CHAPTER 2: WATERSHED INVESTIGATIONS AND FINDINGS

In order to better understand the condition of the Upper Granite Creek Watershed and identify sources of excess nutrients and bacteria causing water quality impairments, efforts were undertaken as part of the Watershed Improvement Planning process to collect various types of data. These efforts included water quality monitoring, a riparian buffer assessment, watershed field survey, and a social survey of watershed residents. Each dataset was analyzed individually for what it reveals about the condition of the watershed; the datasets were then combined and analyzed for a more comprehensive analysis of the watershed. The sections below describe each data collection effort and the analysis and findings of the associated dataset.

WATER QUALITY MONITORING

A volunteer water quality monitoring program was initiated in 2010 to help fill some of the gaps in existing water quality data. Local "Creek Crew" volunteers received training in the collection and handling of field data and water samples during a day-long event with the Sierra Club Water Sentinels on January 31, 2010. Nearly 40 people attended the event.

Nutrients and Bacteria

The Creek Crew conducted water quality monitoring primarily during the winter and spring months of 2010 to gather data on nutrient and bacteria concentrations. One monitoring event occurred during the monsoon season. Creek Crew monitoring events occurred on:

- February 11, 2010
- March 8, 2010
- April 12, 2010
- August 9, 2010

In addition to Creek Crew data, ADEQ water quality data from 2000-2010 was included in this analysis. The data is available in document titled "Granite Creek Watershed Surface Water Quality Data 2000-2010."

Data Summary and Findings

1. Levels of nutrients (nitrogen and phosphorus) and *Escherichia coli* (a bacterial indicator of fecal contamination) exceed state water quality standards during high stream flow and runoff from precipitation. Exceedances are rare during low flow or as the creeks dry out in the spring.
    - If the nutrient or bacteria sources were from a point source discharge (i.e., sewer line or septic tank), exceedances would occur during lower flows rather than high flows.
    - Sources seem to be related to stormwater either washing in pollutants or inundating sewer lines or septic systems.
2. Low dissolved oxygen levels in Granite Creek (originally believed to indicate nutrient loading) occur only during lower flows -- not when nutrients or bacteria exceeded standards. Low dissolved oxygen is likely related either to natural groundwater upwelling and stagnant pools as the stream flows dry to a trickle.
3. Exceedances of state water quality standards during high stream flows seem to indicate that the nutrients and bacteria are the result of many sources. These pollutants are washed

into the streams with stormwater runoff from roofs, streets, parking areas, dog droppings, horse corrals, gardens, yard trimmings dumped along the stream banks, etc. Stormwater transports these pollutants to the nearest waterway. Impervious cover within the watershed generates a greater volume of stormwater runoff, compounding the problem. Stormwater inundating aging sewer lines may also be a source.

4. High nutrient and bacteria levels during runoff events may indicate that riparian areas along the creeks are not functioning properly because they should intercept surface flow and filter out pollutants. This may be due to degraded riparian condition and also because hard (impervious) surfaces and engineering have routed stormwater directly into the stream, thereby avoiding the natural riparian filters.
5. *E. coli* exceedances have occurred during at least one stormwater runoff event when aging wastewater sewer lines became inundated with floodwater and overflowed with untreated sewage into the creeks.
6. Bacterial pollution is more widespread in the watershed than nutrient pollution based on the number of samples exceeding water quality standards. Assessing only samples taken during critical conditions (high flow) and looking at sites with at least four samples during these conditions, standards were exceeded at more than 25% of the samples:
    a. For nutrients, at three sampling sites: lower Manzanita (MAN007), lower Aspen (ASP040), and upper Granite (GRA811). Upper Granite's status is most likely due to excess nutrients from the 2002 Indian Fire. The most recent monitoring does not show nutrients to be a continuing issue at that site.
    b. For *E. coli*, at six sites: lower Manzanita (MAN007), lower Aspen (ASP040), lower Butte (BUT005), Miller above Butte (MIL038), lower North Fork Granite (NFG025), and Granite at Watson Woods (GRA063).

For more information about the water quality data analysis, please refer to the document titled "An analysis of water quality in the Upper Granite Creek Watershed, 2000-2010."

Recommendations for Future Monitoring

After compiling state data with volunteer, we have concluded that further monitoring for these pollutants should be conducted during "critical conditions" – conditions or activities in the watershed when past exceedances occurred. The data indicates that critical conditions occur during winter months when precipitation events are more widespread and tend to linger, as opposed to the localized, "flashy" monsoon events. Winter precipitation events are more likely to result in sustained flows in the creeks. When possible, sampling should also be targeted above and below potential sources or along a stream to try to identify sources.

Above: The North Fork of Granite Creek is black and murky as a result of the "first flush."

Sampling the "first flush" "— the first few hours of precipitation that washes over surfaces (streets and rooftops) — yields misleading results. The first flush consists of highly turbid, flood waters contaminated with sediment, bacteria, and nutrients; these samples will normally exceed standards for only a short period of time and are not helpful in identifying the sources of these pollutants. Therefore, large storm fronts such as Prescott's winter rains produce ideal

conditions for monitoring.

Although current data does not indicate that septic systems are a primary source, further monitoring upstream and downstream of areas served by septic systems is needed to determine whether this source is contributing significant nitrogen loading that accumulates in lower reaches of the watershed, feeding prevalent summer algal blooms in Watson Lake. Identifying where leaking sewer lines or manholes are a significant source is also a priority.

Bacteroides DNA

In addition to *E. coli* testing, the University of Arizona has been employing molecular methods to detect the presence of host-specific strains of *Bacteroides* in order to discern the sources of fecal bacteria in the watershed. Bacteria belonging to the genus *Bacteroides* have been suggested as alternative fecal indicators to *E.coli* or fecal coliform. This is due to the fact that they make up a significant portion of the fecal bacteria population, have little potential for re-growth in the environment (unlike *E. coli*), and have a high degree of host specificity that likely reflects differences in host animal digestive systems. The use of fecal bacteria to determine the host animal source of fecal contamination is based on the assumption that certain strains of fecal bacteria are associated with specific host animals and that strains from different host animals can be differentiated based on genotypic markers.

The goal of the *Bacteroides* testing was to help discern where the bacteria in the watershed are coming from, with a specific interest in bacteria from human sources (i.e.; sewer infrastructure, septic systems). Both the sewer infrastructure and septic systems have long been suspected as contributing to water quality problems in the creeks and lakes, however no data was collected and this remained speculation. By identifying where sewer infrastructure or septic systems are failing, appropriate solutions can be designed and measures taken to alleviate the situation.

Data Summary and Findings

In addition to testing by the University of Arizona, the samples were analyzed at the USEPA National Risk Management Research Laboratory lab in October 2010 using a variety of different analyses.
markers have been used to assess water quality

1) All – Total *Bacteroides*
2) Hu – Human *Bacteroides*
3) Bov – Bovine *Bacteroides*
4) All2 – Total *Bacteroides*
5) Bov2 – Bovine *Bacteroides*
6) Av – Avian *Bacteroides*

Figure 7 displays the sites where these samples were collected. As of May 2011, molecular testing has yielded results only as presence-absence. Seventy-eight percent of the samples (N=23) collected within the project area were positive for the human genetic marker, meaning that human bacteria were present in those samples. Without quantification of the human bacteria found in the samples, we are unable to discern whether human bacteria is a significant portion of the bacteria in a sample and, therefore, at which locations human sources may be a serious impact to water quality. The presence of the human molecular marker may indicate that human recreation or improperly treated/disposed sewage or septage is currently impacting water quality

in the watershed near those sampling locations. Quantification is needed before drawing conclusions about human sources of bacteria from this data.

Of the samples collected for *Bacteroides* testing, only one tested positive for the bovine marker. This same sample was positive for the swine marker. This sample was collected in January 2010 from Granite Creek in the Watson Woods Riparian Preserve during a heavy winter storm. This site is downstream of the YPIT land where a small herd of cattle had been grazing in pastures near the creek. None of the samples were positive for the avian marker. More detail on the data can be found in **Appendix A**.

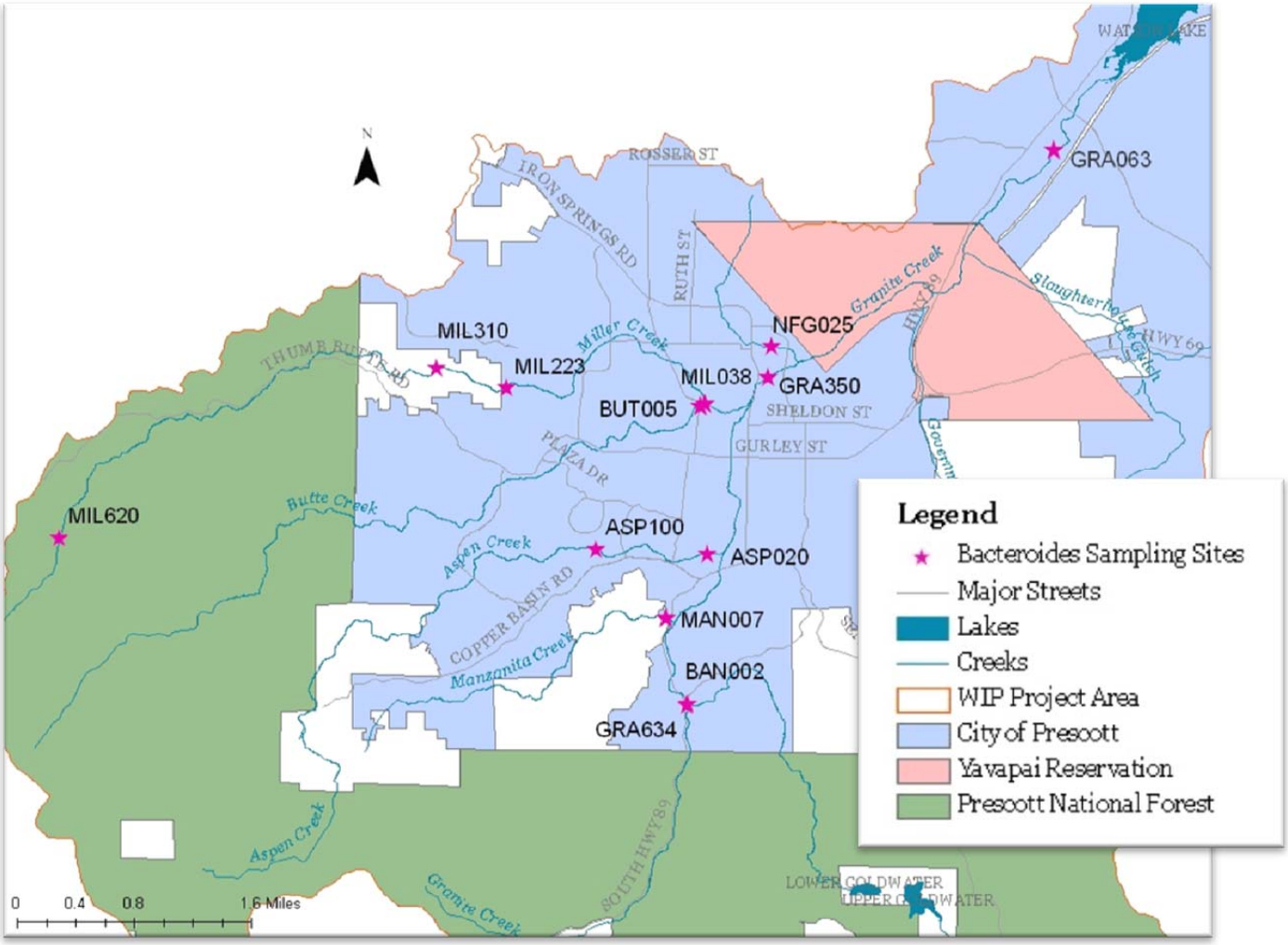

Figure 7: *Bacteroides* Sampling Sites

Water samples were collected at 13 sites around the watershed for molecular testing at a University of Arizona lab for host-specific strains of bacteria from the genus *Bacteroides.* The sites were chosen to reflect lower watershed, background, and potential for septic/sewer impacts.

Recommendations for Future Monitoring

In addition to targeted monitoring for bacteria and nutrients, where human sources are suspected to be primary sources, *Bacteroides* samples should be part of the monitoring suite. Sampling for *Bacteroides* under base flow conditions may help determine where leaking septic systems and sewer lines are problems. *Bacteroides* sampling in the upper watershed may also contribute to a better understanding of what background bacteria conditions are within the project area.

If possible, testing for caffeine, pharmaceuticals, or other personal care products through the Arizona Laboratory for Emerging Contaminants (ALEC) at the University of Arizona in addition to *Bacteroides* may help further pinpoint where human sources are significant.