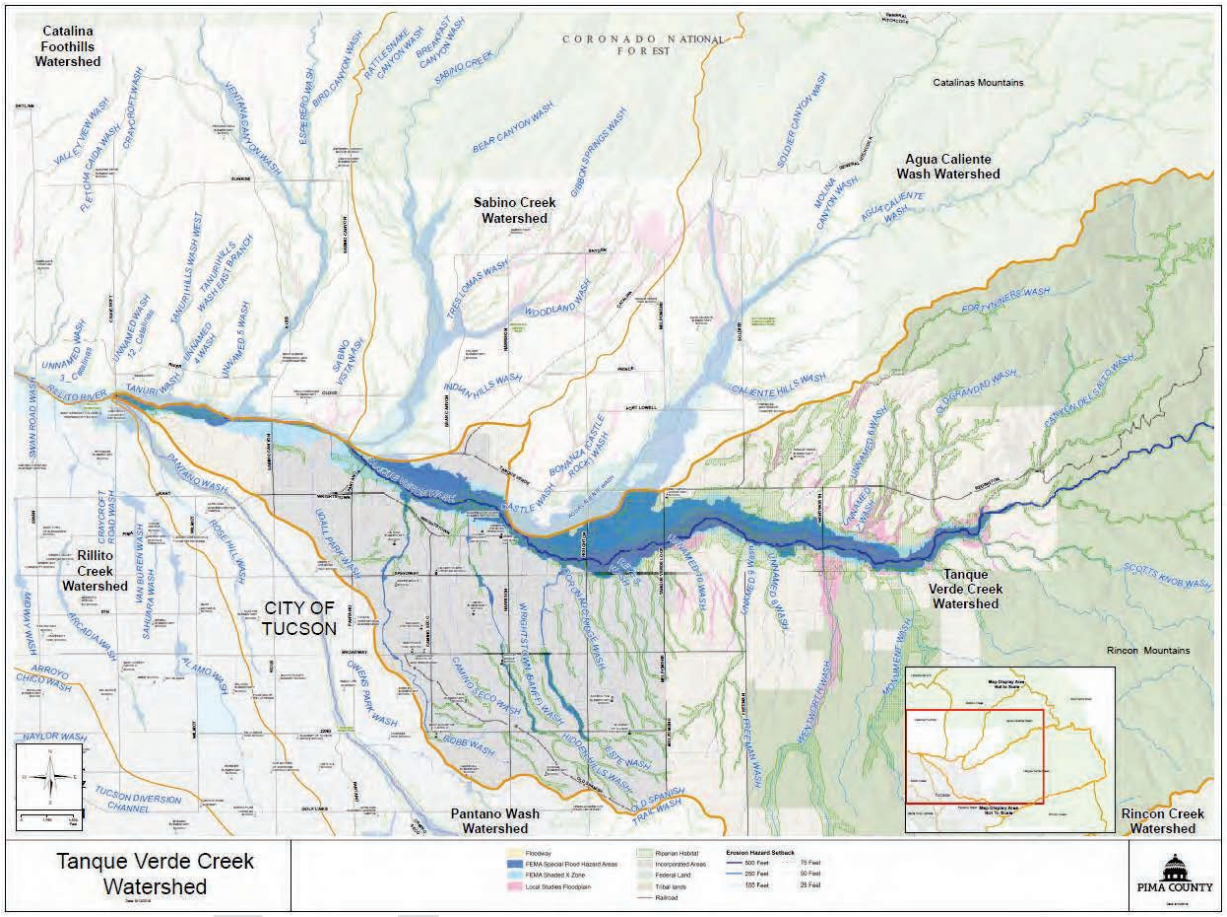
5.4.15 Tanque Verde Creek

Tanque Verde Creeks' headwaters are on both sides of Redington Pass in the Rincon and Santa Catalina Mountains. Originating at nearly 9000', it descends steeply through dramatic canyon walls before spilling out onto the bajada foothills and geologic floodplains associated with the Agua Caliente Wash and Sabino Creek, where they merge to become Rillito Creek. Within Pima County, it is comprised of 70,188 acres (109.7 square miles), including 9,408 within the City of Tucson.

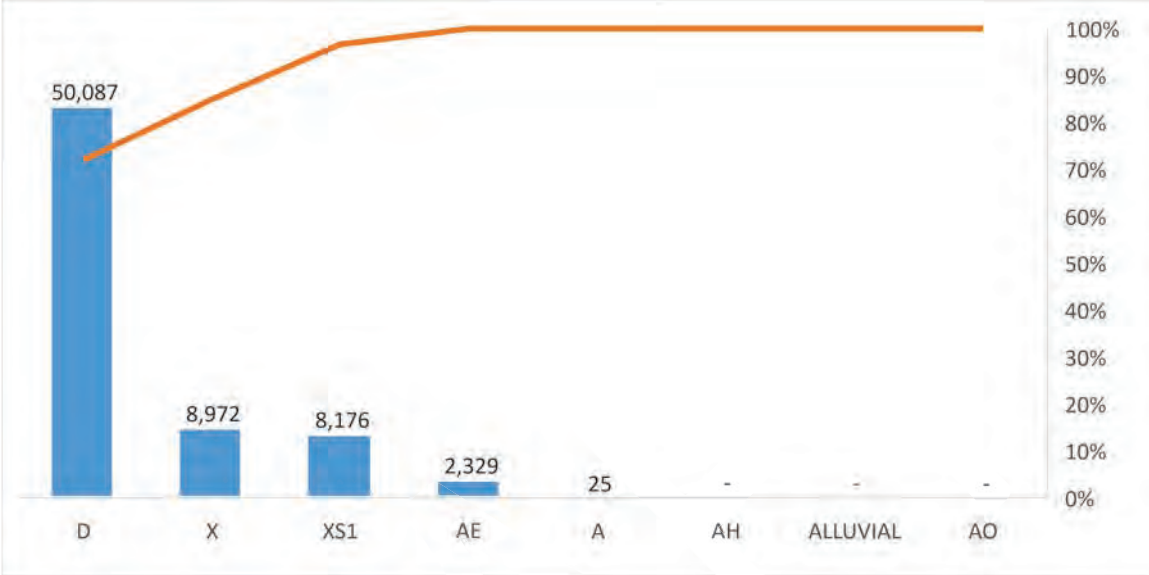
Figure 156 - Tanque Verde Wash Watershed Map



5.4.15.1 Flood Characteristics

In addition to the 2,354 acres of SFHA zones included on the chart above, there are also 1,179 acres of Special Studies Floodplains in this watershed.

Figure 157 - Tanque Verde Creek Federal Floodplain Designations in Acres



The Tanque Verde Creek watershed originates at higher elevations in the Coronado National Forest, areas subject to snowfall, higher annual rainfall and more frequent runoff events than other parts of Pima County. The watershed is relatively static resulting in stable hydrologic response over time. However, vegetation, slope and rainfall characteristics change dramatically from the upper parts of the watershed, which receive more than twice as much rainfall as the lower portions of the watershed, to the lower portions of the watershed. Lower portions of this watershed south of Tanque Verde Creek are more densely developed and lie primarily within the flood control jurisdiction of the City of Tucson. Twenty-one ALERT Gauges are in place to provide advance warning and monitoring of flow rates, depths and rainfall.

Unlike most of Pima County flow, flow in these watersheds can continue for extended periods, and the upper watersheds may even experience perennial flow. Flow measurement in the Tanque Verde is more complete than many other watersheds. A summary of the USGS gauging station records on the Tanque Verde Creek is as follows:

Table 50 - Tanque Verde Creek Watershed USGS Gages

USGS Gages	USGS 09483100 TANQUE VERDE CREEK NEAR TUCSON, ARIZ	USGS 09484500 TANQUE VERDE CREEK AT TUCSON, AZ.
Period of Record	Nov. 1960 to Dec. 2012	Aug. 1940 to Jan. 2015
Watershed Area (sq. m)	43	219
Flood Peak of Record (cfs)	8,600	26,600
Date	2-Oct-83	31-Jul-06
FIS Discharge (cfs)	16,000	34,000

These records indicate that floods in the Tanque Verde can occur from all three of the three primary flood mechanisms that occur in Pima County, convective storms, tropical storms and frontal storms. Rain on snow events occur in this watershed when frontal storms produce rain on existing winter snow.

The table below summarizes Pima County's Alert Gages. The locations are from the District's Alert map.

Table 51 - Tanque Verde Creek Watershed ALERT Streamflow Gages

Pima County Alert Gage	Tanque Verde Creek at Chiva Tank ID: 2073	Tanque Verde Creel at Tanque Verde Guest Ranch ID: 2093
Location (Latitude, Longitude)	(32.2675, -110.6069)	(32.246,-110.6827)
Period of Record	1987-01-05 to Present	1987-08-03 to Present
Watershed Area (sq. m)	43.07	43.18
Flood Peak of Record (cfs)	7768.3	33542.9
Date	07-27-2017	12-05-1994

Table 52 - Tanque Verde Creek Watershed ALERT Precipitation Gages

Pima County Alert Gage	Park Tank-Tanque Verde Basin ID:2020	Italian Trap-Tanque Verde Basin ID: 2030	White Tank-Tanque Verde Basin ID: 2040	Tanque Verde Creek at Chiva Tank ID:2070	Tanque Verde Creek at Tanque Verde Guest Ranch ID: 2090
Location (Latitude, Longitude)	(32.2625 -110.5464)	(32.2853,-110.5636)	(32.3044,-110.5708)	(32.2675,-110.6069	(32.2458,-110.6827)
Period of Record	1985-07-02 to Present	1985-07-02 to Present	1985-06-27 to Present	1986-06-17 to Present	1987-07-02 to Present

Below are excerpts for Tanque Verde Creek and major tributaries from the District's Table of Regulatory Discharges (Revised October 28, 2014).

Table 53 - Tanque Verde Creek Watershed Regulatory Discharges

Watercourse	Regulatory Discharge, cfs 1% Return Frequency	Drainage Area, sq. miles	Source of Discharge Information
Agua Caliente Split Flow @ Divergence from Agua Caliente Wash @ Confluence with Tanque Verde Creek	 3,360 5,820		 FEMA Map Revision (11-09-1817S) "
Forty-Niners Wash @ National Forest Boundary @ Tanque Verde Road	 4,578 3,500		From Previous Discharge Table "

Watercourse	Regulatory Discharge, cfs 1% Return Frequency	Drainage Area, sq. miles	Source of Discharge Information
Old Grandad Tank Wash: @ Tanque Verde Creek Confluence	3,942	2.02	Pima County Regional Flood Control District Special Study (#57)
Tanque Verde Creek: Upstream of Confluence with Rillito Creek	34,000	241.0	FEMA, Flood Insurance Study
Upstream of Confluence with Sabino Creek	28,000	149.0	"
Near the confluence with the Agua Caliente Wash	23,000	99.60	"
Wentworth Wash: Upstream of Speedway Boulevard	4,719	5.3	Pima County Regional Flood Control District Special Study (#58)

Flood characteristics vary greatly on the watershed. While flow is primarily constrained in mountainous channels, distributary flow patterns develop where these channels enter the valley floor at the apex of alluvial fans, and residential properties are at risk for flood damage where drainage infrastructure does not exist. Potential for overbank flow leading to flooding exists along the Tanque Verde Creek, particularly at its confluence with Agua Caliente Wash. Potential overbank flow conditions along Sabino Creek affect fewer residential properties

Likewise, flood characteristics themselves vary greatly depending on whether the event is convective, such as the July 31, 2006 event, which was produced by a high intensity, shorter duration event, or a rain on snow event, which can release a higher volume of water over a longer period. Tributary flooding is likely during short and long duration storms while main stem flooding typically occurs during long duration or overlapping storm events.

Floods from the Tanque Verde Creek have posed the greatest risk downstream of Wentworth Road, particularly for many homes on the north bank at Forty-niners Country Club Estates, which are in the mapped FEMA floodplain. Some of these have been flooded more than once and are a Repetitive Loss Area.

Downstream of North Tanque Verde Loop Road, properties south of Tanque Verde Creek generally lie within the flood control jurisdiction of the City of Tucson.

Agua Caliente Creek and Sabino Creek and tributaries to these sub-watersheds enter the valley floor onto alluvial fans, which is where most of the development has occurred. Flows on these fans can cause erosion, deposition and channel avulsion. The July 31, 2006 also produced debris flows on these alluvial fans, which resulted in flooding of some structures that would not have been at risk if the debris flow had not altered the flow pattern at the apex in Soldier Canyon. In addition, even where flow-patterns were not altered, such as in Sabino Canyon upstream of Bear Canyon, the sediment released in the debris flow filled the channel and reduced the flood capacity.

As flows enter the valley floor in the main channel of Tanque Verde creek, flows are contained. Downstream of Sabino Creek the District has installed bank protection to limit the potential for channel migration.

In general, the watercourses have been well-mapped as indicated by 92% of the SFHA from detailed studies and only about 8% in approximate studies.

5.4.15.2 Existing Development & Infrastructure Trends

The chart below shows the distribution of residents within known floodplains, and distribution between incorporated and unincorporated areas. Almost 50% of watershed residents live in a floodplain.

Figure 158 - Tanque Verde Creek Watershed Population Distribution

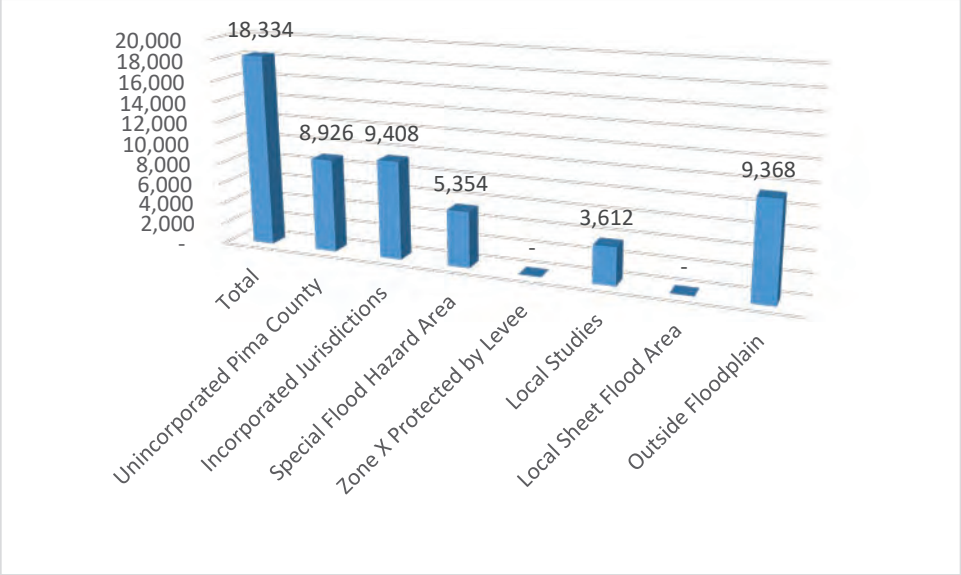
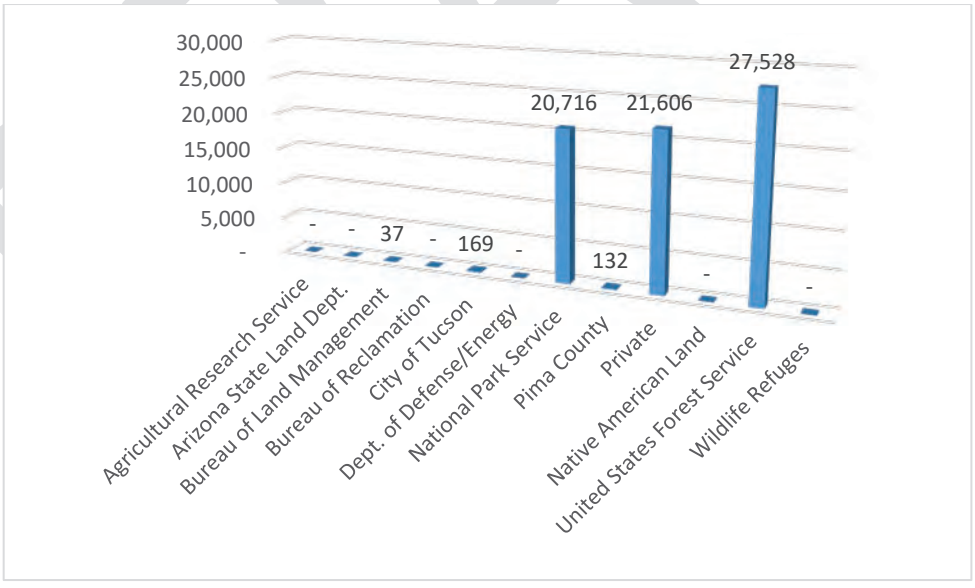
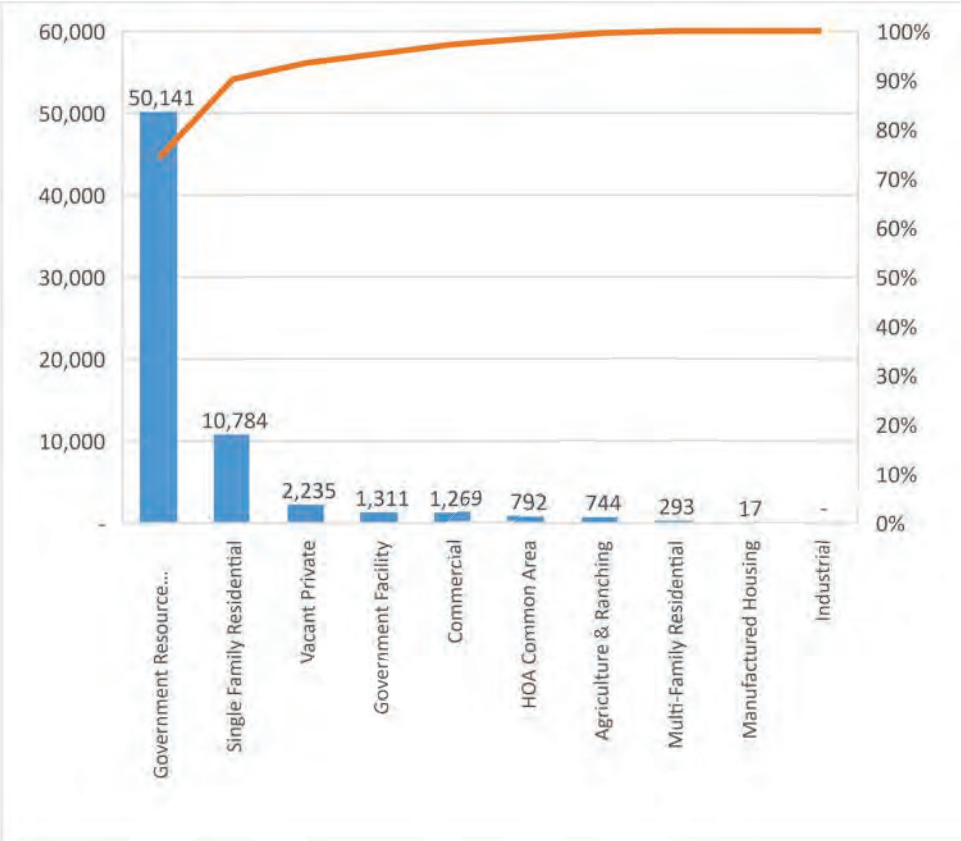


Figure 159 - Tanque Verde Creek Watershed Ownership in Acres



Outside the National Park, single family residential is the predominant use throughout this watershed.

Figure 160 - Tanque Verde Creek Watershed Land Use in Acres



In recent years, the County has approved increased densities on areas previously left open due to flood and other limitations. While build out of improved developments and some lot splitting can be expected few large tracts are available for development. The low density of current development does suggest that density increases are due to the attractiveness of the area, which is tied to the riparian characteristics.

Figure 161 - Tanque Verde Creek Floodplain Land Use

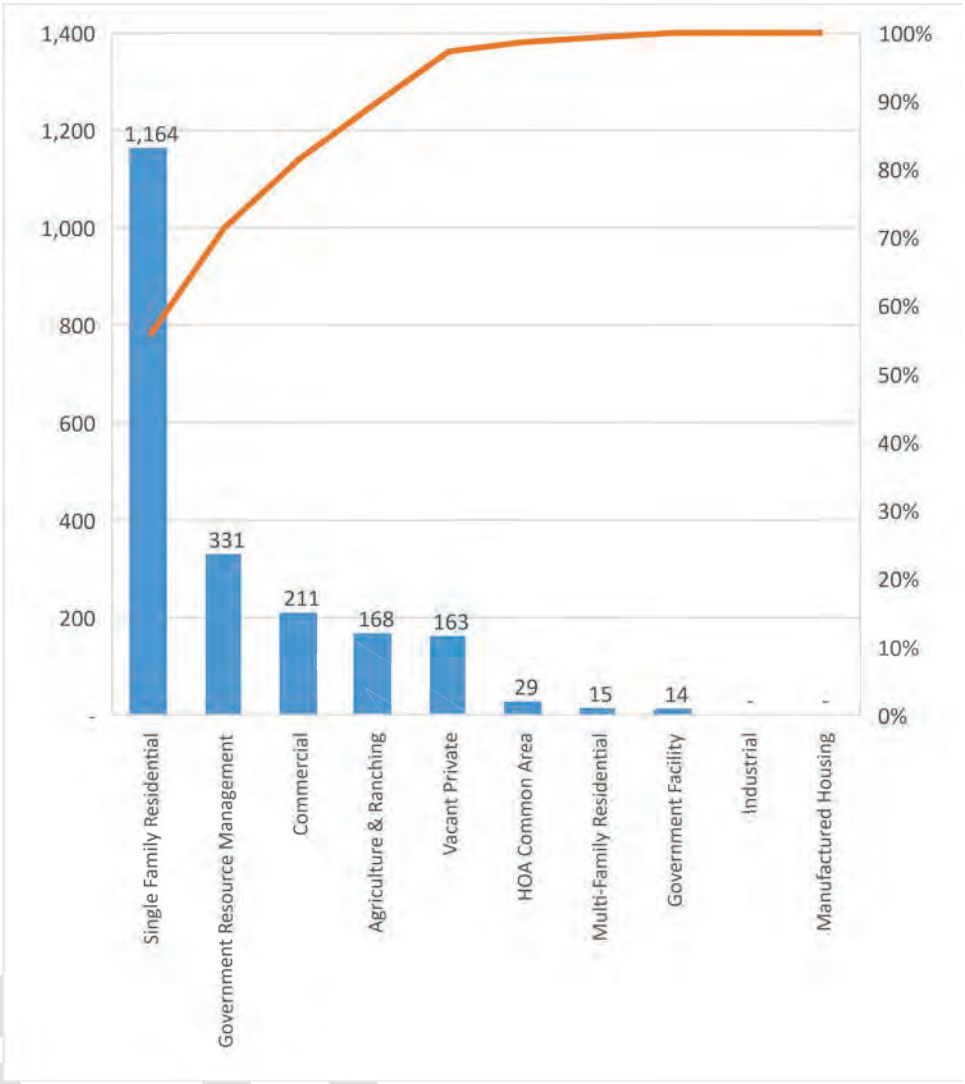
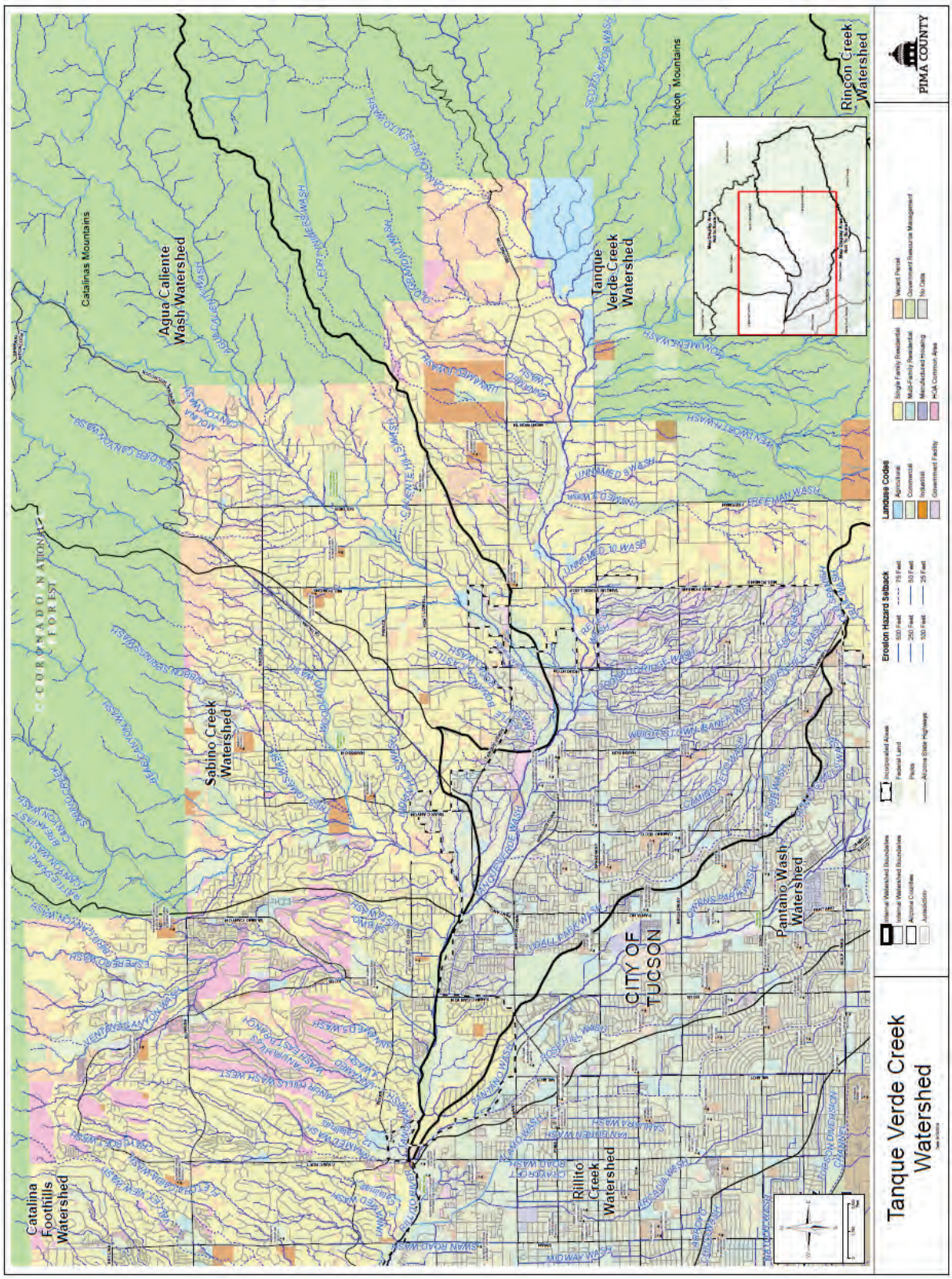


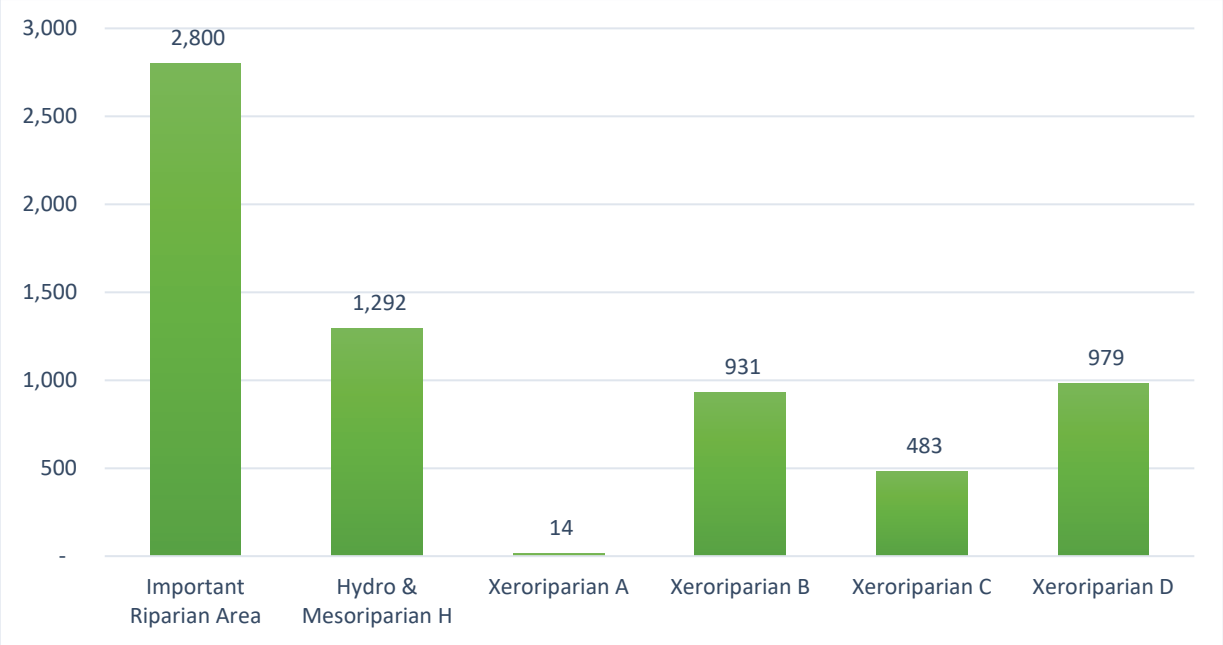
Figure 162 - Tanque Verde Creek Land Use Map



5.4.15.3 Riparian Habitat and Natural Areas

As shown on the figure below, there are 3,699 acres of Pima County Regulated Riparian Habitat in this watershed and 2,800 acres of IRA. There are also 50,508 preserved acres in this watershed, including 597 in regulatory floodplain.

Figure 163 - Tanque Verde Creek Watershed Riparian Habitat in Acres

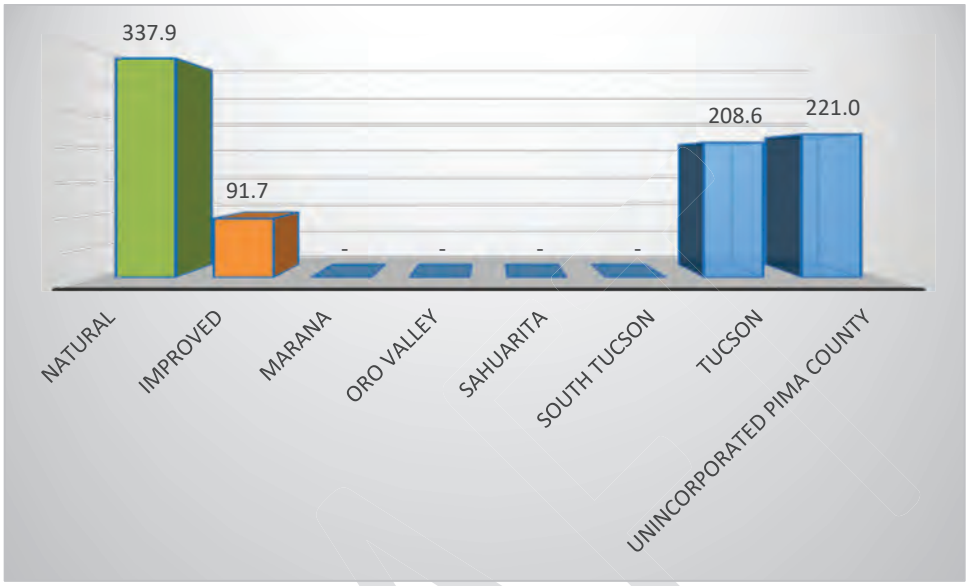


The confluence with the Rillito as well as the canyon headwaters contain some of the largest networks of springs, surface flows and shallow groundwater anywhere in the County. This water availability has contributed both to the biologic, historic and cultural significance of this region as well as current high property and recreational amenity values. Today, landowners and community groups including, Friends of Redington Pass, Watershed Management Group, Coalition for Sonoran Desert Protection and Audubon Society are pursuing preservation and enhancement of these values and they warrant the full measure of protection afforded by floodplain management practices.

5.4.15.4 Historic Floodplain Management Approach

The figure below shows the split between natural and improved drainageways, and how many acres the District is responsible for in each jurisdiction.

Figure 164 - Tanque Verde Creek Drainageway Acreage



In 2010, the District began mapping tributaries to larger watercourses where typically FEMA mapping existed on the watercourse but not on the tributaries. Performing these studies at a level of detail suitable for floodplain management and permitting, allowed better-informed permitting decisions. Notification of constituents of improved floodplain information is part of the protocol for these recent mapping studies. Both the District and property owners can make decisions that decrease flood risk to safety and property.

Tanque Verde Creek can convey large amounts of flow. The Agua Caliente 2,200 (+/-) foot long soil cement levee is located on along the western embankment of the upstream of the Tanque Verde Road Bridge. The Agua Caliente spur dike is not a levee but had to pass many of the FEMA levee criteria in order for them not to map the floodplain as if the spur dike failed. It is located upstream of Tanque Verde Road along east embankment of the Agua Caliente Wash. The southern portion of the spur dike, adjacent to the channel, is soil cement. On the northern end, the structure bends to the east and becomes an earthen embankment with armoring. There is one flap gate upstream of the bridge

There are stream gauges at Chiva (ALERT ID# 2073), Tanque Verde Guest Ranch (ALERT ID# 2093), Tanque Verde Road (ALERT ID# 2109), and Sabino Canyon Road (ALERT ID# 2123). There is no bank protection upstream of Tanque Verde Road. The primary concern with higher discharges is overbank flooding resulting from high levels of flow. Locations of concern include 49's Country Club that the District has identified as a Repetitive Loss Area and the Woodland Road area. The District estimates initial breakout at 49er's to occur at 8,000 – 9,000 cfs. The district estimates initial breakout at Woodland Road at 13,000 – 15,000 cfs. The full report; Flood Hazard and Early Warning Analysis

Tanque Verde Creek, includes inundation maps. Flows in the Tanque Verde that are a result of combined flows from the Tanque Verde Creek, Agua Caliente Wash, and Monument Wash impacts this area. Impacted at-grade crossings include Wentworth Road and Tanque Verde Loop Road. At 200 cfs the COT Street Maintenance Division is contacted. Streamflow of 5,000 cfs at Chiva Tank (2073) or streamflow of 8,000 cfs at Tanque Verde Guest Ranch (2093) may affect 49's area or Woodland Road area. At these rates, senior staff decides whether to notify OEM. Due to sediment deposition near the gauge, judgment is required on the part of the Storm Monitor.

Large flows in Sabino Creek may affect numerous road crossings in the recreation area and some residential access and structures downstream of the USFS boundary. Lower flows are likely to overtop driveway access to some residential structures below the Forest Service boundary. The stream gauge on this channel is located at the dam in the US Forest Service (USFS) recreation area. No at-grade Crossings below the National Forest boundary are impacted. At streamflow of 2,000 cfs and flood stage of 3.4 feet at Sabino Canyon Dam (ALERT ID# 2163) residences in Sabino floodplain may be impacted and therefore senior staff decides whether to notify OEM.

5.4.15.5 Needs – Capital Improvement

For each watershed; monitoring, frequently flooded structures and properties subject to damage, exposed infrastructure, and safety concerns have been described in full detail in the District's Flood Response Field Manual (April 2019). Each of the areas so identified have addresses and geodetic coordinates associated with them and District personnel have them mapped in the Geographic Information System used. For planning purposes, specific items of concern follow; the complete report is in Appendix D.

Data Gathering Needs

- No site-specific issues identified.

Frequently Flooded Structures and Properties Subject to Damage

- Tanque Verde Creek breaks-out on the right overbank onto Woodland Road at 13,000- 15,000 cfs. There is an ALERT system trigger for this discharge. (T14S R15E Sec. 03)
  <GIS Point ID: TVC-FSP-001>
- Based on modeling, Tanque Verde Creek breaks-out of the main channel at Tanque Verde Loop Road between 14,000-16,000 cfs. (T14S R16E Sec. 06) <GIS Point ID: TVC-FSP- 002>
- Based on modeling, Tanque Verde Creek breaks-out of the main channel at Houghton Road between 12,000-14,000 cfs. (T14S R15E Sec. 01) <GIS Point ID: TVC-FSP-003>
- The south half of 49ers subdivision is subject to overbank flooding from Tanque Verde Creek at around 14,000-16,000 cfs. (T14S R16E Sec. 05) <GIS Point ID: TVC-FSP-004>
- 12140 E. Barbary Coast Rd. (205-50-0890) - Repetitive Loss Property, with losses claimed in 1983, 1984 and 2010. (T14S R16E Sec. 05) <GIS Point ID: TVC-FSP-005>
- 12150 E. Barbary Coast Rd. (205-50-0900) - Repetitive Loss Property, with losses

claimed in 1978, 1983, 1984, 1990 and 2010. (T14S R16E Sec. 05) <GIS Point ID: TVC-FSP- 006>

- 12530 E Gold Dust Dr. (205-50-0130) - Repetitive Loss Property, with losses claimed in 2006 and 2010. (T14S R16E Sec. 05) <GIS Point ID: TVC-FSP-007>

Infrastructure

- Washes within Forty Niners subdivision fill with sediment and the reduced channel capacity may increase flooding, especially west of the bend in Gold Dust Drive. The washes are public except for one. (T14S R16E Sec. 05) <GIS Point ID: TVC-INF-001>
- An interceptor sewer follows the north bank of Tanque Verde Creek upstream of Sabino. There is no bank protection for this infrastructure. (T13S R15E Sec. 33) <GIS Point ID: TVC-INF-002>

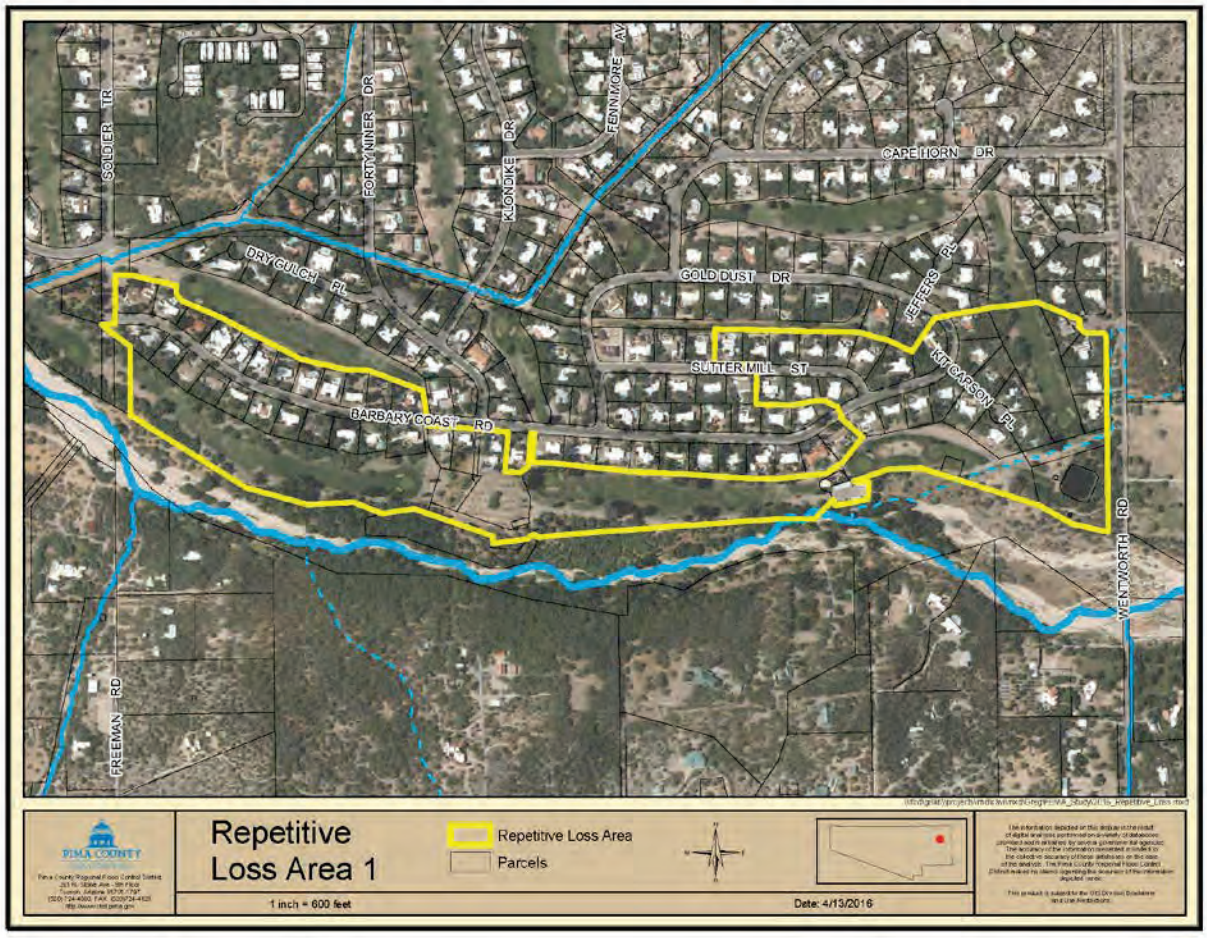
Safety Concerns

- Hazardous conditions exist at the dip crossings of Tanque Verde Creek at Tanque Verde Loop Road (T14S R16E Sec. 06) <GIS Point ID: TVC-SAF-001>
- Hazardous conditions exist at the dip crossings of Tanque Verde Creek at Wentworth Road. (T15S R16E Sec. 04) <GIS Point ID: TVC-SAF-002>

5.4.15.6 Floodplain Management

Future needs identified by District staff include:

- Riparian preservation
- Shallow groundwater
- High value unprotected property
- Repetitive Loss Properties
- Cumulative Improvements to non-conforming uses
- Bank reclamation
- Warning System Outreach



Repetitive Loss Area Map