



MEMORANDUM

Date: July 10, 2000

To: The Honorable Chair and Members
Pima County Board of Supervisors

From: C.H. Huckelberry
County Administrator 

Re: **Water Usage Along Selected Streams in Pima County**

Overview

In January 2000 the Pima Association of Governments drafted a report as part of the Sonoran Desert Conservation Plan on the topic of *Perennial Streams, Intermittent Streams, and Areas of Shallow Groundwater*. The study identified and mapped fifty-five perennial and eighty-two intermittent stream reaches, along with nearly one hundred shallow groundwater zones. Based on the dataset created for the January 2000 report, a new study from Pima Association of Governments, *Water Usage Along Selected Streams*, contributes to the Riparian Protection Element of the Sonoran Desert Conservation Plan by characterizing water usage, including:

- The total number of wells within one mile of previously identified sources.
- The number of non-exempt wells within one mile of these water sources.
- The average annual withdrawal from non-exempt wells.
- The water users, water sources, and average annual system withdrawals (non-exempt).
- A discussion of known surface water diversions.

Potential Threat -- Cumulative Impact of Diversions and Groundwater Pumping

The findings of the report that are particularly relevant for the Conservation Plan indicate:

- Most streams and areas of shallow groundwater have at least one well located within one mile. Only twenty-four of the one hundred twenty-two streams in the data set did not have a well. These untapped sites are found along remote, rugged mountain slopes.
- The number of exempt wells is far greater than the number of non-exempt wells (those with pump capacities greater than 35 gallons per minute). Exempt wells do not require groundwater rights and are free from water measurement and annual reporting requirements under State law. Therefore the amount of water pumped is greater than figures provided within the study, which was limited to data available through the Arizona Department of Water Resources for non-exempt wells within the Tucson Active Management Area.
- Streams and springs subject to known surface water diversions include those most important to imperiled species that depend on these aquatic or riparian environments.

A map showing the location of perennial and intermittent streams and shallow groundwater in relation to the Tucson Active Management Area is found on the next page.

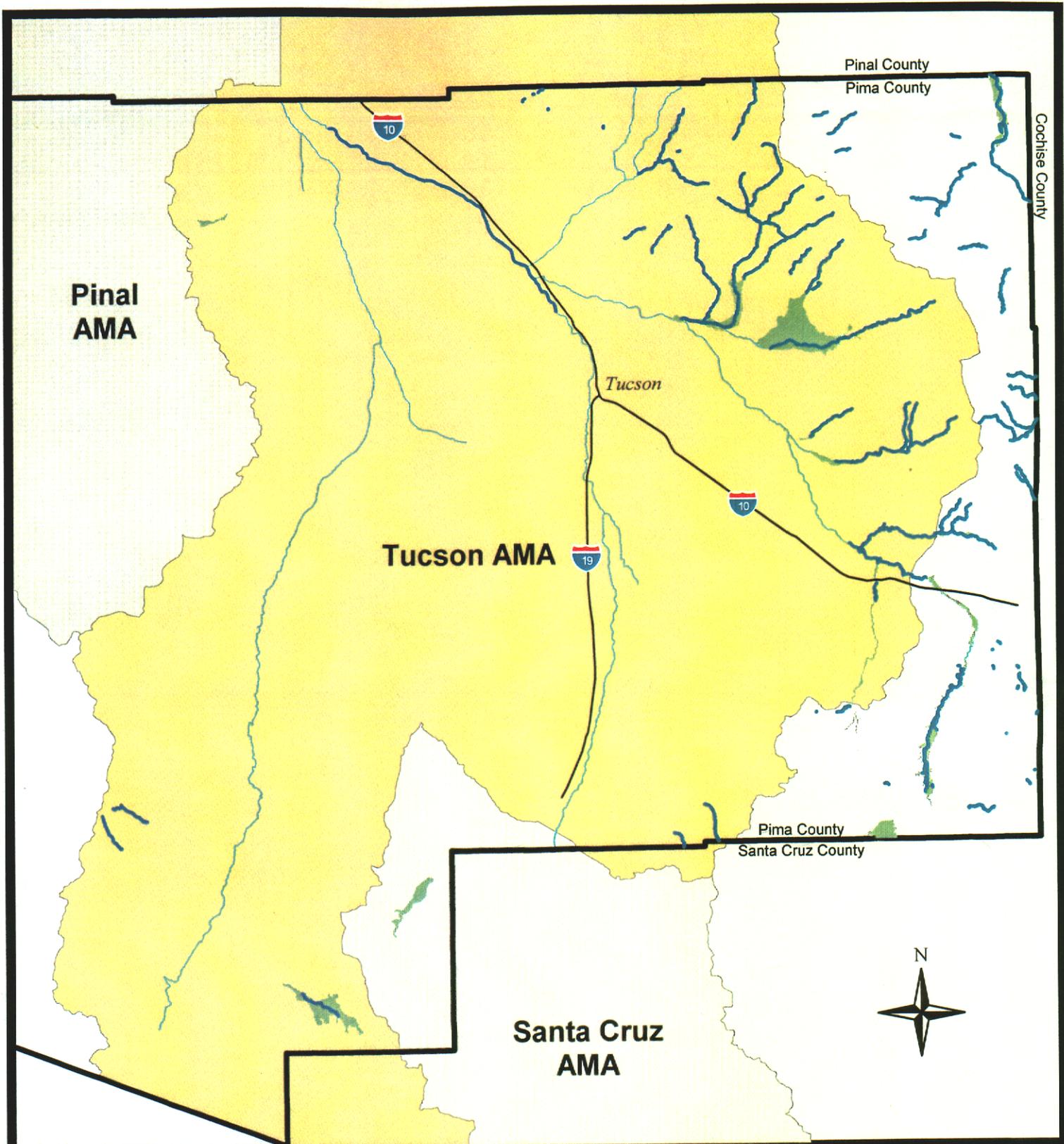


Figure 1. Active Management Areas (AMA)



Previously Identified Intermittent and Perennial Stream (PAG 2000)



Major Highway



Previously Identified Shallow Groundwater Area (PAG 2000)



Major Water Course

Note: Owners of wells outside an AMA are not required to report annual well withdrawals to ADWR.



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Water Usage Along Selected Streams in Pima County

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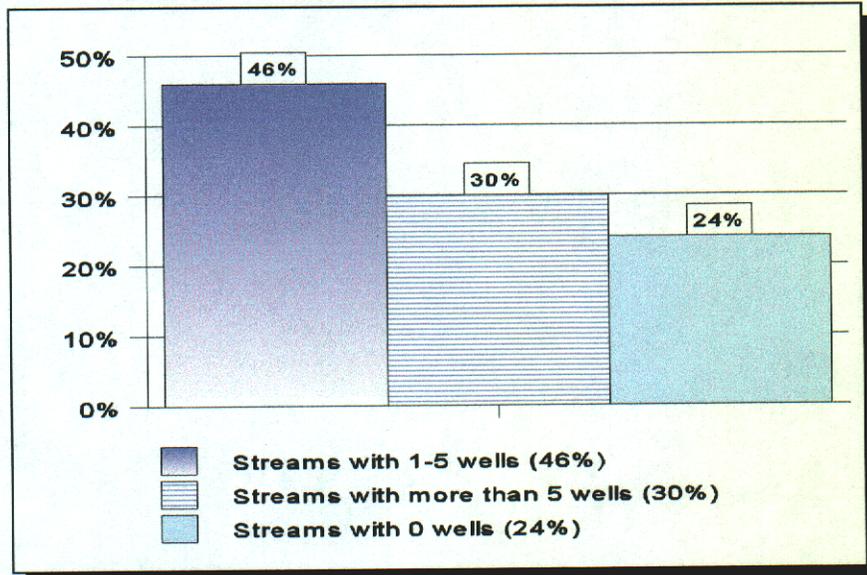
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Number of Wells Within One Mile of Perennial and Intermittent Streams

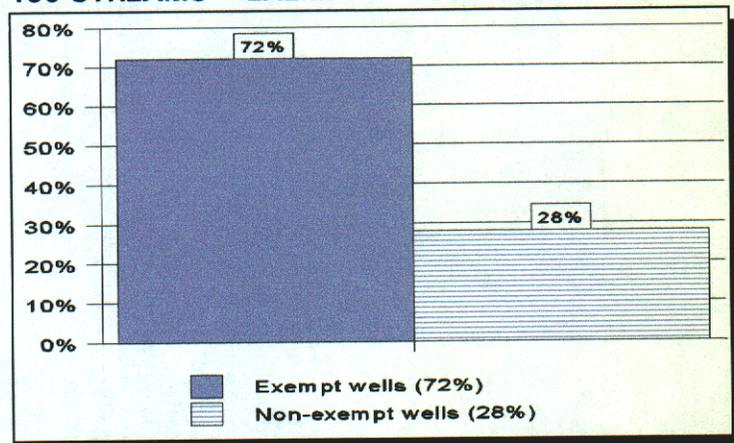
STREAM NAME	# non-exempt wells w/in 1 mile	# exempt wells w/in 1 mile	# total wells w/in 1 mile	% EXEMPT
1. Santa Cruz River	140	264	404	65%
2. Tanque Verde (mid)	59	170	229	74%
3. Tanque Verde (lower)	91	120	211	57%
4. Sabino Canyon (lower)	75	111	186	60%
5. Arivica Creek	17	88	105	84%
6. Rincon Creek	11	82	93	88%
7. Ventana Canyon	19	46	65	71%
8. San Pedro River	31	26	57	46%
9. Agua Verde Creek	4	26	30	87%
10. Mud Spring Canyon	0	24	24	100%
11. Sutherland Wash	5	19	24	79%
12. Cienega Creek (lower)	3	18	21	86%
13. Box Canyon (Rincon)	1	18	19	95%
14. Chiminea Canyon	3	16	19	84%
15. Canada Agua	1	17	18	94%
16. Sabino Creek (mid)	2	16	18	89%
17. Cienega Creek (upper)	6	6	12	50%
18. Bear Canyon (lower)	0	11	11	100%
19. Barrel Canyon	0	10	10	100%
20. Madrona Canyon	4	6	10	60%
21. Molino Canyon	0	10	10	100%
22. La Milagrosa Canyon	0	8	8	100%
23. Brown Canyon	0	7	7	100%
24. Distillery Canyon	0	7	7	100%
25. Florida Canyon	0	7	7	100%
26. Geesaman Wash	0	7	7	100%
27. Madera Canyon	0	7	7	100%
28. Buehman Canyon	1	5	6	83%
29. Sabino Creek (upper)	0	6	6	100%
30. Turkey Creek	2	4	6	67%
31-76. All streams/ 1-5 wells	18	80	98	82%
Total	493	1,242	1,735	72%

Perennial and Intermittent Stream Reach Comparisons

100 STREAMS -- PERCENT WITH WELLS WITHIN ONE MILE



100 STREAMS -- EXEMPT & NON-EXEMPT WELLS



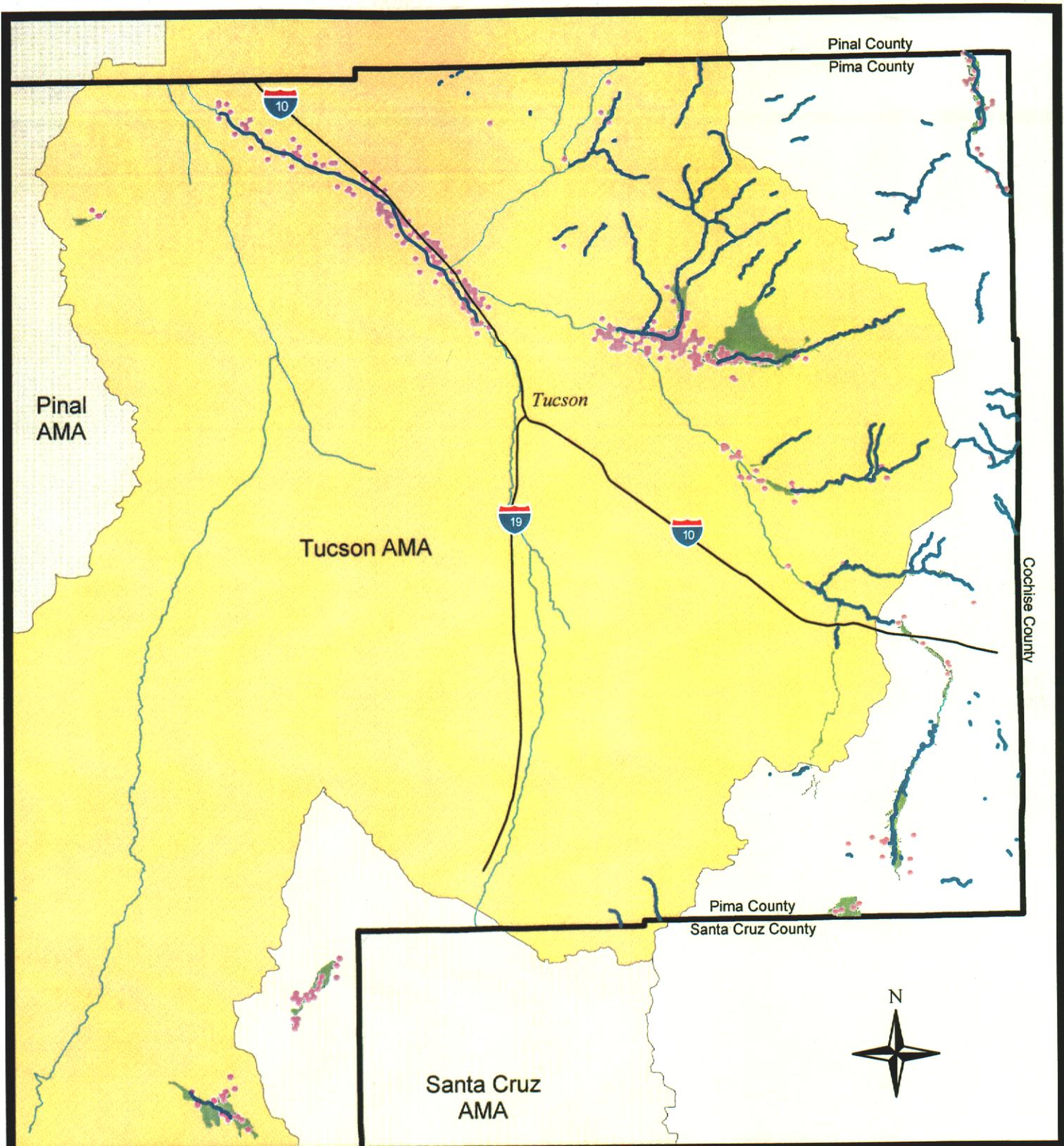


Figure 2. Locations of Non-Exempt Wells within One Mile of Previously Identified Stream or Shallow Groundwater Area

-  Previously Identified Intermittent and Perennial Stream (PAG 2000)
-  Previously Identified Shallow Groundwater Area (PAG 2000)
-  Non-Exempt Well (ADWR Wells-55 Registry)
-  Major water course
-  Major Highway

Note: Owners of non-exempt wells outside an AMA are not required to report annual well withdrawals to ADWR.



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Water Usage Along Selected Streams in Pima County

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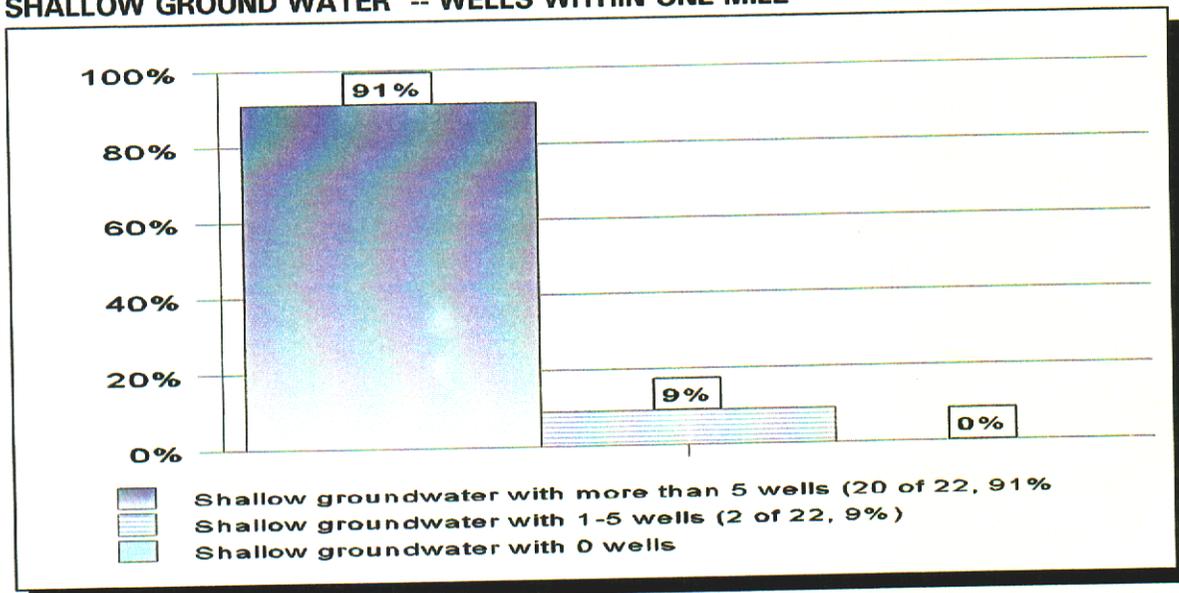
Number of Wells Within One Mile of Identified Shallow Groundwater Areas

Shallow groundwater is defined within the two reports by Pima Association of Governments as being within 50 feet of the land surface. This number was chosen based on the assumption that mesquite bosques can be sustained with groundwater at this depth. The January 2000 report lists more than 100 areas, and maps the areas prioritized by a technical advisory team assisting with the project. Larger more threatened areas were mapped. The chart below shows the number of wells within one mile of twenty-two shallow groundwater areas.

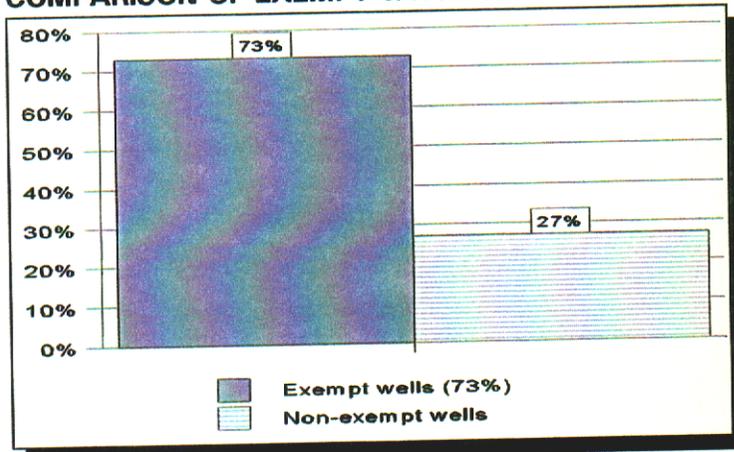
STREAM NAME	# non-exempt wells w/in 1 mile	# exempt wells w/in 1 mile	# total wells w/in 1 mile	% EXEMPT
1. Tanque Verde area	68	196	264	74%
2. Tanque Verde (lower)	98	129	227	57%
3. Sabino Canyon	88	132	220	60%
4. Agua Caliente Canyon	53	156	209	75%
5. Arivaca Creek	21	176	197	89%
6. Rillito Creek Area	43	55	98	56%
7. Davidson Canyon	0	79	79	100%
8. San Pedro River	25	42	67	63%
9. Sopori Wash	25	42	67	63%
10. Rincon Creek	11	54	65	83%
11. Cienega Creek (lower)	4	38	42	90%
12. Pantano Wash	8	31	39	79%
13. Box Canyon (Rincon)	7	30	37	81%
14. Gardner Canyon	4	30	34	88%
15. Agua Verde Creek	3	20	23	87%
16. Cienega Creek (lower)	5	18	23	78%
17. Sutherland Wash 1	3	18	21	86%
18. Cienega Creek (upper)	9	9	18	50%
19. Davidson Canyon (u)	0	10	10	100%
20. Cocio Wash	4	5	9	56%
21. Posta Quemada Canyon	2	3	5	60%
22. Sutherland Wash 2	1	1	2	50%
Total	482	1,274	1,756	73%

Shallow Ground Water Comparisons

SHALLOW GROUND WATER -- WELLS WITHIN ONE MILE



**SHALLOW GROUNDWATER --
COMPARISON OF EXEMPT & NON-EXEMPT WELLS**



Water Users Within One Mile of Perennial and Intermittent Streams and Shallow Groundwater

The water companies that have service areas extending to within a mile of shallow groundwater areas or perennial and intermittent streams are analyzed in the report. The authors made these findings:

- "Companies with the highest annual pumpage within one mile of a stream or shallow groundwater area are Tucson Water, Metropolitan Domestic Water Improvement District, Forty-Niner Water Company, and Cortaro Marana Irrigation District." (P. 10)
- "Tucson Water, Vail Water Company, Town of Marana, Metro Water, Flowing Wells Irrigation District, Oro Valley Water Company, and Spanish Trail Water Company have CAP allocations." (P. 10)
- "Existing reclaimed water lines are located in or comparatively close (less than 2 miles) to eight of the water companies identified in this project." (P. 11)
- "Thirteen water companies had boundaries between 2 and 10 miles from an existing reclaimed water line." (P. 11)
- "The following water users are located over ten miles from the nearest reclaimed water lines: Arivaca Township Co-op Water Company, and Anderson Water Company." (P. 11)

Figures on the pages that follow show the boundaries of water company service areas in relation to streams or shallow groundwater areas for:

- Twenty-three water companies in Eastern Pima County
- Three water companies, and non-exempt wells in northeastern Tucson
- Seven water companies, and non-exempt wells in southeast Tucson
- Non-exempt and exempt wells near the San Pedro River
- One water company and wells near Arivaca and Sopori Wash
- Eleven water companies, and non-exempt wells near the Santa Cruz River.

Surface Water Diversions

The surface water diversions discussed in the study are limited to the present knowledge of the authors, including the:

- Cienega Creek
- San Pedro River
- Santa Cruz River
- headwaters of Sabino Creek

Conclusions

Based on the analysis in the *Water Usage* report, the authors conclude that the study provides "a very general assessment of water usage along perennial streams, intermittent streams and shallow groundwater areas in Pima County. From the results:

- "It appears to be very likely that the northeastern part of the Tucson Basin is associated with the largest amounts of nearby groundwater pumpage. Streams and shallow groundwater areas in this part of the Basin include Tanque Verde Creek, Sabino Creek, Ventana Canyon, Rillito Creek and the Agua Caliente area. However, [this] cannot be confirmed because groundwater pumpage data are not reported for areas outside the Tucson Active Management Area."
- "The stream with the largest reported pumpage within one mile is the Santa Cruz River."
- "Areas outside the Tucson Active Management Area with the largest number of registered wells include the San Pedro River and Mud Spring. Groundwater usage in these areas is presumably comparatively high as well." (P. 11)

A number of ideas for expanding this research are included and these will be forwarded to the Science Technical Advisory Team for the Sonoran Desert Conservation Plan. Future reports will incorporate the data and findings of this study. Studies issued to date to develop the Riparian Protection Element of the Sonoran Desert Conservation Plan include:

- *Paseo de las Iglesias*
- *Water Resources and the Sonoran Desert Conservation Plan*
- *Environmental Restoration in Pima County*
- *Stream Reaches and Shallow Groundwater*
- *Arivaca Resources*
- *Prioritization of Streams*
- *Overview of Watersheds and Watercourses*
- *Cocio Wash and the Gila Topminnow*
- *Pilot Riparian Mapping*
- *Draft Riparian Analysis*
- *Springs in Pima County*

In the near future, these reports will be issued to continue to develop the Riparian Element:

- *Aquatic Vertebrate Conservation in Pima County*
- *Recent Regulatory Developments in Aquatic and Riparian Protection*
- *Focus on Conserving the Cienega Watershed*
- *Riparian Protection, Management and Restoration -- An Element of the SDCP*

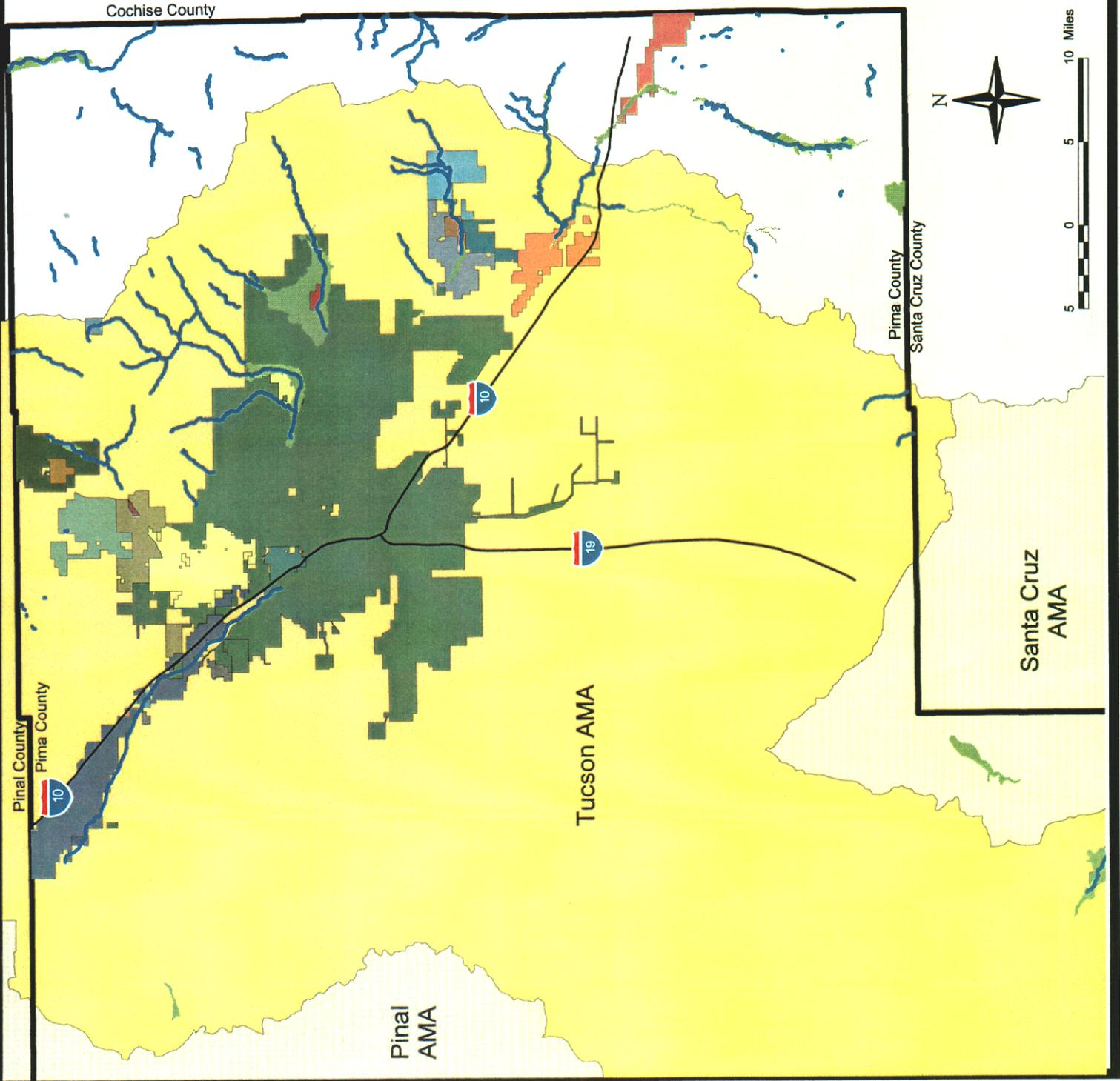
These reports, and the Riparian Element will be integrated with other Elements and discussed in the Preliminary Sonoran Desert Conservation Plan, which will be released later this summer.

Figure 3.
Water System Boundaries
within One Mile of Streams or
Shallow Groundwater Areas

- Water Systems within One Mile of Stream or Shallow Groundwater Area
- Anderson Water Company
 - Arivaca Townsite Co-op Water Company
 - Canada Hills Water Company Limited Pt. City of Tucson
 - Cortaro-Marana Irrigation District
 - Cortaro Water Users Association
 - Flowing Wells Irrigation District
 - Forty-Niner Water Company
 - Lago Del Oro Water Company
 - Los Cerros Water Company
 - Lyn-Lee Water Company
 - Marana Water Service
 - Metropolitan Domestic Water Improve Dist
 - Mt. Lemmon Cooperative Water Company
 - Oro Valley Water Company
 - Procter J. M.
 - Rillito Water Users
 - Rincon Creek Water Company
 - Rincon Water Company
 - Saguaro Water Company
 - Spanish Trail Water Company
 - Town of Marana Municipal Property Corp.
 - Vail Water Company
- Previously Identified Stream (PAG 2000)
- Previously Identified Shallow Groundwater Area (PAG 2000)
- Major Highway



Note: All water system boundaries from ADWR Certificate of Convenience & Necessity (CCN) database, except Flowing Wells Irrigation District and the largest Tucson Water service area boundary (ADWR Water Providers database), and Cortaro-Marana Irrig. Dist., (ADWR Irrig. District database). July 2000



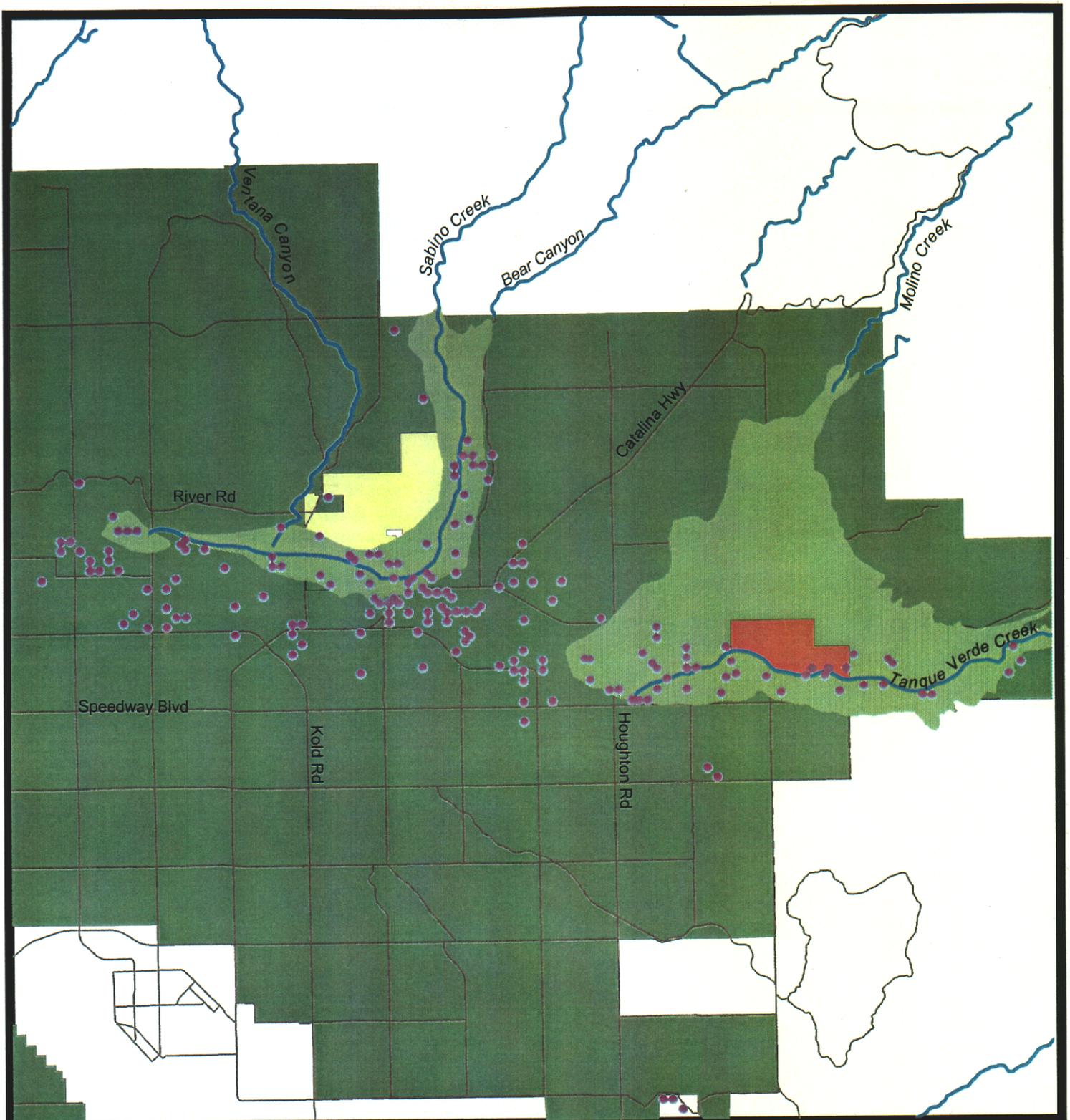
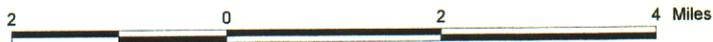


Figure 4. Water Users in Northeastern Tucson within One Mile of Streams and Shallow Groundwater Areas

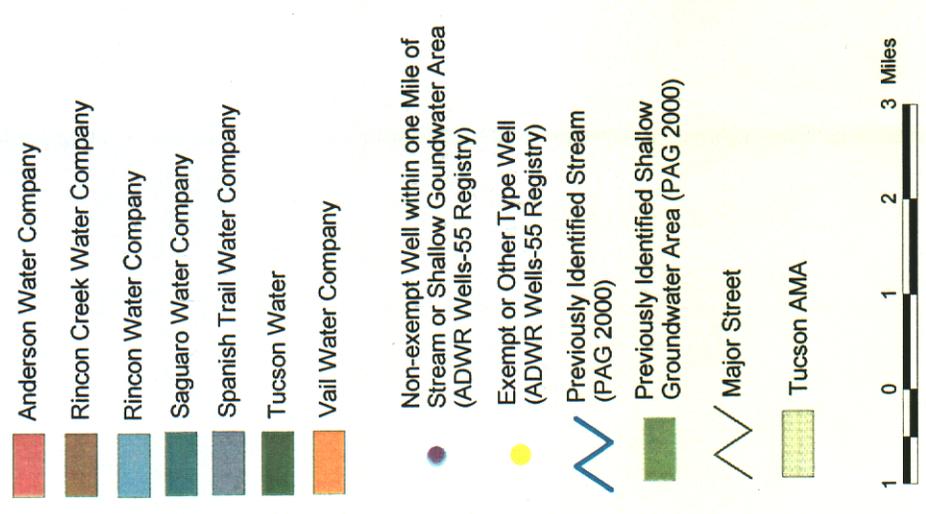
-  Previously Identified Stream (PAG 2000)
-  Previously Identified Shallow Groundwater Area (PAG 2000)
-  Major Street
-  Non-Exempt Well (ADWR Wells-55 Registry)
-  Forty-Niner Water Company
-  Metropolitan Domestic Water Improve District
-  Tucson Water



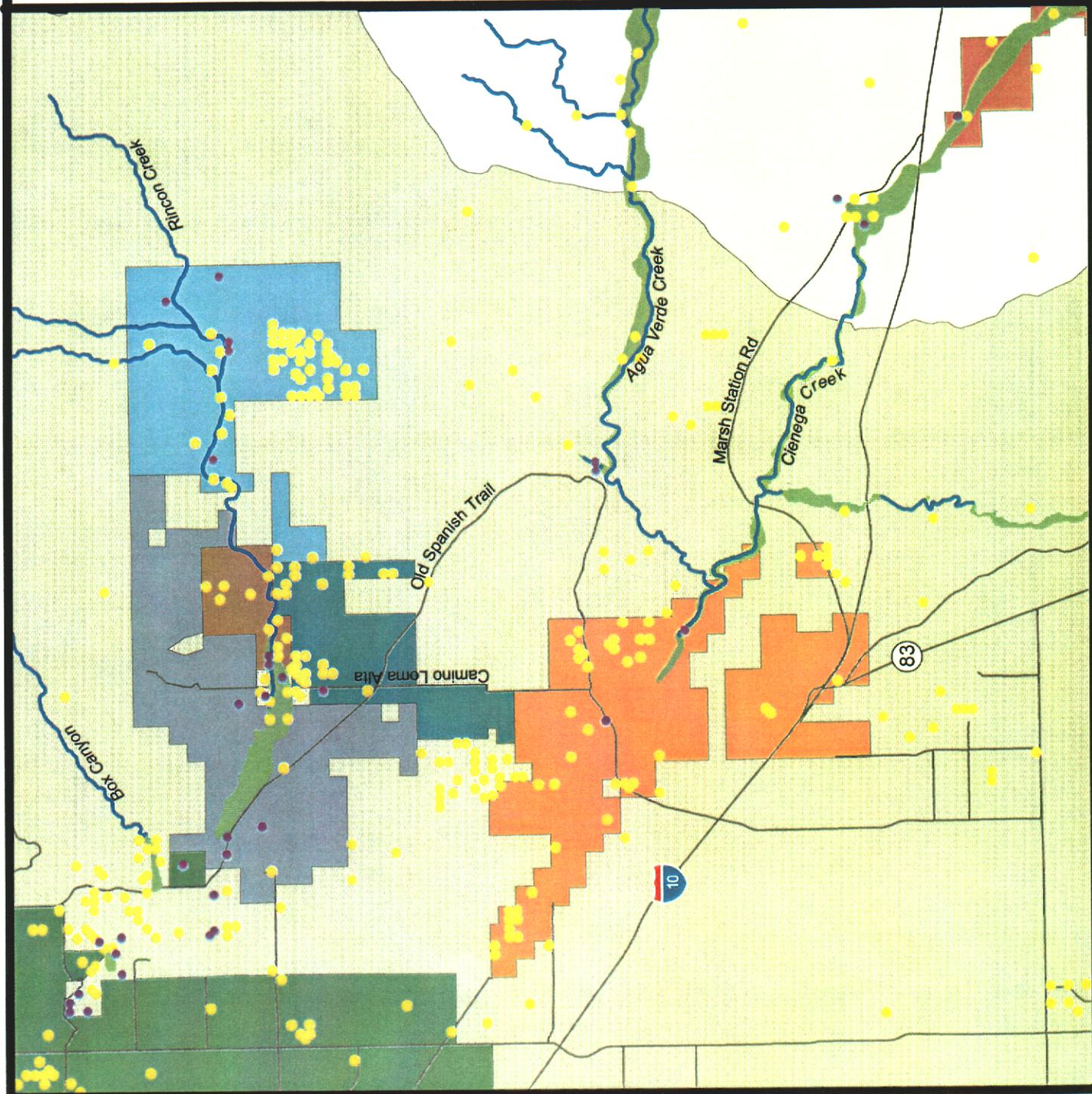
July 2000



Figure 5.
Water Users within One Mile
of Tucson within One Mile
of Streams and
Shallow Groundwater Areas



July 2000



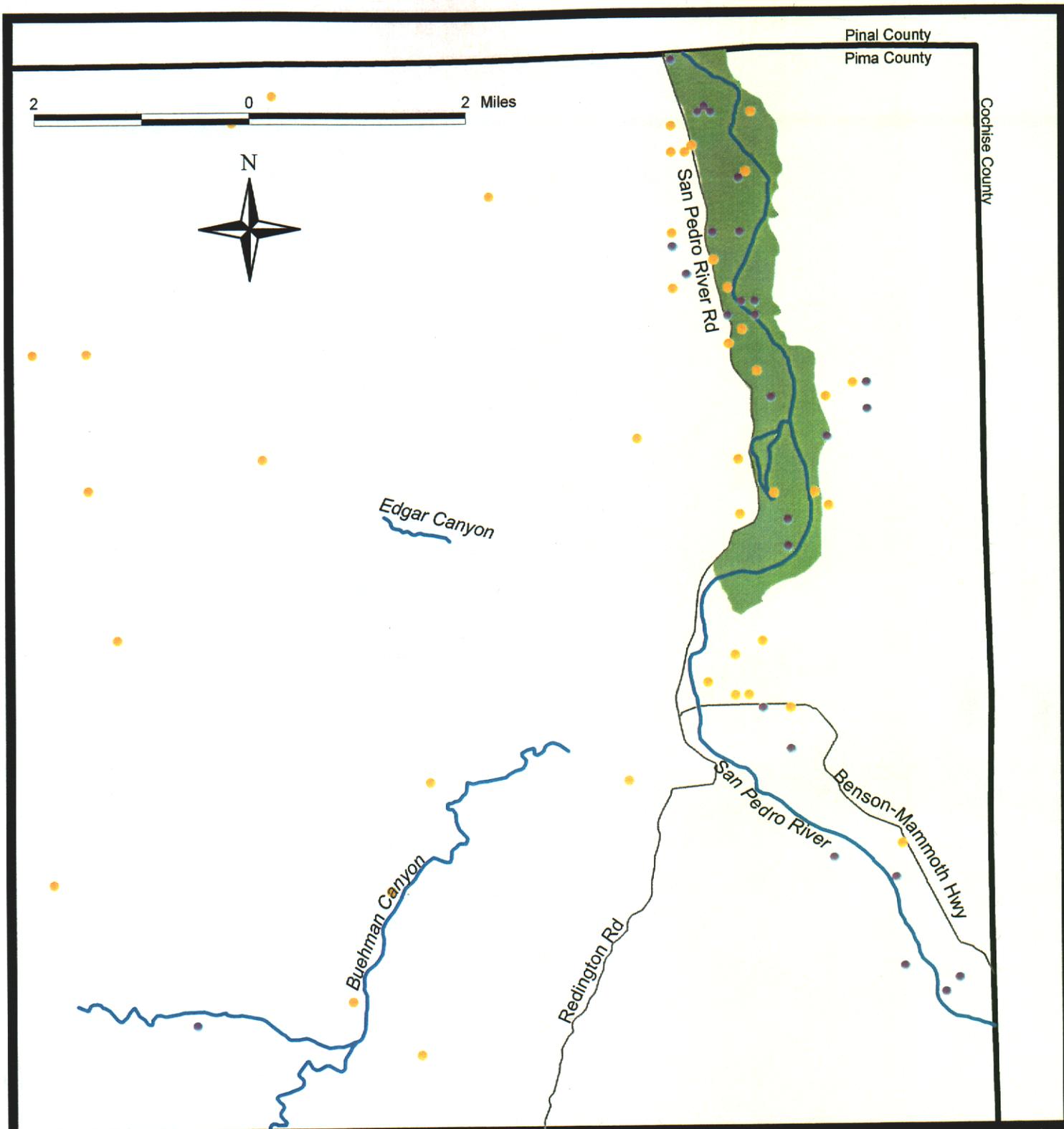


Figure 6. Water Users near the San Pedro River in Pima County within One Mile of Streams and Shallow Groundwater



Previously Identified Stream (PAG 2000)



Previously Identified Shallow Groundwater Area (PAG 2000)



Major Street



Non-exempt Well within one Mile of Stream or Shallow Groundwater Area (ADWR Wells-55 Registry)



Exempt or Other Type Well (ADWR Wells-55 Registry)



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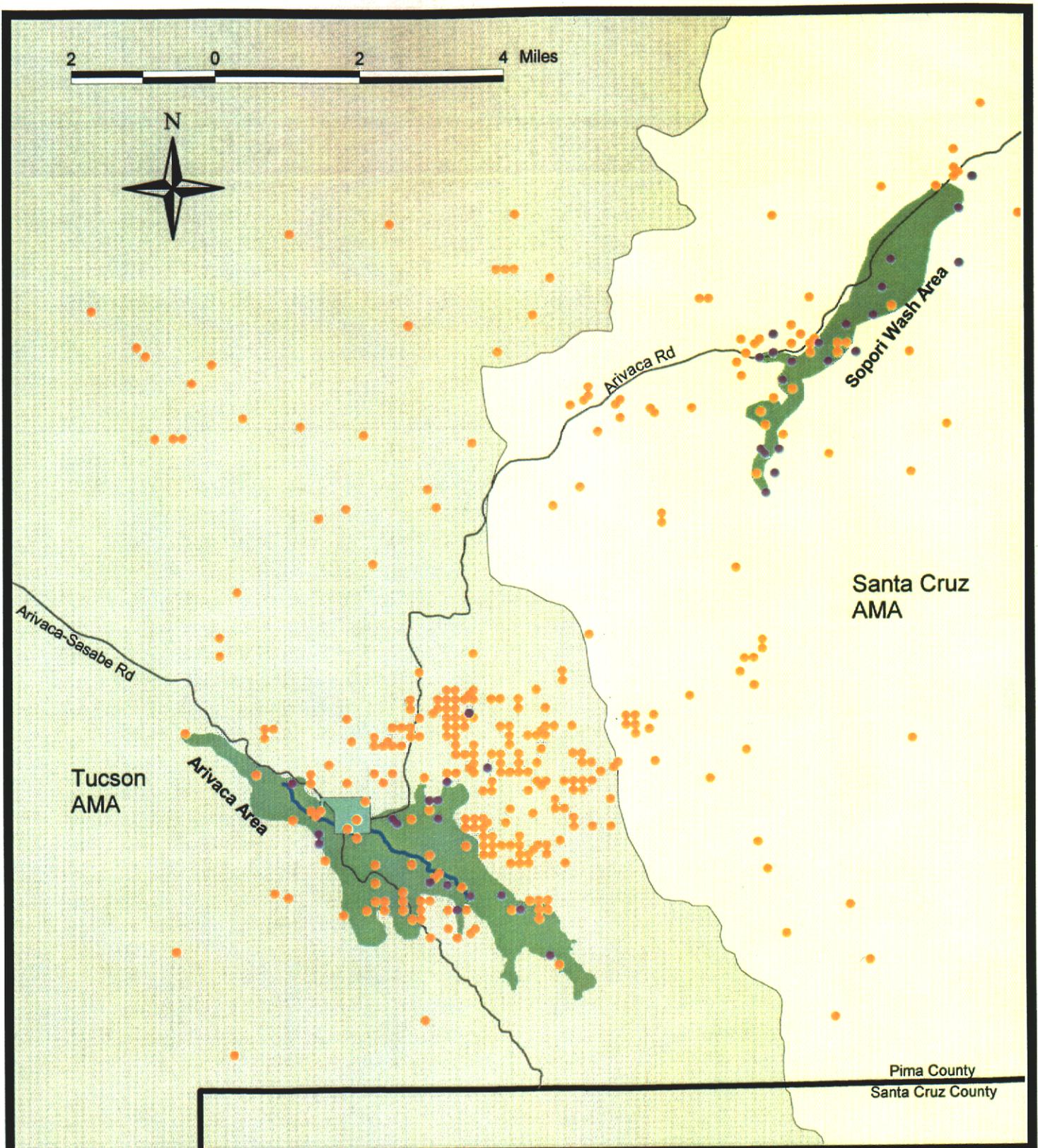


Figure 7. Water Users in Arivaca and Sopori Wash area within One mile of Streams and Shallow Groundwater Areas

-  Previously Identified Stream (PAG 2000)
-  Previously Identified Shallow Groundwater Area (PAG 2000)
-  Major Street
-  Arivaca Townsite Co-op Water Company
-  Non-exempt Well within one Mile of Stream or Shallow Groundwater Area (ADWR Wells-55 Registry)
-  Exempt and Other Type Well (ADWR Wells-55 Registry)

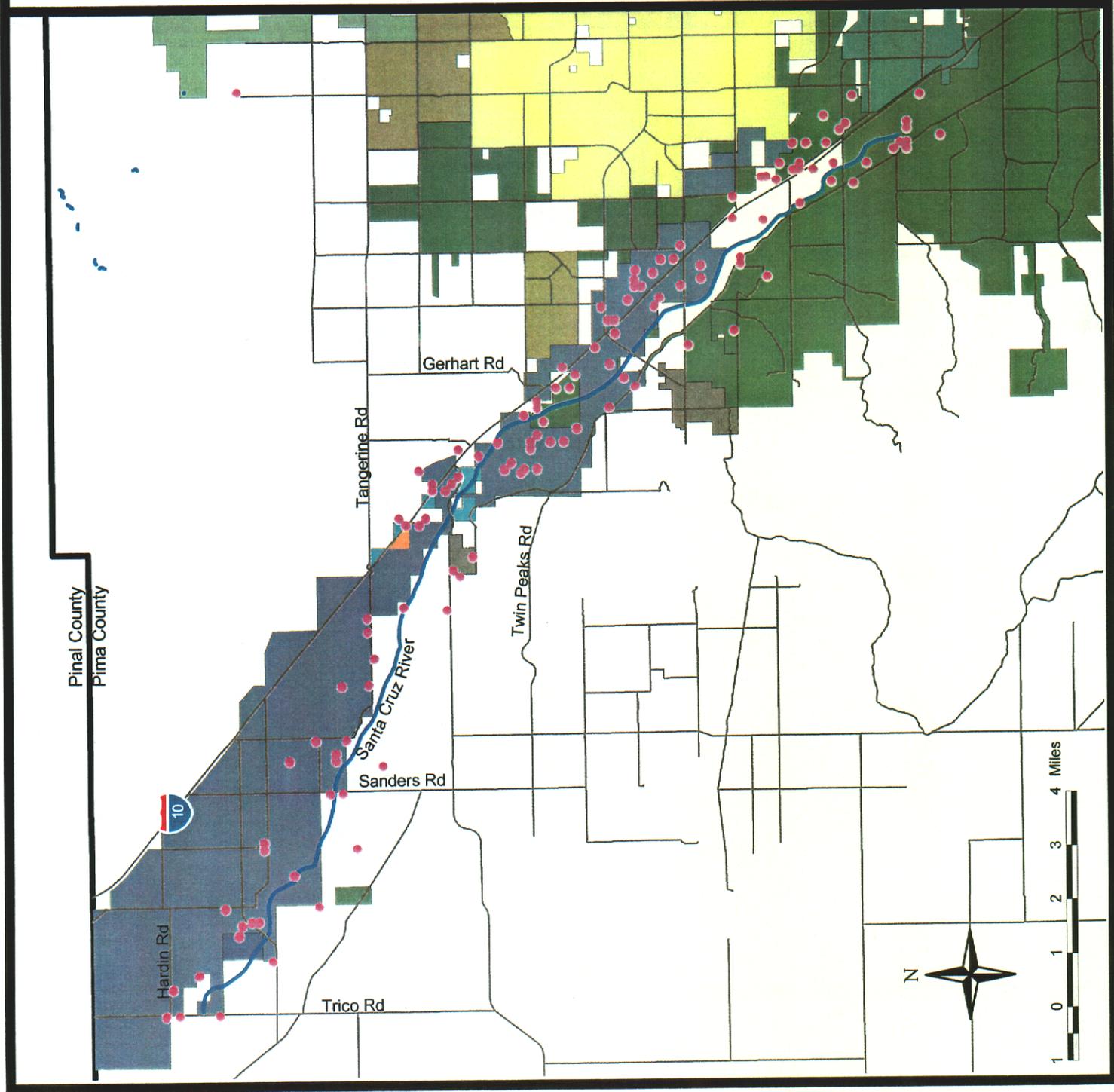


Figure 8.
Water Users near the
Santa Cruz River
within One Mile of Stream
and Shallow Groundwater
Area

-  Canada Hills Water Company Limited Pt.
-  City of Tucson
-  Cortaro-Marana Irrigation District
-  Cortaro Water Users Association
-  Flowing Wells Irrigation District
-  Lyn-Lee Water Company
-  Marana Water Service
-  Metropolitan Domestic Water Improve Dis
-  Oro Valley Water Company
-  Rillito Water Users
-  Town of Marana Municipal Property Corp.
-  Non-exempt Well (ADWR Wells-55 Registry)
-  Previously Identified Stream (PAG 2000)
-  Previously Identified Shallow Groundwater Area (PAG 2000)
-  Major Street



July 2000





SONORAN DESERT CONSERVATION PLAN

**WATER USAGE ALONG SELECTED STREAMS
IN PIMA COUNTY, ARIZONA**

FINAL PROJECT REPORT

July 2000



Prepared by Pima Association of Governments for Pima County

SONORAN DESERT CONSERVATION PLAN

**WATER USAGE ALONG SELECTED STREAMS
IN PIMA COUNTY, ARIZONA**

FINAL PROJECT REPORT

JULY 2000

Prepared by Pima Association of Governments for Pima County

ACKNOWLEDGMENTS

PAG would like to thank a number of people who helped with this project. PAG is grateful to Julia Fonseca and Maeveen Behan at Pima County for including the study in PAG's work program, for providing guidance on the project approach, and for reviewing draft materials. John Regan at Pima County Technical Services provided several shapefiles. Reg Lopez at the Arizona Corporation Commission provided access to maps showing locations of Certificates of Convenience and Necessity (CC&N) for water companies. PAG is especially indebted to the Tucson AMA office of the Arizona Department of Water Resources, in particular Linda Stitzer, Virginia Welford, Jeff Tannler, and Kelly Kessler for providing the majority of the data used in this study, and for answering various questions along the way. In addition, PAG would like to thank Liz Greene at Tucson Water for clarifying Tucson Water pumpage information and Tom Victory at Tucson Water for providing a map of reclaimed water lines. PAG also owes a special thanks to M. L. Fuhrmann for completing a large amount of data compilation and analysis for this project.

This project was funded by Pima County.

SONORAN DESERT CONSERVATION PLAN
WATER USAGE ALONG SELECTED STREAMS
IN PIMA COUNTY, ARIZONA

FINAL PROJECT REPORT – JULY 2000

Prepared by Pima Association of Governments for Pima County.

INTRODUCTION

Background

Pima County is developing the Sonoran Desert Conservation Plan (SDCP), which will guide future growth in Pima County and protect the lands with the highest quantity and quality of environmental, cultural, and historical resources. Preserving and restoring riparian and aquatic habitats will be very important to the goals of the SDCP. Therefore, the Pima Association of Governments (PAG), under contract to Pima County, completed an inventory of perennial streams, intermittent streams, and areas of shallow groundwater in Pima County. The results of the study were presented in a January 2000 report which accompanied a set of three GIS coverages (ArcView GIS shape files) showing perennial and intermittent streams and shallow groundwater locations throughout the county. As a follow-up to PAG's stream and shallow groundwater inventory, Pima County contracted with PAG to characterize water usage near streams and shallow groundwater areas identified in the January 2000 report. The findings of the follow-up study are presented in this document.

Purpose

The purpose of this project was to compile information on groundwater withdrawals and surface water diversions near perennial streams, intermittent streams, and shallow groundwater areas previously identified by PAG for the Sonoran Desert Conservation Plan (SDCP). The information could be used to prioritize future investigations of potential impacts of these withdrawals and diversions on riparian and aquatic habitats for the SDCP.

Study Area and Scope

The study area for this project was Pima County, excluding Indian reservations; water withdrawals in Mexico or other counties were not addressed. The study included only those areas located within one mile of the perennial streams, intermittent streams and areas of shallow groundwater delineated previously by PAG for the SDCP. Three short stream reaches (Fresnal and San Luis washes and Bolt Canyon) were identified by Pima County after the PAG streams project was completed, but these were not addressed in this follow-up project.

This study was limited to compilation of existing data.

PROJECT APPROACH

Data Sources

The Arizona Department of Water Resources (ADWR) and the Pima County Land Information System (PCLIS) were the primary data sources for this project. ADWR manages groundwater resources and regulates water usage in the state of Arizona. To this end, ADWR requires all groundwater wells to be registered. The well registry, referred to in this report as the "wells-55 database," was a major data source for this project. Annual groundwater withdrawals are reported to ADWR by regulated well owners. These reported pumpage volumes were another major source of data for this project. ADWR also provided ArcView GIS shapefiles for water companies and other potential water users, and water pumpage data for small water providers and large municipal water providers.

The PCLIS is a series of ArcView GIS shapefiles containing information about land in Pima County. Information includes parcel ownership, township-range-section, streets, environmental features, water companies, and many other data sets. Selected PCLIS files served as the base map for this project.

Several possible data sources were not used for this study. The ADWR surface water rights database was obtained and reviewed, but it was not used because of its complexity, given the time and budget constraints of this project. Therefore, the only surface water diversions identified in this study were those of which PAG was already aware. The study did not include Arizona Department of Environmental Quality (ADEQ) records for water companies regulated under the Safe Drinking Water Act. PAG obtained a hardcopy list of drinking water systems in Pima County. However, the information did not contain location or pumpage data. A list of drinking water systems using groundwater suspected of being under the influence of surface water was also requested from ADEQ, but this information was not available at the time of this report. Using the ADEQ drinking water system data probably would not have affected the study results significantly. Water system boundaries should have been adequately identified by the existing shape files provided by ADWR and PCLIS, and water system well locations should have been included in the wells-55 database.

Individual data sets, file names, and the sources of the data used for this study are listed on Table 1.

Table 1. Data Sources

Data Set or File Name	Source	Format	Description and Use
Wells-55 Registry	ADWR	CD-ROM with ArcView shapefile	Contained registered wells; only data for non-exempt wells were used. Data source for: number of wells w/in 1 mile; closest well data; water users within one mile.
Municipal Water Providers	ADWR	CD-ROM with ArcView shapefile	Contained boundary data for water providers statewide. Used to determine water systems within one mile.
Certificates of Convenience and Necessity (CCN)	ADWR	CD-ROM with ArcView shapefile	Contained boundary data for CCNs statewide. Used to determine number of water users within one mile. Extensively used for this project.
Irrigation Districts	ADWR	CD-ROM with ArcView shapefile	Contained irrigation district boundary data statewide. Used to determine irrigation districts within one mile.
Active Surface Water Filings	ADWR	CD-ROM with ArcView shapefile	Contained points for surface water filings statewide. Too complex for easy use for this project.
Arizona Grandfathered Groundwater Rights (GFR)	ADWR	CD-ROM with ArcView shapefile	Contained boundary data for gfr's statewide. Used to determine gfr's within one mile. File did not include right owner names.
Water Companies	PCLIS	ArcView shapefile	Contained boundary data for water companies in Pima County. Used to double check ADWR Water Providers and CCN shapefiles.
Irrigated Lands	Pima County	ArcView shapefiles	Contained boundary data for irrigated lands in Pima County. Used to determine irrigated lands within one mile.
Active Mines	Pima County	ArcView shapefile	Contained boundary data for active mines in Pima County. Used to determine mines within one mile. No names of mines were included.
Reclaimed water lines	Tucson Water	Draft ArcView shapefile	Contained locations and extent of existing reclaimed water lines. Used for general assessment of distance from water user boundaries to reclaimed water lines.
PAG Digital Orthophotography	PAG	Digital Image (.tif)	Used to identify location of surface water diversion on Santa Cruz River

Table 1 (con't). Data Sources

Arizona Corporation Commission Maps	ACC	Hardcopy	Used for verifying information shown in ArcView shapefiles, particularly where information from different shapefiles conflicted (ie boundary extent, or company name).
Groundwater Pumpage for Non-exempt Wells	ADWR	Hardcopy	Contained annual withdrawal data reported to ADWR. Used to calculate annual average withdrawal, 1994-1998.
Cienega Creek Project Files	PAG	Hardcopy	Used for surface water diversions and groundwater levels for Cienega Creek and Davidson Canyon
Arizona Directory of Active Mines 1999	Tucson Main Library	Hardcopy	Used to determine names of mines within one mile.
Small and Large Water Providers Pumpage	ADWR	Hardcopy	Contained annual withdrawal data reported to ADWR. Used to calculate average annual system withdrawals, 1994-1999.
Pumpage and well locations for small water companies	ADWR	Electronic spreadsheet	Used to confirm that all wells for small water companies were included in the requested pumpage data for non-exempt wells.
Personal communication	PDEQ	Phone conversation	Summerhaven water source
Certificates of Assured Water Supply	ADWR	Hardcopies and personal communication	Contained information on subdivisions with certificates, including number of lots and company providing water. Used to determine number of lots with certificates and the associated water company.
Active systems listing from Safe Drinking Water Database	ADEQ	Hardcopy	Contained data on regulated water systems within Pima County. Not used.

Limitations

The study was limited to compilation and analysis of existing information from the data sources listed on Table 1. PAG did not field-verify any information, or conduct any surveys or other types of investigations to generate original data. For water use data, PAG relied almost entirely on groundwater pumpage data reported to the Arizona Department of Water Resources (ADWR) and provided to PAG by ADWR. The study did not address any pumpage that was not reported to ADWR. This is a significant limitation, because the only pumpage that must be reported to ADWR is that from non-exempt wells (pump capacities greater than 35 gallons per minute) located within an active management area (AMA). Therefore, annual water usage reported by PAG in this study is probably underestimated for streams and shallow groundwater areas located outside the Tucson AMA (Figure 1) and in areas with large numbers of exempt wells.

The study relied heavily on the ADWR Wells-55 Registry. The information in this database is submitted by well owners and drillers, and it is not verified. In previous studies, this database has been found to contain errors. It is, however, by far the most comprehensive inventory of wells that is available for projects such as this.

Methodology

This project consisted of obtaining data sets available from public agencies, and using ArcView GIS to create new shape files from the information that was obtained. Data sources are listed on Table 1 above. PAG created four new shapefiles from the existing data: wustreams.shp (previously identified streams), wushallgw.shp (previously identified shallow groundwater areas), waterusers.shp (water users within one mile of stream or shallow groundwater area), and withdrwlpts.shp (withdrawal points within one mile of stream or shallow groundwater area). The “wu-” in front of the shapefile name was used to distinguish the shapefiles for the streams and shallow groundwater areas assessed in this Water Usage project versus the shapefiles created for streams and areas identified in the previous PAG project. These files were provided to Pima County for use in developing the Sonoran Desert Conservation Plan. Fields included in these new shapefiles are listed on Table 2.

The shapefiles “wustreams” and “wushallgw” are the primary products of this study. They contain information about the water usage that occurs within one mile of each intermittent stream, perennial stream, and shallow groundwater area. The files contain one record for each stream reach and shallow groundwater area. In a number of cases, reaches of a particular stream that were treated separately in PAG’s previous project were merged into a single reach to make it easier to determine which streams could be the most heavily impacted by groundwater pumping.

In order to create the “wustreams” and “wushallgw” shapefiles, the ArcView GIS shapefiles developed by PAG in January 2000, showing the locations of perennial streams, intermittent streams, and areas of shallow groundwater, were overlain on the PCLIS base. A one-mile buffer was created around each of the streams and shallow groundwater areas in PAG’s coverages. Next, a series of shapefiles were overlain on the PAG coverages. These included: “cnn”, “watercos”, “waterprov”, “wells55”, “irrigdist”, “irrig_99”, “mines”, and “gfi”. Through a visual analysis (or, when necessary, selections and listings by ArcView scripts) of the features located within the buffers, PAG identified the water companies, exempt wells, non-exempt wells, certificates of convenience and necessity, active mines, grandfathered rights, and irrigated lands located within one mile of each stream and shallow groundwater area. The relative significance of the grandfathered rights and irrigated lands was described qualitatively in the “Notes”

field with terms such as “numerous” or “several.” Boundaries of the Active Management Areas (AMA) were also overlain to determine if the streams and shallow groundwater areas were within an AMA.

For each of the wells located within the buffers, PAG calculated an average annual reported pumpage volume from the data provided by ADWR for the years 1994 through 1998. Most of the wells did not have pumpage data associated with them; PAG assumed that the average annual reported pumpage for these wells was zero. For water companies whose service area extended to within one mile of a perennial or intermittent stream or shallow groundwater area, PAG obtained the total system withdrawals from ADWR, and calculated the average annual pumpage volume for the years 1994 through 1998.

The “waterusers” and “wthdrwlpts” shapefiles were created in order to provide more detailed, supporting information about the water companies and withdrawal points located within one mile of the streams and shallow groundwater areas. The water user shapefile includes information regarding whether a water company has a CAP allocation, and it includes the minimum distance between the water company service area and the nearest reclaimed water line. This information might be useful for estimating the likelihood that the company will have access in the future to renewable water supplies, and consequently reduce (or at least lessen the increases in) its groundwater withdrawals. PAG used the non-exempt well withdrawal data to calculate each water user’s average annual withdrawal within one mile of a stream or shallow groundwater area from 1994 to 1998. In doing so, it was assumed that each water user’s active wells were included in the withdrawal and Wells-55 databases.

The “wthdrwlpts” shapefile contains records queried from the Wells-55 database. To create this file, several steps were taken. First, all wells located in Pima County were queried out of the statewide database. Next, all non-exempt wells were queried out of the Pima County list using the “Welltype” field of the Wells-55 database. An Avenue script was then used to select and list all non-exempt wells within one mile of each selected stream and shallow groundwater area. The same script was used to select and list all registered wells (exempt and non-exempt) within one mile of the streams and shallow groundwater areas. While reviewing the well withdrawal data reported to ADWR for wells within one mile of streams and shallow groundwater areas, PAG noticed that a large number of wells listed on the withdrawal datasheets were not included in the query of Wells-55 non-exempt wells within one mile. PAG discovered that many of these wells were listed with a “Welltype” identifier other than non-exempt. These wells were identified as “domestic stock exempt”, “exempt”, “monitor”, “non-service”, “recovery”, “replacement well in new location”, “service”, or “withdrawal permit” in the database. These wells were selected individually and added to the “wthdrwlpts” shapefile. Many other wells were not included in the Wells-55 database and had to be added to the “wthdrwlpts” shapefile manually using cadastral locations. Most of the wells not included in the Wells-55 shapefile had reported pumpage of zero. Fields for average annual reported withdrawal and names of streams within one mile were added to the “wthdrwlpts” shapefile. Records for surface water diversions were also added to the shapefile.

Table 2 describes the information provided in each shapefile created for this project.

Table 2. Field names for shapefiles.

Streams and Shallow Groundwater shapefiles (wustreams and wushallgw)	Withdrawal points shapefile (wthdrwlpnts)	Water Users shapefile (waterusers)
Stream or shallow gw area name	Well or surface water diversion	Water user name
Stream/Area ID	Withdrawal point name	Water user ID
# of water users within one mile	Wells-55 registry #	Average annual system withdrawals
Names of water users within one mile	Well owner	Names of streams/shallow gw areas within one mile
Type of water users within one mile	Well use	Average annual system withdrawals within one mile
Water user source	Well cadastral location	CAP allocation
Distance to closest non-exempt well	Depth to water in well	Renewable water notes
Name/owner of closest non-exempt well	Average annual withdrawal from well	Data sources
Wells-55 registry # of closest non-exempt well	Pump rate	Notes
Cadastral location of closest non-exempt well	Surface water diversion owner	
Depth to water of closest non-exempt well	Diversion cadastral location	
# non-exempt wells within one mile	Average annual surface water volume diverted	
Total # of wells within one mile	Names of stream/shallow gw areas within one mile	
# surface water diversions within one mile	Data sources	
Average annual well withdrawals within one mile	Notes	
Average annual surface water volume diverted		
AMA		
Data sources		
Notes		

RESULTS AND DISCUSSION

Findings

The project findings are summarized as follows.

The vast majority of the perennial and intermittent stream reaches and shallow groundwater areas included in this study have no reported groundwater pumpage within one mile of the flowing reaches. 96 out of 122 streams and shallow groundwater areas (or 79%) had no reported pumpage within one mile.

Most of the streams and shallow groundwater areas had at least one well located within one mile. 24 streams had no wells within a mile. These were primarily in remote areas outside the Tucson AMA and along rugged mountain slopes.

The streams and shallow groundwater areas with the highest annual reported pumpage within one mile are the Santa Cruz River, Tanque Verde Creek, Sabino Canyon, Ventana Canyon, Agua Caliente Wash, and Rillito Creek. Streams with relatively moderate annual reported pumpage within one mile are Arivaca Creek, Rincon Creek, Chiminea Creek, Madrona Creek, Pantano Wash, and Box Canyon.

Streams and shallow groundwater areas located outside the Tucson Active Management Area did not have any reported pumpage within one mile. This is presumably because there are no requirements for reporting groundwater pumping in these areas.

Several areas outside the Tucson AMA have no reported groundwater pumpage, but a comparatively high number of registered wells. These areas are San Pedro River, Barrel Canyon, Mud Spring, portions of Davidson Canyon, Gardner Canyon, upper Cienega Creek, portions of lower Cienega Creek, and Sopori Wash. Groundwater usage in these areas is presumably relatively high, because of the large number of wells. There are also several areas within the Tucson AMA which have little or no reported pumpage, but have a relatively high number of registered wells within one mile. These areas are Canada Agua, portions of Agua Verde Creek, portions of Davidson Canyon, portions of lower Cienega Creek, and Box Canyon.

Streams with known surface water diversions are Cienega Creek, the San Pedro River, and the Santa Cruz River. In addition, springs that feed the headwaters of Sabino Creek on Mount Lemmon are diverted for domestic water use in Summerhaven.

Sites with no registered wells within one mile are upper Bear Canyon, Bear Creek, Bootlegger Spring, Bullock Canyon, Canada del Oro, Deer Creek, East and West Forks Sabino Creek, Edgar Canyon, upper Espiritu Canyon, Honey Bee Canyon, Lemmon Creek, Palisade Canyon, Peck Basin, Quitobaquito Spring and Pond, Romero Canyon, Smitty Spring, Sycamore Canyon, Unnamed Spring, and Youtcy Canyon. These areas are presumably associated with little or no groundwater pumpage.

Detailed findings, including number of wells and well withdrawals within one mile, for specific streams and shallow groundwater areas are summarized on Tables 3 and 4.

Water companies whose service areas extend to within one mile of the streams and shallow groundwater areas included in this study are listed on Table 5. Companies with the highest annual pumpage within one mile of a stream or shallow groundwater area are Tucson Water, Metropolitan Domestic Water Improvement District, Forty-Niner Water Company, and Cortaro Marana Irrigation District. Access to CAP water or reclaimed water might help some of these water companies reduce groundwater withdrawals or limit future increases. Tucson Water, Vail Water Company, Town of Marana, Metro

Water, Flowing Wells Irrigation District, Oro Valley Water Company and Spanish Trail Water Company have CAP allocations. Existing reclaimed water lines are located in or comparatively close (less than 2 miles) to 8 of the water companies identified in this project. Thirteen water companies had boundaries between 2 and 10 miles from an existing reclaimed water line. The following water users are located over ten miles from the nearest reclaimed water lines: Arivaca Township Co-op Water Company, and Anderson Water Company.

Conclusions and Data Needs

This study provided a very general assessment of water usage along perennial streams, intermittent streams and shallow groundwater areas in Pima County. From the results, it appears to be very likely that the northeastern part of the Tucson Basin is associated with the largest amounts of nearby groundwater pumpage. Streams and shallow groundwater areas in this part of the Basin include Tanque Verde Creek, Sabino Creek, Ventana Canyon, Rillito Creek, and the Agua Caliente area. However, the ranking of which streams or areas have the highest groundwater usage cannot be confirmed, because groundwater pumpage data are not reported for areas outside the Tucson AMA. The stream with the largest reported pumpage within one mile is the Santa Cruz River. Areas outside the Tucson AMA with the largest numbers of registered wells include San Pedro River and Mud Spring. Groundwater usage in these areas is presumably comparatively high as well.

This study did not identify, nor does it contain sufficient information to identify, the potential impacts of water usage on aquatic or riparian habitats, the relative rank of the streams according to potential impacts, or the relative threat from an individual well(s) or water user(s).

In order to conduct such an assessment, the following should be pursued:

- interviews with well owners to determine pumpage in areas outside the Tucson AMA, or;
- an assessment of population, irrigated acreage and crop types to estimate water usage in areas outside the Tucson AMA;
- field investigations to confirm the locations of wells and surface water diversions;
- measurement of water levels in wells;
- review of lithologic logs and well construction information to determine the aquifer(s) from which the water in each well is drawn;
- assessment of stream flows, local geology, local aquifer characteristics, and groundwater flow directions to determine the origin of the water in the streams, and to determine the interaction between streamflows, groundwater, and riparian vegetation;
- compilation of historical groundwater level and streamflow data to establish baseline, steady-state conditions;
- estimation of evapotranspiration rates;

- projections of future population, urban development, water usage, and locations of wells; and
- development of groundwater flow models using the information compiled.

For purposes of a fairly simple, qualitative assessment limited to an individual well's potential impact on a given stream reach, information on the proximity of the well to the stream reach, the depth of water in the well, the lithologic log, the perforated interval, and the annual pumpage should be sufficient if the local hydrologic system is understood. Alternatively, a tracer test could be conducted to establish a link between the stream and the well, but this could be objectionable to the owners of wells used for potable purposes.

Table 3. Previously Identified Perennial and Intermittent Streams

Stream Name	# Non-exempt wells within one mile	Total # wells within one mile	Avg. reported annual withdrawal from non-exempt wells (acre-feet)**	AMA
Agua Verde Creek	4	30	7	Tucson (partial)
Alder Canyon	0	3	NA	outside
Apache Spring	0	1	NA	outside
Arivaca Creek	17	105	98	Tucson
Ash Creek	0	2	NA	outside
Atchley Canyon	0	1	NA	outside
Barrel Canyon	0	10	NA	outside
Bear Canyon (lower)	0	11	0	Tucson
Bear Canyon (upper)	0	0	0	Tucson
Bear Creek	0	0	NA	outside
Bootlegger Spring	0	0	NA	outside
Box Canyon (Rincon)	1	19	13	Tucson
Brown Canyon	0	7	0	Tucson
Buehman Canyon	1	6	NA	outside
Bullock Canyon	0	0	NA	outside
Bullock Canyon	1	3	NA	outside
Canada Agua	1	18	0	Tucson

Table 3 (con't)

Stream Name	# Non-exempt wells within one mile	Total # wells within one mile	Avg. reported annual withdrawal from non-exempt wells (acre-feet)**	AMA
Canada Del Oro	0	0	0	Tucson
Canada del Oro	0	1	0	Tucson
Cargodera Canyon	0	1	0	Tucson
Chimineia Canyon	3	19	57	Tucson
Chimney Canyon	0	5	NA	outside
Cienega Creek (lower)	3	21	0	Tucson (partial)
Cienega Creek (upper)	6	12	NA	outside
Cinco Canyon	1	2	NA	outside
Davidson Canyon	0	2	0	Tucson
Davidson Canyon	0	2	0	Tucson
Davidson Canyon	0	2	0	Tucson
Davidson Canyon	0	2	0	Tucson
Deer Canyon	0	0	NA	outside
Distillery Canyon	0	7	NA	outside
East Fork Sabino Canyon	0	0	0	Tucson
Edgar Canyon	0	0	NA	outside
Empire Gulch	4	4	NA	outside
Empire Gulch	1	3	NA	outside
Espiritu Canyon	0	2	NA	outside
Espiritu Canyon	0	0	NA	outside

Table 3 (con't)

Stream Name	# Non-exempt wells within one mile	Total # wells within one mile	Avg. reported annual withdrawal from non-exempt wells (acre-feet)**	AMA
Finger Rock Canyon	0	2	0	Tucson
Florida Canyon	0	7	0	Tucson
Gardner Canyon	4	4	NA	outside
Geesaman Wash	0	7	NA	outside
Honey Bee Canyon	0	0	0	Tucson
La Milagrosa Canyon	0	8	0	Tucson
Lemmon Creek	0	0	0	Tucson
Little Nogales Spring	0	1	NA	outside
Madera Canyon	0	7	0	Tucson
Madrona Canyon	4	10	57	Tucson
Mattie Canyon	0	1	NA	outside
Mattie Canyon	0	2	NA	outside
Miller Creek	2	3	NA	outside
Molino Canyon	0	10	0	Tucson
Montosa Canyon	0	1	NA	outside
Mud Spring Canyon	0	24	NA	outside
Nogales Spring	0	1	NA	outside
Paige Creek	2	5	NA	outside
Palisade Canyon Creek	0	0	0	Tucson
Peck Basin	0	0	NA	outside

Table 3 (con't)

Stream Name	# Non-exempt wells within one mile	Total # wells within one mile	Avg. reported annual withdrawal from non-exempt wells (acre-feet)**	AMA
Pima Canyon	1	2	0	Tucson
Posta Quemada	2	5	7	Tucson
Quitobaquito Pond	0	0	NA	outside
Quitobaquito Spring	0	0	NA	outside
Rincon Creek	11	93	80	Tucson
Romero Canyon	0	0	0	Tucson
Romero Canyon (lower)	0	0	0	Tucson
Romero Canyon (upper)	0	0	0	Tucson
Rose Canyon Creek	0	1	0	Tucson
Ruelas Canyon	0	2	0	Tucson
Sabino Canyon (lower)	75	186	3603	Tucson
Sabino Creek (mid)	2	18	12	Tucson
Sabino Creek (upper)	0	6	0	Tucson
San Pedro River	31	57	NA	outside
Santa Cruz River	140	404	32401	Tucson
Scholefield Spring	0	4	NA	outside
Simpson Creek	0	2	NA	outside
Smitty Spring	0	0	NA	outside
Soldier Canyon	0	3	0	Tucson
Sutherland Wash	5	24	23	Tucson

Table 3 (con't)

Stream Name	# Non-exempt wells within one mile	Total # wells within one mile	Avg. reported annual withdrawal from non-exempt wells (acre-feet)**	AMA
Sycamore Canyon	0	0	0	Tucson
Tanque Verde Creek (lower)	91	211	1205	Tucson
Tanque Verde Creek (mid)	59	229	3479	Tucson
Tanque Verde Creek (upper)	0	2	0	Tucson
Tanque Verde Creek (upper)	0	1	0	Tucson
Thomas Canyon	0	2	0	Tucson
Turkey Creek	2	6	NA	outside
Unnamed Spring	0	0	NA	outside
Unnamed tributary to Ash Creek	0	2	NA	outside
Ventana Canyon	19	65	1054	Tucson
Wakefield Canyon	0	1	NA	outside
Wakefield Canyon	0	1	NA	outside
West Fork Sabino Canyon	0	0	0	Tucson
Wild Burro Canyon	0	1	0	Tucson
Wild Burro Canyon	0	1	0	Tucson
Wild Burro Canyon	0	1	0	Tucson
Wild Burro Canyon	0	1	0	Tucson
Wild Burro Canyon	0	1	0	Tucson
Wild Cow Spring	0	2	NA	outside
Youtcy Canyon	0	4	0	Tucson

Table 3 (con't)

Stream Name	# Non-exempt wells within one mile	Total # wells within one mile	Avg. reported annual withdrawal from non-exempt wells (acre-feet)**	AMA
Youtcy Canyon	0	3	0	Tucson
Youtcy Canyon	0	0	NA	outside
Youtcy Canyon	0	0	NA	outside

Note: Numbers and types of wells based on ADWR Wells-55 database
 Pumpage data based on data reported to ADWR, 1994-1998

** NA = not available, outside AMA

Table 4. Previously Identified Shallow Groundwater Areas

Area Name	# Non-exempt wells within one mile	Total # wells within one mile	Avg. reported annual withdrawal from non-exempt wells (acre-feet)**	AMA
Agua Caliente Canyon	53	209	3069	Tucson
Agua Verde Creek	3	23	7	Tucson (partial)
Arivaca Area	21	197	98	Tucson
Box Canyon	7	37	120	Tucson
Cienega Creek (lower)	4	42	NA	outside
Cienega Creek (lower)	5	23	10	Tucson (partial)
Cienega Creek (upper)	9	18	NA	outside
Cocio Wash	4	9	0	Tucson
Davidson Canyon	0	79	0	Tucson (partial)
Davidson Canyon (upper)	0	10	NA	outside
Gardner Canyon	4	34	NA	outside
Pantano Wash	8	39	112	Tucson
Posta Quemada Canyon	2	5	7	Tucson
Rillito Creek Area	43	98	800	Tucson

Table 4 (con't)

Area Name	# Non-exempt wells within one mile	Total # wells within one mile	Avg. reported annual withdrawal from non-exempt wells (acre-feet)**	AMA
Rincon Creek	11	65	157	Tucson
Sabino Canyon	88	220	3607	Tucson
San Pedro River	25	67	NA	outside
Sopori Wash	25	67	0	Santa Cruz
Sutherland Wash 1	3	21	8	Tucson
Sutherland Wash 2	1	2	0	Tucson
Tanque Verde Creek Area	68	264	3351	Tucson
Tanque Verde Creek Area (lower)	98	227	3768	Tucson

Note: Numbers and types of wells based on ADWR Wells-55 database. Pumpage data based on data reported to ADWR, 1994-1998.

** NA = not available, area outside AMA.

Table 5. Water Users within One Mile of Streams and Shallow Groundwater Areas

Water User Name	Avg. reported annual system withdrawals (acre-feet)	Avg. reported annual system withdrawals within one mile of stream or sgwa (acre-feet)	Name of stream or shallow groundwater area within one mile	Cap allocation
Anderson Water Co.	NA	NA	Lower Cienega Creek; Cienega Creek; Wakefield Canyon	
Arivaca Townsite Co-op Water Co.	21	21	Arivaca Area; Arivaca Creek	
ASARCO	NA	NA	Santa Cruz River	
Canada Hills Water Co., Ltd.	NA	NA	Santa Cruz River; Sutherland Wash	
Cortaro Marana Irrigation District	32001	22735	Santa Cruz River	
Cortaro Water Users Association	310	104	Santa Cruz River	

Table 5 (con't)

Water User Name	Avg. reported annual system withdrawals (acre-feet)	Avg. reported annual system withdrawals within one mile of stream or sgwa (acre-feet)	Name of stream or shallow groundwater area within one mile	Cap allocation
Flowing Wells	2892	15	Santa Cruz River	Y
Forty-Niner Water Co.	837	735	Tanque Verde Creek; Agua Caliente Canyon	
Lago Del Oro Water Co.	1645	20	Sutherland Wash; Lower Romero Canyon; Cargodera Canyon	
Los Cerros Water Co.	142	0	Sutherland Wash	
Lynn Lee Water Co.	19	19	Santa Cruz River	Y
Marana Water Service	408	195	Santa Cruz River	Y
Metropolitan Domestic Water Improvement District 1	8867	472	Santa Cruz River	Y

Table 5 (con't)

Water User Name	Avg. reported annual system withdrawals (acre-feet)	Avg. reported annual system withdrawals within one mile of stream or sgwa (acre-feet)	Name of stream or shallow groundwater area within one mile	Cap allocation
Metropolitan Domestic Water Improvement District 2	8867	1074	Lower Tanque Verde Creek; Sabino Canyon; Ventana Canyon	Y
Mt. Lemmon Co-op Water Co.	15	15	Upper Sabino Canyon	
Oracle Ridge Mining 1	NA	NA	Atchley Canyon; Geesaman Wash	
Oracle Ridge Mining 2	NA	NA	Santa Cruz River	
Oro Valley Water Company	4521	0	Honey Bee Canyon; Sutherland Wash	
Procter, J.M.	NA	NA	Sutherland Wash	
Rillito Water Users	35	34	Santa Cruz River	

Table 5 (con't)

Water User Name	Avg. reported annual system withdrawals (acre-feet)	Avg. reported annual system withdrawals within one mile of stream or sgwa (acre-feet)	Name of stream or shallow groundwater area within one mile	Cap allocation
Rincon Creek Water Co.	3	6	Rincon Creek	
Rincon Water Co.	30	28	Rincon Creek; Chiminea Canyon; Madrona Canyon	
Saguaro Water Co.	13	8	Rincon Creek	
Silverbell Mining	NA	NA	Cocio Wash Area	
Spanish Trail Water Co.	124	124	Box Canyon; Rincon Creek	Y
Town of Marana Municipal Property Co	NA	NA	Santa Cruz River	Y
Tucson Water 1	111215	10245	Santa Cruz River; Sabino Canyon; Tanque Verde Creek; Pima Canyon; Finger Rock Canyon; Ventana Canyon; Tanque Verde Creek; etc	Y

Table 5 (con't)

Water User Name	Avg. reported annual system withdrawals (acre-feet)	Avg. reported annual system withdrawals within one mile of stream or sgwa (acre-feet)	Name of stream or shallow groundwater area within one mile	Cap allocation
Tucson Water 2	111215	13	Box Canyon	Y
Vail Water Co.	174	10	Lower Cienega Creek; Davidson Canyon; Agua Verde Creek	Y

Note: Pumpage data based on data reported to ADWR, 1994-1998, except Mt. Lemmon Co-op Water Co. (1995 only)

