

December 2019 Working Report

TOWN OF PATAGONIA ROADMAP TO WATER QUALITY

**Santa Cruz County,
Arizona**

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Prepared for:
The Town of Patagonia



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Summary

The Sonoita Creek watershed has supported human life for over 12,000 years and is home to many endangered species. Good water quality has been essential for life in the area to thrive. This report was written with the purpose to inform stakeholders of the status of water quality in the watershed and to identify data gaps so that additional action can be taken to get an understanding of the baseline profile of water quality. Data was taken from reliable sources, primarily from government sponsored databases.

Surface Water samples did not exceed drinking water standards. However, some constituents were identified as exceeding ADEQs water quality standards for Aquatic and Wildlife. There were no apparent exceedances found for groundwater water quality standards. The data gap analysis showed that additional surface water and groundwater sampling/data collection needed to be performed during the 2010-2019 decade. Additionally, there were few sampling locations for the northern section of the watershed for surface water and little to no groundwater data points around the periphery of the watershed. It is recommended that additional sampling/further data mining be performed to fill these gaps. Lastly, these recommendations have been made for management of the watershed to continue communication with stakeholders, pursue funding opportunities, and to implement a sampling and data mining program that would better fill the data gaps.

Introduction

The purpose of this report is to identify the status of water quality monitoring data within the Sonoita Creek Watershed, provide a baseline profile of waste quality and provide next steps information so that data gaps can be minimized. A wealth of baseline water quality data will allow vested parties to monitor water quality efficiently, detect changes, and enable action to correct possible sources of contaminants. The Sonoita Creek watershed is home to over 1700 people (*Profile of General Population and Housing Characteristics: 2010 Demographic Profile Data*, 2010) and over 100 federally threatened, endangered, and/or threatened species (*Federally Threatened, Endangered and Sensitive Species: Patagonia Mountain Area*, 2013) making the quest for reliable, clean water vital. This need has driven the efforts described in this report to create a collection of quality data to establish a baseline of water quality for the watershed. This baseline will allow the general public to understand areas of concern for pollutants, areas, and times where water quality data is limited, and to provide next steps for vested parties.

History of Water Quality Issues Within the Sonoita Creek Watershed

The majority of the Sonoita Creek Watershed has a history in ranching as well as mining (Town of Patagonia, 2019). Additionally, the watershed is home to a wildlife corridor that allows for the movement of a multitude of species including endangered species such as the Lesser Long Nosed Bat, ocelots, and jaguars (*Federally Threatened, Endangered and Sensitive Species: Patagonia Mountain Area*, 2013). These endangered populations are exceedingly vulnerable to environmental conditions.

Ranching has had an intertwined history with water quality. Overgrazing from poor management practices can expose and compact soil therefore contributing to erosion (Noah et al. 2001). This eventually contributes to water pollution via sediment transport, exposure of water soluble contaminants in the soil, and contribution of constituents such as nitrogen from animal waste (Noah et al. 2001). Contaminants from waste such as nitrogen can pollute waters downstream causing algal

growth and therefore lowering the dissolved oxygen value in waters. This low oxygen environments can be harmful to other aquatic species.

Existing mines within the watershed have contributed to water pollution (Prendergast, 2015). Acid mine drainage from existing/abandoned mines poses a threat to the overall quality of water within the watershed. The low pH of this mine drainage dissolves limestone and other rock, resulting in the exposure of sulfur minerals which add to the overall acidity of the water (US Environmental Protection Agency). This in turn creates a snowball effect acidifying the water and dissolving additional rock which exposes and then allows for the heavy metals and many other constituents contained within to be dissolved into the water (US Environmental Protection Agency). The mine drainage itself often contains heavy metals and other pollutants before this process begins (US Environmental Protection Agency).

Groundwater quality data began appearing as early as the 1940's in the Sonoita Creek watershed (National Water Quality Monitoring Council) and some groundwater sources are still being tested yearly. Surface water quality, however, has not been reliably monitored by governmental agencies until 1990. There have been instances of water quality monitoring for the watershed prior to the 1990s; however, much of this data is not usable for analyses today.

Data

The majority of the data provided in this roadmap was taken from the National Council on Water Quality's (NCWQ) Water Quality Portal (WQP). This portal uses multiple data sources (ADEQ, AZ Game and Fish, USGS, EPA) to create a database with public historic data. Additional data was pulled from local sources such as the Town of Patagonia, local land/well owners, and academic publications. The NCWQ and the other published sources used standardized sampling and analyses for the era that the samples were taken. Some sources that did not provide complete data with sampling information, specific locations, and/or methodology were excluded. This methodology for screening the data extraction allowed for data of the highest reliability to be obtained.

The collected data is organized into two primary categories: Groundwater quality and Surface Water quality. For each of these main categories, data is organized by decade starting with the earliest reliable data available for the category.

The data collected for this roadmap is available electronically at:

<https://drive.google.com/drive/folders/1wM9y2a0EMHMFY4UucWkm7hsk7UvsDNOu?usp=sharing>

Storymap

A story map has been made to give an overview, and help illustrate the background of this watershed and illuminate areas that are in need of remediation. The storymap can be found at:

<https://tinyurl.com/wpwpdinx>

Data Sample Categories

Data attained for water quality include the following constituent categories for surface water:

- | | | | |
|---------------|--------------------|---------------------|-------------|
| • Alkalinity | • Carbonate | • Kjeldahl nitrogen | • Potassium |
| • Ammonia | • Chloride | • pH | • Selenium |
| • Antimony | • Chromium | • Lead | • Sulfate |
| • Arsenic | • Copper | • Magnesium | • TDS |
| • Bicarbonate | • Dissolved Oxygen | • Mercury | • Zinc |
| • Beryllium | • E. coli | • Nitrate | |
| • Cadmium | • Fluoride | • Nitrite | |
| • Calcium | • Hardness | • Phosphorous | |

The following constituent categories were found for groundwater:

- | | | | |
|---------------|-----------------|--------------|-------------|
| • Alkalinity | • Cadmium | • Kjeldahl | • Organics |
| • Aluminum | • Calcium | • Nitrogen | • pH |
| • Ammonia | • Carbon | • Lead | • Phosphate |
| • Antimony | • Tetrachloride | • Lithium | • Potassium |
| • Arsenic | • Carbonate | • Magnesium | • Selenium |
| • Barium | • Chloride | • Manganese | • Silica |
| • Benzene | • Chromium | • Mercury | • Silver |
| • Beryllium | • Copper | • Molybdenum | • Sodium |
| • Bicarbonate | • Fluoride | • Nickel | • Sulfate |
| • Boron | • Hardness | • Nitrate | • TDS |
| • Bromide | • Iron | • Nitrite | • Zinc |

Additionally, a selection of waters in close proximity to mines have been characterized by the USGS (Wanty et al. 2001). These cation/anion analyses quantify the following for surface water constituents:

- | | | | |
|-------------|-------------------|--------------|----------------|
| • Iron | • Vanadium | • Zirconium | • Cerium |
| • Fluorine | • Manganese | • Molybdenum | • Praseodymium |
| • Chlorine | • Cobalt | • Silver | • Neodymium |
| • Bromine | • Nickle | • Indium | • Samarium |
| • Nitrite | • Copper | • Antimony | • Europium |
| • Calcium | • Zinc | • Tellurium | • Gadolinium |
| • Magnesium | • Strontium | • Cesium | • Terbium |
| • Sodium | • Cadmium | • Tantalum | • Dysprosium |
| • Potassium | • Barium | • Tungsten | • Holmium |
| • Sulfate | • Lead | • Rhenium | • Erbium |
| • Silicone | • Silicon Dioxide | • Thallium | • Thulium |
| • Lithium | • Titanium | • Thorium | • Ytterbium |
| • Beryllium | • Gallium | • Uranium | • Lutetium |
| • Boron | • Arsenic | • Yttrium | • Hafnium |
| • Aluminum | • Rubidium | • Lanthanum | |

These cation/anion analyses allowed for a characterization of the water. The USGS found that of the surface water sources they tested, most were low in pH and concentrations of dissolved metals and sulfates were elevated (Wanty et al. 2001). The piper plot in figure below provides an indication of the water character for the samples in this study.

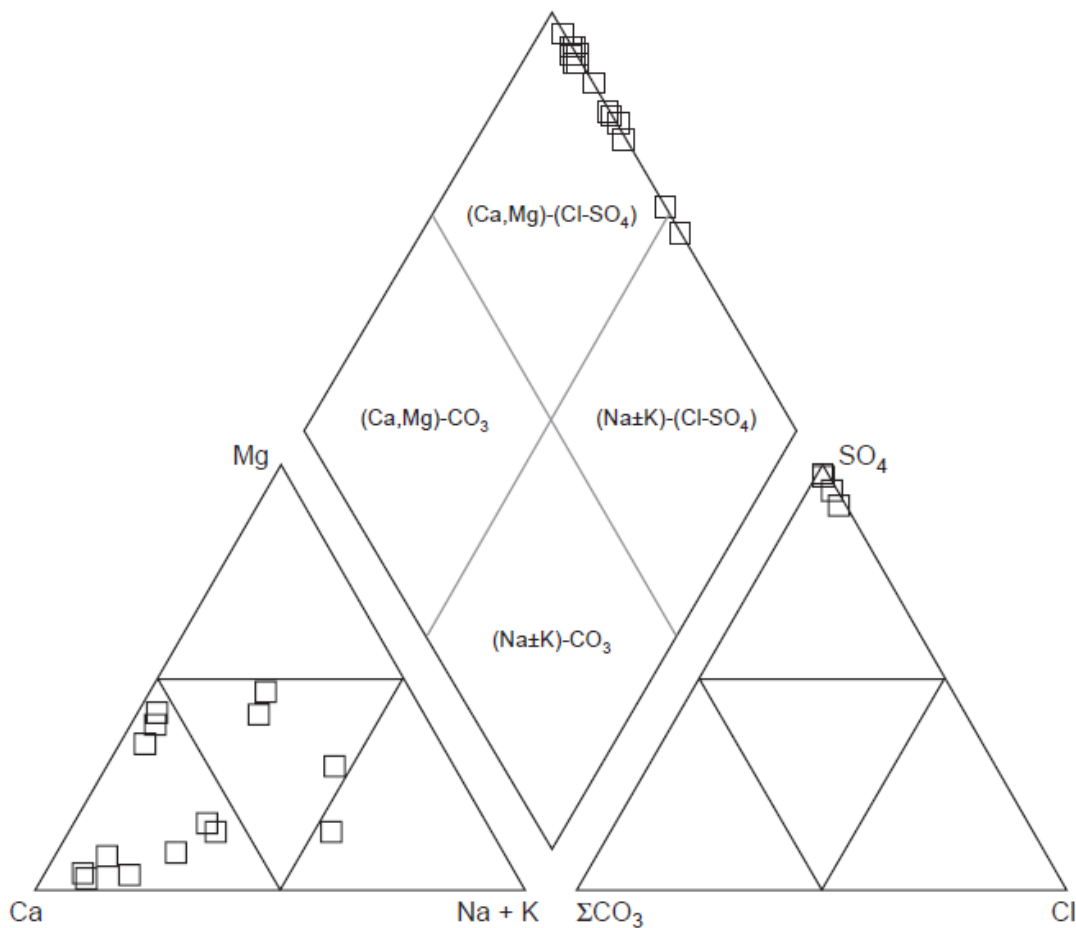


Figure 1: Piper plot for the water constituent (cation/anion) analyses performed by USGS (Wanty et al., 2001)

Exceedances

All the surface water samples pass the drinking water standards. But within the Watershed there have been surface water exceedances for aquatic and wildlife (A&W) reported for the following:

- Beryllium
- Cadmium
- Hardness
- Zinc
- Copper
- Dissolved Oxygen
- Lead
- Ph (low)

Copper, Zinc, and pH violations are the among the most common violations for surface water. Graphs of exceedances are shown below. Beryllium as well as lead have been implicated as constituents of exceedance; however, ADEQ has not yet provided some of this data.

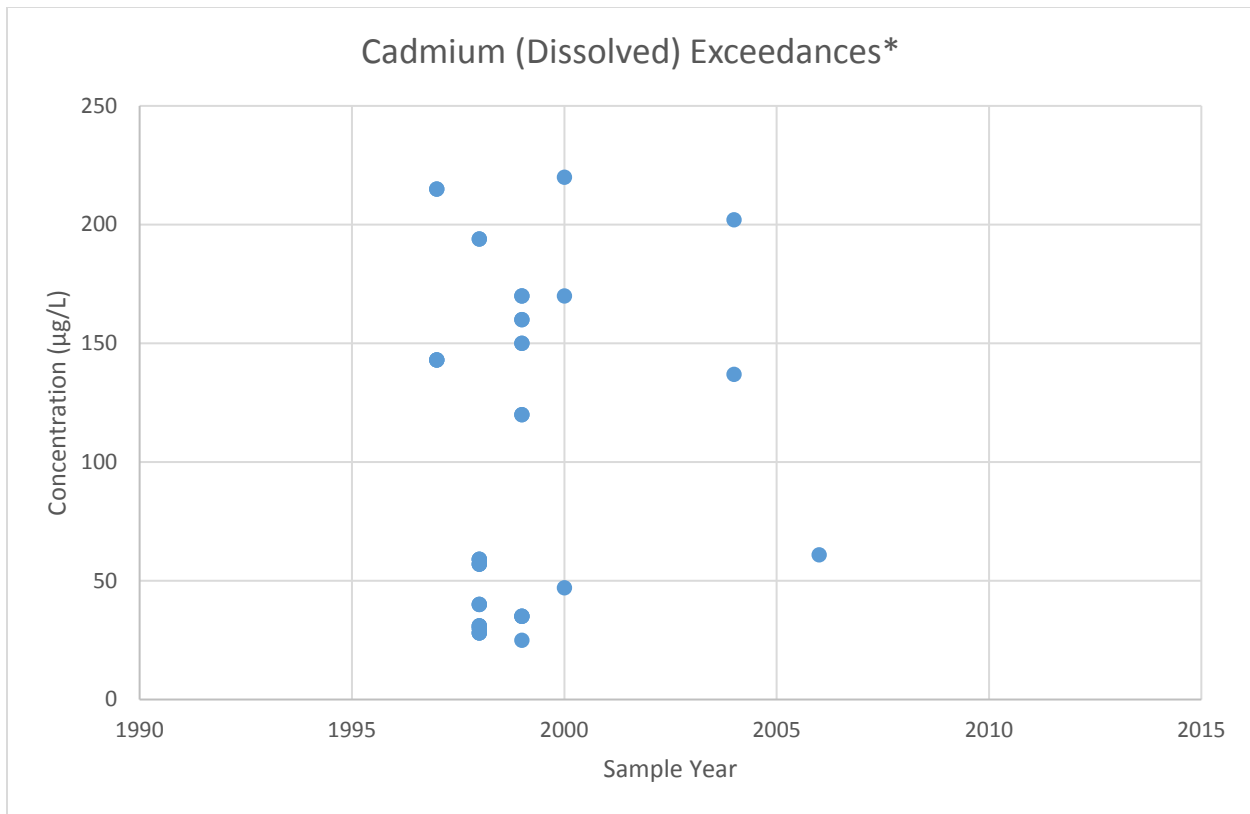


Figure 2: Dissolved Cadmium exceedances by sample year. *Exceedance threshold based on most probable hardness.

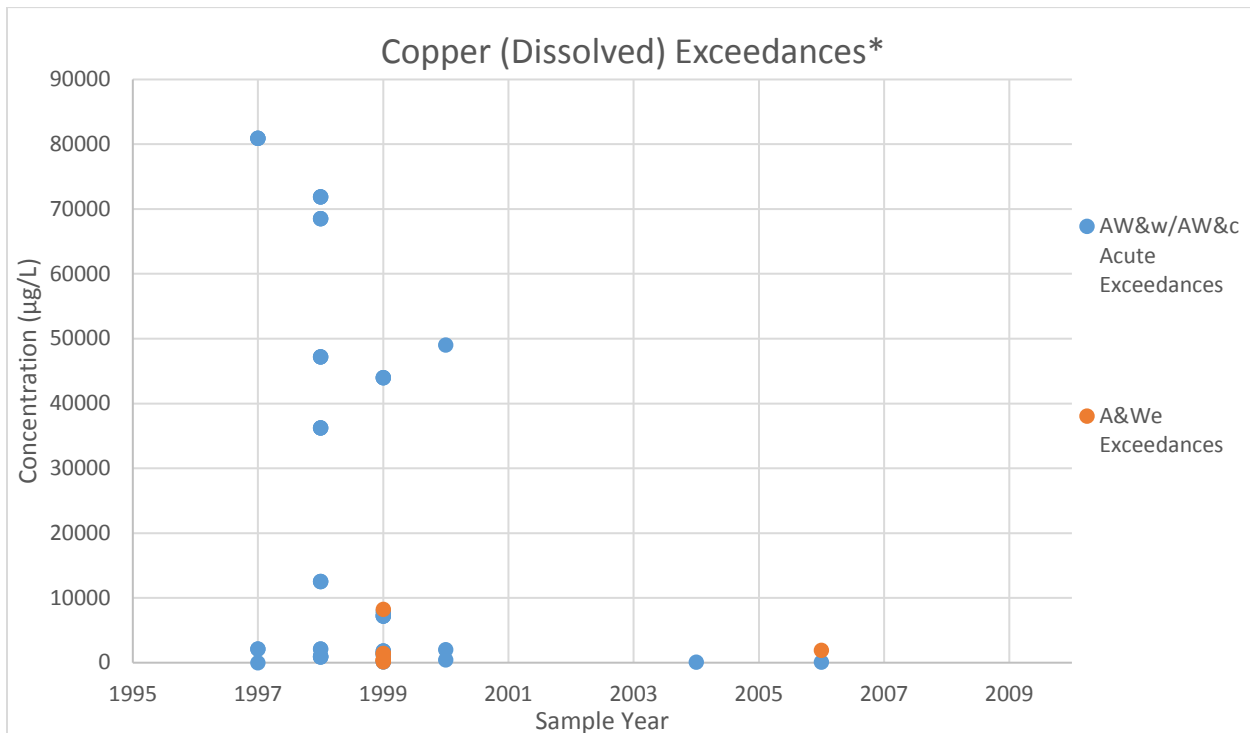


Figure 3: Dissolved Copper exceedances by sample year. *Exceedance threshold based on most probable hardness.

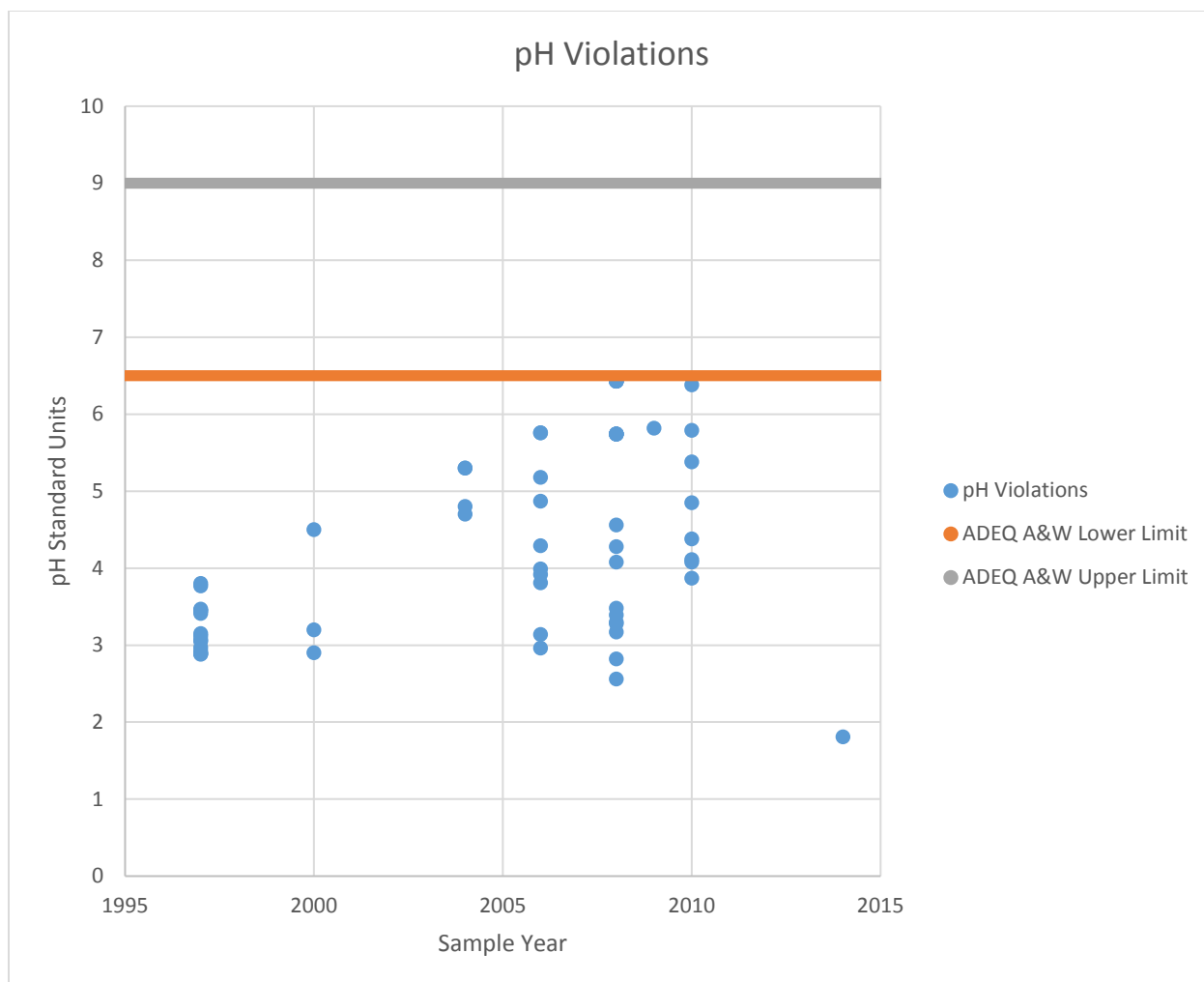


Figure 4: Occurrences of pH values outside ADEQ threshold range by sampling year

No known groundwater exceedances have been reported/discovered at this time.

Data Gap Analysis

The purpose of this data gap analysis is to identify areas both spatially and temporally that lack sufficient data to establish a baseline of water quality. The identification of these gaps in data will allow for the mobilization of resources to therefore close these gaps and allow for better understanding of the status of water quality within the watershed.

Spatial Analysis

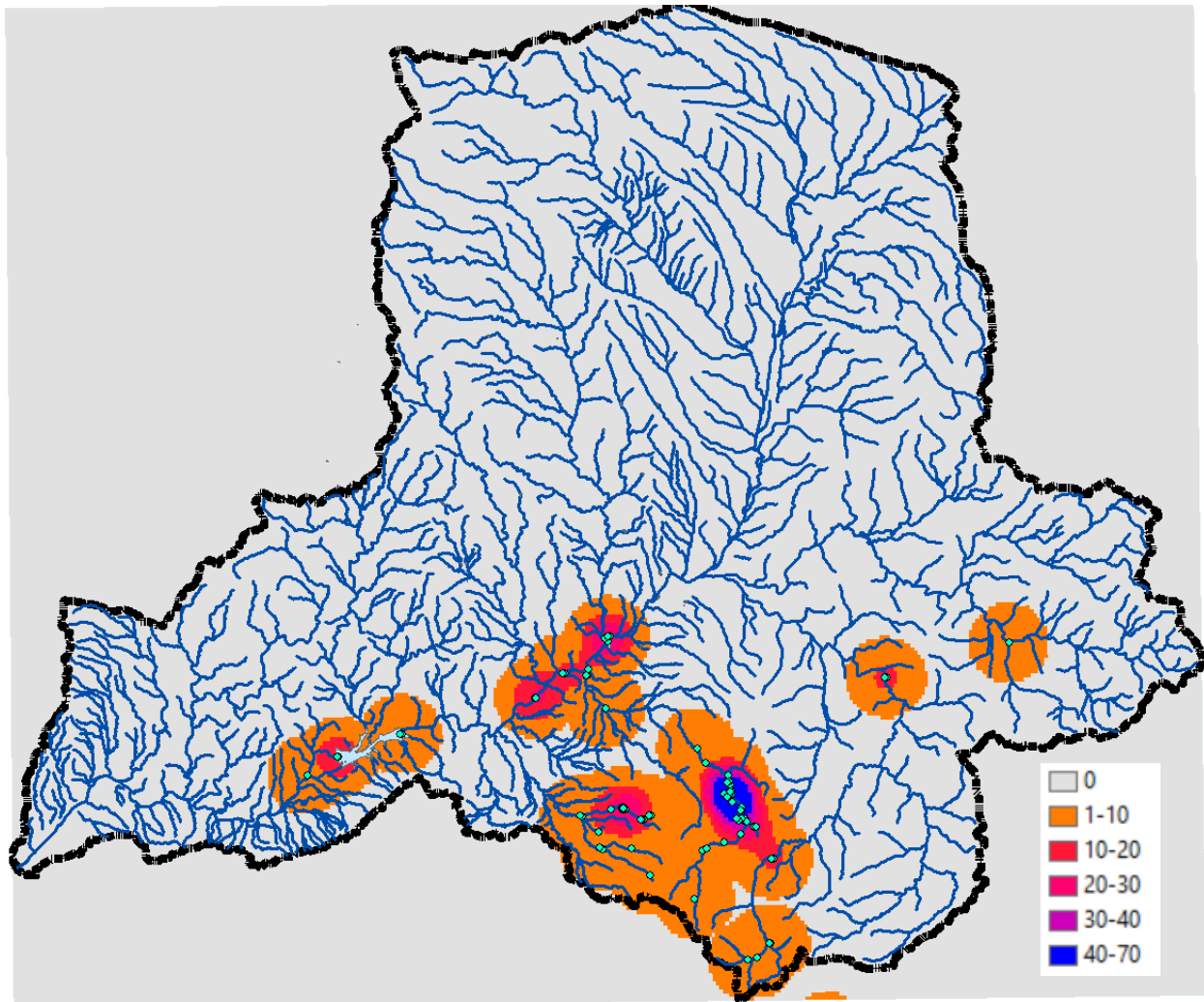


Figure 5: Surface Water Sampling Distribution Density

It is clear from the surface water sampling analysis that there are large gaps in data coverage in terms of sampling. Much of the northern portion of the watershed has no available data. Many of the streams shown in this watershed are ephemeral, making sampling time dependent and therefore difficult to obtain new samples.

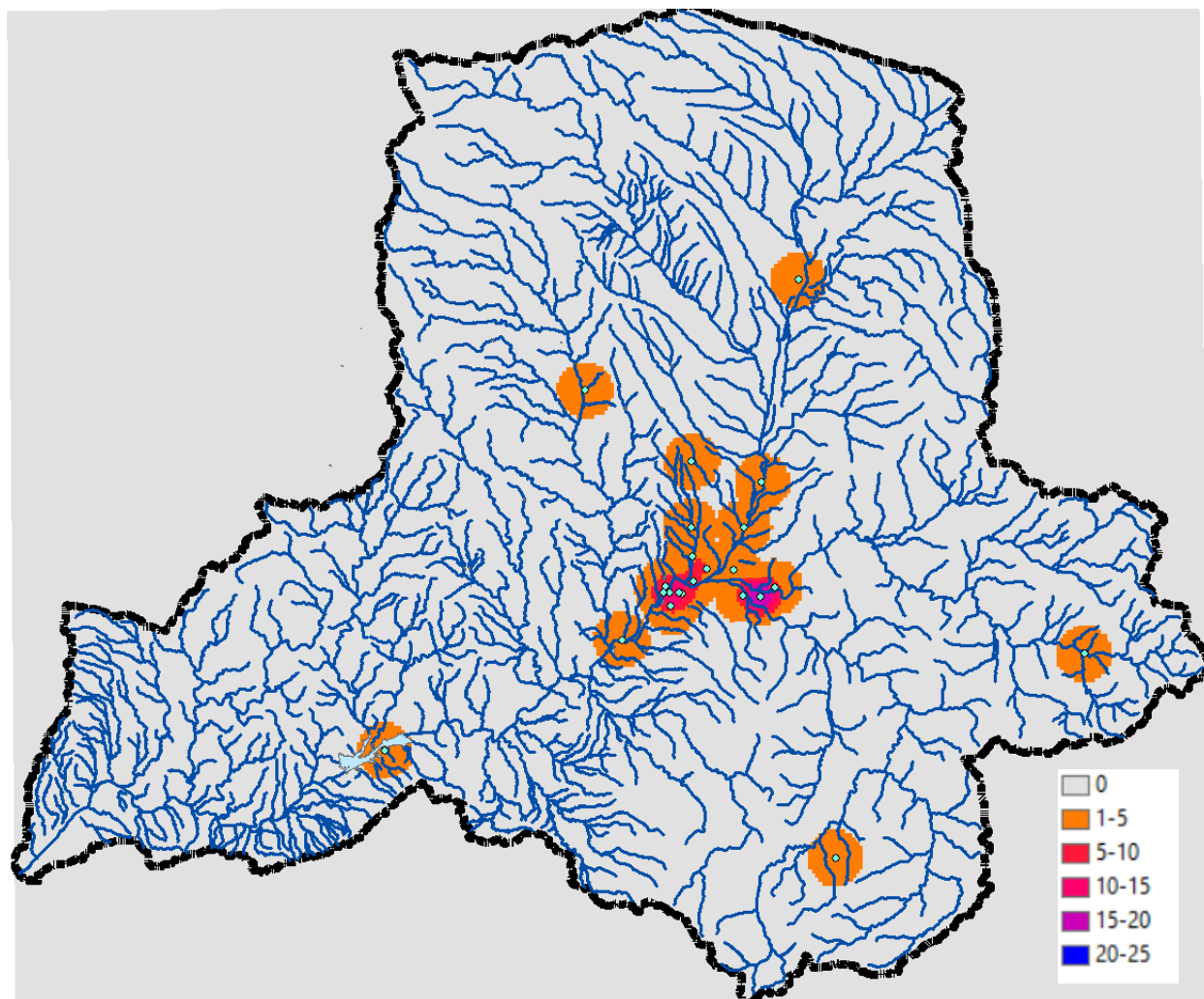


Figure 6: Groundwater Sampling Distribution Density

Groundwater sampling spatially across the watershed shows that there are few datapoints around the periphery of the watershed. Most wells have been sampled around the town of Patagonia with a few outliers.

Sonoita Creek Watershed: Surface Water Sampling Sites

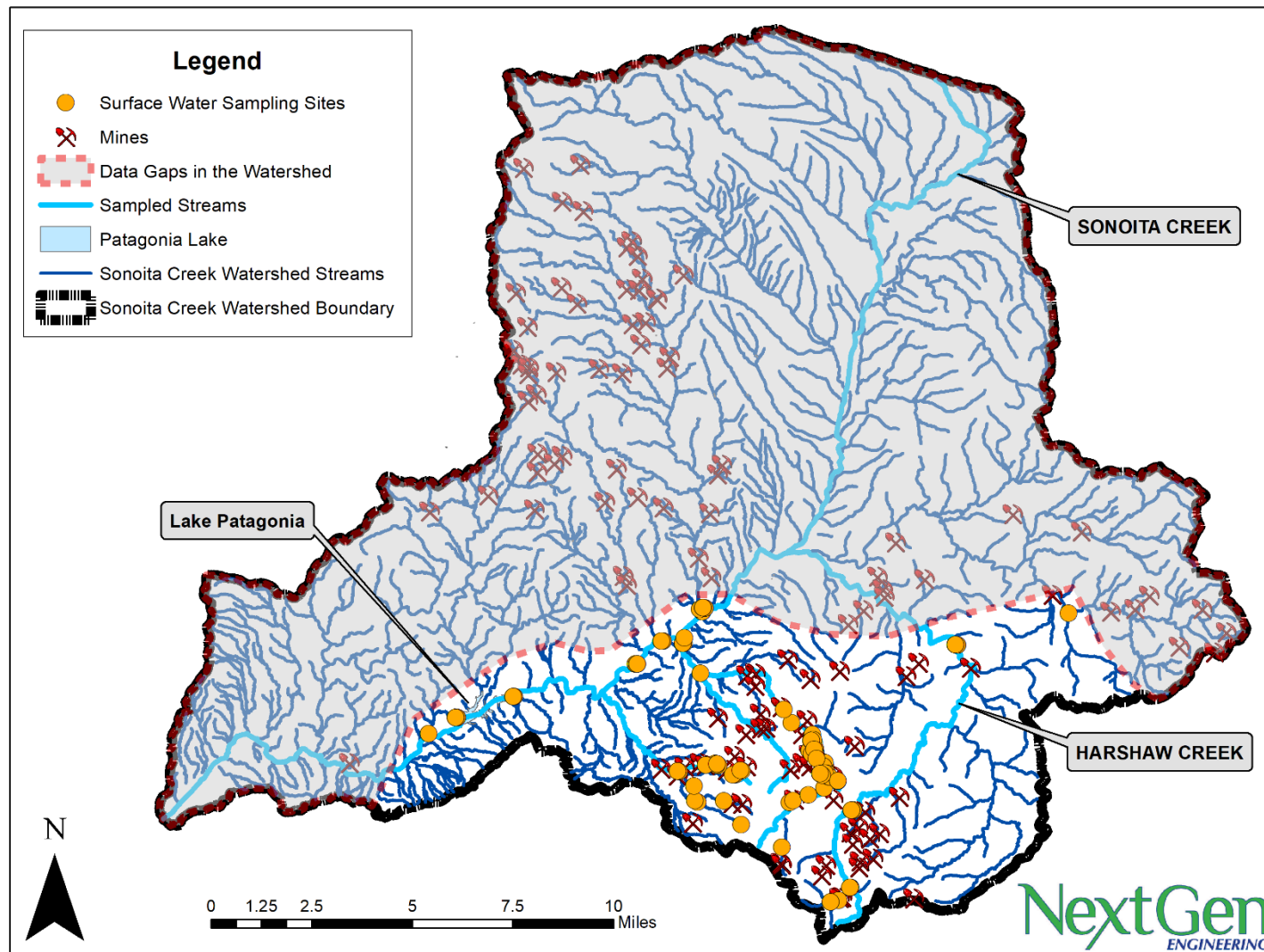


Figure 7: Surface Water Data Gap Distribution

Sonoita Creek Watershed: Groundwater Sampling Sites

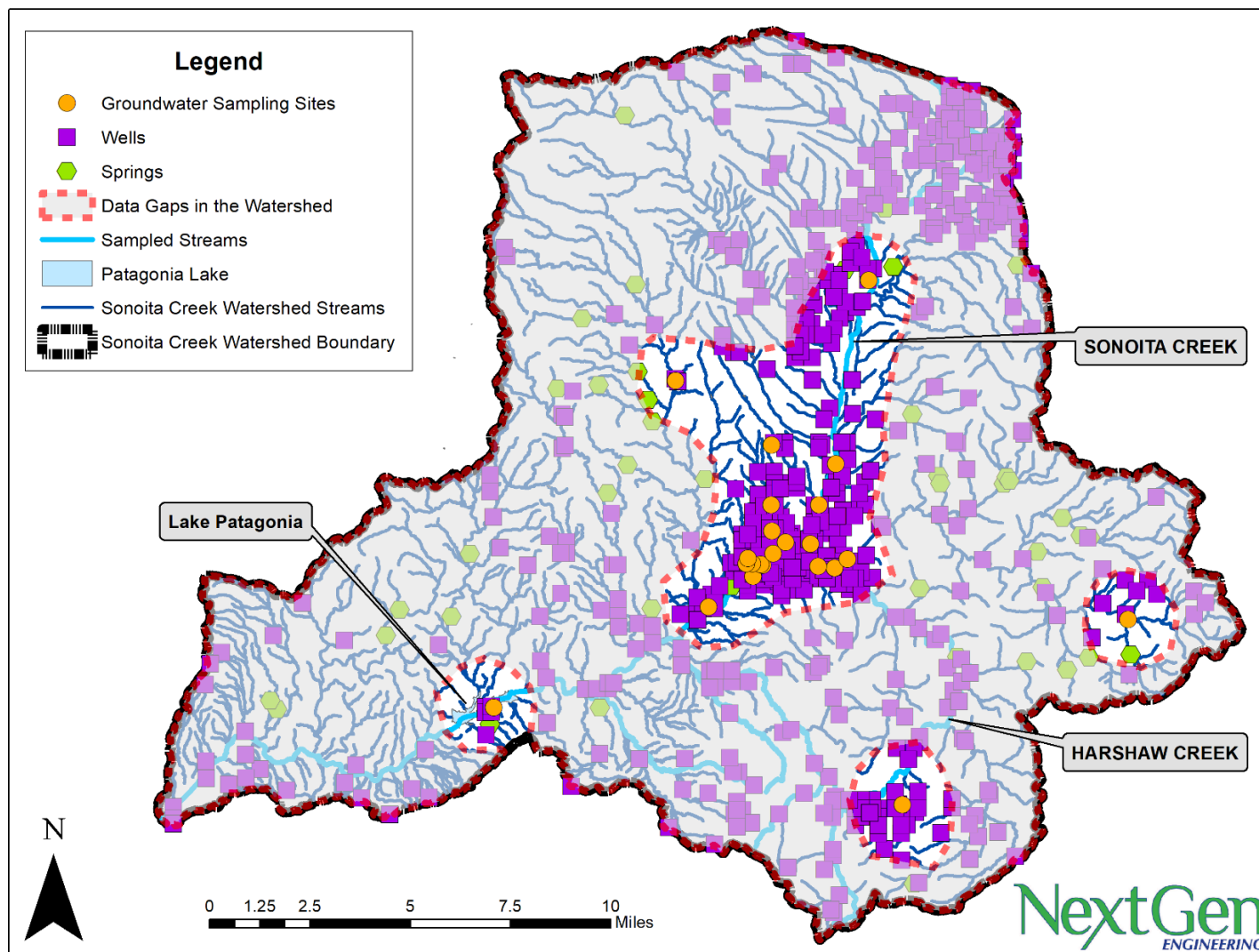


Figure 8: Groundwater Data Gap Distribution

Temporal Analysis

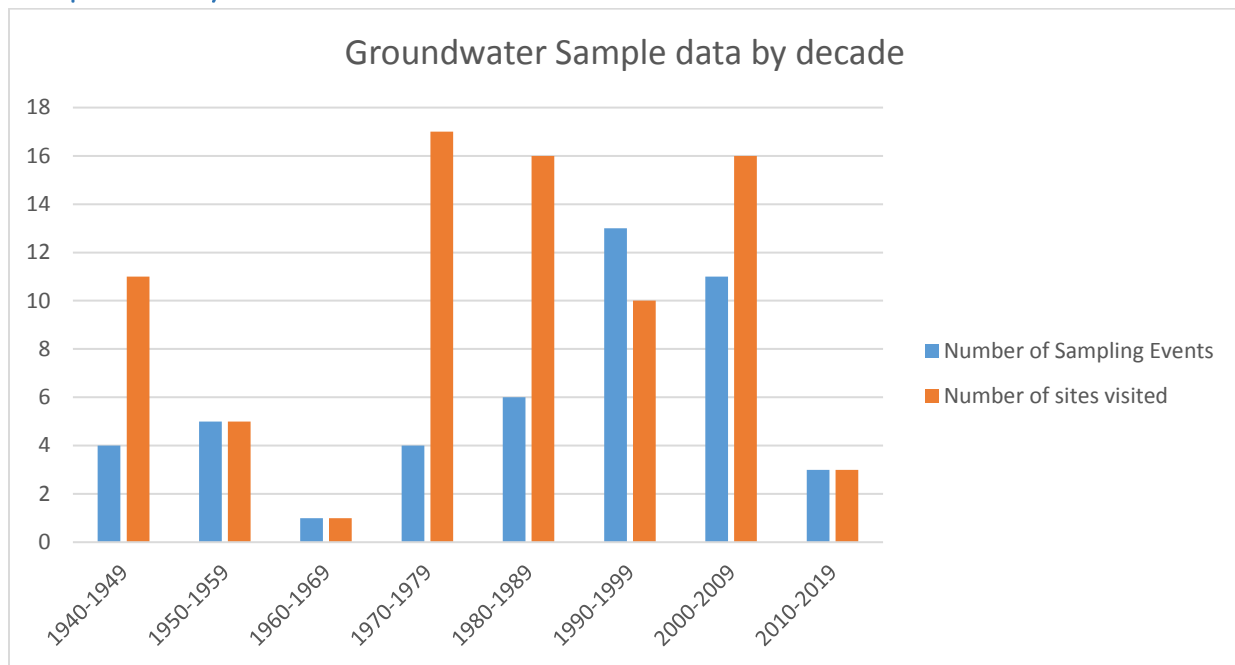


Figure 9: Temporal Analysis of Sampling Events and Number of Sites Visited by Decade for Groundwater

Figure 3 displays both the number of sampling events and the number of sites visited each decade for the data set. A sampling event occurs when there is a unique date and time implemented for sampling collection. During these events it is possible for samples from multiple sites to be obtained. The number of sites visited represents the difference locations sampled throughout each decade. The more sites sampled, the better the data coverage for the watershed. There are clear data gaps in the 1960's where only one sampling event occurred for only one site. Additionally, there appear to be fewer sample sites and sampling events present for the 2010 decade indicating a decline from the previous decades' sampling regime.

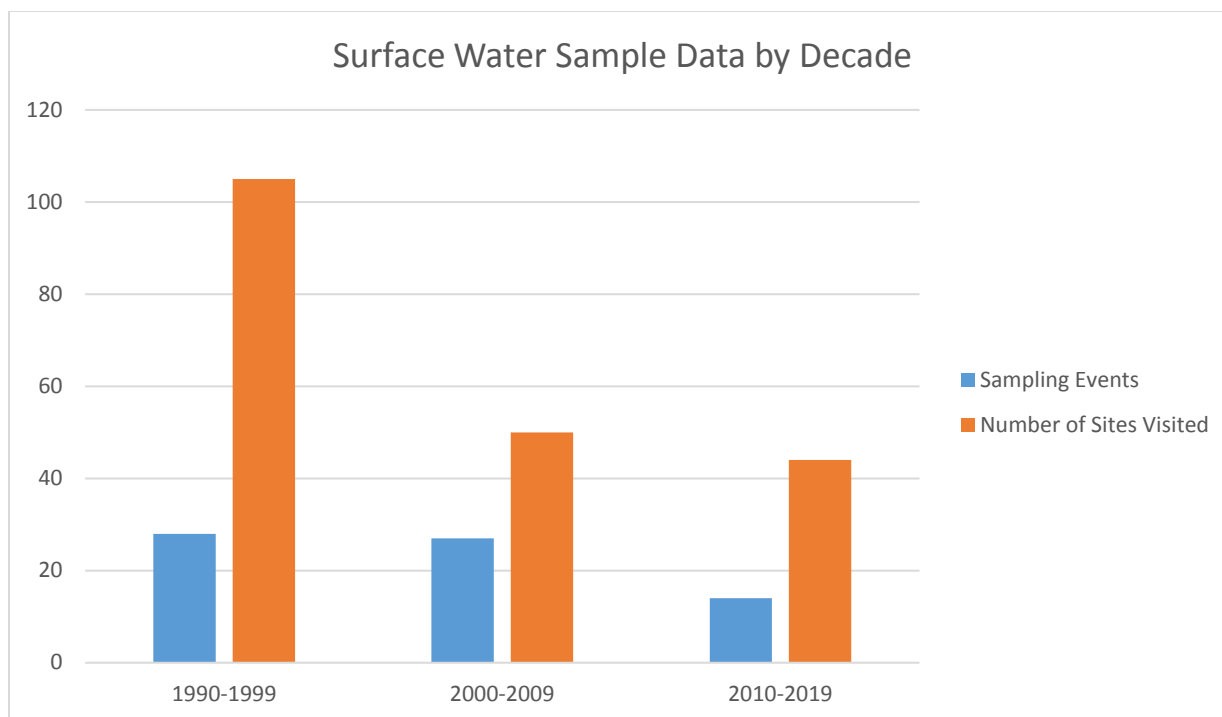


Figure 10: Temporal Analysis of Sampling Events and Number of Sites Visited by Decade for Surface Water

Figure 4 displays both the number of sampling events and the number of sites visited each decade for the data set. A sampling event occurs when there is a unique date and time are implemented for sampling collection. During these events it is possible for samples from multiple sites to be obtained. The number of sites visited represents the difference locations sampled throughout each decade. The more sites sampled, the better the data coverage for the watershed. The figure demonstrates that there is little water quality data prior to the 1990 decade. Additionally, the number of sampling events for the 2010 decade is approximately half of the previous decade.

Recommended Future Monitoring

Future monitoring should focus on both aspects of the Data Gap Analysis (Temporal and Spatial) in order to get a better water quality baseline for the watershed. There is a trend of decline for both the surface water and groundwater quality sampling events. Furthermore, the number of sites sampled for the 2010-2019 decade is lower than all previous decades for surface water and the number of groundwater sampling sites is lower for the 2010-2019 decade than all other decades aside from the 1960s.

Based on the temporal and spatial data gap analysis the following water quality data are needed:

- Groundwater
 - Peripheral well sites in regard to the watershed, including additional sampling from springs
 - Additional data for the 2010-2019 decade
- Surface water
 - Additional data for the 2010-2019 decade

Recommended Management Strategies

All stakeholders should commit time to assist in the monitoring of the watershed. Continued baseline data is crucial for the characterization of the watershed. Mine drainage from existing/abandoned mines poses a threat to the watershed.

- Water management stakeholders to review water quality report and select next steps
- Explore funding sources for additional monitoring
- Start/continue monitoring water quality
 - Initiate/continue to encourage citizen scientist sampling programs.
 - Include schedule of which people are responsible for certain areas during certain time frames (the majority of streams within the watershed are ephemeral and will need to be sampled in short periods of time after rainfall events)
 - For areas that have not been sampled, establish consistent sampling locations and reference, if possible, with GPS.
 - Focus sampling on constituents of concern and then, as resources allow, sample additional constituents that may not be of concern
 - Focus sampling in areas where data is lacking
 - Areas where there is no data
 - Particularly in the northern portion of the tributary
 - Temporal Canyon?
 - Areas that have not been sampled recently
 - Increase spring monitoring data as these are “low hanging fruit” in terms of groundwater, i.e. water doesn’t have to be pumped. Springwater also provides a snapshot of water quality for the stream that they contribute to. There are 43 known springs within the watershed, which the USGS stopped sampling in 1985.
 - Monkey Springs
- Continue search for existing data on the watershed, including only the most accurate data available for the sampling time period
 - Pursue the following data sources:
 - Forest Service
 - Steak Out (well water quality data)
 - Well data from landowners in the watershed (877 ADWR registered wells within watershed, only have samples for 28 unique sites)

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