Semidesert Grassland and the upper elevations of the Arizona Upland Subdivision of Sonoran Desertscrub on east, west, and south facing slopes on alluvial fans and hills between 3,000 and 4,600 feet (915 to 1,400 meters) in elevation (RECON 2002, AGFD 2003a). The cactus occurs on light-colored gravels, such as felsic volcanics, granite, and limestone, and on alluvial soils of rock and gravel over sandstone conglomerates (AGFD 2003a).

The cactus is typically found in areas that are dominated by velvet mesquite, creosote bush, foothills paloverde, ocotillo, prickly pear cactus, fineleaf yucca (*Yucca angustissima*), and various grass species (AGFD 2003a). Additional associates include whitethorn acacia, desert broom, desert hackberry, and various species of cacti, yucca, and agave (AGFD 2003a).

4.7.3 Baseline Conditions

4.7.3.1 City of Tucson Population Status

Within the City HCP planning area, there are records of this species from the far eastern edge of the Southlands planning sub-area where a total of eight individuals were recorded by Baker (2005) within an approximately 2-hectare (4.9 acre) area. Two known populations also occur near the eastern edge of the Southlands planning sub-area in the vicinity of Colossal Cave County Park and the Cienega Creek Natural Preserve (RECON 2002).

4.7.3.2 Habitat in and near the City of Tucson

Only one model has been developed to delineate potential habitat for the needle-spined cactus.

Sonoran Desert Conservation Plan Habitat Model. A habitat model for the NSPC was developed as part of the SDCP (RECON 2002). This habitat model consisted of the following three primary variables:

- Vegetation
- Elevation
- Landform

The habitat potential of the categories of each variable were ranked as 0, 1, 2, and 3, with 0 indicating that the category provided no habitat and 3 indicating that the category provided high potential habitat.
The three variables were combined to provide an overall habitat potential. Table 4.7-1 shows the specific categories of the variables considered to provide habitat for the NSPC and their habitat potential ratings. Using this habitat model, the City HCP planning area supports about 1,467 acres (594 hectares) of medium potential habitat for NSPC, all located within the Southlands planning sub-area (Figure 4.7-2).

The NSPC habitat model developed for the SDCP was considered to be as accurate and appropriate for identifying habitat within the City HCP planning area and it was therefore used without revision.

2005 NSPC Surveys. During the summer of 2005, Dr. Marc Baker conducted surveys for NSPC and PPC across the Southlands planning sub-area using random, or semi-random, transects (Baker 2005a). This information was used to validate and/or refine the NSPC potential habitat model. In coordination with Mima Falk (plant ecologist, USFWS) the primary objective of his study was to estimate the geographic distribution and relative densities of NSPC and PPC within the Southlands planning sub-area. In order to estimate the distribution and abundance of NSPC, Baker delineated 67.7 kilometers (42 miles) of pedestrian transects within areas suspected to fall within the range of NSPC. The estimated range of NSPC was provided to the author as an Arcview® shapefile by Clint Chiavarini, City of Tucson – Urban Planning and Design. Baker designed transects that began at a single point and meandered in a loop back to the point of origin. The design was intended to maximize the chance of locating populations, but was not intended to locate 100 percent of the individuals potentially occurring in a given area. In addition to conducting pedestrian transects, Baker recorded all individuals seen along vehicle transect routes. All individuals were recorded as a GPS point (waypoint) using UTM coordinates (NAD27, zone 12).

Table 4.7-1. Value Ratings for Characteristics of the Variables Used in the Needle-spined Pineapple Cactus Habitat Model in the SDCP

Variable/Category	Value Rating
Vegetation	
Scrub-Grassland Upland Sacaton-Scrub (143.14)	2
Scrub-Grassland Upland Mixed Grass-Scrub (143.15)	3
Scrub-Grassland Upland Shrub-Scrub Disclimax (143.16)	2
Scrub-Grassland Xero-riparian biome (143.10XR)	3
Scrub-Grassland Xero-riparian Shrub-Scrub Disclimax (143.16XR)	2
Scrub-Grassland Urban Mixed Grass-Scrub (143.15U)	2
Chihuahuan Desertscrub Upland Creosotebush-Tarbush (153.21)	2
Chihuahuan Desertscrub Upland Mixed Scrub (153.26)	2
Chihuahuan Desertscrub Xero-riparian Creosotebush-Tarbush (153.21XR)	2
Sonoran Desertscrub Upland Creosote-Bursage (154.11)	2
Sonoran Desertscrub Upland Paloverde-Mixed cacti (154.12)	3
Sonoran Desertscrub Upland Agave-Bursage (154.15)	2
Sonoran Desertscrub Xero-riparian biome (154.10XR)	2
Sonoran Desertscrub Xero-riparian Creosote-Bursage (154.11XR)	2
Sonoran Desertscrub Xero-riparian Paloverde-Mixed cacti (154.12XR)	3
Sonoran Desertscrub Urban Paloverde-Mixed cacti (154.12U)	2
Elevation	
801–1,000 meters (2,628–3,282 feet)	2
1,001–1,200 meters (3,283–3,939 feet)	2
1,201–1,400 meters (3,940–4,595 feet)	2
Landform	
drainageways	mask
streambeds	mask
dissected bajadas and fans	3
mountains	2

Baker (2005) concluded that NSPC are apparently restricted to the far eastern edge of the Southlands planning sub-area. He reported that NSPC populations generally occur in aggregations, thus it would be unlikely to find a single individual occurring in the larger survey area to the southeast. Baker said that additional NSPC individuals might be found on the far eastern edge of the Southlands planning sub-area, since his surveys were not intended to find 100 percent of the NSPC potentially present in the area. He noted that although the habitat beyond the recorded individuals did not appear suitable, there remains the possibility of suitable habitat within a few hundred meters. Figure 4.7-2 shows the revised NSPC habitat model for the Southlands planning sub-area.

4.7.3.3 Importance Of Tucson In Species' Range And Ecology

Based on Baker's survey results (Baker 2005a), it appears that the Southlands planning sub-area is located at the western periphery of the range of NSPC. Opposing arguments have been advanced in academic circles about the evolutionary importance of peripheral populations. Some biologists theorize that peripheral populations are important in the ultimate expansion of a species into new areas and may be the point of greatest adaptation and evolution of a given species. Other biologists argue that peripheral populations are less significant than populations at the center of the species distribution. Neither view has been well proven by empirical evidence.

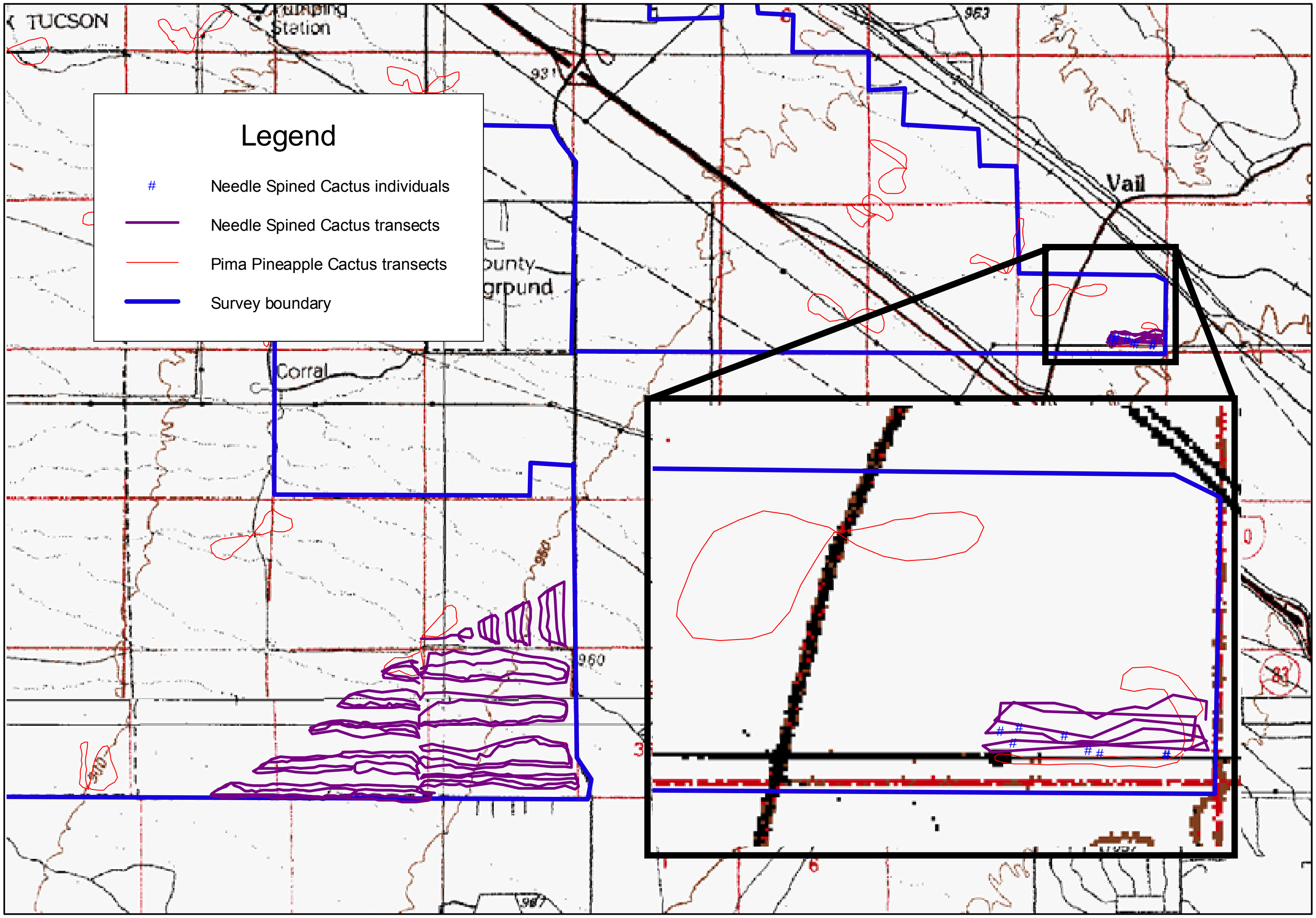

Figure 4.7-2. City of Tucson Revised Needle-spined Pineapple Cactus Potential Suitable Habitat for the Southlands Planning Sub-area including location of transects for and NSPC individuals (Baker 2005a).

4.7.4 Threats and Management Needs

4.7.4.1 Potential Threats and Stressors

Identified threats to this cactus include collection for sale, habitat degradation due to urbanization, and trampling (AGFD 2003a, RECON 2002). The magnitude of these threats has not been documented. Construction activities (e.g., grading and other land disturbance activities) for new residential, commercial, and industrial development and supporting infrastructure would result in the direct loss of NSPC. Urban development in and around NSPC habitat also would result in greater human access to plants, increasing the threat of collection, unintentional disturbance, and vandalism. The population size of this species is not known, but it is patchily distributed and therefore subject to potentially significant impacts depending on the location of development. See Table 4.7-2 for a complete list and discussion of stressors and threats to needle-spined pineapple cactus.

Table 4.7-2. Potential and Current Threats and Stressors for Needle-spined Pineapple Cactus

Stressor/Threat	Relevance to Species
Habitat Loss	
Habitat suitability	Loss of habitat is the primary threat to this species. Suitable habitat consists of more than just the areas inhabited by individual plants; it also includes sufficient areas of suitable habitat for the species to expand or shift in response to environmental factors. It may be possible, based on habitat preferences and historic distribution, to rate areas based on potential to support future populations, including soils (light-colored gravels), elevation, distance to nearest known or historic population, and presence of other cactus species.
Fire threat	The impacts of fire on this species are not well understood, but thought to be negative. Fire loads in the Southlands planning sub-area are fairly low, however.
Habitat Alteration	
Nurse plant availability	Not known to be associated with nurse plants.
Fragmentation	This species appears to be distributed in clusters. Development of small areas might eradicate local populations, and further fragmentation of habitat could reduce the ability of pollinators to reach the cacti. Lower rates of pollination impact reproductive output and decrease gene flow between populations. Patch size is also important to allow for shifts in location of cacti in response to environmental factors.
Invasive plant species	Non-native grasses (e.g., buffelgrass), particularly at high densities, are thought to reduce plant densities. Invasives may also increase risk of fire, which may be detrimental to individual cacti.
Invasive animal species	Individual plants may be trampled by cows and horses.
Habitat rehabilitation potential	Habitat rehabilitation potential is considered high for this cactus; however, critical factors to restore or enhance to increase suitability for cactus are unknown.
Drought	Can have a negative, and potentially severe, impact on cactus populations.
Flood	Inundation can result in mortality of cacti. Floodplains are poor habitat, although areas of sheet flow are not entirely unsuitable.
Artificial water sources	Irrigation could provide a real benefit to cactus, especially during droughts. Water should be supplemented during rainy season and only when rain is limited.
Edge effects	The presence of roads encourages invasive plant species that may have a negative impact on this cactus.
Land use history	The significance of land use history for this cactus relates to whether the seed bank is still present in the soil. Grazing may potentially have some benefit to the extent that grass and shrub densities are reduced. Cactus can recover from the impacts of prior land uses, but only over very long periods of time.

Table 4.7-2. Potential and Current Threats and Stressors for Needle-spined Pineapple Cactus, continued

Stressor/Threat	Relevance to Species
Habitat Alteration, continued	
Colonization potential	The presence of a seed bank is critical for colonization by this species.
Captive breeding/ translocation potential	The success of transplantations has not been adequately evaluated.
Genetic isolation	Genetic isolation is considered a serious issue in some portions of the species range.
Interspecific Factors	
Predation	Potential predators are unknown, but likely include rodents and the larvae of several insect species. Areas with high densities of cacti may be especially susceptible.
Disease	The extent to which this cactus is susceptible to infection is unknown.
Pollinators/seed dispersers	Pollinators and potential seed dispersers are not known.
Competition	The extent to which this cactus competes for space with grasses and other plant species is unknown.
Anthropogenic Factors	
Off-road vehicles	NSPC are run over by ORVs. ORV disturbance may also encourage invasive plant species, which may have negative impact on this cactus.
Passive recreation	People moving off of trails may expose cacti to potential disturbance, trampling, or risk of collection.
Collection/hunting	Collection of this cactus for sale has been identified as a problem.
Insecticides	Non-target insecticides may impact potential pollinators.
Direct take/mortality	Mortality is primarily associated with loss of habitat, trampling, and collection.
Landscaping	The impact on this cactus of using non-native species as landscaping is unknown, but generally is thought to be a risk. Although this cactus can be used in landscaping, this is not a replacement for preservation of the species in its native habitat. Use for landscaping, however, could provide connectivity between isolated reserves for pollinators.
Increased road density	Results in loss of habitat.
Connectivity	
Fragmentation	Fragmentation of habitat at a relatively large scale could dramatically reduce the ability of pollinators to reach these cacti.
Wash incision	If gradual, was incision may provide habitat for this cactus; typically headcuts result in loss of habitat.
Habitat patchiness	From a landscape perspective, a mosaic of habitat types and locations is desirable, as long as individual reserves are not isolated. Minimum patch size is not known.

4.7.4.2 Current Management Recommendations

Essentially the same management recommendations made for PPC would apply to this species. The first and most essential management recommendation is to determine how abundant NSPC is within the Southlands planning sub-area. If it occurs in greater numbers or over a wider area than observed by Baker (2005), then further management recommendations might be developed based upon parameters associated with the population, such as a reserve strategy.

4.7.5 Potential Impacts Of Tucson's Proposed Activities

4.7.5.1 Direct Effects

Because this species appears to be distributed in clusters, intensive development of small areas might eradicate local populations. Construction activities (e.g., grading and other land disturbance activities) for new residential, commercial, and industrial development and supporting infrastructure would result in the direct loss of NSPC. Some cacti may be preserved in place within developments; however, biologists question the value of protecting individual plants in small areas isolated from one another because there is little opportunity for gene flow. Transplantation of cacti is also a questionable strategy. In some species (e.g., Pima pineapple cactus), transplanted individuals exhibit low survival rates and little or no reproduction.

4.7.5.2 Indirect Effects

Urban development in and around NSPC habitat also results in greater human access to plants, increasing the threat of collection, unintentional disturbance, and vandalism. The introduction of exotic plant species, such as fountain grass, buffelgrass, Lehman's lovegrass, and red brome, which often accompanies urbanization, can increase the risk of wildfires and interspecific competition. Invasive species may out-compete NSPC for space and resources or may render open areas vulnerable to wildfires that could potentially result in mortality of cacti. Urban development may also adversely impact pollinators and seed dispersers either by removing the resources needed for their survival or by supporting introduced competitors, predators, parasites, and diseases.

4.7.5.3 Potential Habitat Changes in Tucson

The covered activities within suitable habitat would cause permanent habitat loss and habitat fragmentation. Due to regulatory restrictions that prohibit or limit intrusion into washes and riparian areas, construction activities tend to be concentrated in uplands. These upland habitats are the areas most likely to support NSPC. Habitat requirements of many pollinators and seed dispersers are largely unknown, but some loss of habitat is likely to occur.

4.7.5.4 Population Level Effects

Population level effects of the potential loss of a small number of individuals at the margin of the species distribution are unknown.

4.8 Pale Townsend's Big-eared Bat (*Corynorhinus townsendii pallescens*)

4.8.1 Population Distribution, Taxonomy, and Status

4.8.1.1 Range and Distribution

The pale Townsend's big-eared bat ranges throughout western North America from southern British Colombia south along the Pacific coast to southern California, from the Black Hills of South Dakota to western Texas, and through the Mexican uplands to the Isthmus of Tehuantepec in southern Mexico. It is not known from the Baja California Peninsula. Isolated occurrences in the southern Great Plains, Ozark Mountains and Appalachian Mountains are considered to be relict populations.

The species is widespread throughout Arizona, although not considered common anywhere, and is least common in northeastern grasslands and southwestern desert areas. It has been found from 550 to

7,520 feet (168 to 2,294 meters) in elevation. Most records, however, come from above 3,000 feet (915 meters) (Hinman and Snow 2003). In Arizona, pale Townsend's big-eared bats have been reported in Cochise, Coconino, Gila, Graham, La Paz, Maricopa, Mohave, Navajo, Pima, Pinal, Santa Cruz, Yavapai, and Yuma counties (Figure 4.8-1).

4.8.1.2 Taxonomic Distinctness

The *Corynorhinus* genus, which has been the accepted generic name for most of the taxonomic history of the species, was relegated by Handley (1959) to sub-generic status under the genus *Plecotus* (BISON-M 2004b, AGFD 2003b). After several morphological, phylogenetic, and genetic evaluations (see Frost and Timm 1992, Tumlinson and Douglas 1992, and Bogdanowicz et al. 1998), *Corynorhinus* was re-elevated to full genus status (AGFD 2003b).

The pale Townsend's big-eared bat (PTBB) is one of five subspecies currently recognized under *C. townsendii* (BISON-M 2004b, AGFD 2003b). Three of the subspecies, *C. t. virginianus* (Virginia big-eared bat), *C. t. ingens* (Ozark big-eared bat), and *C. t. australis*, do not occur in the western U.S. (BISON-M 2004b, Kunz and Martin 1982, USFWS 1992). *C. t. townsendii*, known variously as the Pacific western big-eared bat or Western big-eared bat, occurs in Washington, Oregon, California, Nevada, Idaho, and possibly northwest Utah and southwest Montana (BISON-M 2004b, USFWS 1992,). *C. t. pallescens* is found in the same states as *C. t. townsendii* and, in addition, occurs in Arizona, Colorado, New Mexico, Texas, and Wyoming (BISON-M 2004b). However, taxonomic understanding of this complex is still evolving, and recent work suggests that, *C. t. pallescens*, will likely become *C. t. townsendii*. *C. t. pallescens* will be designated as the subspecies restricted to northern New Mexico and Colorado, while *C. t. townsendii* will be the subspecies in Arizona (Piaggio, A. J., and S. L. Perkins. In review. Molecular phylogeny of North American big-eared bats). (Vespertilionidae: *Corynorhinus*): inter- and intraspecific relationships inferred from mitochondrial and nuclear DNA sequences. Molecular Phylogenetics and Evolution.) .

Although there are areas where only one of the two western subspecies apparently occurs, the two subspecies intergrade throughout much of their range and, in these intergrade zones, individuals cannot easily be assigned to subspecies (BISON-M 2004b, Pierson and Rainey 1994). As a result some authors do not distinguish between the two western subspecies, lumping them into a single taxon, *C. t. townsendii* or the Townsend's big-eared bat (Hutson et al. 2001, Pierson and Rainey 1994).

4.8.1.3 Population Status and Threats

Range-wide Population Status and Threats. The two eastern subspecies, *C. t. virginianus* and *C. t. ingens*, were listed as endangered in 1979 primarily as a result of severe population declines and restriction of breeding habitat to only a few caves (USFWS 1979). In 1994, *C. t. pallescens* and *C. t. townsendii* were recognized as Category 2 Federal Candidates, now referred to as Species of Concern (BISON-M 2004b).

The overall population status and trend of the pale Townsend's big-eared bat is uncertain, but the species is believed to have declined in parts of its range. A survey by Pierson and Rainey (1994) suggested that substantial population declines in pale Townsend's big-eared bats have occurred in California over the last 40 to 60 years based on the following:

- 52 percent loss in the number of maternity colonies,
- 44 percent decline in the number of roosts,
- 55 percent decline in the number of bats, and
- 32 percent decrease in the average size of remaining colonies.

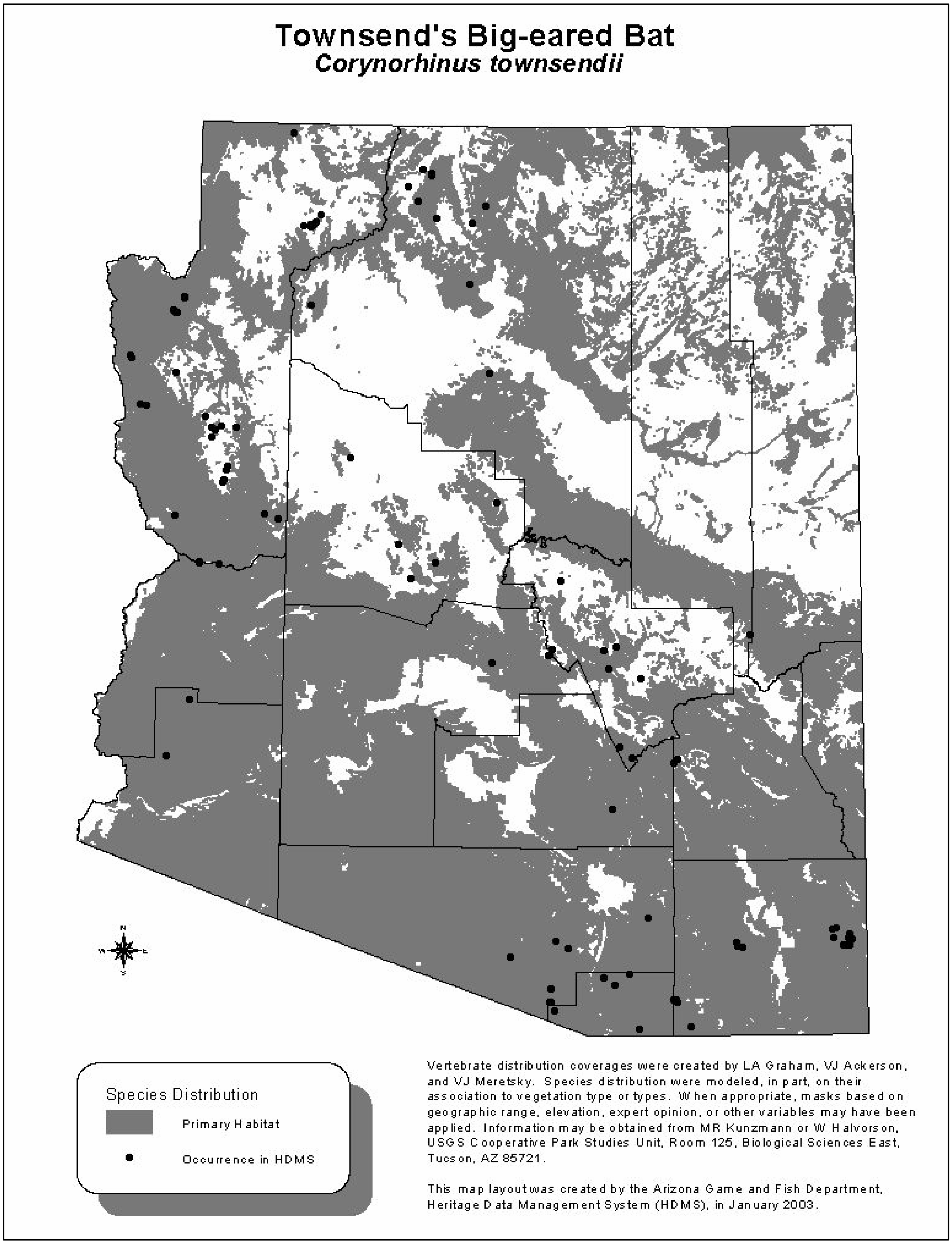

Figure 4.8-1. Habitat Range and Occurrence of Pale Townsend's Big-eared Bat in Arizona. Points Represent Maternity Colonies, Roosts of Five or More Individuals, Sites Where Five or More Males Have Been Netted, and Sites Where Pregnant or Lactating Females Have Been Netted.

The lower Colorado Desert along the Colorado River, an area that experiences heavy recreational use, is one of three areas in California in which marked declines in the numbers of pale Townsend's big-eared bat colonies have taken place.

The pale Townsend's big-eared bat is threatened by:

- Human disturbance at major maternity roosts,
- Mining,
- Closure and sealing of abandoned mines,
- Vandalism at maternity and hibernation sites,
- Loss of foraging habitat, and possibly exposure to pesticides (AGFD 2003b).

Pale Townsend's big-eared bats are extremely sensitive to human disturbance, and simple entry into a maternity roost can result in the abandonment of the site (Pierson et al. 1991). Because this bat feeds heavily on Noctuid moths, which require wetland habitats, a decline in wetland habitats could contribute to a decline in the bat population.

Arizona Population Status and Threats. Population trends for Townsend's big-eared bats in Arizona are unclear, but losses of and reductions in bat numbers at maternity colonies have been reported (Hinman and Snow 2003). Pierson and Rainey (1994) reported that only 13 maternity roosts have been verified in Arizona. These 13 sites represent 10 separate colonies totaling about 1,000 adult females. More than half of the sites are in mines and only four are known to contain more than 200 individuals (RECON 2002). According to more recent reports, only five to seven maternity colonies, ranging in size from 100 to several hundred bats, are currently known (RECON 2002). The largest colony in Arizona, Stanton's Cave in the Grand Canyon, disappeared in the 1970s shortly after the roost site was gated to protect archeological and paleontological remains. After the gate was modified in the mid-1980s, several bat species (but not *C. townsendii*) were observed inside the site (RECON 2002). Current bat use of these sites is not known (AGFD 2003b).

Maternity sites for the species have been found at Agua Caliente Cave, Dixie Mine, Crystal Cave, Stanton's Cave in Grand Canyon National Park, the Chiricahua Mountains, a cave in Sycamore Canyon, a cave near Union Pass, and a cave in Hereford, although not all of these sites remain in use (BISON-M 2004b, Dalton and Dalton 1994; Castner et al. 1994). Pale Townsend's big-eared bat hibernacula have been located within the Gold Button Mining Claim in Prescott National Forest (one site) and along the Bill Williams River (two sites) (Snow et al. 1995, Castner et al. 1994).

Mist net and roost surveys during the 1990s (see BISON-M 2004b, Snow and Castner 1996, Snow et al. 1996, Snow et al. 1995, Castner et al. 1994) yielded pale Townsend's big-eared bat records in numerous locations including:

- Apache-Sitgreaves, Coconino, Coronado, Prescott, Kaibab, and Tonto National Forests,
- Cave and Walnut Creeks,
- Klondyke Mine,
- Arivaca and Duquesne Quads in Santa Cruz County,
- McDowell Peak Quad in Maricopa County,
- Harcuvar Mountains (Happy Day Pond),
- Harquahala Mountains (Browns Canyon Spring),

- In foothills southeast of Kingman (Boulder Well),
- Along the Bill Williams River,
- Batamote Hills, Helvetia, and Stevens Mountain Quads in Pima County, and
- Pale Townsend's big-eared bats have also been found roosting under bridges in Arizona (BISON-M 2004b).

4.8.2 Ecology

4.8.2.1 Life History

Pale Townsend's big-eared bats are active in summer, but hibernate in winter. They mate in autumn and winter and sperm is stored in the female's reproductive tract until spring. Fertilization occurs at the time of ovulation. Males produce few sperm in their first autumn and are considered to be largely sterile and probably non-breeding. In contrast, females breed in their first autumn and bear young the following summer. Gestation varies from 56 to 100 days after fertilization, depending on climatic conditions and the resultant metabolic rates of the females (i.e. development slows when females go into daily torpor). In summer, females form maternity colonies of 12 to about 200; males, however, roost alone, or in small groups (as many as three individuals) (Pierson and Rainey 1994, Tigner and Stukel 2003).

In Arizona, females are pregnant in April and maternity colonies have been reported in late April. Indirect evidence (near term embryos and presence of newborns) indicates that the single young is born in June in Arizona. Dates of birth vary considerably throughout the bat's range (from late April to mid July). In Arizona, most young are flying by the end of July and nursery colonies begin to disperse during August (Hinman and Snow 2003).

Banding studies indicate high roost and group fidelity and colonies will, if undisturbed, use the same site indefinitely. Most, if not all, females return to their natal group each breeding season resulting in multi-generational, matrilineal colonies. Banded females have been found to remain within a few kilometers of their natal site and when foraging or shifting between alternate roost sites, movement is confined to within 15 kilometers of the primary roost. Even when disbanding from summer colonies to winter hibernacula, banded individuals have not been documented to disperse more than 43 kilometers (Pierson and Rainey 1994).

The mortality rate is high for juvenile bats. The average number of yearling females that return to their natal site in the following breeding season is between 38 and 45 percent. In succeeding years, the survival rate rises to around 75 percent (BISON-M 2004b, Pierson and Rainey 1994). Five years is the average age of pale Townsend's big-eared bats within a population. A single banded individual, however, has been documented at more than 21 years old (BISON-M 2004b). Little is known about the causes of mortality in pale Townsend's big-eared bats; however, predation is thought to be significant with house cats, black rats, and ringtails among the species observed to prey on the bat. Interspecific competition and disease are not considered to significantly impact populations of this species (BISON-M 2004b). Since *P. t. pallescens* is easily disturbed, arousal during winter hibernation could lead to starvation of a bat based on the expenditure of 10 to 30 days of fat reserves (BISON-M 2004b).

The species forages by echolocation, capturing insects in flight and sometimes from leaves along forest edges (BISON-M 2004b, Hinman and Snow 2003). Studies of stomach contents from bats in the southwest have revealed that their diet consists primarily of lepidopterans, with small quantities of Coleoptera, Diptera, Hemiptera, Hymenoptera, Homoptera, Neuroptera, Trichoptera, and Plecoptera

(BISON-M 2004b). Small moths, 3 to 10 millimeters (average of about six millimeters), are the primary food of these bats (AGFD 2003b).

The species forages over desertscrub, riparian habitats, wetlands or open water, typically within 15 miles (24 kilometers), and often within 4 to 5 miles (6.6 to 8 kilometers), of the roost sites (Hinman and Snow 2003, AGFD 2003b). However, recent studies by Rick Sherwin and Antoinette Piaggio indicate that *C. townsendii* may travel large distances while foraging, including movements of over 93 miles (150 kilometers) during a single evening (R. Sidner, pers. comm.). Following a late night peak of activity, they usually go to a night roost. They may forage again in the early morning since they are reported not to return to their daytime roosts until shortly before sunrise (AGFD 2003b).

4.8.2.2 Habitat Requirements

In Arizona, summer day roosts include caves and mines in areas of desertscrub, oak woodland, oak/pine woodland, pinyon/juniper woodland, and coniferous forest. Pale Townsend's big-eared bats prefer to hang from open ceilings at roost sites and do not use cracks or crevices. At maternity roosts, these bats apparently prefer the dim light near the edge of the lighted zone. In Arizona, emergence times and especially return times and patterns probably vary, as they do elsewhere, depending on insect activity and development stage of young. Night roosts are often in abandoned buildings (Hinman and Snow 2003).

In winter, big-eared bats hibernate in cold caves, lava tubes, and mines. Of all North American bats, this species seems to be the most dependent on availability of abandoned or inactive mines for roost sites (BISON-M 2004b). In Arizona, hibernation sites are mostly in upland and mountainous areas, from the vicinity of the Grand Canyon to the southeastern part of the state. Winter roosts generally contain fewer individuals (usually singles or small groups, and in Arizona occasionally as many as 50) than summer roosts. For hibernation, they prefer roost sites where the temperature is 54 °F (12° C) or less. Such sites may be near entrances or in well-ventilated areas of the roost. The bats may arouse and move to other spots in the roost during the winter so as to be in areas of stable cold temperatures (Hinman and Snow 2003). Roost selection appears to be limited by the temperature within potential sites (BISON-M 2004b).

4.8.3 Baseline Conditions

4.8.3.1 City of Tucson Population Status

According to the AGFD Heritage Data Management System (AGFD, unpublished data accessed 2003), there are no known roost sites within the City HCP planning area. Given the low elevations and relatively flat topography of the planning area, there is also little or no potential for undocumented roosts sites to be present. In Pima County, this species is known to use Colossal Cave Mountain Park, Tucson Mountain Park, Organ Pipe Cactus National Monument, and Saguaro National Park (Pima County 2000).

4.8.3.2 Habitat in and Near the City of Tucson

Two different models have been developed to delineate potential habitat for the pale Townsend's big-eared bat:

- The Sonoran Desert Conservation Plan habitat model, and
- The City of Tucson Habitat Conservation Plan habitat model.

Sonoran Desert Conservation Plan Habitat Model. A habitat model for the pale Townsend's big-eared bat was developed as part of the SDCP (RECON 2002). This habitat model consisted of the following six primary variables:

- Hydrology
- Vegetation
- Slope
- Elevation
- Aspect
- Carbonates

The habitat potential of the categories of each variable were ranked as 0, 1, 2, and 3, with 0 indicating that the category provided no habitat and 3 indicating that the category provided high potential habitat. The six variables were combined to provide an overall habitat potential. Table 4.8-1 shows the specific categories of the variables considered to provide habitat for the pale Townsend's big-eared bat and their habitat potential ratings. Using this habitat model, the City HCP planning area supports about 664 acres (269 hectares) of high potential habitat and 4,676 acres (1,892 hectares) of medium potential habitat for pale Townsend's big-eared bat (Figure 4.8-2).

Table 4.8-1. Value Ratings for Characteristics of the Variables Used in the SDCP Pale Townsend's Big-eared bat Habitat Model

Variable/Category	Value Rating
Hydrology	
Intermittent stream	2
Adjacent habitat within ½ mile of intermittent stream	2
Adjacent habitat within 1 mile of intermittent stream	2
Perennial stream	2
Adjacent habitat within ½ mile of perennial stream	1
Adjacent habitat within 1 mile of perennial stream	1
Spring	2
Adjacent habitat within ½ mile of spring	2
Vegetation	
Rocky Mountain Montane Conifer Forest Douglas fir-White fir (122.31)	2
Rocky Mountain Montane Conifer Forest Pine (122.32)	2
Rocky Mountain Montane Conifer Forest Xero-riparian biome (122.30XR)	2
Great Basin Conifer Woodland Pinyon-Juniper (122.41)	2
Madrean Montane Conifer Forest Douglas fir-Mixed Conifer (122.61)	2
Madrean Montane Conifer Forest Pine (122.62)	2
Madrean Evergreen Forest and Woodland Encineal (Oak) (123.31)	2
Madrean Evergreen Forest and Woodland Oak-Pine (123.32)	2
Madrean Evergreen Forest and Woodland Xero-riparian biome (123.30)	2
Madrean Evergreen Forest and Woodland Xero-riparian Encineal (Oak) (123.31XR)	2
Relict Conifer Forest and Woodland Xero-riparian biome (123.50XR)	2
Sonoran Riparian Woodland Xero-riparian Mesquite (124.71XR)	1

Table 4.8-1. Value Ratings for Characteristics of the Variables Used in the SDCP Pale Townsend's Big-eared bat Habitat Model, continued

Variable/Category	Value Rating
Vegetation, continued	
Scrub-Grassland (Semidesert Grassland) Sacaton-Scrub (143.14)	2
Scrub-Grassland (Semidesert Grassland) Mixed Grass-Scrub (143.15)	2
Scrub-Grassland (Semidesert Grassland) Scrub-Shrub Disclimax (143.16)	2
Scrub-Grassland (Semidesert Grassland) Xero-riparian biome (143.10XR)	2
Scrub-Grassland (Semidesert Grassland) Xero-riparian Scrub-Shrub Disclimax (143.16XR)	2
Scrub-Grassland (Semidesert Grassland) Urban Mixed Grass-Scrub (143.15U)	1
Chihuahuan Desertscrub Creosotebush-Tarbush (153.21)	1
Chihuahuan Desertscrub Mixed Scrub (153.26)	1
Chihuahuan Desertscrub Xero-riparian Creosotebush-Tarbush (153.21XR)	1
Sonoran Desertscrub Creosote-Bursage (154.11)	1
Sonoran Desertscrub Paloverde-Mixed Cacti (154.12)	2
Sonoran Desertscrub Xero-riparian biome (154.10XR)	2
Sonoran Desertscrub Xero-riparian Creosote-Bursage (154.11XR)	2
Sonoran Desertscrub Xero-riparian Paloverde-Mixed Cacti (154.12XR)	2
Sonoran Desertscrub Urban Paloverde-Mixed Cacti (154.12U)	1
Interior Southwestern Riparian Deciduous Forest and Woodland Meso-riparian biome (223.20)	2
Interior Southwestern Riparian Deciduous Forest and Woodland Cottonwood-Willow (223.21)	2
Interior Southwestern Riparian Deciduous Forest and Woodland Mixed Broadleaf (223.22)	2
Sonoran Riparian and Oasis Forests Mesquite (224.52)	1
Sonoran Riparian and Oasis Forests Cottonwood-Willow (224.53)	1
Sonoran Riparian and Oasis Forests Urban Cottonwood-Willow (224.53U)	1
Sonoran Deciduous Swamp and Riparian Scrub Meso-riparian biome (234.70)	2
Sonoran Deciduous Swamp and Riparian Scrub Mixed Scrub (234.71)	2
Sonoran Deciduous Swamp and Riparian Scrub Saltcedar Disclimax (234.72)	2
Sonoran Deciduous Swamp and Riparian Scrub Urban biome (234.70U)	2
Active Agriculture (999.11)	2
Urban – Developed (999.21)	1
Lake (999.31)	2
Mining Pond (999.32)	1
Sewage Pond (999.33)	2
Permanent Stream (999.35)	1
Stock Pond (999.36)	2
Slope	
2–5 %	3
5–10 %	3
10–15 %	3
15–30 %	3
30–50 %	3
> 50 %	3

Table 4.8-1. Value Ratings for Characteristics of the Variables Used in the SDCP Pale Townsend's Big-eared bat Habitat Model, continued

Variable/Category	Value Rating
Elevation	
195–400 meters	1
401–600 meters	1
601–800 meters	1
801–1,000 meters	1
1,001–1,200 meters	2
1,201–1,400 meters	2
1,401–1,600 meters	2
1,601–1,800 meters	2
1,801–2,000 meters	2
2,001–2,200 meters	2
2,201–2,400 meters	2
2,401–2,600 meters	2
2,601–2,800 meters	2
South	1
Southwest	2
West	2
Northwest	1
Carbonates	
Carbonates	3
Area within 1 mile of carbonates	3
Area within 1 mile of known caves and mines	3

Source: Recon (2002) Priority Vulnerable Species Analysis and Review of Species Proposed for Coverage by the Multiple Species Conservation Plan.

City of Tucson Pale Townsend's Big-eared Bat Habitat Model.

The SDCP suitable pale Townsend's big-eared bat habitat model appeared to be influenced too strongly by the "slope" variable, which resulted in the identification of only small isolated patches of suitable habitat across the City HCP planning area. The City HCP Technical Advisory Committee felt that the foraging potential for the bat was more extensive than was captured by the SDCP model and thus proposed an alternative model.

Potential habitat model for the pale Townsend's big-eared bat was developed with the input of the City HCP Technical Advisory Team, and in particular, the input of Dr. Linwood Smith. A composite vegetation map developed by Pima County as part of the SDCP was used to identify areas characterized as Arizona Upland Subdivision of the Sonoran Desertscrub and Semidesert Grassland biomes. To account for disturbance that has removed the natural vegetation cover from areas within Avra Valley, a mask was applied that removed lands, which have recently been cultivated and have not recovered their natural vegetation composition (Figure 4.8-2). Based on this model, 28,255 acres (11,435 hectares) of potential ground snake habitat is predicted to occur in the Tucson planning sub-area; 25,986 acres (10,516 hectares) in the Southlands planning sub-area, and 2,269 acres (918 hectares) in the Avra Valley planning sub-area.

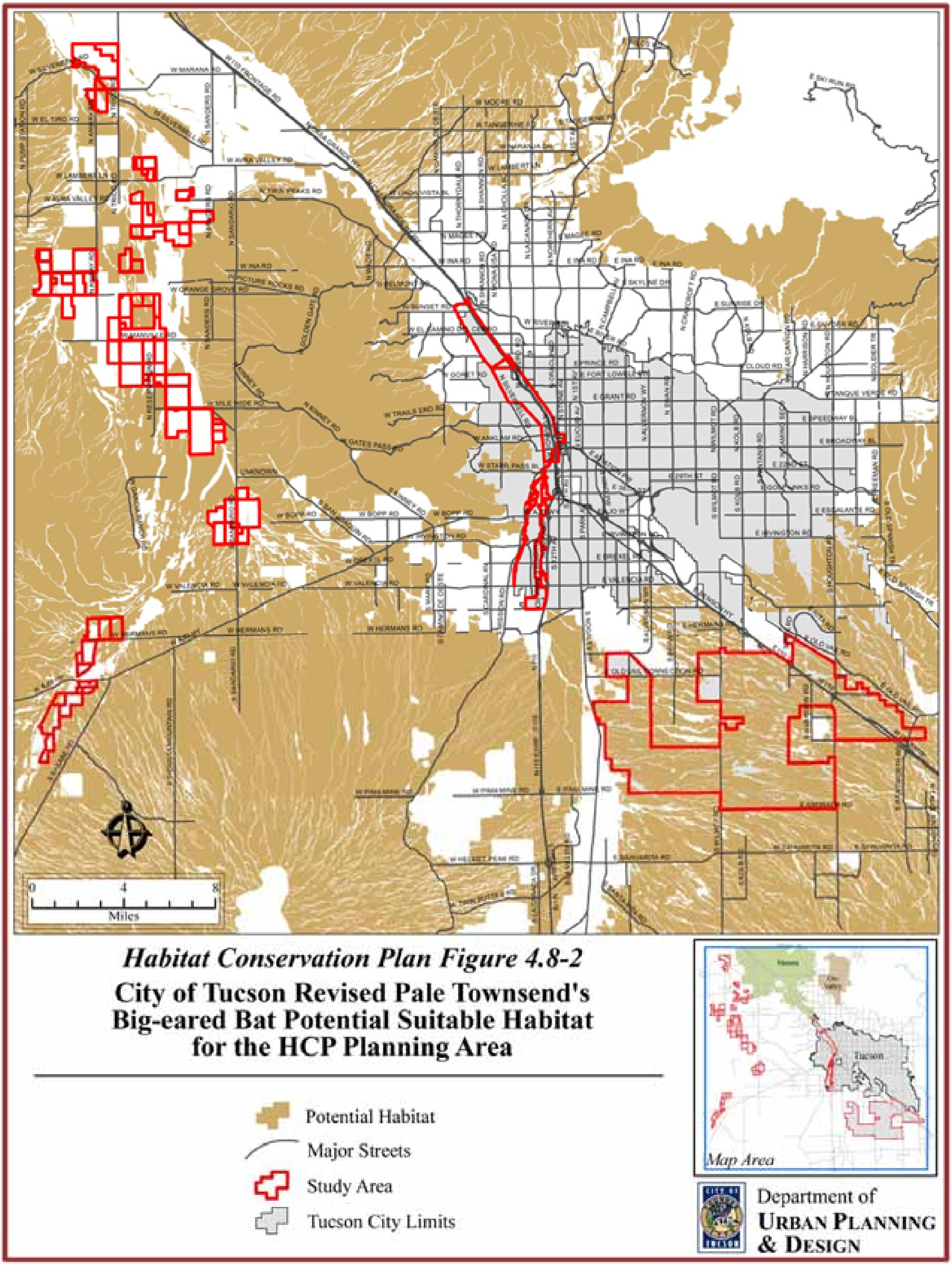

Figure 4.8-2. City of Tucson Revised Pale Townsend's Big-eared Bat Potential Suitable Habitat for the HCP Planning Area.

4.8.3.3 Importance of City of Tucson in Species' Range and Ecology

The level of use and potential importance to pale Townsend's big-eared bat of habitats in the City HCP planning area is uncertain. No known roost sites (i.e., mines or caves) are known to occur in the City HCP planning area. Several roosts are known outside of the City HCP planning area and bats from these roosts potentially could forage in portions of the planning area. Of the known bat roosts, the nearest is Colossal Cave, which is less than 15 miles (24.1 kilometers) from the City planning area. Given the distances this bat may travel while foraging, the entire planning area is within foraging distance of several known roosts.

4.8.4 Threats and Management Needs

4.8.4.1 Potential Threats and Stressors

The pale Townsend's big-eared bat is believed to have declined in parts of its range. This bat is extremely sensitive to human disturbance, and simple entry into a maternity roost can result in the abandonment of the site (Pierson et al. 1991). Because pale Townsend's big-eared bat feeds heavily on Noctuid moths, which require wetland habitats, a decline in wetland habitats also could be contributing to a decline in the bat population. This bat prefers to feed at interface between upland and riparian vegetation communities, so impacts to these environments, particularly in the Southlands planning sub-area, could reduce foraging opportunities. See Table 4.8-2 for a complete list and discussion of stressors and threats to pale Townsend's big-eared bat.

Table 4.8-2. Potential and Current Threats and Stressors for Pale Townsend's Big-eared Bat

Stressor/Threat	Relevance to Species
Habitat Loss	
Foraging	The size of the foraging area is unknown, but this bat apparently will forage over large distances. It is thought to prefer habitat "edges", preferably the interface between upland and riparian environments because of the abundance of insects.
Wintering	Winter roosts are generally caves or mines, which in some cases are threatened by closure.
Migratory stops	Roosts are necessary for migrants.
Roost preferences	Caves and mines are extremely important as roosts for this bat. Temporary roosts include bridges, buildings, and possibly drainage culverts.
Habitat Alteration	
Prey	This bat preys primary on moths (3–10 millimeters in length) in the Family Noctuidae. It also eats other insects.
Nest sites	Maternity roosts are critically important to this species.
Contaminants	There is some indication that bats can acquire toxic materials while in roosts, and considerable evidence that some bat species can acquire toxic doses of insecticides by consuming contaminated prey.
Water accessibility	This bat drinks water and is know to forages over water. It appears that very small water sources are used; large water bodies have not been surveyed. This bat could benefit from the presence of vegetation near water.
Edge effects	This bat prefers to forage along edges, specifically at the interface of upland and riparian communities.
Fire threat	Fire may affect the prey base for this species.
Water quality	This bat appears to be broadly tolerant of water quality.

Table 4.8-2. Potential and Current Threats and Stressors for Pale Townsend's Big-eared Bat, continued

Stressor/Threat	Relevance to Species
Species Characteristics	
Behavior traits	This bat is sensitive to disturbance at roosts.
Habitat rehabilitation potential	This bat would benefit from habitat rehabilitation that increases prey base. It could also benefit from gating mines and caves.
Fecundity	Fecundity is low (1 young per year) as with most bats.
Off-site mortality - from surrounding land uses	Could be driven from areas by renewed mining, urban expansion, human disturbance.
Interspecific Factors	
Predation	Although not considered likely, this bat may be subject to predation by cats.
Disease	This bat may be affected by rabies; other diseases are unknown.
Competition	Although this species has been found in roosts with other species, the level of competition with other bats is unknown.
Anthropogenic Factors	
Off-road vehicles	ORVs may be a problem because they provide access to isolated roost sites and may result in disturbance.
Mining	Renewed mining in areas with old mines may result in disturbance or loss of active or potential roosts.
Passive recreation	Passive recreation can result in disturbance to roosts; hiking trails should be routed to avoid roosts.
Grazing	Grazing may affect the prey base of this species, particularly when it occurs in the upland/riparian interface.
Collection/hunting	Not thought to be a problem.
Pesticides - impacts to prey	Pesticides may represent a significant problem for this species, especially to the extent that they affect the prey base
Direct take/mortality	Direct take of this bat is thought to be limited, except from mine hazard abatement practices, which could have serious impacts. Road paving and de-icing also may affect this bat.
Light	Bright lights near roosts may affect this bat.
Domestic/feral animals	Domestic/feral animals may affect bats if they are present in roost sites.
Connectivity	
Traffic volumes	Increased traffic volume would result in higher probability of vehicular collisions with bats.
Corridor width	Buffers along washes would be beneficial by protecting preferred foraging habitat for this bat. Optimum buffer width is unknown.
Riparian/upland connection	Bridges could be improved as bat roosts.

4.8.4.2 Current Management Recommendations

The *Arizona Bat Conservation Strategic Plan* outlined a number of management strategies for protecting this and other bat species in the state (Hinman and Snow 2003). These recommendations include:

- Identify, protect, and enhance key roosting, feeding, and drinking resources for bats.

Priority actions include:

a. Protect 90 percent of the sites sheltering hibernation populations or maternity colonies that rank within the largest 10 percent of known sites;

b. Incorporate bat-friendly bridge and culvert designs into 25 percent of new highway structures that are potential roosts because of macrohabitat features, and retrofit 25 percent of existing structures with roost potential;

c. Identify and protect foraging areas for bats near key roost sites;

d. Protect, restore, maintain, and monitor key open water drinking sites; and

e. Protect, restore, maintain, and monitor key flight and migratory corridors

- Develop education materials to reach important audiences.

Priority actions include:

a. Target bat education programs in communities near important bat roosts or other habitats; and

b. Develop and implement conservation and education programs for urban residents about bats living in urban environments.

Among other management considerations are the following concepts summarized in the Michrochiropteran Bats: Global Status Survey and Conservation Action Plan (Hutson et al. 2001) and from the Habitat Conservation Assessment and Conservation Strategy for the Townsend's Big-Eared Bat (BISON-M 2004b, RECON 2002).

- USGS and other maps often include cave locations and are freely distributed to civic groups, the media, and the general public. In concert with improved and increased road access, this has made many potential bat caves easily accessible to the general public, thus increasing site visitation and potential harassment.
- Many potential roost sites are located on public lands and the land management agencies encourage various recreational uses of their holdings. Recreational caving, and hiking, camping, and other activities occurring near potential roosts can result in levels of disturbance that limit or prevent use of the sites by bats. Caving or other recreational communities may also be hesitant to report locations of bats for fear that the sites may be closed to future recreational use. Visitor access to hibernacula and maternity colonies should be prohibited during critical times of the year.
- Paleontological and archeological sites, which are fairly common in caves in the Southwest, are sometimes protected by the installation of gates or other barriers. These gates can result in sites becoming inaccessible or unsuitable for bats. Similar impacts arise from closures of inactive mine shafts and adits or improper design or installation of bat-friendly gates.
- The presence of mining-associated ponds, often containing toxic concentration of metals or other chemicals, near potential roosts can create significant consequences for bats. This is a particular concern in desert areas where mining ponds may be the only available water source near a roost site.
- Heavy use of non-target insecticides can significantly reduce populations of moths, which are a staple in the species' diet, and therefore lead to significant reductions in food availability.

In addition, due to an entirely insectivorous diet and high rate of food intake, high metabolic rates, and high rates of fat mobilization during migration, hibernation, and lactation, this species may be susceptible to direct poisoning as a result of insecticide application.

- Livestock grazing and other land use activities have resulted in the conversion of riparian habitats into xeric upland habitats. Data on the species indicates a preference for foraging along edge environments between riparian and upland areas. As riparian habitats are lost, these edge areas disappear. Riparian habitats within 10 miles of roosts sites should be improved and maintained.
- Changes in plant density and composition in areas of potential foraging habitat may result in a reduction in plant species necessary to support moth populations. Given its preference for moths, these changes can significantly impact the prey base for the Townsend's big-eared bat.

4.8.5 Potential Impacts of City of Tucson's Proposed Activities

4.8.5.1 Direct Effects

Pale Townsend's big-eared bats require caves or mines as hibernacula and maternity roosts. No known roost sites occur in the City HCP planning area and no suitable roost sites are expected to occur in areas of projected urban development. Therefore, take of bats resulting from destruction of roosts during construction activities is not anticipated.

4.8.5.2 Indirect Effects

Indirect effects from urban development include vandalism, noise, and other construction-related disturbance that could cause individual bats to move to other foraging areas, potentially increasing the energetic demands of bats. However, since these bats forage at night or at dawn when construction activities typically are not being conducted, there is little potential for these types of effects. Further, pale Townsend's big eared bats have not been documented within the City HCP planning area and given the distance of the HCP planning area from all but one of the known roosts, the HCP planning area is probably not heavily used by this species.

4.8.5.3 Potential Habitat Changes in City of Tucson

Impacts to Potential Pale Townsend's Big-eared Bat Habitat in the Southlands Planning Sub-area

Potential effects to pale Townsend's big-eared bats from the proposed covered activities primarily relate to potential reduction in foraging opportunities resulting from loss of foraging habitat. This bat is insectivorous and is thought to preferentially forage along the riparian/upland habitat edge. Planned residential and commercial development and capital improvement projects could directly impact all suitable habitat in the Southlands planning sub-area, through permanent habitat loss and degradation.

Previous land use concepts, although not currently supported, have called for high intensity development through out the Southlands planning sub-area in conjunction with complete wash channelization. This level of high intensity use would result in loss of upland vegetation and additional loss of riparian vegetation, and promote long-term and frequent disturbance of any remaining habitat as a result of the proximity to an urban environment.

As a result, for purposes of the impact analysis in the City HCP, we are assuming a worst-case scenario and, at this point in time, it is possible for urban development under the current regulatory environment to impact 100 percent of the modeled potential pale Townsend's bat habitat within the Southlands planning sub-area.

The nearest known roosts of this bat are more than 15 miles (24 kilometers) from the Southlands planning sub-area. Although pale Townsend's big-eared bat is capable of foraging flights in excess of 90 miles, the majority of flights are likely much shorter (less than 15 miles) and the extent of use of habitats in the City HCP planning area for foraging is probably low. As a result, a reduction in the amount of potential foraging habitat in the City HCP planning area is not likely to substantially reduce foraging opportunities for this species.

Impacts to Potential Pale Townsend's Big-eared Bat Habitat in the Avra Valley Planning Sub-area

As proposed in the City Water Plan, planned public water infrastructure projects could directly impact all suitable Pale Townsend's big-eared bat habitat in the Avra Valley planning sub-area. Given the uncertainty in the Plan regarding the types and scope of projects that may be constructed within the Avra Valley planning sub-area, we are assuming a worst-case scenario. The total footprint of covered activities in Avra Valley, e.g., recharge basins, evaporation ponds, treatment plant, etc., may require almost 7,500 acres (3,035 hectares). Construction of these projects will create impacts outside of the project footprints, long-term disturbance to habitat may result from operation of these facilities, and the covered activities may, depending on their location and configuration, result in fragmentation of the remaining habitat within these properties. Without knowing the final location and design of any of these facilities, we cannot say that any habitat in Avra Valley will not be impacted in some fashion by these covered activities.

The nearest known roosts of this bat are more than 15 miles (24 kilometers) from the Avra Valley planning sub-area. Although pale Townsend's big-eared bat is capable of foraging flights in excess of 90 miles, the majority of flights are likely much shorter (less than 15 miles) and the extent of use of habitats in the City HCP planning area for foraging is probably low. As a result, a reduction in the amount of potential foraging habitat in the City HCP planning area is not likely to substantially reduce foraging opportunities for this species.

4.8.5.4 Population Level Effects

Pale Townsend's big-eared bats are not likely to be directly affected by urban development and associated infrastructure projects in the City HCP planning area. The SDCP habitat model predicts that Pima County supports about 1.3 million acres (520,000 hectares) of high potential habitat. Given the relatively low level of use of foraging habitat predicted in the City HCP planning area and the abundance of potential habitat elsewhere in Pima County, reductions in potential foraging habitat for pale Townsend's big-eared bat in the City HCP planning area would not be expected to affect the population viability of this species.

4.9 Western Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*)

4.9.1 Population Distribution, Taxonomy, and Status

4.9.1.1 Range and Distribution

Two subspecies of the yellow-billed cuckoo are currently recognized in North America by the American Ornithologists' Union (AOU 1957), one in the east and one in the west**.** The western yellow-billed cuckoo (*Coccyzus americanus occidentalis)*, the only subspecies of yellow-billed cuckoo that occurs in Arizona, was formerly widespread and locally common in California and Arizona, locally common in a few river reaches in New Mexico, common very locally in Oregon and Washington, generally local and uncommon in scattered drainages of the arid and semiarid portions of western Colorado, western Wyoming, Idaho, Nevada, and Utah, and probably uncommon and very local in British Columbia (USFWS 2001). Currently, the western yellow-billed cuckoo is known to breed in California, Arizona, New Mexico, extreme western Texas, Sonora, Chihuahua, and south irregularly to Zacatecas, Mexico (Howell and Webb 1995, Russell and Monson 1998, Hughes 1999). It winters in north and central South America east of the Andes (Hughes 1999).

In Arizona, the western yellow-billed cuckoo nests primarily in the southern and central portions of the state (Figure 4.9-1) (Recon 2002, AGFD 2002). It has been extirpated from most lower elevation localities, especially the Colorado River valley (AGFD in prep.) and most of the Santa Cruz River in Pima County (Corman and Magill 2000). The western yellow-billed cuckoo was documented along 25 drainages in Arizona in 1998 and 1999, with the major concentrations occurring along the Agua Fria, San Pedro and Verde rivers, and Cienega and Sonoita creeks (Corman and Magill 2000).

4.9.1.2 Taxonomic Distinctness

The taxonomic distinctness of western and eastern yellow-billed cuckoos remains in question. It should be noted that there are no universally accepted criteria for differentiating subspecies of birds (or anything else) and that taxonomy at this level is a rapidly evolving science.

Ridgway named two subspecies in 1887 based on morphological measurements of a small number of individuals, and accepted as valid in the American Ornithologists Union 1957 Checklist of North American Birds (AOU 1957). In subsequent editions of the checklist, the AOU has not used subspecies names because the authors considered it necessary to review and evaluate the subspecific taxonomic status of North American birds. Recognition of subspecies was questioned or rejected by several authors over a period of decades, largely because morphological differences appear to be very slight and not statistically significant (Laymon 2000). Franzreb and Laymon (1993) concluded that the two subspecies should be retained based on the morphological, behavioral, and ecological differences between western and eastern birds. Laymon (2000) reviewed dissenting opinions and his own conclusion is that a complete and modern study of geographic variation in the species should be conducted to evaluate the taxonomic status. However, he emphatically concludes that the western birds represent a DPS separated from the eastern birds based on several behavioral aspects of their biology (Laymon and Halterman 1987). The AOU Committee on Classification and Nomenclature, at the request of the USFWS, reviewed the taxonomic validity of the subspecies, and concluded that the species should be considered monotypic, without subspecies, because the differences between the populations were too small to support separation as subspecies (USFWS 2001).

Genetic analysis has so far been inconclusive, at least in part because standards for recognizing subspecies are not established. In one recent analysis of mitochondrial DNA (mtDNA) variation in yellow-billed cuckoos across their historic range, the hypothesis that western U.S. populations are a separate subspecies or Evolutionarily Significant Unit (ESU) from eastern U.S. populations was not supported (Fleischer 2001). Nevertheless, Fleischer concedes, based on a significant divergence in haplotype frequencies between cuckoos from the two regions, that eastern and western regions might be separated as Management Units. Another genetic study, published at essentially the same time (Pruett et al 2001) concluded that the evidence supports continued separation of the two subspecies and recognition of the western subspecies as an ESU.

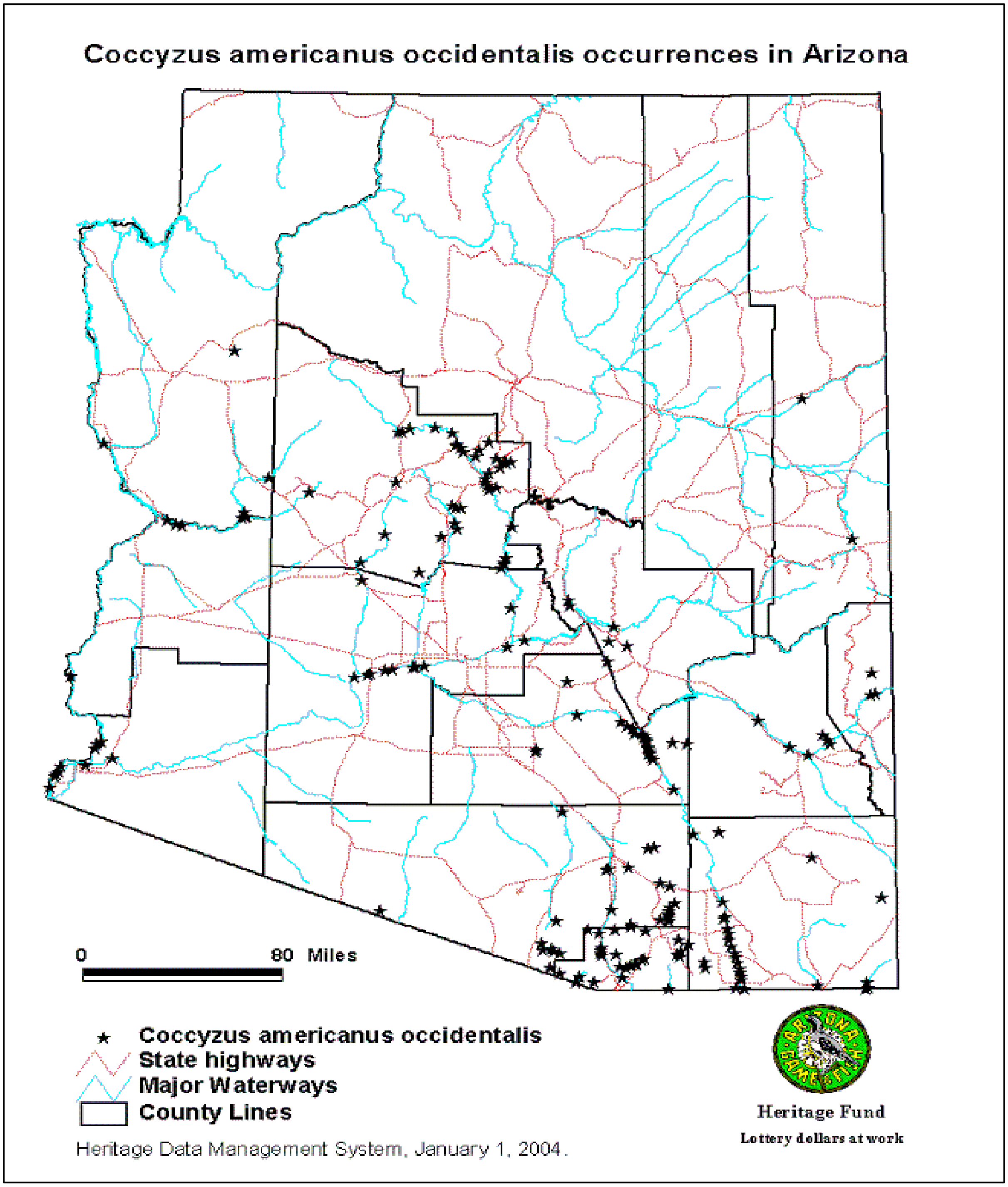

Figure 4.9-1. Historical Distribution Map of Western Yellow-billed Cuckoo in Arizona; Based on Locations Reported in the AGFD Heritage Data Management System. Source: Arizona Game and Fish Department website (http://www.gf.state.az.us/w_c/edits/images/coccamoc.gif).

4.9.1.3 Population Status and Threats

Federal Status. The USFWS considers the western population of yellow-billed cuckoo a DPS based on the physical, ecological, and behavioral discreteness of the population segment and determined that listing this DPS as threatened is warranted but precluded by higher priority listing actions (USFWS 2001).

Range-wide Population Status and Threats. Like many riparian obligate species, the breeding distribution and number of western yellow-billed cuckoos has declined in the past 80 years throughout western North America (AGFD 2002). It disappeared from British Columbia in the 1920s, from Washington in the 1930s, from Oregon in the 1940s, and from northernmost California in the 1950s.
It is extremely rare in the interior West. The only remaining western “strongholds” are three small populations in California, scattered populations in Arizona (especially on the San Pedro River) and New Mexico (especially the Gila River), and an unknown number of birds in northern Mexico (BISON-M 2004b). The species was listed by the state of California as threatened in 1971 and was reclassified as endangered in 1987. It is ranked as critically imperiled in Washington, and in Nevada the yellow-billed cuckoo is listed as State Rank S1 Nevada State Protected, meaning that the species is protected within the state and is considered critically imperiled due to extreme rarity, imminent threats, and/or biological factors.

Arizona Population Status and Threats. Arizona probably contains the largest remaining western yellow-billed cuckoo population among states west of the Rocky Mountains and is therefore considered critically important since breeding populations throughout the West have been extirpated or greatly reduced (Recon 2002, USFWS 2001). In a 1998/1999 study (Corman and Magill 2000), western yellow-billed cuckoos were detected along 25 main drainages in Arizona, with the major concentrations occurring along the Agua Fria, San Pedro and Verde rivers, and Cienega and Sonoita creeks. It is considered a Species of Special Concern within the state because it has been extirpated from most Lower Sonoran localities, especially the Colorado River Valley, by unmitigated destruction of riparian gallery forests (AGFD in prep.). Loss of mature cottonwood-willow riparian habitat through degradation, modification and fragmentation is the primary threat to the remaining populations of yellow-billed cuckoos in central and southern Arizona (AGFD in prep., RECON 2002). Major threats to this habitat include:

- Reclamation, flood control, and irrigation projects;
- Urbanization and agricultural activities;
- Invasion of non-native salt cedar into riparian areas; and
- Livestock grazing and off-road vehicle use within riparian habitats.

4.9.2 Ecology

4.9.2.1 Life History

The western yellow-billed cuckoo is a member of the avian family Cuculidae (cuckoos and roadrunners) in the order Cuculiformes, members of which share the common feature of a zygodactyl foot, in which two toes point forwards and two toes point backwards. Of the six species of Cuculidae that breed in the United States, two species, western yellow-billed cuckoo and the greater roadrunner, breed west of the Continental Divide (USFWS 2001).

The western yellow-billed cuckoo arrives on the breeding grounds beginning in mid- to late May, initiating nesting activity in early to mid-June (southern California) through August and frequently into September (southeastern Arizona) (Corman and Magill 2000). Nesting peaks in mid-July and early August. Breeding may be triggered by an abundance of insects or other large prey that form the bulk of the species' diet (AGFD 2001, RECON 2002). Populations fluctuate substantially in response to fluctuations in caterpillar abundance (BISON-M 2004b). Prey abundance may lead to the production of excess eggs and thus to brood parasitism, where the cuckoo's excess eggs are laid in other birds' nests (RECON 2002).

Both male and female yellow-billed cuckoos build the nest, generally from 4 to 30 feet (1.2 to 9.1 meters) above the ground, often in willow or mesquite thickets (AGFD 2002). West of the Continental Divide, nesting occurs almost exclusively close to water, and biologists have hypothesized that the species may be restricted to nesting in moist river bottoms in the west because of humidity requirements for successful hatching and rearing of young (Rosenberg et al. 1991). The nest is well concealed by the surrounding foliage, and consists of an unkempt stick platform, thinly lined with leaves, mesquite and cottonwood strips, grass, and catkins, with a depression to hold the eggs (Ehrlich et al. 1988, AGFD 2002). The clutch size is usually 2 or 3 eggs, and the development of the young is very rapid, with a breeding cycle of 17 days from egg laying to fledging of young (USFWS 2001). The male feeds the early fledglings while the female feeds the late fledglings (Ehrlich et al. 1988).

4.9.2.2 Habitat Requirements

The western yellow-billed cuckoo appears to require large blocks of riparian habitat for nesting, particularly woodlands with Fremont cottonwoods and Goodding willows (USFWS 2001). In Arizona, the species occurs from 90 to 6,710 feet (27 to 2,045 meters) above mean sea level, preferring streamside cottonwood/willow groves and larger mesquite bosques for migrating and breeding. It is rarely observed as a transient in xeric desert or urban settings (AGFD 2002). Rosenberg et al. (1991) speculated that in the Lower Colorado River Valley, mature cottonwoods, with willows forming a sub-canopy layer, provide the best shading of any riparian habitat against the extremely high midsummer temperatures; salt cedar and open mesquite bosques are inadequate in buffering lethal temperatures. In addition, standing water in many cottonwood-willow groves may help to lower air temperature by evaporative cooling, and thus the decline of cuckoo populations may be attributed largely to the removal of necessary thermal cover (Rosenberg et al. 1991).

The western yellow-billed cuckoo has been found in mature Sonoran Riparian Deciduous Forest, Cottonwood-Willow Series, and Sonoran Riparian Scrub in well-developed mesquite bosques (Corman and Magill 2000). Areas where cuckoos have been found in recent years were at least 37 acres (15 hectares) in size, and included 7 acres (3 hectares) or more of closed canopy, with canopy heights of 16 to 100 feet (5 to 30 meters) and understory heights of 3 to 20 feet (1 to 6 meters) (Hughes 1999). Of the six active cuckoo nests found in Arizona during the 1998 and 1999 seasons, one was found in Arizona alder (*Alnus oblongifolia*), one in salt cedar, two in Fremont cottonwood, and two in Goodding willow (Corman and Magill 2000).

Caterpillars form the main component of the diet of western yellow-billed cuckoo, with cicadas, grasshoppers, birds' eggs, frogs, lizards, ants, beetles, wasps, flies, and fruit being consumed in smaller amounts (Howe 1986, Ehrlich et al. 1988, Hughes 1999).

Western yellow-billed cuckoos may be found in less than optimal habitat during migration. Even though such habitats do not support breeding, they are definitely important for survival of the species (Magill and Halterman 1999). Potentially suitable migration habitat includes areas of Sonoran Riparian Deciduous Forest, Cottonwood-Willow Series and Sonoran Riparian Scrub with large mesquites that are less well developed than those in breeding habitat. No minimum size for suitable migration habitat has been determined, and it is possible that only a few trees would be sufficient for migrating birds (T. Corman, AGFD, pers. comm.). Most recent records of the cuckoo from sites along the effluent-dominated reach of the lower Santa Cruz River and Tanque Verde Creek are thought to be unpaired birds (Sage 2003), but records at the Simpson Farm North property during 2005 suggest that nesting may occur at this location (see below).

4.9.3 Baseline Conditions

4.9.3.1 City of Tucson Population Status

The City HCP planning area provides some migratory stopover habitat for yellow-billed cuckoo. The amount of potential stopover habitat will likely increase if the proposed Santa Cruz River restoration projects are completed and vegetation matures in those project areas.

Although yellow-billed cuckoos may nest in small numbers in broadleaf riparian habitat along the Santa Cruz River planning sub-area at the Simpson North property, nesting has not yet been confirmed. In July 2005, Scott Wilbur of the Audubon Society detected yellow-billed cuckoo(s) during avian point count surveys along a 2,380-meter stretch of the Santa Cruz River at Simpson Farm North. The Simpson property is being managed by Tucson Audubon Society for habitat restoration, and has some well-developed cottonwood-willow vegetation. On July 14, 2005, Wilber detected at least two cuckoos along the same survey route. Although cuckoos were detected at more than one location along the transect route, it is possible that some of the detections were of the same individual(s) following Wilber as he moved west along the transect. On July 22, 2005, Kendall and June Kroesen of Tucson Audubon conducted another avian point count survey at the Simpson Farm property. They detected one cuckoo at several points along the survey route. As a result of Tucson Audubon Society's findings and at the request of the City HCP Technical Advisory Committee, Scott Blackman and Cathy Crawford of AGFD Research Branch conducted a call-playback survey for the cuckoo at the Simpson Property on July 29, 2005 and heard one cuckoo. AGFD biologists concluded that it is possible that this cuckoo might have been nesting on the Simpson Farm property based on the fact that it was still in the area fairly late in the breeding season. Blackman and Crawford returned to the Simpson Farm property on August 19, 2005 and conducted another call-playback survey, but no cuckoos were detected. In conclusion, neither Tucson Audubon Society nor AGFD were able to verify yellow-billed cuckoo nesting on the Simpson Farm property (AGFD 2005).

Western yellow-billed cuckoos are known to be present along Cienega Creek, in Cienega Creek County Park, immediately upstream from the dam and at intervals upstream from the road bridge along the wet reaches of the creek. Although no nests or young birds were located, frequent calling during breeding season and persistence in June and July suggest that cuckoos may be breeding there (K. Kingsley, personal observations, 2004). Cuckoos were found during post-breeding season surveys conducted in 2002 along the effluent-dominated reach of the Santa Cruz River and Tanque Verde Creek (Sage 2003). Cuckoos were known to be present in abundance in the pecan orchards in Green Valley, along the Santa Cruz River south of Tucson in the late 1980s (Kingsley 1989). Other nearby records are from the Santa Cruz River near San Xavier Mission and along Tanque Verde Wash in the Rincon Mountains.

4.9.3.2 Habitat in and Near the City of Tucson

Two different models have been developed to delineate potential habitat for the yellow-billed cuckoo:

- The Sonoran Desert Conservation Plan habitat model, and
- The City of Tucson Habitat Conservation Plan cuckoo habitat model.

Sonoran Desert Conservation Plan Habitat Model. A habitat model for the yellow-billed cuckoo was developed as part of the SDCP (RECON 2002). This habitat model consisted of the following five primary variables:

- Hydrology
- Vegetation
- Slope
- Elevation
- Landform

The habitat potential of the categories of each variable were ranked as 0, 1, 2, and 3, with 0 indicating that the category provided no habitat and 3 indicating that the category provided high potential habitat. The five variables were combined to provide an overall habitat potential. Table 4.9-1 shows the specific categories of the variables considered to provide habitat for the yellow-billed cuckoo and their habitat potential ratings. Using this habitat model, the City HCP planning area supports about 11,298 acres (4,572 hectares) of high potential habitat and 7,421 acres (3,003 hectares) of medium potential habitat for yellow-billed cuckoo (Figure 4.9-2).

City of Tucson Western Yellow-billed Cuckoo Habitat Model. The SDCP suitable western yellow-billed cuckoo habitat model was heavily influenced by the floodplain “landform” variable, with historic floodplain areas along the Santa Cruz River being mapped as suitable cuckoo habitat in this model. Although the floodplain would have historically been the location of suitable riparian habitat for this species, specifically cottonwood-willow gallery forests and to some extent mature mesquite bosques, the Santa Cruz River has become entrenched through the City and the channel has become isolated from the historic floodplain, in may areas by 10 to 15 vertical feet (3.1 to 4.5 meters), preventing the floodplain from supporting riparian-obligate cottonwood and willow species. The City HCP Technical Advisory Committee supported the development of an alternate model, which focused on the low-flow channel, rather than on the disconnected floodplain. The low-flow channel, i.e., the sandy river bottom, does not currently support suitable cuckoo habitat, except perhaps in a few isolated patches, however the model recognizes the dynamic nature of riparian systems and includes areas that may become potential habitat for the cuckoo in addition to any areas that may currently provide habitat. To capture the potential for riparian systems to evolve over time, including shifts in the location of patches of riparian habitat, the mapped floodway was used as the basis for modeled potential habitat along the Santa Cruz River planning sub-area.

There are no documented cases of western yellow-billed cuckoos breeding in the Tucson area and, based on the current understanding of the cuckoo’s habitat preferences, it is fairly certain that no potential breeding habitat currently exists within the City HCP planning area. All of the cuckoos reported in and around the planning area are assumed to be migratory, using existing riparian patches as stopover habitat as they pass through the area. All modeled potential habitat within the planning area is therefore assumed to be dispersal habitat, which supports migration of birds between breeding habitat north of Tucson and wintering habitat in South America. Although a number of proposed river restoration projects may result in the creation of potential breeding habitat within the City HCP planning area, natural conditions are not likely to produce any riparian areas of sufficient size and structure to support breeding birds. Limited water availability also makes it unlikely that any significant stands of high suitability breeding habitat can be restored as part of the river restoration; however, habitat within the planning area may be used

Table 4.9-1. Value Ratings for Characteristics of the Variables Used in the SDCP Western Yellow-billed Cuckoo Habitat Model

Variable/Category	Value Rating
Hydrology	
Intermittent stream	2
Adjacent habitat within 0.5 miles of intermittent stream	1
Perennial stream	2
Vegetation	
Sonoran Riparian Woodland Xero-riparian mesquite (124.7)	3
Scrub-Grassland Mixed grass-scrub (143.15)	1
Scrub-Grassland Xero-riparian biome (143.10.XR)	1
Sonoran Desertscrub Upland Paloverde-mixed cacti (154.12)	3
Sonoran Desertscrub Xero-riparian Paloverde-mixed cacti (154.12XR)	3
Sonoran Desertscrub Urban Paloverde-mixed cacti (154.12U)	2
Interior Southwestern Riparian Deciduous Forest and Woodland Meso-riparian biome (223.20)	3
Interior Southwestern Riparian Deciduous Forest and Woodland Meso-riparian cottonwood-willow (223.21)	3
Interior Southwestern Riparian Deciduous Forest and Woodland Meso-riparian mixed broadleaf (223.22)	3
Interior Southwestern Riparian Deciduous Forest and Woodland Urban biome (223.20U)	2
Sonoran Riparian and Oasis Forests Meso-riparian mesquite (224.52)	3
Sonoran Riparian and Oasis Forests Meso-riparian cottonwood-willow (224.53)	3
Sonoran Riparian and Oasis Forests Urban mesquite (224.52U)	2
Sonoran Riparian and Oasis Forests Meso-riparian cottonwood-willow (224.53U)	2
Sonoran Deciduous Swamp and Riparian Scrub Meso-riparian biome (234.70)	1
Sonoran Deciduous Swamp and Riparian Scrub Meso-riparian mixed scrub (234.71)	1
Sonoran Deciduous Swamp and Riparian Scrub Meso-riparian saltcedar disclimax (234.72)	1
Slope	
0–2%	1
2–5%	1
Elevation	
195–400 meters	1
401–600 meters	2
601–800 meters	2
801–1,000 meters	2
1001–1,200 meters	2
Land Form	
Drainage ways	2
Floodplains	2
Terraces	2

Source: Recon (2002) Priority Vulnerable Species Analysis and Review of Species Proposed for Coverage by the Multiple Species Conservation Plan.

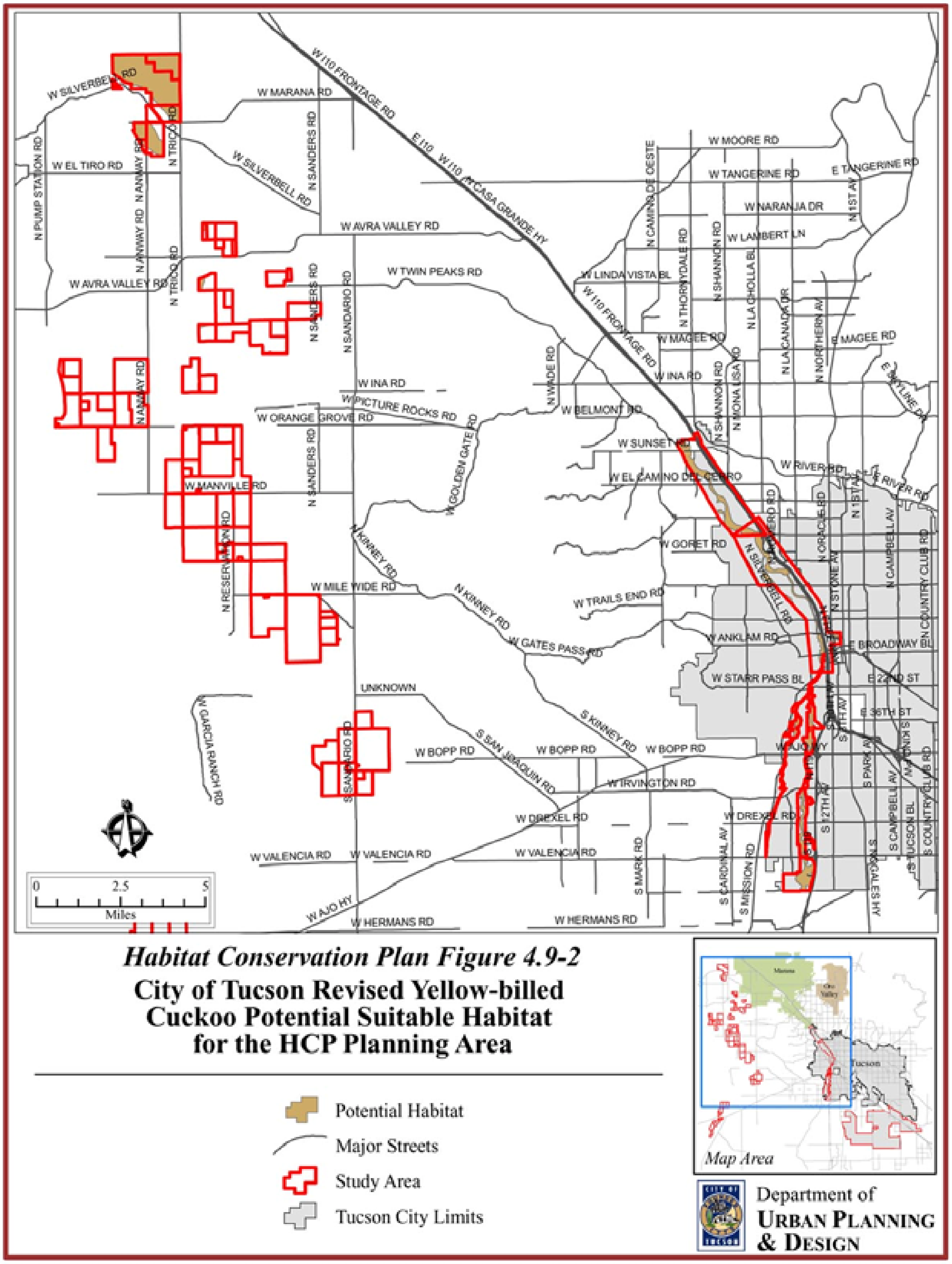

Figure 4.9-2. Habitat Potential for Western Yellow-billed Cuckoo Within the Santa Cruz River Planning Sub-area.

Based on this habitat model, within the Tucson planning area, 3,395 acres (1,374 hectares) of potential dispersal habitat is predicted to occur along the Santa Cruz River planning sub-area, 1,403 acres (568 hectares) of which lies within the northernmost Avra Valley parcels which are adjacent to the river (see Figure 4.9-2).

4.9.3.3 Importance of City of Tucson in Species' Range and Ecology

Western yellow-billed cuckoos have been documented within the City HCP planning area during migration (probably throughout the Santa Cruz River corridor) and during the breeding season (Simpson Farm North). Recent records at Simpson Farm North suggest that some riparian habitats along the Santa Cruz River planning sub-area may provide potential breeding as well as migratory stopover habitat for cuckoos (AGFD 2005). The riparian and wetland habitat of the Santa Cruz River is sustained by effluent discharges from the Rogers Road and Ina Road Wastewater Treatment Plants. While the effluent provides a consistent source of water in portions of the river, the habitat along the river is strongly influenced by the interaction of flooding frequency and intensity, variation in infiltration rates, and the amount of regional groundwater pumping, resulting in the spatial and temporal variability of suitable western yellow-billed cuckoo habitat (CH2M Hill 2003).

4.9.4 Threats and Management Needs

4.9.4.1 Potential Threats and Stressors

Loss of mature cottonwood-willow riparian habitat is the primary threat to the remaining populations of yellow-billed cuckoo in southern Arizona. Major threats to this habitat include: (1) reclamation, flood control, and irrigation projects; (2) urbanization and agricultural activities; (3) Invasion of non-native salt cedar into riparian areas; and (4) livestock grazing and off-road vehicle use within riparian habitats.

Excessive noise and movement of people through riparian areas may affect nesting cuckoos. Although cars occasionally hit cuckoos, collisions are probably not a major source of mortality, except perhaps in the vicinity of bridges. There is little of no information on susceptibility to diseases, and limited information on population biology. See Table 4.9-2 for a complete list and discussion of stressors and threats to yellow-billed cuckoo.

Table 4.9-2. Potential and Current Threats and Stressors for Western Yellow-billed Cuckoo

Stressor/Threat	Relevance to Species
Habitat Loss	
Breeding	Yellow-billed cuckoo breeds in large blocks of dense riparian vegetation with tall trees and a well developed mid-story. High humidity and shade apparently are necessary for cooling eggs. Loss of riparian habitat, and removal of thermal cover, is thought to be the primary threat to this species.
Dispersal	Dispersal habitat is unknown, but cuckoos probably follow river courses. Two potential corridors have been identified for the City HCP planning area: the Santa Cruz River and the Brawley Wash system in Avra Valley (as an extension of the Altar Wash).
Foraging	The size of the foraging area is unknown, but cuckoos generally forage on large insects in trees.
Wintering	This species winters in South America.
Migratory stops	Migratory stops are generally in large trees or in dense clusters of smaller trees.

Table 4.9-2. Potential and Current Threats and Stressors for Western Yellow-billed Cuckoo, continued

Stressor/Threat	Relevance to Species
Habitat Alteration	
Prey	The principal prey of this species is large insects usually found in trees, including caterpillars, cicadas, grasshoppers, and katydids. Consequently, the loss of trees in the riparian setting results in the loss of prey diversity and abundance.
Nest sites	Dense riparian vegetation with well developed mid-story and canopy layers and high humidity are necessary components of nesting habitat for this species.
Vegetation composition/density	The maintenance of a high density of riparian vegetation at different stages of growth is important to this species.
Habitat conversion	Fire, and projects that result in water withdrawal and/or water diversion can result in adverse impacts to yellow-billed cuckoo habitat.
Escape cover	Cuckoos require cover, not only for thermal regulation, but also for escape and protection from raptors.
Fragmentation	Although cuckoos prefer large continuous blocks of vegetation, they can utilize isolated patches. However, extensive fragmentation of riparian vegetation patches interspersed with open un-vegetated areas is probably not as beneficial as large continuous blocks of habitat. Minimum patch size and maximum distance between patches is not known.
Invasive plant species	Cuckoos are known to nest and roost in tamarisk, but patches of tamarisk alone do not provide adequate thermal cover.
Habitat rehabilitation potential	The rehabilitation of cuckoo habitat, especially for migratory stops, is considered a useful mitigation strategy. However, the cost and resources available for creating suitable breeding habitat may be prohibitive.
Contaminants	The effect of contaminants on cuckoos is unknown, although some concern has been expressed about pesticide drift in California.
Water accessibility	Cuckoos drink water and forage near water; even very small water sources may be used. As discussed previously, cuckoos benefit from the high humidity associated with dense vegetation around water.
Drought	Drought, especially long-term, may result in loss of riparian habitat and reduction of prey populations.
Flood	Natural flooding is necessary for regeneration of riparian habitat; however, catastrophic flooding and flood control result in loss of habitat and failure to regenerate.
Groundwater depletion	Groundwater depletion results in loss of riparian habitat.
Edge effects	Edges are not considered beneficial for this species; this bird prefers large blocks of habitat.
Water quality	Broadly tolerant of water quality.
Behavior traits	Cuckoos are difficult to detect except during nesting season using playback calls, and during nesting they are present in a specific area for only a very brief period of time.
Habitat rehabilitation potential	Potential habitat rehabilitation may best be accomplished by using resources to create suitable migratory stops.
Colonization potential	Cuckoos are known to be able to locate isolated areas of suitable habitat.
Breadth of resource use	Cuckoos utilize a diverse and relatively abundant prey base. More critical to cuckoos are nesting and roosting habitat, which are uncommon and declining.

Table 4.9-2. Potential and Current Threats and Stressors for Western Yellow-billed Cuckoo, continued

Stressor/Threat	Relevance to Species
Interspecific Factors	
Predation	Cuckoos may be susceptible to predation by raptors, but this is not considered a major population-limiting factor.
Disease	This species is susceptible to West Nile Virus and is known to reside in areas of high mosquito density; however, the effect of the virus on populations is unknown at present. Whether other diseases affect cuckoos is unknown.
Domestic/feral animals	Predation by cats is not considered a problem for this species.
Invasive species	Although currently unknown, invasive species are not considered a problem for cuckoos.
Anthropogenic Factors	
Edge effect	This bird prefers large blocks of vegetation, so does not benefit from edge effects.
Fire threat	Fires can destroy riparian habitat for cuckoos.
Grazing	Grazing may be a problem if it results in impacts to riparian vegetation or inhibits the growth of new riparian vegetation.
Collection/hunting	The scientific collection and hunting of cuckoos is not considered a problem.
Pesticides	Pesticides may reduce the prey base of cuckoos, but this has not been scientifically demonstrated.
Direct take/mortality	Direct take/mortality of cuckoos is not considered a problem.
Noise	Excessive noise may cause abandonment of nests during the early breeding season.
Movement	Movement of people through riparian zones may be problem depending on frequency and duration.
Landscaping	Landscaping with native plants could provide opportunities for habitat improvement, especially if landscaping results in an increase in populations of large insects that are this bird's prey base.
Invasives	Tamarisk control may be harmful if plants are not replaced with native vegetation.
Domestic/feral animals	Domestic/feral animals are not considered a problem for cuckoos.
Automobile collisions	Although cars occasionally hit cuckoos, vehicular collisions are probably not a major problem, except perhaps in the vicinity of bridges.
Connectivity	
Fragmentation	Although cuckoos prefer large continuous blocks of vegetation, they can utilize isolated patches. However, extensive fragmentation of riparian vegetation patches interspersed with open un-vegetated areas is probably not as beneficial as large continuous blocks of habitat. Minimum patch size and maximum distance between patches is not known.
Wash incision	Wash incision is beneficial if it results in the creation of new habitat.
Habitat patchiness	Potential cuckoo habitat consists of large patches of dense riparian vegetation.
Riparian/upland connection	The connection between riparian and upland habitat is not considered a problem except with regard to maintaining healthy riparian areas.
Road crossings	Bridges at canopy level may increase vehicular collisions.

4.9.4.2 Current Management Recommendations

Management recommendations for western yellow-billed cuckoo are based on Laymon and Halterman 1989, Latta et al. 1999, and Wiggins 2005. These recommendations can be broadly summarized as follows:

- Restore riparian woodlands by restoring natural flow regimes to watercourses and by restricting or eliminating livestock grazing in riparian areas.
- Evaluate the use of pesticides in riparian woodlands and nearby areas.
- Census riparian woodlands for before/after effect of any habitat manipulations.
- Monitor reproductive success in managed/unmanaged plots, as well as compare reproductive success before and after habitat manipulations.

Additional recommendations provided by Arizona Partners in Flight (Latta et al. 1999) build upon those listed above by providing more specific management details for cuckoos in Arizona.

Habitat Loss and Modification

- Establish a "no net loss" policy.
- Eliminate destruction (i.e. grazing; off-road vehicle use) of existing native cottonwood-willow dominated riparian forests.
- Encourage the use of buffer zones between riparian habitats and adjacent development.
- Establish corridors between "islands" of suitable habitat.
- Manage for large, contiguous blocks of habitat (>15 hectares or 37 acres) in conjunction with removal of competing exotic species (i.e. saltcedar).

Lack of Recruitment (of cottonwood-willow forests)

- Closely monitor grazing impacts on cottonwood and willow seedlings in riparian systems and reduce or remove grazing when seedlings are being impacted.
- Maintain flow regimes that mimic natural level and timing of high and low water to allow accumulation of sediments and subsequent establishment of seedlings.
- Promote natural regeneration from seed sources. Augment with plantings (>15 hectares or 37 acres) when necessary.
- Reduce or eliminate recreational impacts and disturbance to nursery beds during and after seedling establishment.

Pesticide Use

- Limit or eliminate use of pesticides adjacent to riparian areas.
- If used, apply locally to avoid drift into adjacent habitat (i.e. not broad applications).

Demographics (low colonization potential due to fragmented breeding localities)

- Establish riparian corridors and "island" habitats to allow natural dispersal and recolonization of historic habitats.

- Establish target areas near existing occupied habitat for restoration, before focusing on areas farther away.

Human Disturbance

- Avoid intense and repeated human disturbance from nesting areas especially from May 20 through September 1.

Implementation Opportunities

- Increase enforcement of access into restricted areas.
- Increase cooperation between state and federal agencies and private organizations regarding western yellow-billed cuckoo habitat.

4.9.5 Potential Impacts of the City of Tucson's Proposed Activities

4.9.5.1 Direct Effects

It is unlikely that construction activities for new residential, commercial, and industrial development and supporting infrastructure would directly kill or injure western yellow-billed cuckoos. Within the City HCP planning area, cuckoos are most likely to occur in floodplain habitats associated with the Santa Cruz River planning sub-area, which are not likely to be directly impacted by construction activities. Further, there are no confirmed cuckoo nesting records within the Santa Cruz River planning sub-area.

4.9.5.2 Indirect Effects

Western yellow-billed cuckoos could be adversely affected through indirect mechanisms facilitated or caused by the implementation of proposed Santa Cruz River restoration projects resulting in the removal or reduction of existing broadleaf riparian habitats (i.e. cottonwood/willow). This would limit the potential for cuckoos to use the Santa Cruz River planning sub-area for migration stopover or breeding habitat in the future. Information currently available suggests that only a small number of cuckoos occur in the City during migration and the breeding season such that the impact of these activities in the City is probably insignificant.

4.9.5.3 Potential Habitat Changes in Tucson

As proposed in the City Water Plan, planned public water infrastructure projects could directly impact all 1,403 acres (568 hectares) of suitable cuckoo habitat in the Avra Valley planning sub-area. Given the uncertainty in the City Water Plan regarding the types and scope of projects that may be constructed within the Avra Valley planning sub-area, we are assuming a worst-case scenario. The total footprint of covered activities in Avra Valley, e.g., recharge basins, evaporation ponds, treatment plant, etc., may require almost 7,500 acres. Construction of these projects will create impacts outside of the project footprints, long-term disturbance to habitat may result from operation of these facilities, and the covered activities may, depending on their location and configuration, result in degradation of the remaining habitat within these properties. Without knowing the final location and design of any of these facilities, we cannot say that any cuckoo habitat in Avra Valley will not be impacted in some fashion by these covered activities.

An additional 1,992 acres (806 hectares) of modeled suitable cuckoo habitat is located within the Santa Cruz River planning sub-area. The impacts to cuckoo habitat along the Santa Cruz River depend on the outcome of restoration projects planned for the river corridor. It is assumed, based on the objectives of these restoration projects, that they will result in a net increase in suitable cuckoo habitat within this planning sub-area, although short-term loss of habitat may result from the construction of restoration features.

4.9.5.4 Population Level Effects

Development could result in a small reduction in potential western yellow-billed cuckoo habitat in the Tucson HCP planning area. However, distribution of breeding cuckoos in the planning area is poorly understood and numbers of breeding cuckoos are likely small, if cuckoos breed at all.

The level of use of habitats in the City by migratory cuckoos also is unclear. If City properties are used by cuckoos during migration from within and outside of Arizona, then reductions and/or modifications of habitat from changes in effluent availability or restoration projects could contribute to reductions in cuckoo populations elsewhere. While it is possible that future impacts (particularly reductions in effluent water released into the Santa Cruz River) could occur, the number of cuckoos affected and the impact on local and regional populations is unclear.

SECTION 5

Conservation Program

5.1 Introduction

The City of Tucson is covering eight species in its HCP:

- Cactus ferruginous pygmy-owl
- Pima pineapple cactus
- Western burrowing owl
- Needle-spined pineapple cactus
- Tucson shovel-nosed snake
- Ground snake (valley form)
- Pale Townsend's big-eared bat, and
- Western yellow-billed cuckoo.

The City's HCP program consists of species-specific conservation strategies designed to: (1) minimize and mitigate the impact of the proposed taking to the maximum extent practicable as required by Section 10 of the ESA, and (2) contribute to the long-term persistence of these species on a regional and/or local level. As required by USFWS's Five Points Policy, the City will also develop species-specific monitoring and adaptive management programs where necessary to ensure achievement of the biological goals and objectives for each species.

This section presents the conservation strategies for each of the covered species. Each species is addressed individually. The specific conservation measures the City would implement to achieve the species-specific goals and objectives are described. A monitoring and adaptive management program will be developed to complement these conservation measures (see Section 6). To satisfy the conservation strategies described above, the City of Tucson has selected habitat conservation priority lands in the Southlands (Figure 5.1-1) and Avra Valley (Figure 5.1-2). These habitat conservation priorities were selected based on a variety of specific considerations designed to preserve habitat and maintain movement corridors for covered species.

For Southlands planning sub-area, conservation considerations included the following:

- Conservation of large blocks of riparian and adjacent upland habitats along the Fagan and Petty Ranch watersheds in the southern portion of the planning sub-area. The selection of these watersheds is based on a number of considerations including:
    - Presence of "higher density" Pima pineapple cactus populations (see 2005 PPC Surveys under Section 4.3.3.2);
    - Size and relative intactness of associated riparian habitat; and
    - Distance from expanding City of Tucson urban core and existing infrastructure.

- Outside of the Petty Ranch and Fagan watersheds, preservation of species and habitats will occur within the context of urban development and focus on:
  - Protection of washes and associated riparian habitat through the City's Environmental Resource Zone (ERZ) Overlay;
  - Protection of native plant species and undisturbed habitat through the City's Native Plant Preservation Ordinance (NPPO); and
  - Protection and/or enhancement of an east-west wildlife movement corridor from Pima County Regional Park, across the Davis-Monthan AFB paddle to Cienega Creek.

For Avra Valley, these considerations included:

- Riparian habitats along Black, Brawley, and Blanco washes;
- Undisturbed uplands;
- City lands adjacent to Pima County-owned properties and/or Pima County acquisition priorities;
- Areas with the capacity to buffer important upland or riparian habitats;
- Areas with high revegetation/restoration potential; and
- Opportunities for the protection and/or enhancement of critical east-west and north-south movement corridors for pygmy-owl and other wildlife, especially linkages between Ironwood Forest National Monument and Saguaro National Park West and along Brawley and Blanco washes.

5.1.1 Related Planning Efforts

The conservation program outlined in this section is still very conceptual. Effective and adequate conservation strategies must be built upon a solid understanding of the types and levels of direct and indirect impacts to covered species and their habitats, which are expected to result from implementation of covered activities. However, as noted in previous sections, there is still a significant amount of uncertainty regarding the scope and extent of urban development, water supply, and river restoration projects that are anticipated to occur within the HCP planning area. There are currently a number of planning efforts that will refine our expectations regarding future public and private development within the planning area. These planning efforts are critical in that they result in constraints or limitations on conservation possibilities within the planning area. At the same time, they also present opportunities to integrate conservation planning into land use and infrastructure planning. Ideally, we will have the opportunity to identify and protect the most environmentally sensitive portions of the landscape in a manner that maximizes the potential for long-term persistence of these systems, while, at the same time, provide for growth and development that is appropriate for this urban setting, and promotes economic growth and stability. The following paragraphs briefly describe the intent and expected outcomes of each of these planning efforts.

5.1.1.1 Southlands Planning Sub-area

Southeast Area Arterial Study. The City is updating its Major Streets and Routes (MSR) Plan to include the Southlands planning sub-area. The Southlands arterial network has been conceptualized in the Southeast Area Arterial Study, completed under the umbrella of the Pima Association of Governments (PAG) in 2005. The Southeast Area Arterial Study identifies major roadway alignments deemed necessary to adequately serve current and future growth in the greater Southlands area.

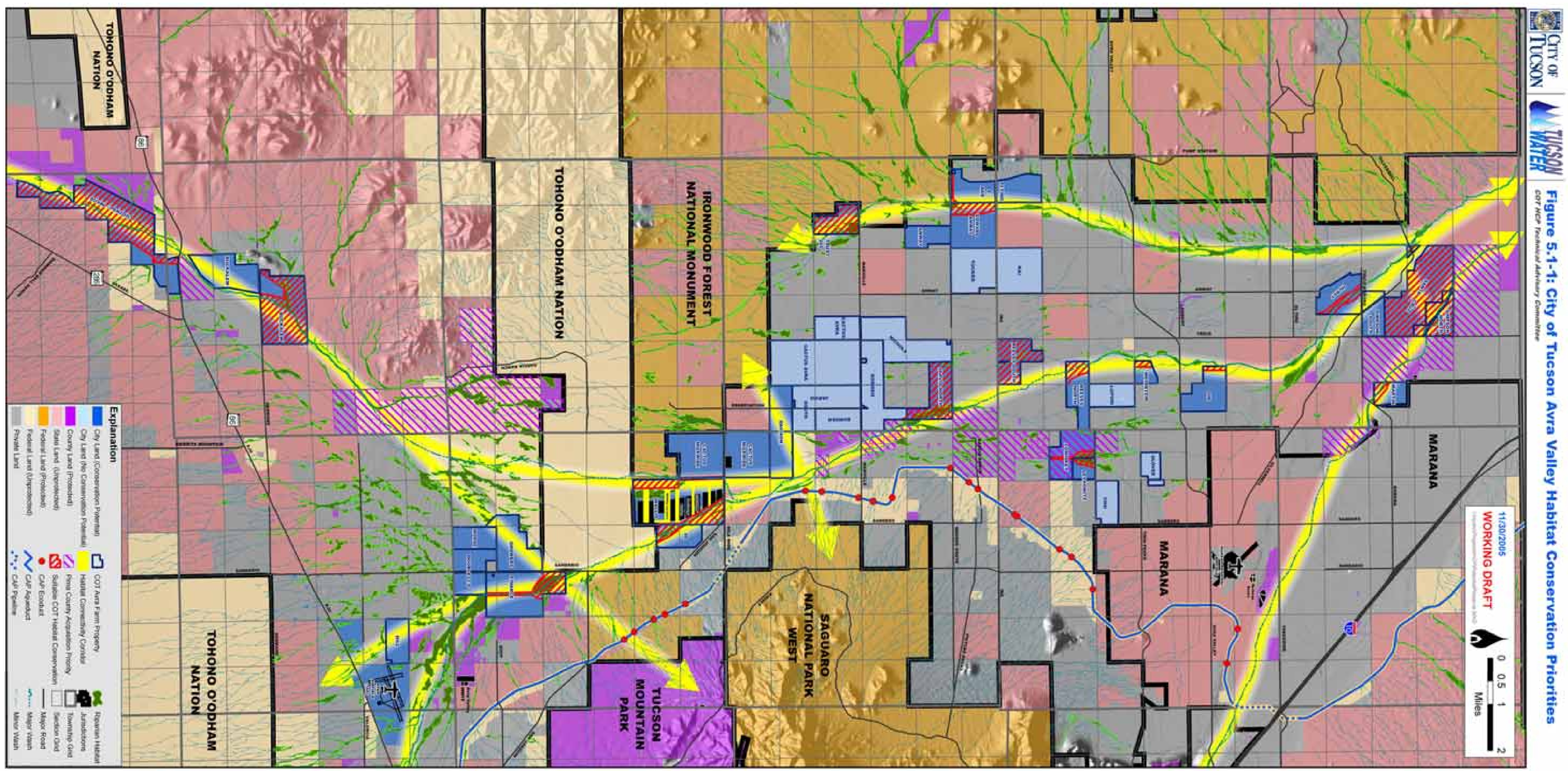

Figure 5.1-1. City of Tucson Avra Valley Habitat Conservation Priorities.

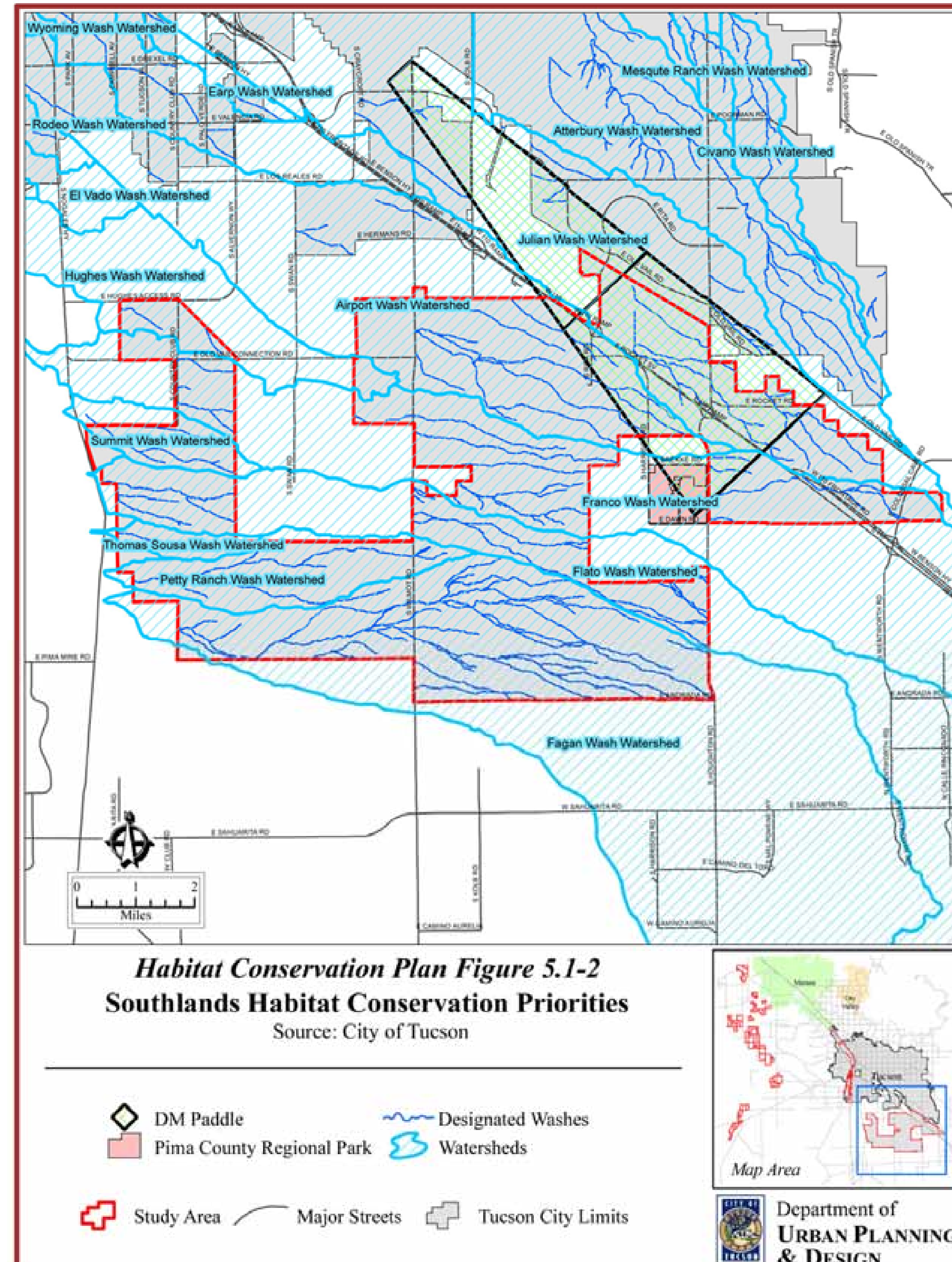

Figure 5.1-2. Southlands Habitat Conservation Priorities.

At present, 10 roads, with a total length of about 61 miles (98 kilometers) and a right-of-way footprint of approximately 1,330 acres (538 hectares), are anticipated for the Southlands planning sub-area. The conceptual nature of these alignments makes it possible for refinements to their future siting in order to support achievement of the conservation goals outlined in this HCP. It is also envisioned that the conservation program will include development and implementation of environmentally sensitive roadway design principles. A number of basic concepts have been developed thus far in the HCP planning process, including:

- Avoiding washes altogether where possible,
- Crossing as few washes as possible,
- Spanning all washes crossed,
- Crossing washes at right angles, and
- Crossing riparian areas where width of habitat is narrowest.

In order to facilitate incorporation of these guidelines in the transportation planning process, it was requested that the following language be inserted in the Southeast Area Arterial Study document:

> *Roadway alignments in the Southlands Area are conceptual corridor locations. Future roadway alignments in the Southlands Area shall be located in a manner that is sensitive to the topography and natural environment of the area. The alignments shall conform to any requirements of approved Habitat Conservation Plans and subsequent Endangered Species Act Permits. Before any roadway is constructed or right of way purchased or dedicated a corridor alignment study shall be conducted in conformance with the City of Tucson Roadway Development Policies. Studies for future roadways shall consider alignments that avoid wash crossings and are less damaging to biological and cultural resources. Alignments shall be designed in a manner that limits wash crossings. Corridors that cross perpendicularly to resource areas generally minimize impacts caused by the roadway. Design standards similar to Pima County's Environmentally Sensitive Roadways Guidelines shall be used for the design of roadways in the Southlands Area.*

Lee Moore Watershed Basin Management Study. Pima County is in the process of initiating a basin management study for the Lee Moore Watershed, located southeast of the City of Tucson core. This watershed extends from the Santa Rita Mountains north and west to the Santa Cruz River, and includes much of the Southlands planning sub-area. Sub-watersheds within the Lee Moore Watershed include those associated with Gunnery Range Wash, Sycamore Canyon Wash, Fagan Wash, Petty Ranch Wash, Flato Wash, Summit Wash, and Franco Wash. The Fagan and Petty Ranch Washes have been identified as priority conservation areas in the Southlands (see Figure 5.1-1) through the City's HCP planning process and are discussed as elements of the conservation program.

The purpose of the Lee Moore study is to provide guidance and regulatory authority to discourage development in flood prone areas by managing encroachments into regional floodplains. The study will identify flood and erosion hazard areas and drainage problems, and identify cost-effective solutions to alleviate or manage floodwater in the Lee Moore Watershed. After an assessment of existing hydrologic and hydraulic conditions, floodplain delineations, future land use analysis, and the identification and evaluation of alternative flood and erosion hazard remediation solutions, a set of preliminary "Rules of Development" will be created to manage development in the Lee Moore Watershed. This document will provide details of what can and cannot be constructed, ways to alleviate the impacts of construction on the watershed, and how to protect structures from flooding and erosion. Adoption of these development guidelines by all municipalities within the watershed is desired by Pima County. These guidelines present an opportunity for effective regional stormwater management in a manner that encourages consistency across the landscape and that compliments both the City and Pima County's conservation plans.

It is anticipated that some of these regional flood management structures and activities will be located within the Southlands planning sub-area and may be constructed and/or maintained by the City. The location and configuration of these facilities may also allow for enhancement or creation of habitat within the planning sub-area.

Greater Southlands Conceptual Land Use Plan. ASLD, the principal land manager within the Southlands sub-area, is refining its development suitability analysis of the Southlands, initially completed in 2001, in preparation for developing a conceptual land use plan for its holdings. ASLD, City of Tucson, and Pima County are working toward a multi-jurisdictional land use planning process for an area that would include all of the Southlands and the area bordered by I-19 on the west, I-10 on the north, State Route 83 on the east and the Santa Rita Experimental Range on the south.

Although ASLD is mandated by Arizona Statute and Constitution to dispose of state trust land for the highest economically-valued purpose, this large-scale planning process presents an opportunity to incorporate the most environmentally sensitive lands into the resulting land use plan in a manner that protects sensitive species, ecosystem function, and other critical resources, while increasing the value of nearby properties through protected view sheds and other quality of life benefits.

5.1.1.2 Avra Valley Planning Sub-area

The City of Tucson Water Department is currently in the process of updating its 50-year water resources plan (City Water Plan). Many of the future activities in the Avra Valley planning sub-area are dependent on decisions still to be made by the community and the City's Mayor and Council regarding enhanced treatment for mineral content (salinity control) and the utilization of effluent. Since these decisions are yet to be made, the extent of water supply development needed in the Avra Valley is not known at this point. The HCP planning process however can highlight the environmental consequences of the water development choices facing our community.

Decisions regarding the control of salinity in drinking water, for instance, will determine whether brine (evaporation) ponds are needed in the Avra Valley. These brine ponds may cover as many as 5,600 acres (2,266 hectares), potentially removing important habitat areas and resulting in barriers to movement of wildlife. They also likely would not serve as habitat enhancement features, given that most plant and wildlife species cannot tolerate or make use of brine water. Recharge facilities (CAP water or effluent), on the other hand, may cover an additional 1,000 acres (405 hectares) in the Avra Valley planning subarea but could serve as habitat enhancement areas. The recharge basins could be configured in such a manner as to support riparian vegetation along their fringes, in long-term pools, or on islands within the basins. This riparian habitat, in conjunction with the water that would be available within the basins, could provide important habitat in an area with no natural surface water.

A number of opportunities for regional coordination have already been identified for the Avra Valley planning subarea, including buffelgrass management, restoration of the Altar/Brawley Wash, and protection/enhancement of wildlife corridors between the Ironwood National Forest, and the Saguaro National Park – East, including crossings of the CAP canal.

Buffelgrass management has become an immediate concern for the region due to the high flammability of this non-native grass species in conjunction with the severe drought the area is experiencing. The City of Tucson is taking short-term management actions to address the issue in Avra Valley, as well as working with other entities to identify long-term eradication and control strategies. The short-term actions include preparation to remove extensive buffelgrass infestations from approximately 2,000 acres (800 hectares) in central Avra Valley. In addition to immediate removal of the buffelgrass, the City is working with the University of Arizona, USGS, Tucson Audubon Society, and other experts to evaluate the efficacy of buffelgrass removal methods and identify approaches to re-introduce native vegetation to the site while preventing further buffelgrass establishment. As a longer-term solution, the City is working with many other partners to create a Cooperative Weed Management Area in order to begin addressing control of buffelgrass and other invasive species on a regional basis.

A General Investigation (GI) through the USACE Civil Works Environmental Planning Program has been proposed for the Altar/Brawley Wash. A GI begins with a Reconnaissance Study to define water resource problems and opportunities; investigate opportunities for providing aquatic ecosystem restoration and, to the extent that it can be integrated with restoration, provide additional benefits such as flood damage reduction, water supply, and recreation; and determine whether planning should proceed into the Feasibility Phase. If further investigation is warranted, the GI proceeds into the Feasibility Phase, in which resource issues are examined in greater detail, an array of alternative solutions to these issues are identified and evaluated, and a preferred alternative is chosen.

The state of the Altar/Brawley Wash has been a concern to local resource managers for several decades. In 1992, the Soil Conservation Service (now Natural Resources Conservation Service), in cooperation with the Pima Natural Resource Conservation District, published a natural resource restoration plan for the Brawley Watershed. This report identified a number of issues within the watershed including: (1) stream bank erosion and associated loss of riparian and range habitat along the Brawley Wash; (2) sheet, rill, and gully erosion and associated damages to rangeland and improvements; (3) sedimentation effects on downstream water quality, farmland, and county and state road crossings; (4) flash flooding and associated damages to roads, farmland, and local communities; and (5) loss of groundwater recharge due to accelerated flows within the incised wash.

The importance of restoration along the Altar/Brawley Wash to conservation of sensitive species and habitats within Avra Valley is reflected in statements made by Dr. Phil Rosen, who was contracted by the City to assess the level of degradation to City-owned lands due to past agricultural uses and evaluate the potential for natural recovery or restoration of these properties to a more natural and better functioning state. Dr. Rosen stated that:

> *Large portions of Brawley Wash…are highly degraded barrens with adobe soils and low perennial plant diversity…Restoration of the Brawley Flats that would be valuable enough to justify the effort and costs that would be likely should, in my evaluation, include especially the partial elimination of enhanced drainage of the flats, and the partial increase of "overbank flood storage" – the restoration of sheet flow and short-duration standing water on broad areas of the Brawley Floodplain.*

5.1.1.3 Santa Cruz River Planning Sub-area

The USACE, with local sponsorship from the City of Tucson, Pima County and the Town of Marana, is leading an effort to study the feasibility of restoring vegetation along an approximately 29.5-mile (47.5-kilometer) section of the Santa Cruz River, including the entire 14.5-mile (23.3-kilometer) reach within the City. The three restoration feasibility studies, each of which is in a different stage of the planning process, are, from upstream to downstream, Paseo de las Iglesias, El Rio Medio, and Tres Rios de Norte. Paseo de las Iglesias is furthest along in its planning, with a Final Environmental Impact Statement (EIS) and Feasibility Report issued in July 2005. Tres Rios de Norte will have a draft EIS released early in 2006. El Rio Medio was kicked off in the summer of 2005, and is currently in the initial planning stages. These projects have proceeded under a General Investigations framework as described previously.

The Paseo de las Iglesias river restoration study, which encompasses approximately 5,005 acres (2,025 hectares), involves an approximately 7-mile (11.3-kilometer) stretch of the upstream Santa Cruz River between Los Reales Road and West Congress Road. The Paseo de las Iglesias Feasibility Report proposes the creation of 1,098 acres (444 hectares) of riparian habitat. Among the habitat restoration proposed is: 18 acres (7 hectares) of cottonwood-willow, 718 acres (290 hectares) of mesquite bosque, and 6 acres (2.4 hectares) of emergent marsh. The Paseo de las Iglesias EIS anticipates that approximately 420 acres (170 hectares) of existing Paloverde Mixed Cacti, Saltbush, and Saltcedar Disclimax communities, and another 934 acres (378 hectares) of vacant or fallow land, would be lost to urban development or converted during restoration.

The Tres Rios de Norte restoration study involves approximately 19,803 acres (8,014 hectares) along an 18-mile (29-kilometer) stretch of the Santa Cruz River between Prince Road and Sanders Road. Preliminary projections from the Tres Rios de Norte study show a proposed 2,970 acres (1,202 hectares) of riparian habitat to be created. Among the habitat restoration proposed is: 231 acres (93 hectares) of cottonwood-willow, 1,819 acres (736 hectares) of mesquite bosque, and 73 acres (30 hectares) of wet river-bottom.

El Rio Medio involves approximately 3,080 acres (1,246 hectares) along a 4.5-mile (7.2-kilometer) stretch of the Santa Cruz River, between Congress Street and Prince Road. The El Rio Medio Feasibility Study is currently ongoing, and potential restoration acreages have not yet been identified. However, proposed restoration is expected to be similar to that in Paseo de las Iglesias and Tres Rios de Norte.

There is currently little cottonwood-willow existing along the Santa Cruz River. Outside of the effluent-dominated stretch of the river, at the far downstream end of the Santa Cruz River planning sub-area, cottonwoods and willows are found as individuals or stands of only a few trees. Mesquites are more common within the planning area, but are much less extensive than they were historically. By the 1950s, the river became entirely ephemeral, flowing only in response to stormwater runoff. As a result, no areas of permanent or long-term standing water are supported within the river.

Creation of these three types of communities can provide critical habitat for sensitive species. Pygmy-owls, for example, are thought to have predominantly utilized riparian areas historically. Significant reductions in the amount and quality of riparian habitat after the turn of the century is thought, by some, to be a leading cause in the decline of this species in Arizona. Cottonwood-willow gallery forests are the preferred habitat for the endangered southwest willow flycatcher and the yellow-billed cuckoo.
No breeding habitat for these species currently exists within the planning areas of these 3 restoration projects. Emergent marshes and other areas of permanent surface water could support aquatic or riparian-obligate species such as the Gila chub, Mexican garter snake, and endangered Huachuca water umbel, species which have been extirpated from this portion of the Santa Cruz River.

Since the re-establishment or reintroduction of a number of sensitive species is possible within these restoration projects, it is anticipated that these species will be addressed in the HCP in the context of Safe Harbor (SHA) or Candidate Conservation Agreements with Assurances (CCAA). SHAs, which deal with federally listed species, and CCAAs, which cover candidate species, allow landowners and jurisdictions to restore habitat without fear of regulatory consequences if these projects result in the re-establishment or population expansions of these species.

The predicted loss of Paloverde Mixed Cacti, Saltbush, and Saltcedar Disclimax habitat within the Paseo planning area does carry the potential for negative consequences for species covered under this HCP. The Paseo de las Iglesias EIS states that:

> *The riverbank protection with soil cement may negatively affect habitat suitable for burrowing owl under each of the action alternatives due to the re-grading of the currently steep eroded riverbanks. Ultimately, stabilization of these banks may provide greater protection for nest sites as the erodability of the unprotected banks leads to destruction of nest sites during floods.*

It is likely that the other two restoration projects (El Rio Medio and Tres Rios del Norte) will present similar concerns.

Given the preliminary status of land use and infrastructure planning in the City's HCP planning area, especially within the Southlands and Santa Cruz River planning sub-areas, the conservation program remains conceptual in nature. The conservation principles offered in this section, however, do provide guidance for the other planning process that will encourage development that has fewer impacts to the covered species and their habitats, and greater environmental benefits overall.

5.1.2 Existing City Tools for Environmental Protection

In addition to the opportunities presented by these planning efforts, the City currently possesses a number of adopted and proposed ordinances and policies that can serve as tools in the implementation of the conservation program. These ordinances are applicable City-wide. In the Avra Valley planning sub-area, which it outside of the City limits and therefore not subject to these ordinances, the City has a history of voluntarily complying as applicable.

Environmental Resource Zone (ERZ) Overlay. The purpose of these regulations is to recognize the value of Tucson's natural open space resources, particularly the critical and sensitive wildlife habitat of eastern Pima County. Specifically, this overlay zone serves to conserve certain designated washes which extend from nearby Federal and County parks and preserves as areas of natural and scenic resources and protect valuable wildlife habitat associated with these washes.

Under these regulations, resource corridors (ERZ washes), along which critical riparian habitat is associated, are shown on a series of maps (ERZ maps) approved by the City's Mayor and Council. The ERZ maps include all parcels along the subject washes that may contain riparian habitat, including those parcels that are not vacant. Any new development that occurs on parcels that include property designated as ERZ wash are reviewed for compliance with these regulations.

Under the ERZ regulations, development of parcels with ERZ washes can precede under one of two options. The first option requires preservation of the 100-year floodplain as natural undisturbed open space. Alternatively, project proponents can prepare a Resource Corridor Study that: (1) identifies critical riparian habitat, (2) explains why 100 percent preservation of this habitat is not possible, (3) documents the specific impact of the proposed development on existing critical riparian habitat, and (4) presents a mitigation plan that presents techniques to lessen the impacts of the proposed development on this habitat and restore habitat areas that will be disturbed during construction. All applications made under this second option are reviewed by the Stormwater Advisory Committee and the Stormwater Technical Advisory Committee, are subject to public hearing requirements, and must be approved by the Director of the Development Services Department.

Watercourse Amenities, Safety, and Habitat (WASH) Ordinance. The intent of these regulations is, within urbanized areas of the City, to maintain existing vegetation as valuable natural resources that contribute to the health and well being of the residents of the City. These regulations serve to maximize opportunities for groundwater recharge through the preservation of specific washes with earthen channels and banks, protect existing vegetation found within and near these washes, and provide for the restoration of vegetation disturbed as a result of development in and adjacent to these washes.

Specific washes to which these protections apply are identified within the ordinance. These regulations apply to all lots or parcels that are adjacent to these WASH-designated washes. Project proponents must evaluate the presence of natural vegetation and wildlife habitats, the location of the 100-year floodplain, soil conditions and erosion potential, sediment transport characteristics, groundwater recharge potential, and other relevant characteristics of the watercourse, both on and adjacent to the site, within a study area defined as the channel and banks of the wash, and the land area extending 50 feet from the banks.

Inside the more restrictive resource area, defined as the channel and banks of the specified wash, no development, including vegetation removal, grading, channelization, or any other type of alteration, can occur unless a mitigation plan is developed. This mitigation plan must demonstrate that the loss of existing vegetation and wildlife habitat as a result of development within the resource area is minimized, and that lost vegetation and wildlife habitat are restored or recreated. All mitigation plans are reviewed by the Stormwater Advisory Committee and must be approved by the Director of the Development Services Department.

Native Plant Preservation Ordinance (NPPO). These regulations are intended to encourage preservation-in-place of healthy native plants through sensitive site design which minimizes the disruption of areas within the site containing native plants, while allowing for salvage and transplanting plants on the site that are likely to survive.

These regulations apply to all new development within the City and the expansions of existing develop-ment. Plants protected under these regulations include: pima pineapple cactus, needle-spined pineapple cactus, saguaros, and all other cacti; blue and foothills paloverde, Fremont cottonwood and Goodding willow, ironwood, velvet and screwbean mesquite, and other native tree species; and catclaw and whitethorn acacia, desert hackberry, and other native shrubs; and ocotillo and soaptree yucca.

Plant preservation requirements can be determined using one of four approved methodologies: plant inventory, plant appraisal, set aside, and a combination approach. Under the plant inventory methodology, all native plants on site must be inventoried and preservation must meet specified minimum percent protections for these plants. A minimum of 100 percent of endangered species and “crested saguaros”, 50 percent of saguaros and ironwoods, and 30 percent of all other protected native plant species must be preserved-in-place or salvaged and transplanted on-site. Any plants that are removed from the site or salvaged and transplanted on-site must be mitigated at ratios ranging from 1 additional plant to 3 additional plants for each individual removed or transplanted. A credit towards this mitigation requirement is provided for preservation-on-site of plants at a ratio of 1 credit to 4 credits for every individual preserved in place.

The second approach allowed under these regulations is the plant appraisal methodology in which the project proponent uses the monetary replacement value for each individual of the protected species that are removed from the site to purchase an equal value of native plants of the same species to be planted on site.

The set aside methodology allows the provisions of the NPPO to be met through permanent protection of at least 30 percent of the site as undisturbed open space. This set aside should consist of the area(s) on site with the highest resource value. In addition, 100 percent protection of all federally endangered plant species, saguaros, and ironwoods is required through preservation-in-place or salvage and transplantation on-site.

Environmentally Sensitive Roadway Design Guidelines. The City is also considering development of Environmentally Sensitive Roadway Design Guidelines. Pima County currently has a set of adopted guidelines; however, the results of recent studies may provide a basis on which to refine these guidelines in a manner that will provide better outcomes.

One source of new information comes from Arizona's first wildlife linkage conference, titled “Missing Linkages”, which was a cooperative effort of the AGFD, Arizona Department of Transportation, USFWS, U.S. Forest Service, Federal Highway Administration, Bureau of Land Management, the Wildlands Project and Northern Arizona University. This conference, held in April 2004, demonstrated the urgency and need to cooperatively address wildlife connectivity on a statewide level, and aimed to identify and map areas that are important wildlife habitats and corridors. The goals of the conference were to identify (1) linkages vital to maintaining biodiversity across Arizona, (2) constraints to wildlife movement, and (3) threats to linkages and quality of nearby habitat.

This workshop resulted in the mapping and prioritizing of 80 key wildlife linkages throughout Arizona. The linkage map is being used as a planning tool for placement of wildlife crossing structures on highways. When fully developed, the map will greatly assist Arizona’s future highway planning, construction, and maintenance activities in tandem with the state's wildlife management goals. This information can help in the refinement of environmentally sensitive roadway design guidelines for Pima County and the City of Tucson.

The remainder of this section outlines the species-specific conservation measures proposed for each of the species addressed in this HCP. Many of these measures relate back to the planning efforts and existing tools discussed previously.

5.2 Cactus Ferruginous Pygmy-owl Conservation Program

5.2.1 Biological Goals and Objectives

The only recent (since 1993) record of a pygmy-owl occurring within the City HCP planning area was of a single dispersing female on the Duval/Pennzoil Farm parcel in the Avra Valley planning sub-area in 2005. In 2003–2004, AGFD Research Branch tracked another female pygmy-owl crossing Avra Valley, but this female was not recorded on City lands (S. Richardson, USFWS, pers. comm.; D. Abbate, AGFD, pers. comm.). The planning area contains no suitable breeding habitat for this species. There are1,588 acres (635 hectares) of over-wintering habitat, 6,513 acres (2,605 hectares) of dispersal habitat, and 677 acres (271 hectares) that can be potentially restored as dispersal habitat within the planning area. Proposed Critical Habitat Unit (CHU) 2 for the pygmy-owl encompasses portions of the Avra Valley planning sub-area (Federal Register 2002). CHU 2 was established primarily to provide connectivity and allow for dispersal of CFPO between nesting areas in CHU 1, CHU 3, CHU 4, and the Tohono O’odham Nation. Providing areas for dispersal is necessary for the maintenance and expansion of pygmy-owl subpopulations found within these CHUs. USFWS reports that CHU 2 provides breeding, roosting, perching, and foraging habitat, and maintains an important linkage function among blocks of nesting habitat both locally and over the pygmy-owl’s range that is essential to the species’ conservation. The CHU also contains habitat that may become more important for nesting if the overall CFPO population expands (Federal Register 2002).

Implementation of anticipated covered activities will result in the loss of potential over-wintering and dispersal habitat in the Southlands due to urban development and associated infrastructure, and the loss of potential over-wintering and dispersal habitat in Avra Valley as a result of water development projects. Direct take of pygmy-owls is not likely. The indirect effects of urban development may impact the owl through reduction in native prey base, predation by domestic animals, disturbance by humans, e.g., off-road vehicle use and construction activities. Long-term effects may include reduced opportunities for dispersal between known populations of owls leading to isolation and reduced owl pairings, and loss of marginal breeding opportunities that may affect the success of future augmentation efforts and reduced opportunities for dispersal between known populations of owls leading to isolation and reduced owl pairings.

Based on this information, the City's biological goals and objectives for pygmy-owl relate to ensuring that development activities within the City do not lead to the permanent loss of pygmy-owls and will maintain sufficient habitat within the City to support significantly more owls than are currently present. Specifically, the City's biological goal for CFPO is to:

- Contribute to maintaining local and regional populations of CFPO.

The City's specific objectives for cactus ferruginous pygmy-owl are to:

- Provide for long-term availability of suitable dispersal and over-wintering habitat for pygmy-owls;
- Reduce barriers to movement for pygmy-owls;
- Minimize potential for mortality of pygmy-owls; and
- Preserve breeding opportunities to support potential expansion of pygmy-owl distribution resulting from augmentation.

5.2.2 Conservation Measures

Through implementation of the pygmy-owl conservation program, the City seeks to make a positive and long-term contribution to the conservation of this species. The City's conservation strategy for pygmy-owls consists of actions to:

- Maintain existing suitable dispersal and over-wintering habitat;
- Provide for the long term protection of dispersal corridors;
- Reduce adverse impacts associated with urbanization and by future water development projects; and
- Promote integrated, regional conservation planning for pygmy-owls.

The specific conservation measures that the City will implement are detailed below. The conservation program is outlined by planning sub-area (i.e., Southlands, Avra Valley, and Santa Cruz River). A monitoring and adaptive management program will be developed to complement the conservation measures (see Section 6).

5.2.2.1 Southlands Planning Sub-area

Actions to: Maintain Existing Suitable Dispersal and Over-wintering Habitat

Pygmy-owl Measure 1A: *The City will, by the ERZ Overlay, other ordinances, zoning, or some other mechanism, permanently protect suitable cactus ferruginous pygmy-owl dispersal and over-wintering habitat within the Southlands planning sub-area.*

The concept is for CFPO habitat to be protected in the Petty Ranch and Fagan watersheds and along ERZ-designated washes in the Southlands planning sub-area (see Figure 5.1-1). The Petty Ranch and Fagan Watersheds contain 100 percent of modeled suitable CFPO habitat in the Southlands.

The goals of this strategy are not only to minimize impacts to CFPO suitable habitat and movement corridors, but also preserve ecosystem functions necessary to maintain this habitat over the long term, by:

(1) Encouraging less urban development, development at rural densities, and/or location of less intensive uses, such as parks, within the Petty Ranch and Fagan Watersheds if complete preservation of the watersheds is not possible; and

(2) Strengthening the ERZ ordinance to ensure maximum protection of existing riparian habitat and hydrologic function of designated washes.

Goal (1) will be pursued through coordination with the Arizona State Land Department in their conceptual land use planning process for all state trust lands within the greater Southlands.

One step in achieving Goal (2) is to move from the descriptive wash protection approach taken by the current ERZ and WASH ordinances to an envelope-driven approach that identifies the critical riparian corridor surrounding each wash and applies protections to all land within that mapped area. The second approach would be similar to Pima County's designation and protection of Important Riparian Areas.

Actions to: Provide for the Long-term Protection of Dispersal Corridors

Pygmy-owl Measure 2A: *The City will, through the NPPO, require the protection of CFPO suitable habitat outside of any reserves established under Measure 1A.*

Currently, the NPPO requires that at least 50 percent of all viable saguaros and 30 percent of all other cacti and protected native tree species will be preserved-in-place or salvaged and transplanted on-site. The NPPO does not, however, require protection of the habitats within which these trees and saguaros reside.

The goals of this measure are to: (1) protect large trees and saguaros that are thought to be preferentially used by dispersing CFPO; (2) preserve a sufficient amount of understory vegetation around trees and saguaros with a density and composition that offers escape cover and foraging options for dispersing owls; (3) locate patches of protected habitat in proximity to each other and to other natural open space such that continuity between sites is preserved and corridors throughout the Southlands are protected; and (4) maintain the long-term sustainability of these patches by buffering them from intensive land uses, minimizing human disturbance, and preserving ecological functions (e.g., hydrology) within and around these areas.

There are very few saguaros found within the Southlands planning sub-area at present. A minimum target for the preservation of this species would therefore be to allow no net loss of saguaros within the sub-area.

The protection of the Petty Ranch and Fagan watersheds and ERZ-designated washes will ensure the preservation of east-west corridors through the Southlands planning sub-area. A second target for this measure would be to protect or enhance linkages from these watersheds, north and east to the Pima County Regional Park, the Davis Monthan AFB paddle, and across to Cienega Creek and the Rincon Mountains.

Options for implementation of the NPPO for purposes of achieving conservation program goals include:

(1) Using the NPPO ordinance as currently drafted;

(2) *Revising the ordinance to require a higher percentage protection of some/all plant species, stronger guidelines regarding the siting and configuration of open space in the 30 percent set-aside option, inclusion of additional plant species for protection, and/or incentives to encourage preservation-in-place of more plants versus transplanting them on site; or*

(3) Reworking or replacement of the NPPO with protections oriented towards preservation of natural habitats versus the protection of individual plants.

Guidelines would have to be developed to ensure that areas are established and maintained in a manner that is most conducive to use by CFPO, including standards for patch size, spatial relationship to other uses, proximity of protected patches, and monitoring and management.

Pygmy-owl Measure 3A: *The City will work with Pima County to encourage, through the Lee Moore Watershed Basin Management Study, the siting and management of retention and/or detention basins that enhance the quality and availability of suitable dispersal habitat.*

The concept is to encourage revegetation of stormwater basins with native plants, including large trees, at an appropriate density and structure to facilitate movement of dispersing CFPO through the Southlands planning area. Not all basins, due to location, configuration, or intended use, may be appropriate for this type of enhancement. Situations in which habitat enhancement may not be appropriate in basins include when: (1) vegetation would compromise the stormwater management purpose, (2) long-term persistence of vegetation is not likely due to prevailing environmental conditions, (3) basins are isolated within urban development and could not offer dispersal benefits for CFPO, (4) other uses are deemed more appropriate, or (5) for other health and human safety reasons. For those basins that are deemed appropriate, revegetation and management standards would have to be developed to ensure that areas are created and maintained in a manner that is most conducive to use by CFPO, while not impairing function and maintenance of the facilities for stormwater management.

The goal of this measure is to locate basins, specifically those appropriate for revegetation, in a manner that provides continuity of habitat throughout the Southlands planning sub-area and, in particular, maintains the ability of CFPO to move from the southern portion of the planning area to the northeast and to Cienega Creek and the Rincon Mountains by providing linkages between reserve areas and protected washes (Measure 1A) and habitat patches protected through the NPPO (Measure 2A).

Actions to: Reduce Adverse Impacts from Development and Associated with Urbanization

Pygmy-owl Measure 4A: *In order to prevent lethal take of pygmy-owls, the City will require any construction project proponent to request and receive written confirmation from USFWS on whether any pygmy-owls are located in the project area. If there is a pygmy-owl on the project site, the proponent will coordinate with USFWS to modify construction timing, development phasing, development configuration, or otherwise modify their project to avoid lethal take of the owls.*

The goal of this measure is to prevent injury to or death of CFPO during ground clearing or other vegetation removal activities.

Pygmy-owl Measure 5A: *The City will require, where appropriate, wildlife-friendly fences within, and adjacent to, protected dispersal and over-wintering habitat and stopover patches and prohibit fencing that prevents the movement of pygmy-owls within and between these areas.*

The goal of this measure is to minimize human intrusions into protected areas while still allowing for movement of CFPO and other wildlife through the Southlands planning sub-area.

Pygmy-owl Measure 6A: *Public infrastructure improvements within identified pygmy-owl dispersal and over-wintering habitat must be designed according to Pima County's environmentally-sensitive road design guidelines or a similar standard. Any alternative design guidelines will be reviewed by USFWS; The City will ensure that any alternate guidelines are consistent with all HCP objectives.*

The goal of this measure is to limit disturbance to suitable CFPO habitat, maintain adequate movement corridors, and minimize impacts to hydrologic functions needed to maintain the quality of protected habitat over time.

Major concepts to be considered in environmentally sensitive roadway design include:

- *Avoiding washes altogether where possible,*
- *Crossing as few washes as possible,*
- *Spanning all washes crossed,*
- *Crossing washes at right angles, and*
- *Crossing riparian areas where width of habitat is narrowest.*

Pygmy-owl Measure 7A: *Utilities, not a part of development or road projects, within identified pygmy-owl dispersal and over-wintering habitat will be required to comply with all environmentally sensitive roadway design guidelines (see concepts in Measure 6A). Utilities will be encouraged to avoid or minimize whenever possible activities in washes, and the removal of saguaros or large trees. Utilities are required to revegetate any disturbance with the same mix of species removed, except for any necessary and approved access easements. Any suitable saguaros or large trees will be transplanted back onto the site. Grading and revegetation plans, showing both existing and replacement plant types, numbers, and relative sizes/volumes must be reviewed by USFWS and approved by the City prior to disturbance.*

Pygmy-owl Measure 8A: *The City will, by ordinance or some other mechanism, prohibit use of ORVs in washes within the City's jurisdictional limits.*

The goals of this measure are to minimize: damage to vegetation, potential for wash degradation (e.g., erosion, incision, headcutting), disturbance to wildlife due to noise and proximity of humans, and potential for introduction of toxic materials, fire, or other environmentally damaging factors.

Pygmy-owl Measure 9A: *The City will prohibit, to the extent possible, domestic dogs and cats in identified pygmy-owl over-wintering and dispersal habitat.*

The goal of this measure is minimize potential predation of CFPO by domestic animals.

Actions to: Promote Integrated, Regional Conservation Planning for Pygmy-owls

Pygmy-owl Measure 10A: *The City will inform neighboring jurisdictions about the City's conservation program for CFPO and encourage implementation of compatible conservation* *measures by these jurisdictions. In implementing its conservation program, the City will coordinate with regional conservation efforts for CFPO and encourage other jurisdictions to coordinate conservation actions for CFPO at a regional level.*

The goal of this measure is to work towards consistent outcomes across jurisdictions and, ultimately, to preserve a regional landscape that supports the recovery of CFPO within Pima County, especially by maintaining elements of connectivity between City-protected pygmy-owl dispersal and over-wintering habitat and known pygmy-owl populations or other areas of protected breeding, over-wintering, or dispersal habitat outside of the City HCP planning area, such as across I-19 and the Nogales Highway.

5.2.2.2 Avra Valley Planning Sub-area

Actions to: Maintain Existing Suitable Dispersal and Over-wintering Habitat

Pygmy-owl Measure 1B: *The City will minimize permanent impacts to suitable pygmy-owl dispersal and over-wintering habitat within the Avra Valley planning sub-area.*

The goals of this measure are to avoid loss of existing suitable habitat and, where avoidance is not possible, minimize the extent of the impact and mitigate for lost habitat with the same type (e.g., dispersal or over-wintering), and in a location and configuration that compensates for the function of the impacted habitat.

The priority conservation areas identified in Figure 5.1-2 include 100 percent of suitable CFPO habitat in the Avra Valley planning sub-area.

Pygmy-owl Measure 2B: *When constructing recharge basins or evaporation ponds, the City will, where possible, create sites that will capture and retain sheet flow to enhance or create patches of suitable pygmy-owl habitat.*

The goals of this measure are to increase the amount of suitable over-wintering habitat and to enhance connectivity of habitat through Avra Valley.

Actions to: Provide for the Long term Protection of Dispersal Corridors

Pygmy-owl Measure 3B: *The City will restore land in areas identified as critical dispersal corridors in order to facilitate movement of pygmy-owls through Avra Valley. These corridors are identified in Figure 5.1-2.*

The goals of this measure are to: (1) preserve existing natural habitat and native species within these critical corridors, (2) repair previous degradation caused by agricultural uses, including loss of native vegetation, wash channelization, introduction or infestation of invasive species, soil compaction, reduced soil organic matter, loss of the native seed bank, removal of site topography, and other impacts and (3) restore a more natural vegetation community suitable for supporting dispersal of CFPO.

Actions to: Reduce Adverse Impacts from Development and Associated with Urbanization

Pygmy-owl Measure 4B: *In order to prevent lethal take of pygmy-owls, the City will request and receive written confirmation from USFWS regarding the location of any pygmy-owls in the project area. If there is a pygmy-owl on the project site, the City will coordinate with USFWS to modify construction timing, development phasing, development configuration, or otherwise modify their project to avoid lethal take of the owls.*

The goal of this measure is to prevent injury to or death of CFPO during vegetation clearing or other ground disturbance activities.

Pygmy-owl Measure 5B: *The City will erect and maintain wildlife-friendly fences around all properties in Avra Valley with existing, enhanced, or restored suitable over-wintering or dispersal habitat to prevent unauthorized grazing and use of ORVs in these areas.*

The goals of this measure are to minimize: damage to vegetation, potential for wash degradation (e.g., erosion, incision, headcutting), disturbance to owls due to noise and proximity of humans, and potential for introduction of toxic materials, fire, or other environmentally damaging factors.

Actions to: Promote Integrated, Regional Conservation Planning for Pygmy-owls

Pygmy-owl Measure 6B: *The City will inform neighboring jurisdictions about the City's conservation program for CFPO and encourage implementation of compatible conservation measures by these jurisdictions. In implementing its conservation program, the City will coordinate with regional conservation efforts for CFPO and encourage other jurisdictions to coordinate conservation actions for CFPO at a regional level. The City will participate in coordination with local, state, and federal jurisdictions and private landowners to control exotic plant species and minimize the potential for wildfire in Avra Valley.*

The goal of this measure is to work towards consistent outcomes across jurisdictions and, ultimately, to preserve a regional landscape that supports the recovery of CFPO within Pima County, especially by maintaining elements of connectivity between City-protected pygmy-owl dispersal and over-wintering habitat and known pygmy-owl populations or other areas of protected breeding, over-wintering, or dispersal habitat outside of the City HCP planning area.

5.2.2.3 Santa Cruz River Planning Sub-area

Conservation strategies for the Santa Cruz River planning sub-area have not yet been developed. It is anticipated, however, that these strategies will address short-term impacts resulting from the construction of restoration projects and short- and long-term impacts of future capital improvement projects and urban development on established restoration areas.

5.3 Pima Pineapple Cactus Conservation Program

5.3.1 Biological Goals and Objectives

The status of the PPC population within the City HCP planning area is currently unknown. At this time, PPC populations are anticipated only in the Southlands planning sub-area, which has approximately 25,598 acres (10,239 hectares) of potential PPC habitat. A range of estimates exists for the entire population of the species, but the only surveys to date in the Southlands planning sub-area are those by Baker (2005a); the Southlands has not been surveyed intensively. However, results from surveys in the vicinity of the City's planning area provide some indication of the relative densities at which PPC may occur.

Implementation of anticipated covered activities will result in the loss of potential habitat in the Southlands planning sub-area due to urban development and associated infrastructure. Direct take of PPC individuals is a consequence of development-associated ground disturbance activities. The indirect effects of urban development may impact the cactus through impacts to pollinators and seed dispersers, invasion or increased densities of exotic plants, and disturbance by humans (e.g., off-road vehicle use and recreation activities). Long-term effects may include fragmentation of habitat and isolation of habitat patches that can result in restricted gene flow. Specifically, the City's biological goal for PPC is to:

- Contribute to maintaining local and regional PPC populations.

The City's specific objectives for PPC are to:

- Provide for long-term availability of suitable PPC habitat; and
- Minimize loss of PPC individuals.

5.3.2 Conservation Measures

Through implementation of the PPC conservation program, the City seeks to make a positive and long-term contribution to the conservation of PPC populations. The City's conservation strategy for PPC consists of actions to:

- Maintain existing suitable habitat;
- Provide for the long term protection of pollination processes through the protection of connectivity between PPC populations;
- Reduce adverse impacts from development associated with urbanization; and
- Promote integrated, regional conservation planning for PPC.

The specific conservation measures that the City will implement are detailed below. A monitoring and adaptive management program will be developed to complement the conservation measures (see Section 6).

5.3.2.1 Southlands Planning Sub-area

Actions to: Maintain Existing Suitable Habitat

Pima Pineapple Cactus Measure 1A: *The City will, by zoning, ordinance, or some other mechanism, permanently protect suitable PPC habitat within the Southlands planning sub-area.*

The concept is for PPC habitat to be protected in the Petty Ranch and Fagan watersheds in the Southlands planning sub-area (see Figure 5.1-1). The Petty Ranch and Fagan watersheds contain 35 percent of modeled suitable PPC habitat in the Southlands planning sub-area.

The goals of this strategy are not only to minimize impacts to PPC suitable habitat, but also preserve ecosystem functions necessary to maintain this habitat over the long term, by encouraging less urban development, development at rural densities, and/or location of less intensive uses, such as parks, within the Petty Ranch and Fagan Watersheds if complete preservation of the watersheds is not possible.

This goal will be pursued through coordination with the ASLD in their conceptual land use planning process for all state trust lands within the greater Southlands.

Pima Pineapple Cactus Measure 2A: *The City will, through the NPPO, protect suitable PPC habitat outside of any reserves established under Measure 1A.*

Currently, the NPPO requires that at least 50 percent of all viable saguaros and 30 percent of all other cacti and protected native tree species will be preserved-in-place or salvaged and transplanted on-site. The NPPO does not, however, require protection of the habitats within which these plants reside.

The goals of this measure are to: (1) preserve PPC; (2) protect other native cacti, such as Opuntia fulgida, *that are important to the ground nesting bees that pollinate PPC; (3) preserve a sufficient amount of habitat surrounding protected PPC populations to allow for expansion and/or shifts in the population in the sites over time; (4) locate patches of protected habitat in proximity to each other and to other natural open space such that continuity between sites is preserved; and (5) maintain the long-term sustainability of these patches by buffering them from intensive land uses, minimizing human disturbance, and preserving ecological functions (e.g., hydrology) within and around these areas.*

Options for implementation of the NPPO for purposes of achieving conservation program goals include:

(1) Using the NPPO ordinance as currently drafted;

(2) *Revising the ordinance to require a higher percentage of protection for some/all plant species, stronger guidelines regarding the siting and configuration of open space in the 30 percent set-aside option, inclusion of additional plant species for protection, and/or incentives to encourage preservation-in-place of more plants versus transplanting them on site; or*

(3) Reworking or replacement of the NPPO with protections oriented towards preservation of natural habitats versus the protection of individual plants.

Guidelines would have to be developed to ensure that areas are established and maintained in a manner that will protect PPC suitable habitat over the long term, including standards for patch size, spatial relationship to other uses, proximity of protected patches, and monitoring and management.

Pima Pineapple Cactus Measure 3A: *The City will acquire, through fee-simple purchase, conservation easements, or other dedications, additional off-site mitigation, the location and configuration of which will be coordinated with Pima County's PPC conservation effort. The acreage to be acquired will be based on the anticipated loss of habitat within the Southlands planning sub-area resulting from activities covered under this HCP.*

The concept is that between Measures 1A, 2A and 3A, sufficient PPC suitable habitat will be protected to ensure that the long-term survival of the species in the wild is not jeopardized and that the PPC conservation program meets all other USFWS approval criteria for HCPs.

Actions to: Provide for the Long term Protection of the Pollination Processes through the Protection of Connectivity between PPC Populations

Pima Pineapple Cactus Measure 4A: *The City will encourage the use of PPC displaced during development within the Southlands planning sub-area, when feasible, as a landscaping plant in private yards, public areas, and along roads and trails.*

The goal of this measure is to maintain connections between areas of preserved PPC suitable habitat with PPC and other native cacti, such as Opuntia fulgida, *located continuously at distances less than the maximum 600 to 800 meters (1,968 to 2,624 feet) that PPC pollinators are thought to move between individual plants.*

This measure would require a plan/permit approved by USFWS and the Arizona Department of Agriculture for transplanting PPC displaced from areas within the Southlands planning sub-area, including methods of proper handling and siting of displaced cacti. Emphasis would be placed on locating PPC in areas where long-term protection of the individual plants, with appropriate monitoring and management, can be ensured.

<u>Actions to: Reduce Adverse Impacts from Development and Associated with Urbanization</u>

Pima Pineapple Cactus Measure 5A: *The City will require developers to survey for PPC prior to approval of development plans and will encourage the siting of development away from areas of higher PPC density.*

The goal of this measure is to minimize the loss of PPC individuals.

This measure is currently required under the City's NPPO.

Pima Pineapple Cactus Measure 6A: *The City will educate recreationists, school groups, residents, and plant collectors regarding how their activities can impact PPC.*

The goal of this measure is to reduce the likelihood of vandalism, collection, and unintended damage to PPC plants.

<u>Actions to: Promote Integrated, Regional Conservation Planning for PPC</u>

Pima Pineapple Cactus Measure 7A: *The City will inform neighboring jurisdictions about the City's conservation program for PPC and encourage implementation of compatible conservation measures by these jurisdictions. In implementing its conservation program, the City will coordinate with regional conservation efforts for PPC and encourage other jurisdictions to coordinate conservation actions for PPC at a regional level.*

The goal of this measure is to work towards consistent outcomes across jurisdictions and, ultimately, to preserve a regional landscape that supports the recovery of PPC within Pima County, especially by maintaining elements of connectivity between City-protected PPC habitat and known PPC populations or other areas of protected habitat, such as the Santa Rita Experimental Range and near Sahuarita.

5.4 Burrowing Owl Conservation Program

5.4.1 Biological Goals and Objectives

The current level and pattern of use of the City HCP planning area by western burrowing owls is unclear. The City is known to have breeding pairs within the Santa Cruz River and Avra Valley planning sub-areas. Burrowing owls also are known to winter and migrate through southeastern Arizona, but specific use of habitats in the City for wintering and migration has not been verified. Based on this information, the City's biological goals and objectives for burrowing owls relate to providing conditions to support breeding, over-wintering and migration by burrowing owls. Specifically, the City's biological goal for burrowing owls is to:

- Contribute to maintaining local and regional populations of burrowing owls.

The City's specific objectives for burrowing owl are to:

- Increase the number of breeding pairs of burrowing owls in the City and support breeding pairs in the City over the HCP permit term; and
- Provide habitat for over-wintering and migrating owls.

5.4.2 Conservation Measures

Through implementation of the burrowing owl conservation program, the City seeks to make a positive and long-term contribution to the conservation of burrowing owls. The City's conservation strategy for burrowing owls consists of actions to

- Provide for the long term availability of breeding and dispersal habitat;
- Reduce adverse impacts from development and urbanization; and
- Promote integrated, regional conservation planning for burrowing owls.

The specific conservation measures that the City will implement are detailed below. The conservation program is outlined by planning sub-area (i.e., Southlands, Avra Valley, and Santa Cruz River). A monitoring and adaptive management program will be developed to complement the conservation measures (see Section 6).

5.4.2.1 Southlands Planning Sub-area

Actions to: Provide for the Long term Availability of Breeding and Dispersal Habitat

Burrowing Owl Measure 1A: *The City will, by zoning, ordinance, or some other mechanism, permanently protect suitable burrowing owl habitat within the Southlands planning sub-area.*

The concept is for burrowing owl habitat to be protected in the Petty Ranch and Fagan watersheds and along ERZ-designated washes in the Southlands planning sub-area (see Figure 5.1-1). The Petty Ranch and Fagan watersheds contain 10 percent of modeled suitable burrowing owl habitat in the Southlands.

The goals of this strategy are not only to minimize impacts to burrowing owl suitable habitat, but also preserve ecosystem functions necessary to maintain this habitat over the long term, by encouraging less urban development, development at rural densities, and/or location of less intensive uses, such as parks, within the Petty Ranch and Fagan watersheds if complete preservation of the watersheds is not possible.

This goal will be pursued through coordination with the ASLD in its conceptual land use planning process for all state trust lands within the greater Southlands.

Suitable burrowing owl habitat that is lost to urban development will be mitigated by the establishment of Burrowing Owl Management Areas (BOMAs) within the Southlands planning sub-area.

The City will develop a management plan to maintain and/or create suitable nesting and foraging opportunities for burrowing owls in the BOMAs including, as needed, installation of artificial burrows. Burrowing owls will be allowed to independently colonize the BOMAs. Also, the City will allow use of the BOMAs as hacking and release sites for burrowing owls relocated from other areas as long as it will not adversely affect owls already inhabiting the management areas. The specific BOMAs will be determined through consultation with USFWS and AGFD. BOMAs will be, where possible, integrated into parks, natural open space areas, and along washes. The City will ensure the long-term conservation of the BOMAs through purchasing lands, obtaining easements or other mechanisms approved by the USFWS.

Actions to: Reduce Adverse Impacts from Development and Associated Urbanization

Burrowing Owl Measure 2A: *The City will prohibit, to the extent possible, domestic dogs and cats in identified pygmy-owl over-wintering and dispersal habitat.*

The goal of this measure is minimize potential predation of burrowing owl by domestic animals.

Burrowing Owl Measure 3A: *The City will implement an education program to inform the public about burrowing owls and the City's conservation program for burrowing owls. The education program will target four main groups:*

- *Residents living near BOMAs;*
- *Recreationists using public parks encompassing BOMAs;*
- *Developers approved to develop near BOMAs; and*
- *School children attending schools near BOMAs.*

The goal of this measure is to reduce the likelihood of vandalism of BOMAs and protected burrowing owl habitat, direct harm to owls, and unintended damage to habitat sites. The resident education program will focus on informing residents living near BOMAs about the potential impacts to burrowing owls from free-ranging cats and dogs, and to encourage cat owners to keep cats indoors. The recreationist education program will inform people about the presence of the BOMAs, provide basic information about the species' ecology and inform the public about recreational activities potentially harmful to owls. The developer education program will inform developers and construction personnel about burrowing owls, the City's conservation efforts, construction activities that could impact the burrowing owls, a mechanism to protect burrowing owls found during construction activities, and how to relocate burrowing owls from within the development area. The school children education program will teach children about burrowing owls, the City's conservation efforts, and activities that may be harmful to burrowing owls. The City will initiate the education program within 1 year of establishing the BOMAs.

Actions to: Promote Integrated, Regional Conservation Planning for Burrowing Owls

Burrowing Owl Measure 4A: *The City will inform neighboring jurisdictions about the City's conservation program for burrowing owl and encourage implementation of compatible conservation measures by these jurisdictions. In implementing its conservation program, the City will coordinate with regional conservation efforts for burrowing owl and encourage other jurisdictions to coordinate conservation actions for burrowing owls at a regional level.*

The goal of this measure is to work towards consistent outcomes across jurisdictions and, ultimately, to preserve a regional landscape that supports the recovery of burrowing owl within Pima County.

5.4.2.2 Avra Valley Planning Sub-area

Actions to: Provide for the Long term Availability of Breeding and Dispersal Habitat

Burrowing Owl Measure 1B: *The City will minimize permanent impacts to suitable burrowing owl habitat within the Avra Valley planning sub-area.*

The priority conservation areas identified in Figure 5.1-2 include approximately 22 percent of suitable burrowing owl habitat in the Avra Valley planning sub-area.

The goals of this measure are to avoid loss of existing suitable habitat and, where avoidance is not possible, minimize the extent of the impact and mitigate for lost habitat by establishing BOMAs within the Avra Valley planning sub-area.

The City will develop a management plan to maintain and/or create suitable nesting and foraging opportunities for burrowing owls in the BOMAs including, as needed, installation of artificial burrows. Burrowing owls will be allowed to independently colonize the BOMAs. Also, the City will allow use of the BOMAs as hacking and release sites for burrowing owls relocated from other areas as long as it will not adversely affect owls already inhabiting the management areas. The specific BOMAs will be determined through consultation with USFWS and AGFD. BOMAs will be, where possible, integrated into parks, natural open space areas, and along washes. The City will ensure the long-term conservation of the BOMAs through purchasing lands, obtaining easements or another mechanisms approved by the USFWS.

Actions to: Reduce Adverse Impacts from Development and Associated with Urbanization

Burrowing Owl Measure 2B: *For projects determined to support or potentially support burrowing owls, surveys for burrowing owls will be conducted within 1 year of initiation of construction activities. Surveys will be conducted between April 15 and July 15. If burrowing owls are found, they will be passively evicted before initiation of construction activities. Burrowing owls will be evicted between September 1 and January 31, the non-breeding season. In addition, a clearance survey for burrowing owls on proposed project areas will be conducted within 30 days of initiation of construction activities. If burrowing owls are found, the owls will be evicted prior to the start of construction. If eviction of owls during the breeding season is necessary, the project proponent will coordinate with the USFWS and AGFD to evict the owls in a manner that minimizes potential harm to adults and nestlings.*

The goal of this measure is to prevent injury to or death of burrowing owl during vegetation clearing or other ground disturbance activities.

Burrowing Owl Measure 3B: *The City will erect and maintain wildlife-friendly fences around all properties in Avra Valley with existing, enhanced, or restored suitable habitat to prevent unauthorized grazing and use of ORVs in these areas.*

The goals of this measure are to minimize: damage to vegetation, potential for wash degradation (e.g., erosion, incision, headcutting), disturbance to owls due to noise and proximity of humans, and potential for introduction of toxic materials, fire, or other environmentally damaging factors.

Actions to: Promote Integrated, Regional Conservation Planning for Burrowing Owls

Burrowing Owl Measure 4B: *The City will inform neighboring jurisdictions about the City's conservation program for burrowing owl and encourage implementation of compatible conservation measures by these jurisdictions. In implementing its conservation program, the City will coordinate with regional conservation efforts for burrowing owl and encourage other jurisdictions to coordinate conservation actions for burrowing owl at a regional level. The City will participate in coordination with local, state, and federal jurisdictions and private landowners to control exotic plant species and minimize the potential for wildfire in Avra Valley.*

The goal of this measure is to work towards consistent outcomes across jurisdictions and, ultimately, to preserve a regional landscape that supports the recovery of burrowing owl within Pima County.

5.4.2.3 Santa Cruz River Planning Sub-area

Conservation strategies for the Santa Cruz River planning sub-area have not yet been developed. It is anticipated, however, that these strategies will address short-term impacts resulting from the construction of restoration projects; loss of suitable habitat, especially breeding opportunities, due to conversion to riparian habitat; and short- and long-term impacts of future capital improvement projects and urban development on established restoration areas

5.5 Tucson Shovel-nosed Snake Conservation Program

5.5.1 Biological Goals and Objectives

The current Tucson shovel-nosed snake population status within the City HCP planning area is unknown. At this time, shovel-nosed snake populations are anticipated only in the Avra Valley planning sub-area, which has approximately 12,729 acres (5,092 hectares) of potential shovel-nosed snake habitat. Another 337 acres (135 hectares) of habitat within the Santa Cruz River corridor has suitable soil and elevational characteristics, but this species has not been documented within the river, and it is not known whether the snake could utilize this habitat. The last known record of the Tucson shovel-nosed snake in the vicinity of the HCP Avra Valley planning sub-area was at Sanders Road and Avra Valley Road in 1979. It is unknown whether the species persists within Pima County. It was not observed during species-specific surveys conducted in and around Marana in 2003. However, these surveys were initiated during the latter half of the seasonal activity cycle when the snake was much less active. The record of a Tucson shovel-nosed snake observed near Picacho in 2004 demonstrates that the species is not regionally extinct, and may still inhabit the Avra Valley.

Implementation of anticipated covered activities will result in the loss of potential habitat in the Avra Valley planning sub-area due to development of water supply projects. Direct take of shovel-nosed snake individuals may occur as a consequence of development-associated ground disturbance activities. The indirect effects of development may impact the snake through facilitation of invasion or increased densities of exotic plants and disturbance by humans during maintenance of facilities. Long-term effects may include fragmentation of habitat and isolation of habitat patches. Specifically, the City’s biological goal for the Tucson shovel-nosed snake is to:

- Contribute to maintaining local and regional Tucson shovel-nosed snake populations.

The City’s specific objectives for Tucson shovel-nosed snakes are to:

- Provide for long-term availability of suitable Tucson shovel-nosed snake habitat; and
- Minimize loss of Tucson shovel-nosed snake individuals.

5.5.2 Conservation Measures

Through implementation of the Tucson shovel-nosed snake conservation program, the City seeks to make a positive and long-term contribution to the conservation of shovel-nosed snake populations. The City’s conservation strategy for shovel-nosed snake consists of actions to:

- Maintain existing suitable habitat;
- Reduce adverse impacts from development of water supply projects; and
- Promote integrated, regional conservation planning for Tucson shovel-nosed snake.

The specific conservation measures that the City will implement are detailed below. A monitoring and adaptive management program will be developed to complement the conservation measures (see Section 6).

5.5.2.1 Avra Valley Planning Sub-area

Actions to: Maintain Existing Suitable Habitat

Tucson Shovel-nosed Snake Measure 1B: *The City will minimize permanent impacts to suitable Tucson shovel-nosed snake habitat within the Avra Valley planning sub-area.*

The priority conservation areas identified in Figure 5.1-2 include approximately 26 percent of suitable shovel-nosed snake habitat (including areas with restoration potential) in the Avra Valley planning sub-area.

The goals of this measure are to avoid loss of existing suitable habitat and, where avoidance is not possible, minimize the extent of the impact and mitigate for lost habitat by restoring land in areas identified as having restoration potential in the City's Tucson shovel-nosed snake habitat model.

The concept is that, although farming dramatically reduces the suitability of the land for this species, as these lands recover from cultivation, it is plausible that they may be recovered to suitable shovel-nosed snake habitat. The City's former agricultural lands therefore cannot be ruled out as future snake habitat as long as they have appropriate soil types and occur within the elevational range of the species. The level of degradation of these lands, relative to suitable snake habitat, is not currently known. What management actions would be required to improved the suitability or completely restores these lands to suitable habitat is also unknown.

The goals of the restoration are to: (1) repair previous degradation caused by agricultural uses, including loss of native vegetation, wash channelization, introduction or infestation of invasive species, soil compaction, reduced soil organic matter, loss of the native seed bank, removal of site topography, and other impacts and (2) restore a more natural vegetation community suited to supporting Tucson shovel-nosed snakes.

Actions to: Reduce Adverse Impacts from Development and Associated with Urbanization

Tucson Shovel-nosed Snake Measure 2B: *The City will erect and maintain wildlife-friendly fences around all properties in the Avra Valley planning sub-area with existing, enhanced, or restored suitable habitat to prevent unauthorized grazing and use of ORVs in these areas.*

The goals of this measure are to minimize: damage to vegetation, potential for wash degradation (e.g., erosion, incision, headcutting), disturbance to snakes due to noise and proximity of humans, and potential for introduction of toxic materials, fire, or other environmentally damaging factors.

Actions to: Promote Integrated, Regional Conservation Planning for Tucson Shovel-nosed Snake

Tucson Shovel-nosed Snake Measure 3B: *The City will inform neighboring jurisdictions about the City's conservation program for Tucson shovel-nosed snake and encourage implementation of compatible conservation measures by these jurisdictions. In implementing its conservation program, the City will coordinate with regional conservation efforts for the shovel-nosed snake and encourage other jurisdictions to coordinate conservation actions for shovel-nosed snake at a regional level. The City will participate in coordination with local, state, and federal jurisdictions and private landowners to control exotic plant species and minimize the potential for wildfire in Avra Valley.*

The goal of this measure is to work towards consistent outcomes across jurisdictions and, ultimately, to preserve a regional landscape that supports the recovery of Tucson shovel-nosed snakes within Pima County.

5.5.2.2 Santa Cruz River Planning Sub-area

Conservation strategies for the Santa Cruz River planning sub-area have not yet been developed. It is anticipated, however, that these strategies will address short-term impacts resulting from the construction of restoration projects and short- and long-term impacts of future capital improvement projects and urban development on established restoration areas.

5.6 Ground Snake Conservation Program

5.6.1 Biological Goals and Objectives

The status of the ground snake population within the City HCP planning area is currently unknown. At this time, ground snake populations are anticipated only in the Avra Valley planning sub-area, which has approximately 21,596 acres (8,638 hectares) of potential ground snake habitat. There are no known observations of ground snakes within the City's HCP planning area. Four historic records of the ground snake show that it occurs along the Blanco Wash, from the confluence with the Santa Cruz River south to Avra Valley Road. Although these records serve to confirm the presence of this snake in the vicinity of the City's HCP planning area, they are not sufficient to determine the local abundance or population status of the species.

Implementation of anticipated covered activities will result in the loss of potential habitat in the Avra Valley planning sub-area due to development of water supply projects. Direct take of ground snake individuals may occur as a consequence of development-associated ground disturbance activities. The indirect effects of development may impact the snake through facilitation of invasion or increased densities of exotic plants and disturbance by humans during maintenance of facilities. Long-term effects may include fragmentation of habitat and isolation of habitat patches. Specifically, the City's biological goal for the ground snake is to:

- Contribute to maintaining local and regional ground snake populations.

The City's specific objectives for ground snakes are to:

- Provide for long-term availability of suitable ground snake habitat; and
- Minimize loss of ground snake individuals.

5.6.2 Conservation Measures

Through implementation of the ground snake conservation program, the City seeks to make a positive and long-term contribution to the conservation of ground snake populations. The City's conservation strategy for ground snake consists of actions to:

- Maintain existing suitable habitat;
- Reduce adverse impacts from development of water supply projects; and
- Promote integrated, regional conservation planning for ground snake.

The specific conservation measures that the City will implement are detailed below. A monitoring and adaptive management program will be developed to complement the conservation measures (see Section 6).

5.6.2.1 Avra Valley Planning Sub-area

Actions to: Maintain Existing Suitable Habitat

Ground Snake Measure 1B: *The City will minimize permanent impacts to suitable ground snake habitat within the Avra Valley planning sub-area.*

The priority conservation areas identified in Figure 5.1-2 include approximately 27 percent of suitable ground snake habitat in the Avra Valley planning sub-area.

The goals of this measure are to avoid loss of existing suitable habitat and, where avoidance is not possible, minimize the extent of the impact and mitigate for lost habitat by restoring land in areas identified as suitable ground snake habitat but having a history of agricultural use.

The concept is that, although farming reduces the suitability of the land for this species, as these lands recover from cultivation, it is plausible that they may be recovered to a state more suitable for ground snakes. The level of degradation of these and what management actions would be required to improve the suitability of this habitat are not unknown.

The goals of the restoration are to: (1) repair previous degradation caused by agricultural uses, including loss of native vegetation, wash channelization, introduction or infestation of invasive species, soil compaction, reduced soil organic matter, loss of the native seed bank, removal of site topography, and other impacts and (2) restore a more natural vegetation community suited to supporting ground snakes.

Actions to: Reduce Adverse Impacts from Development and Associated with Urbanization

Ground Snake Measure 3B: *The City will erect and maintain wildlife-friendly fences around all properties in the Avra Valley planning sub-area with existing, enhanced, or restored suitable habitat to prevent unauthorized grazing and use of ORVs in these areas.*

The goals of this measure are to minimize: damage to vegetation, potential for wash degradation (e.g., erosion, incision, headcutting), disturbance to snakes due to noise and proximity of humans, and potential for introduction of toxic materials, fire, or other environmentally damaging factors.

Actions to: Promote Integrated, Regional Conservation Planning for Ground Snake

Ground Snake Measure 4B: *The City will inform neighboring jurisdictions about the City's conservation program for ground snake and encourage implementation of compatible conservation measures by these jurisdictions. In implementing its conservation program, the City will coordinate with regional conservation efforts for the ground snake and encourage other jurisdictions to coordinate conservation actions for ground snake at a regional level. The City will participate in coordination with local, state, and federal jurisdictions and private landowners to control exotic plant species and minimize the potential for wildfire in Avra Valley.*

The goal of this measure is to work towards consistent outcomes across jurisdictions and, ultimately, to preserve a regional landscape that supports the recovery of ground snakes within Pima County.

5.6.2.2 Santa Cruz River Planning Sub-area

Conservation strategies for the Santa Cruz River planning sub-area have not yet been developed. It is anticipated, however, that these strategies will address short-term impacts resulting from the construction of restoration projects and short- and long-term impacts of future capital improvement projects and urban development on established restoration areas.

5.7 Needle-spined Pineapple Cactus Conservation Program

5.7.1 Biological Goals and Objectives

The current NSPC population status within the City HCP planning area is unknown. At this time, NSPC populations are anticipated only in the extreme northeastern portion of the Southlands planning sub-area, which has approximately 1,467 acres (587 hectares) of potential NSPC habitat. A range of estimates exists for the entire population of the species, but the only surveys to date in the Southlands planning sub-area are those by Baker (2005a); the Southlands planning sub-area has not been surveyed intensively.

Implementation of anticipated covered activities will result in the loss of potential habitat in the Southlands due to urban development and associated infrastructure. Direct take of NSPC individuals is a consequence of development-associated ground disturbance activities. The indirect effects of urban development may include impacts to pollinators and seed dispersers, invasion or increased densities of exotic plants, and disturbance by humans (e.g., off-road vehicle use and recreation activities). Long-term effects may include fragmentation of habitat and isolation of habitat patches that can result in restricted gene flow. Specifically, the City's biological goal for NSPC is to:

- Contribute to maintaining local and regional NSPC populations.

The City's specific objectives for NSPC are to:

- Provide for long-term availability of suitable NSPC habitat; and
- Minimize loss of NSPC individuals.

5.7.2 Conservation Measures

Through implementation of the NSPC conservation program, the City seeks to make a positive and long-term contribution to the conservation of NSPC populations. The City's conservation strategy for NSPC consists of actions to:

- Maintain existing suitable habitat;
- Reduce adverse impacts from development associated with urbanization; and
- Promote integrated, regional conservation planning for NSPC.

The specific conservation measures that the City will implement are detailed below. A monitoring and adaptive management program will be developed to complement the conservation measures (see Section 6).

5.7.2.1 Southlands Planning Sub-area

Actions to: Maintain Existing Suitable Habitat

Needle-spined Pineapple Cactus Measure 1A: *The City will, by zoning, ordinance, or some other mechanism, permanently protect suitable NSPC habitat within the Southlands planning sub-area.*

All known suitable NSPC habitat is located in an extreme northeast corner of the Southlands. There are at least two potential options for preserving this habitat:

(1) Coordination with the ASLD in their conceptual land use planning process for all state trust lands within the greater Southlands and/or

(2) Protection through the NPPO.

Currently, the NPPO requires that at least 30 percent of all cacti (except saguaros and PPC) be preserved-in-place or salvaged and transplanted on-site. The NPPO does not, however, require protection of the habitats within which plants reside.

The goals of this measure are to: (1) preserve NSPC, (2) protect other native cacti, such as Opuntia fulgida, *that may support NSPC pollinator(s); (3) preserve a sufficient amount of habitat surrounding protected NSPC populations to allow for expansion and/or shifts in the population in the sites over time; and (4) maintain the long-term sustainability of these patches by buffering them from intensive land uses, minimizing human disturbance, and preserving ecological functions (e.g., hydrology) within and around these areas.*

Options for implementation of the NPPO for purposes of achieving conservation program goals include:

(1) Using the NPPO ordinance as currently drafted;

(2) Revising the ordinance to require a higher percentage protection of some/all plant species, stronger guidelines regarding the siting and configuration of open space in the 30 percent set-aside option, inclusion of additional plant species for protection, and/or incentives to encourage preservation-in-place of more plants versus transplanting them on site; or

(3) Reworking or replacing the NPPO with protections oriented towards preservation of natural habitats versus the protection of individual plants.

Guidelines would have to be developed to ensure that areas are established and maintained in a manner that will protect NSPC suitable habitat over the long term, including spatial relationship to other uses, proximity of protected patches and monitoring and management.

Actions to: Reduce Adverse Impacts from Development and Associated with Urbanization

Needle-spined Pineapple Cactus Measure 2A: *The City will require developers to survey for NSPC prior to approval of development plans and will encourage the siting of development away from areas of higher NSPC density.*

The goal of this measure is to minimize the loss of NSPC individuals.

This measure may be accomplished within the context of the NPPO (see Measure 1A).

Needle-spined Pineapple Cactus Measure 3A: *The City will educate recreationists, school groups, residents, and plant collectors regarding how their activities can impact NSPC.*

The goal of this measure is to reduce the likelihood of vandalism, collection, and unintended damage to NSPC plants.

Actions to: Promote Integrated, Regional Conservation Planning for PPC

Needle-spined Pineapple Cactus Measure 4A: *The City will inform neighboring jurisdictions about the City's conservation program for NSPC and encourage implementation of compatible conservation measures by these jurisdictions. In implementing its conservation program, the City will coordinate with regional conservation efforts for NSPC and encourage other jurisdictions to coordinate conservation actions for NSPC at a regional level.*

The goal of this measure is to work towards consistent outcomes across jurisdictions and, ultimately, to preserve a regional landscape that supports the recovery of NSPC within Pima County, especially by maintaining elements of connectivity between City-protected NSPC habitat and known NSPC populations or other areas of protected habitat outside of the City HCP planning area.

5.8 Pale Townsend's Big-eared Bat Conservation Program

5.8.1 Biological Goals and Objectives

According to the HDMS (AGFD, unpublished data accessed 2003), there are no known pale Townsend's big-eared bat (PTBB) roost sites within the City HCP planning area. In Pima County, this species is known to use Colossal Cave Mountain Park, Tucson Mountain Park, Organ Pipe Cactus National Monument, and Saguaro National Park (Pima County 2000). Given the low elevations and relatively flat topography of the planning area, there is little to no potential that undocumented roosts sites are present.

Implementation of anticipated covered activities will result in the loss of potential PTBB foraging habitat in the Southlands planning sub-area due to urban development and associated infrastructure, and the loss of potential foraging habitat in the Avra Valley planning sub-area as a result of water development projects. Direct take of foraging bats is not likely. Mortality, resulting from impacts of maintenance or treatment activities, may occur when bats are occupying night roosts, such as bridges. The indirect effects of urban development may impact the bat through reduction in native prey base, predation by domestic animals, disturbance by humans, such as ORV use in washes, and urban-associated features, such as streetlights. The most significant threat to this species, however, is loss of potential maternity and long-term day roost sites through closure of adits and mine shafts, disturbance of mine shafts and caves, improper cave gating, and renewed mining activities. The City HCP planning area contains no suitable maternity or long-term day roost sites. Specifically, the City's biological goal for PTBB is to:

- Contribute to maintaining regional populations of PTBB.

The City's specific objective for PTTB is to:

- Provide year-round foraging opportunities for PTBB; and
- Minimize potential for direct take of foraging PTBB.

5.8.2 Conservation Measures

Through implementation of the PTTB conservation program, the City seeks to make a positive and long-term contribution to the conservation of the bat. The City's conservation strategy for PTTB consists of actions to:

- Maintain existing suitable foraging habitat;
- Maintain and improve availability of suitable night roosts for PTBB;
- Reduce adverse impacts from development and associated with urbanization; and
- Promote integrated, regional conservation planning for PTTB.

The specific conservation measures that the City will implement are detailed below. The conservation program is outlined by planning sub-area (i.e., Southlands, Avra Valley, and Santa Cruz River). A monitoring and adaptive management program will be developed to complement the conservation measures (see Section 6).

5.8.2.1 Southlands Planning Sub-area

Actions to: Maintain Existing Suitable Foraging Habitat

Pale Townsend's Big-eared Bat Measure 1A: *The City will, by the ERZ Ordinance, other ordinances, zoning, or some other mechanism, permanently protect suitable PTBB habitat within the Southlands planning sub-area.*

The concept is for PTBB habitat to be protected in the Petty Ranch and Fagan watersheds and along ERZ-designated washes in the Southlands planning sub-area (see Figure 5.1-1). The Petty Ranch and Fagan watersheds contain 36 percent of modeled suitable PTBB habitat in the Southlands.

The goals of this strategy are not only to minimize impacts to PTBB suitable habitat, but also preserve ecosystem functions necessary to maintain this habitat over the long term, by:

(1) Encouraging less urban development, development at rural densities, and/or location of less intensive uses, such as parks, within the Petty Ranch and Fagan Watersheds if complete preservation of the watersheds is not possible; and

(2) Strengthening the ERZ ordinance to ensure maximum protection of existing riparian habitat and hydrologic function of designated washes.

Goal (1) will be pursued through coordination with the ASLD in their conceptual land use planning process for all state trust lands within the greater Southlands.

One step in achieving Goal (2) is to move from the descriptive wash protection approach taken by the current ERZ and WASH ordinances to an envelope-driven approach that identifies the critical riparian corridor surrounding each wash and applies protections to all land within that mapped area. The second approach would be similar to Pima County's designation and protection of Important Riparian Areas.

Pale Townsend's Big-eared Bat Measure 2A: *The City will, through the NPPO, require the protection of PTBB suitable habitat outside of any reserves established under Measure 1A.*

Currently, the NPPO requires that at least 50 percent of all viable saguaros and 30 percent of all other cacti and protected native tree species will be preserved-in-place or salvaged and transplanted *on-site. The NPPO does not, however, include protection for the habitats within which these plants reside.*

The goals of this measure are to: (1) preserve native vegetation to support insect populations upon which the PTBB forages; (3) locate patches of protected habitat in proximity to protected washes to provide the riparian/upland edge in which PTBB appear to preferentially forage; and (3) maintain the long-term sustainability of these patches by buffering them from intensive land uses, minimizing human disturbance, and preserving ecological functions (e.g., hydrology) within and around these areas.

Options for implementation of the NPPO for purposes of achieving conservation program goals include:

(1) Using the NPPO ordinance as currently drafted;

(2) Revising the ordinance to require a higher percentage protection of some/all plant species, stronger guidelines regarding the siting and configuration of open space in the 30 percent set-aside option, inclusion of additional plant species for protection, and/or incentives to encourage preservation-in-place of more plants versus transplanting them on site; or

(3) Reworking or replacement of the NPPO with protections oriented towards preservation of natural habitats versus the protection of individual plants.

Guidelines would have to be developed to ensure that areas are established and maintained in a manner that is most conducive to use by foraging bats, including standards for patch size, spatial relationship to other uses, proximity of protected patches, and monitoring and management.

Pale Townsend's Big-eared Bat Measure 3A: *The City will work with Pima County to encourage, through the Lee Moore Watershed Basin Management Study, the siting and management of retention and/or detention basins that enhance the quality and availability of suitable bat foraging habitat.*

The concept is to encourage revegetation of stormwater basins with native plants, including large trees, at an appropriate density and structure to support foraging PTBB. Not all basins, due to location, configuration, or intended use, may be appropriate for this type of enhancement. Situations in which habitat enhancement may not be appropriate in basins include when: (1) vegetation would compromise the stormwater management purpose, (2) long-term persistence of vegetation is not likely due to prevailing environmental conditions, (3) other uses are deemed more appropriate, or (4) for other health and human safety reasons. For those basins that are deemed appropriate, revegetation and management standards would have to be developed to ensure that areas are created and maintained in a manner that is most conducive to use by foraging bats, while not impairing function and maintenance of the facilities for stormwater management.

Actions to: Maintain and Improve Availability of Suitable Night Roosts for PTBB

Pale Townsend's Big-eared Bat Measure 4A: *The City will encourage the use of bat-friendly bridge design for new or rebuilt bridges within the HCP planning area.*

The concept is that, following a late night peak of activity, PTBB usually go to a night roost, and then forage again in the early morning before returning to their daytime roosts shortly before sunrise. Increased availability of suitable night roosts for bats may, therefore, support increased foraging opportunity for bats within the Southlands planning sub-area.

The goal is develop a design for the underside of bridges that supports use of these structures as night roosts by PTBB.

Actions to: Reduce Adverse Impacts from Development and Associated with Urbanization

Pale Townsend's Big-eared Bat Measure 5A: *The City will, by ordinance or some other mechanism, prohibit use of ORVs in washes within the City's jurisdictional limits.*

The goals of this measure are to minimize: damage to vegetation, potential for wash degradation (e.g., erosion, incision, headcutting), disturbance to bats due to noise and proximity of humans, and potential for introduction of toxic materials, fire, or other environmentally damaging factors.

Pale Townsend's Big-eared Bat Measure 6A: *The City will survey under bridges prior to beginning maintenance procedures to minimize impacts to bats which may be roosting under bridges.*

The goal is to reduce potential for injury or death of bats due to maintenance activities, such as resurfacing.

Pale Townsend's Big-eared Bat Measure 7A: *The City will work to educate residents, school children, utility workers, City employees, developers, and recreationists about minimizing impacts to bat populations.*

The goal of this measure is to reduce the likelihood of vandalism of night roost site and protected PTBB habitat, direct harm to bats, and unintended damage to habitat or roost sites.

Pale Townsend's Big-eared Bat Measure 8A: *The City will inform neighboring jurisdictions about the City's conservation program for PTBB and encourage implementation of compatible conservation measures by these jurisdictions. In implementing its conservation program, the City will coordinate with regional conservation efforts for PTBB and encourage other jurisdictions to coordinate conservation actions for the bats at a regional level.*

The goal of this measure is to work towards consistent outcomes across jurisdictions and, ultimately, to preserve a regional landscape that supports the recovery of PTBB within Pima County.

5.8.2.2 Avra Valley Planning Sub-area

Actions to: Maintain Existing Suitable Foraging Habitat

Pale Townsend's Big-eared Bat Measure 1A: *The City will minimize permanent impacts to suitable PTBB habitat within the Avra Valley planning sub-area.*

The priority conservation areas identified in Figure 5.1-2 include approximately 88 percent of suitable PTBB habitat in the Avra Valley planning sub-area.

The goals of this measure are to avoid loss of existing suitable habitat and, where avoidance is not possible, minimize the extent of the impact and mitigate for lost habitat by:

(1) Where possible, when constructing recharge basins or evaporation ponds, creating sites that will capture and retain sheet flow to enhance or create patches of suitable PTBB foraging habitat; and/or

(2) Restoring land in areas identified as not suitable for PTBB foraging habitat due to former agricultural use.

The goals of the restoration are to: (1) repair previous degradation caused by agricultural uses, including loss of native vegetation, wash channelization, introduction or infestation of invasive species, soil compaction, reduced soil organic matter, loss of the native seed bank, removal of site topography, and other impacts and (2) restore a more natural vegetation community suitable for supporting foraging of PTBB.

Actions to: Reduce Adverse Impacts from Development and Associated Urbanization

Pale Townsend's Big-eared Bat Measure 5B: *The City will erect and maintain wildlife-friendly fences around all properties in the Avra Valley planning sub-area with existing, enhanced, or restored suitable foraging habitat to prevent unauthorized grazing and use of ORVs in these areas.*

The goals of this measure are to minimize: damage to vegetation, potential for wash degradation (e.g., erosion, incision, headcutting), disturbance to bats due to noise and proximity of humans, and potential for introduction of toxic materials, fire, or other environmentally damaging factors.

Actions to: Promote Integrated, Regional Conservation Planning for PTBB

Pale Townsend's Big-eared Bat Measure 6B: *The City will inform neighboring jurisdictions about the City's conservation program for PTBB and encourage implementation of compatible conservation measures by these jurisdictions. In implementing its conservation program, the City will coordinate with regional conservation efforts for PTBB and encourage other jurisdictions to coordinate conservation actions for PTBB at a regional level. The City will participate in coordination with local, state, and federal jurisdictions and private landowners to control exotic plant species and minimize the potential for wildfire in Avra Valley.*

The goal of this measure is to work towards consistent outcomes across jurisdictions and, ultimately, to preserve a regional landscape that supports the recovery of PTBB within Pima County.

5.8.2.3 Santa Cruz River Planning Sub-area

Conservation strategies for the Santa Cruz River planning sub-area have not yet been developed. It is anticipated, however, that these strategies will address short-term impacts resulting from the construction of restoration projects and short- and long-term impacts of future capital improvement projects and urban development on established restoration areas.

5.9 Western Yellow-billed Cuckoo Conservation Program

5.9.1 Biological Goals and Objectives

The current level and pattern of use of the City HCP planning area by western yellow-billed cuckoos is unclear. A few cuckoos have been documented migrating through or near the planning area, but specific use of habitats in the planning area for migration has not been verified. There are currently no documented breeding records within the planning area; however, there is recent evidence of breeding season use at Simpson Farm North, suggesting that river restoration efforts along the Santa Cruz River may produce stands of hydroriparian vegetation suitable to support a limited number of breeding cuckoos. Based on this information, the City's biological goals and objectives for western yellow-billed cuckoo in the planning area primarily relate to providing conditions to support migration. However, the conservation program also addresses the possibility of breeding activity at specific sites along the Santa Cruz River. Specifically, the City's biological goal for yellow-billed cuckoo is to:

- Contribute to maintaining local and regional populations of western yellow-billed cuckoos.

The City's specific objectives for western yellow-billed cuckoo are to:

- Provide for long-term availability of suitable dispersal and possible breeding habitat for western yellow-billed cuckoos; and

- Minimize potential for mortality of western yellow-billed cuckoos.

5.9.2 Conservation Measures

Through implementation of the western yellow-billed cuckoo conservation program, the City seeks to make a positive and long-term contribution to the conservation of cuckoos. The City's conservation strategy for western yellow-billed cuckoos consists of actions to:

- Maintain existing suitable dispersal and possible breeding habitat;
- Reduce adverse impacts from development and associated urbanization; and
- Promote integrated, regional conservation planning for western yellow-billed cuckoos.

The specific conservation measures that the City will implement are detailed below. The conservation program is outlined by planning sub-area (i.e., Avra Valley and Santa Cruz River). A monitoring and adaptive management program compliments the conservation measures and is described below.

5.9.2.1 Avra Valley Planning Sub-area

Actions to: Maintain Existing Suitable Dispersal and Possible Breeding Habitat

Yellow-billed Cuckoo Measure 1B: *The City will minimize permanent impacts to suitable western yellow-billed cuckoo habitat within the Avra Valley planning sub-area.*

The goals of this measure are to avoid loss of existing suitable habitat and, where avoidance is not possible, minimize the extent of the impact and mitigate for lost habitat with the same type (e.g., dispersal or over-wintering), and in a location and configuration that compensates for the function of the impacted habitat.

The priority conservation areas identified in Figure 5.1-2 include 100 percent of suitable western yellow-billed cuckoo habitat in the Avra Valley planning sub-area.

Yellow-billed Cuckoo Measure 2B: *When constructing recharge basins or evaporation ponds, the City will, where possible, create sites that will capture and retain sheet flow to enhance or create patches of suitable western yellow-billed cuckoo habitat.*

The goal of this measure is to increase the amount of suitable habitat in the Avra Valley planning sub-area.

Actions to: Reduce Adverse Impacts from Development and Associated with Urbanization

Yellow-billed Cuckoo Measure 3B: *The City will erect and maintain wildlife-friendly fences around all properties in the Avra Valley planning sub-area with existing, enhanced, or restored suitable foraging habitat to prevent unauthorized grazing and use of ORVs in these areas.*

The goals of this measure are to minimize: damage to vegetation, potential for wash degradation (e.g., erosion, incision, headcutting), disturbance to western yellow-billed cuckoo due to noise and proximity of humans, and potential for introduction of toxic materials, fire, or other environmentally damaging factors.

Actions to: Promote Integrated, Regional Conservation Planning for Yellow-billed Cuckoo

Yellow-billed Cuckoo Measure 5A: *The City will inform neighboring jurisdictions about the City's conservation program for western yellow-billed cuckoo and encourage implementation of compatible conservation measures by these jurisdictions. In implementing its conservation program, the City will* *coordinate with regional conservation efforts for YBCU and encourage other jurisdictions to coordinate conservation actions for western yellow-billed cuckoo at a regional level. The City will participate in coordination with local, state, and federal jurisdictions and private landowners to control exotic plant species and minimize the potential for wildfire in Avra Valley.*

The goal of this measure is to work towards consistent outcomes across jurisdictions and, ultimately, to preserve a regional landscape that supports the recovery of western yellow-billed cuckoo within Pima County.

5.9.2.2 Santa Cruz River Planning Sub-area

Conservation strategies for the Santa Cruz River planning sub-area have not yet been developed. It is anticipated, however, that these strategies will address short-term impacts resulting from the construction of restoration projects and short- and long-term impacts of future capital improvement projects and urban development on established restoration areas.

SECTION 6

Monitoring and Adaptive Management

SECTION TO BE PREPARED AND INCLUDED IN LATER DRAFT

Monitoring the effectiveness of the conservation measures and ensuring compliance with the terms of the conservation program are mandatory elements of an HCP. The USFWS elaborated on monitoring and adaptive management requirements for HCPs in its 5-Point Policy Guidance (64 FR 11485). The USFWS identifies two types of monitoring required for HCPs:

- Compliance monitoring – *Monitoring and reporting requirements necessary to demonstrate that HCP requirements are being carried out.*
- Effectiveness monitoring – *Monitoring and reporting requirements necessary to evaluate whether the HCP measures are achieving the biological goals and objectives. Effectiveness monitoring also provides information to support adaptive management decisions.*

The following describes monitoring and reporting requirements for compliance and effectiveness monitoring.

6.1 Compliance Monitoring and Reporting

Compliance monitoring and reporting will be accomplished through the following:

1. The City will submit, to the USFWS, annual reports documenting progress toward and completion of the conservation commitments.
2. The City will require that all development plans within the Southlands planning sub-area, that are submitted to the City for review and approval, contain a narrative discussion documenting compliance with the conservation measures that will be outlined and approved in the final HCP. This statement shall include maps and other graphics and analyses necessary to document this compliance. The submittal shall outline monitoring programs to document compliance with the conservation measures approved in the final HCP.

6.2 Effectiveness Monitoring and Reporting

As noted above, effectiveness monitoring focuses on whether the HCP measures are achieving the biological goals and objectives. The framework for effectiveness monitoring and adaptive management consists of a series of benchmarks at which progress toward the overall goal is assessed and adjustments in management are made if the benchmarks are not achieved.

6.2.1 Surveys

For some species, surveys may be required to document their response to implementation of the conservation measures in the HCP. In other cases, proxy measures of a species’ response may be more appropriate. For example, the diversity and abundance of a species’ prey base may be a lost costly and/or more accurate measure of the effects of the HCP measures than surveys for the species itself.

For reasons of cost-effectiveness and consistency, these surveys will be coordinated with efforts conducted by Pima County, Arizona Game and Fish Department, US Fish and Wildlife Services, and other land or wildlife management agencies.

6.2.2 Effectiveness Assessment and Adaptive Management

Results of annual surveys will be used toward meeting the species-specific biological goals and objectives outlined in the Conservation Program in Section 5. This is done by establishing a set of benchmarks and procedures for evaluating the success of each conservation action relative to these benchmarks.

Benchmarks will establish the result (e.g., population size within the planning area, number of offspring produced per year, amount of habitat protected, etc.) that is expected a particular time interval (e.g., 5 years, 10 years, etc.) after implementation of a specific conservation action. Benchmarks will be developed for each action identified in the HCP conservation program (Section 5).

6.2.3 On-Going Monitoring and Adaptive Management

Following achievement of all benchmarks, the City will continue to annually monitor the effectiveness of the conservation program. The City will continue to meet with the USFWS and other experts at appropriate intervals to verify continued achievement of the biological goals and objectives. If the annual surveys reveal that the benchmarks are no longer being met, the City, USWFS, and other experts will identify appropriate management adjustments to regain the established goals.

SECTION 7

Effects of Implementing the City of Tucson HCP

The conservation program outlined in this draft HCP is still preliminary. Once the conservation measures (Section 5) and monitoring and adaptive management program (Section 6) have been fully developed, an analysis of the effects of the HCP on the species covered in the HCP is required.

As an interim step, this section provides a summary of the major components of the conservation program and identifies the amount of suitable habitat for each covered species that would be protected if the program were implemented as outlined.

7.1 Conservation Program

The focus of the conservation program differs for each of the three planning sub-areas. The major elements of the conservation program for the Southlands, Avra Valley, and Santa Cruz River planning sub-areas are listed below.

7.1.1 Southlands Planning Sub-area

(1) The primary component of the Southlands conservation program is the protection of habitat within the Petty Ranch and Fagan Watersheds (see Figure 5.1-1). The amount of suitable habitat captured for each species within this area is provided in Table 7.1-1. These numbers, however, assume 100 percent protection of these watersheds as undisturbed natural open space. Depending on the species in question and the type of habitat impact, development within these watersheds may have to be mitigated elsewhere. This mitigation may require that lands outside of the HCP planning area be purchased as conservation lands or that additional land protections may be required within development areas throughout the Southlands. This element will be pursued through coordination with the ASLD in their conceptual land use planning process for all state trust lands within the greater Southlands.

(2) To supplement habitat protection within the Petty Ranch and Fagan Watersheds, additional habitat will be protected through the City's Environmental Resource Zone (ERZ) Overlay and Native Plant Preservation Ordinance. At this time, it is impossible to estimate the amount of habitat that will be protected through these regulations.

(3) Opportunities for habitat enhancement and creation will be pursued in association with regional retention/detention basins planned as a part of the Lee Moore Watershed Basin Management Study and through creation of Burrowing Owl Management Areas.

(4) Impacts to wildlife and habitats associated with urban development will be minimized by installing wildlife friendly fencing around protected lands, prohibiting ORV use within washes, and minimizing access to protected lands by domestic cats and dogs.

(5) To further reduce potential impacts to wildlife and habitats, an education program will be implemented to inform developers, residents, and recreationists about these sensitive resources and how they can work to minimize their impacts to these resources.

Table 7.1-1. Suitable Habitat in Proposed Reserves for Target Species Within the Tucson HCP Planning Area

Target Species	Tucson Modeled Habitat Captured within the Proposed Tucson HCP Reserves[1]	Goal for Habitat Protection in Sonoran Desert Conservation Plan	Actual Conservation Described in Pima County Multi-Species Habitat Conservation Plan Permit Area	Standard Section 7 Mitigation Requirements
Cactus Ferruginous Pygmy-owl	Southlands: 100% Avra Valley: 42% Total Acreage: 4547	75%	85%	80% conservation (4:1 mitigation) of breeding habitat; in dispersal habitat, focus on protection of existing suitable habitat and dispersal corridors
Pima Pineapple Cactus	Total: 35%	90%	48%	50% conservation (1:1 mitigation)
Burrowing Owl	Southlands: 10% Avra Valley: 22% Total Acreage: 4451	75%	74%	n/a
Needle-spined Pineapple Cactus	Total: 0%	95%	76%	n/a
Pale Townsend's Big-eared bat[2]	Southlands: 36% Avra Valley: 88% Total Acreage: 11348	75%	93%	n/a
Tucson Shovel-nosed Snake	Total: 26%	75%	46%	n/a
Ground snake[3]	Total: 27%	75%	58%	n/a
Yellow-billed Cuckoo	Total: 80%	75%	93%	n/a

[1] applies only to Southlands and Avra Valley planning sub-areas
[2] modeled suitable habitat was very broadly defined; conservation measures focused on protection of highest quality areas within this habitat area
[3] applies only to modeled suitable habitat and not land considered as potential restoration areas

(6) Finally, the City will work with other jurisdictions and agencies to encourage consistency of conservation efforts throughout the region.

7.1.2 Avra Valley Planning Sub-area

(1) The primary component of the Avra Valley conservation program is the protection of existing natural habitat and critical wildlife corridors (see Figure 5.1-2).

(2) Opportunities for habitat enhancement and creation will focus on restoration of degraded lands within the critical wildlife corridors, the configuration of recharge basins to provide habitat value, the use of stormwater basins outside of future recharge basins to capture sheetflow and provide areas of habitat, and the creation of Burrowing Owl Management Areas.

(3) Impacts to wildlife and habitats on City-owned properties will be minimized by installing wildlife friendly fencing around these lands and by actively managing invasive species, particularly buffelgrass and tumbleweed, on these properties.

(4) Finally, the City will work with other jurisdictions and agencies to encourage consistency of conservation efforts throughout the region

7.1.3 Santa Cruz River Planning Sub-area

Conservation strategies for the Santa Cruz River planning sub-area have not yet been developed. It is anticipated that these strategies will address short-term impacts resulting from the construction of restoration projects and short- and long-term impacts of future capital improvement projects and urban development on established restoration areas. The adequacy of the conservation measures for this sub-area will be evaluated once they have been developed.

SECTION 8

Alternatives

SECTION TO BE PREPARED AND INCLUDED IN LATER DRAFT

Section 10 of the Endangered Species Act of 1973 requires an applicant for an incidental take permit to consider and describe "alternative actions to such [proposed] takings" within the HCP planning area.

The City of Tucson will identify and consider several alternatives to the proposed takings.

8.1 Alternative 1: No Action Alternative

8.2 Alternative 2

8.3 Alternative 3

SECTION 9

Plan Implementation

SECTION TO BE PREPARED AND INCLUDED IN LATER DRAFT

9.1 Changed and Unforeseen Circumstances

9.2 Costs and Funding

9.2.1 Funding for Minimization and Mitigation Measures

9.2.2 Funding for Changed Circumstances

9.3 Revisions and Amendments

9.3.1 Revisions (Changes to the Plan or Incidental Take Permit)

9.3.2 Amendments to the HCP

9.3.3 Amendments to the Section 10(a)(1)(B) Permit

9.4 Suspension/Revocation

9.5 Renewal of the Section 10(a)(1)(B) Permit

9.6 Permit Transfer

SECTION 10

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SECTION 11

Contributors

11.1 Technical Advisory Committee Members

Ms. Ann Phillips (Tucson Audubon Society)
Mr. Guy McPherson (University of Arizona)
Mr. Dennis Abbate (Arizona Game and Fish Department Research Branch)
Mr. Trevor Hare (Sky Island Alliance)
Mr. Rich Glinski (Maricopa County Parks and Recreation Department)
Mr. Ralph Marra (City of Tucson – Tucson Water Department)
Mr. E. Linwood Smith (Environmental Planning Group)
Ms. Marit Alanen (U.S. Fish and Wildlife Service)
Ms. Cathy Crawford (Arizona Game and Fish Department)
Ms. Mima Falk (U.S. Fish and Wildlife Service)

11.2 Stakeholder Advisory Committee Members

Ms. Carolyn Campbell (Coalition for Sonoran Desert Protection)
Ms. Susan Shobe (alternate, Coalition for Sonoran Desert Protection)
Mr. Gerry Perry (Arizona Game and Fish Department)
Ms. Cathy Crawford (alternate, Arizona Game and Fish Department)
Ms. Cheryl Doyle (Arizona State Land Department)
Ms. Catherine Balzano (Arizona State Lands Department)
Ms. Kathleen Longnecker (Metropolitan Pima Alliance)
Mr. David Goldstein (Diamond Ventures)
Mr. Chris Monson (alternate, Diamond Ventures)
Ms. Pricilla Storm (alternate, Diamond Ventures)
Ms. Lori Lustig (Southern Arizona Home Builders Association)
Ms. Nancy Zierenberg (Arizona Native Plant Society)
Mr. Greg Hess (Pima Association of Governments)
Mr. Staffan Schorr (alternate, Pima Association of Governments)
Ms. Claire Zucker (alternate, Pima Association of Governments)
Ms. Emily Brott (Sonoran Institute)
Ms. Nina Chambers (Sonoran Institute)
Mr. Larry Marshall (Santa Cruz River Alliance; Environmental Education Exchange)
Mr. Chuck Huckleberry (Pima County)
Mr. James Stahle (Town of Sahuarita)
Mr. Michael Reuwsaat (Town of Marana)
Ms. Lisa Duncan (alternate, Town of Marana)
Mr. Dennis Alvarez (Arizona Department of Transportation)
Ms. Sherry Barrett (Ex-Officio Member, U.S. Fish and Wildlife Service)
Ms. Mima Falk (alternate, U.S. Fish and Wildlife Service)

11.3 City of Tucson Staff

City Manager’s Office

Ms. Leslie Liberti

Urban Planning and Design

Mr. Michael Wyneken, AICP
Ms. Melissa Antol
Mr. Rafael Sebba
Mr. Clint Chiavarini
Mr. Eric Anderson
Ms. Andrea Marafino (Intern)
Mr. Andrew Hagemier (Intern)
Mr. Eric Anderson
Ms. Maria Gayosso de Bends
Ms. Autumn Figuroa

Tucson Water Department

Mr. Ralph Marra
Mr. Dennis Rule
Mr. Bruce Prior
Mr. Harold Maxwell
Mr. Michael Liberti
Mr. Tim Thomure
Mr. Ries Lindley
Ms. Karen La Martina
Mr. Sandy Elder
Mr. Richard Williamson
Mr. Edward Lopez
Mr. Jeff Biggs
Ms. Linda Smith
Mr. Mark Seamans
Mr. Mike Sanders
Mr. Ray Wilson

Transportation Department

Mr. Frank Sousa
Mr. Bob Peterson
Mr. Brooks Keenan

Attorney’s Office

Mr. Chris Avery
Mr. Blake Ashley

Environmental Services

Ms. Nancy Petersen
Ms. Lynn Hubbard
Mr. Fran La Sala
Mr. Daniel DeBorde
Mr. Richard Byrd

Development Services

Mr. Joe Linville
Ms. Tricia Gehlen

11.4 Consultants

SWCA

Mr. Ken Kingsley
Mr. Ken Kertell
Ms. Jessica Lee
Mr. Geoff Soroka
Ms. Kathryn Schonhorst
Mr. James Feldmann
Mrs. Lisa Dickerson

Southwest Botanical Research

Mr. Marc Baker

University of Arizona School of Natural Resources

Mr. Phil Rosen

Arizona Game and Fish Department Research Branch

Mr. Mike Ingraldi
Mr. Sean Lowrey
Mr. David Grandmaison

11.5 Other Contributors

Mr. Mark Ogonowski (University of Arizona)
Ms. Wendy Burroughs (Pima County Parks and Recreation Department)
Mr. Cecil Schwalbe (University of Arizona)
Mr. Tim Snow (Arizona Game and Fish Department Research Branch)
Ms. Ronnie Sidner (Independent Consultant)
Mr. Troy Corman (Arizona Game and Fish Department Research Branch)
Mr. Brian Wooldridge (U. S. Fish and Wildlife Service)
Mr. Scott Richardson (U.S. Fish and Wildlife Service)
Mr. Julio Betancourt (U.S. Geological Survey)

Mr. Travis Bean (University of Arizona – Desert Lab)
Mr. Tyler Jones (Town of Marana)
Mr. Ben Wilder (University of Arizona Desert Lab)
Mr. Marty Jakle (Partners for Fish and Wildlife, U.S. Fish and Wildlife Service)
Mr. Aaryn Olsson (University of Arizona School of Natural Resources, Arid Lands)
Mr. Todd Esque (U.S. Geological Survey)
Ms. Michelle Menchez (Arizona State Land Department)
Ms. Diana Rhoades (Sonoran Institute)
Ms. Julia Fonseca (Pima County Transportation and Flood Control District)
Ms. Jean Emery (Pima County Real Property Services)
Mr. Michael Bends (Tohono O’odham Nation, San Xavier District)
Mr. Barney Riley (Saguaro National Park)
Ms. Sarah Craighead (Saguaro National Park)
Mr. Noah Greenwald (Center for Biological Diversity)