FINDINGS

The lower subwatershed areas are highly urbanized and, therefore, have a myriad of potential bacteria and nutrient sources. The urbanized creek segments have been channelized and separated from their natural floodplains, increasing the risk of flooding to nearby properties. The majority of natural riparian vegetation has been replaced by walls or other structures and cannot adequately perform biological filtration functions. Stormwater drainage from roads and neighborhoods is directed into the nearest waterway untreated. The data indicates that the primary factors leading to water quality impairments in the project area are nonpoint source pollutants, increased runoff volumes due to impervious surfaces, and a lack of stormwater detention and infiltration/filtration.

Two possibly significant sources in parts of the watershed are the City of Prescott's aging sewer infrastructure and septic systems. While the water quality monitoring data to-date does not conclusively indicate where these are primary sources of bacteria and nutrients (most likely due to sampling conditions and locations) their potential for contributing pollutants to surface waters is pronounced. There are residential areas in the City of Prescott and unincorporated Yavapai County that are not connected to the municipal sewer system and rely on septic systems for wastewater treatment. The existence of septic systems is not inherently a problem; soil suitability, leach field location, and proximity to a water body are all factors that can lead to inadequate septic system performance and, therefore, pose a risk to water quality. An ill-maintained or malfunctioning septic system poses a much greater risk. It must be highlighted that effluent from septic systems will eventually reach water—seeping into ground water; subsurface flow to surface water; or surface water via ground water upwelling. Septic systems were not designed to effectively remove nitrate from the effluent, even when functioning or properly maintained. In short, where septic systems impact, and how much they impact, the water quality of the local creek system will require further study in Phase II.

As with septic systems, Prescott's aging sewer infrastructure poses a significant threat to water quality. This risk is more widespread in the watershed as 33% of the project area is connected to Prescott's 300+ miles of sewer infrastructure. Sewer overflows from manholes in or near local creeks have been documented and are known to frequently occur during heavy storms due to "inflow & infiltration," another side effect of increased runoff volumes and a lack of detention due to impervious cover. Sampling data is not needed to prove the detrimental impact to water quality when untreated sewage is discharged directly into a water body. Consistent, slight leaks from sewer lines that run in the creek bottoms would be more challenging to discern from water quality data.

Further targeted water quality monitoring and investigation is needed to narrow down the significant sources of nutrients and bacteria in the individual subwatersheds as land use and riparian condition varies along the local creeks. It is necessary to know where septic systems, sewer infrastructure, horses, domestic pets, wildlife, squatting along the creeks, or dumping might be significant sources in order to recommended specific BMPs at appropriate locations to mitigate those impacts.

The "Upper Granite Creek Subwatershed Priorities & BMPs Table" identifies priority subwatersheds for targeted water quality monitoring and investigation in Phase II (**Appendix D**). It also begins to outline potential BMPs and project sites, if applicable. The information in the table is based on the data integration and analysis and will be further developed and refined in Phase II.

RECOMMENDATIONS

It is the intention of the Granite Creek Watershed Improvement Council that this document is representative of the watershed stakeholders, watershed issues, and that it is a clear tool for use by all. Improvements in water quality will require coordinated, long-term efforts before any significant change is realized. Therefore, the success of the Planning process lies in the commitment of all parties to the collaborative process and holistic approach outlined here.

Improving our watershed should be a priority for citizens and leaders, as watershed health is connected to the well-being of our local economy, tourism, quality of life and human health and safety. Water quality can be addressed indirectly when other pressing civic issues are addressed such as stormwater, flooding, sewer infrastructure, new development, preservation of natural areas and downtown revitalization/beautification. Conversely, specific water quality improvements can provide a host of other benefits to the community. The following recommendations are based on current knowledge and best science collected during Phase I of the Watershed Improvement Planning process.

Green Infrastructure

'Green infrastructure' (GI) is a broad term for features that rely on natural processes such as soil, water, and plants to provide ecosystem services such as clean air, clean water, and temperature regulation. GI encompasses existing forests and green spaces as well as constructed bio-retention features such as rain gardens, wetlands, and filter strips. Many of these practices were originally developed in temperate climates but are gaining popularity in municipalities in the arid southwest as a way to manage urban stormwater at a lower cost than the traditional "grey" infrastructure (pipes and culverts) while providing other economic, social, and environmental benefits (USEPA, 2009). The WIC recommends that GI practices be explored and adopted to the extent possible within the watershed to address stormwater quantity and quality.

While GI is not a "silver bullet," cities such as Austin, Texas; Portland, Oregon; Los Angeles, California; and Tucson, Arizona have adopted green infrastructure practices in response to water shortages, water pollution, flooding, and energy consumption with proven success and cost-effectiveness. Cookeville, Tennessee embraced GI in updating the city's master plan, stating that "the fostering of an interconnected network of green spaces along streams, greenways, parks and neighborhoods is the most cost effective way to manage stormwater, enhance water and air quality, mitigate climate change and contribute to overall community growth and prosperity" (City of Cookeville, 2010).

Figure 22 describes five GI practices and examines the range of benefits associated with this type of infrastructure. Please note that these benefits accrue at varying scales depending on local factors such as climate and population.

Some of the environmental, social, and economic benefits of GI are listed below (USEPA, 2009).

Environmental Benefits:

- **Reduces flooding:** Increasing infiltration, evapotranspiration, and storage where precipitation falls will reduce runoff and flooding.
- **Improves water quality:** Reducing runoff and allowing runoff to be treated by soils and vegetation will reduce pollutant loads to receiving water bodies.
- **Provides habitat:** Native and drought-adapted plants that thrive on infrequent precipitation can provide habitat for native birds and insects.
- **Reduces the urban heat island effect:** Removing pavement and planting vegetation can cool and shade urban neighborhoods in the hot summer months.
- **Improves air quality:** Urban vegetation removes pollutants from the air and can mitigate smog formation by reducing temperatures.
- **Mitigates climate change:** By sequestering carbon dioxide in soils and plant biomass, urban vegetation can reduce carbon dioxide concentrations and mitigate global warming.
- **Increases groundwater recharge:** GI practices that reduce impervious cover and enhance infiltration can increase the flow of water to the groundwater.

Social Benefits

- **Improves public health:** Cooler summer temperatures and cleaner air can dramatically improve health, particularly for children and the elderly.
- **Beautifies neighborhoods:** Private gardens and public rights-of-way irrigated with passive and active rainwater harvesting can create beautiful landscapes.
- **Calms traffic:** By reducing street widths and introducing curves, green street techniques can slow traffic.
- **Builds communities:** By beautifying neighborhoods and creating a unique sense of place, GI practices can increase neighborhood interaction.
- **Reduces crime:** Urban forest/urban greening research shows that people are more likely to be outside and walk in neighborhoods and cities that foster natural vegetation along streets and open spaces. This, in turn, deters acts of crime, violence, and graffiti (Wolf, 2010).

Economic Benefits

- **Reduces landscape maintenance costs:** Passive rainwater harvesting and drought adapted plants will require less irrigation and maintenance than conventional, turf-based landscaping.
- **Increases groundwater resources:** GI practices that increase groundwater recharge can provide significant cost savings by averting increased pumping costs or increased water imports.
- **Reduces water imports:** GI practices that manage stormwater through passive and active rainwater harvesting can reduce the demand for municipal water and reduce water imports.
- **Reduces energy use:** The energy required to import, treat, and distribute municipal water could be significantly reduced by using precipitation where it falls.

Benefit	Reduces Stormwater Runoff											Improves Community Livability						
	Reduces Water Treatment Needs	Improves Water Quality	Reduces Grey Infrastructure Needs	Reduces Flooding	Increases Available Water Supply	Increases Groundwater Recharge	Reduces Salt Use	Reduces Energy Use	Improves Air Quality	Reduces Atmospheric CO_2	Reduces Urban Heat Island	Improves Aesthetics	Increases Recreational Opportunity	Reduces Noise Pollution	Improves Community Cohesion	Urban Agriculture	Improves Habitat	Cultivates Public Education Opportunities
Practice										CO_2								
Green Roofs	●	●	●	●	○	○	○	●	●	●	●	●	◒	●	◒	◒	●	●
Tree Planting	●	●	●	●	○	◒	○	●	●	●	●	●	●	●	●	◒	●	●
Bioretention & Infiltration	●	●	●	●	◒	◒	○	○	●	●	●	●	●	◒	◒	○	●	●
Permeable Pavement	●	●	●	●	○	◒	●	◒	●	●	●	○	○	●	○	○	○	●
Water Harvesting	●	●	●	●	●	◒	○	◒	◒	◒	○	○	○	○	○	○	○	●

● Yes ◒ Maybe ○ No

Figure 22: Green Infrastructure Benefits and Practices

Green infrastructure, also known as Low Impact Development (LID), is a method of construction and stormwater management that conserves natural systems and hydrologic functions of a site, thereby mitigating development impacts to land, water, and air. The goal of LID is to mimic a site's predevelopment hydrology by using design practices and techniques that effectively capture, filter, store, evaporate, detain, and infiltrate runoff close to its source. Adapted from: *Value of Green Infrastructure: A Guide to Recognizing Its Economic, Environmental and Social Benefits*. Center for Neighborhood Technology & American Rivers. 2010

Municipal Sewer System Upgrades

In 2010, the City of Prescott approved water and wastewater rate increases to provide revenue for operation and maintenance, capital projects, and debt service (City of Prescott, 2010). The proposed increases will raise rates by 15% in 2011, 2012, and 2013, followed by a 10% increase in 2014, and 5% increases in 2015 and 1016. The City asserts that the increases are needed “to assure that the City's highly complex and aged water and wastewater systems are rehabilitated and improved to provide adequate, safe, and reliable utilities services” (City of Prescott, 2010).

The City of Prescott’s Capital Improvement Plan does not list many projects that repair and rehabilitate the wastewater pipelines in the upper watershed in the next five years. Therefore, funding to address faulty sewer infrastructure that is contributing to water quality degradation within the next five years will have to come from another source.

It is not known whether the plan includes extending sewer connections to residences within the City of Prescott or unincorporated areas using municipal water that rely onsite wastewater treatment systems. While current data has not concluded that septic systems are a significant source of nutrients or bacteria in the watershed, the risk to surface and groundwater in this geologic and topographic setting is great. Any measures to connect residences to municipal sewer infrastructure with priority given to the oldest septic systems and residences within the 100-year floodplain should be taken. And due to the inappropriate geologic setting, alternatives to traditional septic systems (tank and leach field) should be explored.

Stormwater Infrastructure Improvements

Similar to upgrades to the municipal sewer infrastructure, the WIC recommends that stormwater infrastructure improvements and greater efforts to detect illicit discharges within the project area be made. As has already been discussed in this document, nonpoint source pollution, impervious cover, and topography compound the quantity and quality of stormwater within the watershed which, in turn, contributes to impaired surface water quality. While both the City of Prescott and Yavapai County are participants in the federally mandated, but currently unfunded, NPDES Phase II program, we believe the stormwater programs deserve greater support and funding. It must be understood that stormwater is related to other important civic issues such as flood risk, public health and safety, city beautification, tourism, lakes management, etc. A “Watershed Protection Fee” (discussed in *Sustainable Funding for Watershed Protection* below) is one method to fund NPDES compliance without taking away from other municipal programs.

While both Yavapai County and the City of Prescott both have ordinances in place that require a defined volume of stormwater from new development to be captured and filtered on site, the WIC recommends that a Low Impact Development (LID) ordinance be adopted as part of a suite of stormwater upgrades and retrofits that would provide further stormwater quality protections. An ordinance such as this would require the retention / infiltration of a specified volume of runoff from all impervious areas, not just from new development or redevelopment sites. LID measures – similar to green infrastructure – would address stormwater at its source using small, cost-effective projects, rather than address large volumes of stormwater downstream using traditional grey infrastructure. The City of Flagstaff approved and adopted an LID ordinance in three phases, starting with a voluntary program in 2009 and progressing into the requirement that developers retain the first inch of runoff of new development in 2011. Additionally, the WIC recommends that a BMP Design Criteria Manual be developed by the municipalities to provide guidance for installing and measuring the performance of stormwater BMPs.

The City of Prescott’s ongoing hydraulic analysis and mapping of the 100-year floodplains and floodways of Granite Creek and its main tributaries in accordance with Federal Emergency Management Agency (FEMA) guidelines is an important step to protecting and improving the watershed. By first identifying and delineating the floodplains and, consequently, identifying risks to proper drainage and stream function, preventative and corrective measures can be taken to reduce the risk of flooding, property damage, and loss of life. Because spikes in pollutants typically occur during high flow events, moderating those flow events will have an impact on water quality.

Sustainable Funding for Watershed Protection

The WIC recommends that continuous, local funding sources be investigated to ensure continued investments in watershed health. One source of funding could be levied through a “watershed protection fee.” The Watershed Residents’ Survey of 2010 found that the majority of respondents supported a fee to address local water quality and watershed issues in addition to supporting protection and restoration efforts within the watershed. The fee would be paid by individual property owners based on, for example, the amount of impervious cover and expected runoff volumes of a property.

Arizona municipalities such as the City of Flagstaff and the Town of Oro Valley have similar fees; however, income generated through these fees is dedicated only to drainage and stormwater infrastructure. The WIC envisions that funds collected through a watershed protection fee in the Granite Creek Watershed could be used to address a broader range of urban watershed issues. Coordination with stakeholders, research, and development of public support are necessary before implementation of such a fee. Determination of the appropriate entity to collect, manage and disperse the funds will be a significant endeavor as there are multiple jurisdictions within the watershed. One challenge is determining the appropriate institution to collect the fee and how to equitably tax residents of the watershed whether they reside in the City of Prescott or in unincorporated Yavapai County.

Another potential funding source is through the Yavapai County Flood Control District, a special political subdivision that collects secondary property taxes to be used for floodplain management. Cities and towns that pay taxes to the Flood Control District have the opportunity to receive funds from the district for special flood control and stormwater projects. Again, a clear institution to receive the funds and plan for the how the funds will be spent are needed.

Public Education and Engagement

The long-term vision for the watershed is to improve surface water quality so that Granite Creek and Watson Lake can be removed from the impaired waters list. Watershed-awareness among the populace and local policymakers is the key to making this vision a reality. The WIC recommends specific education and outreach tasks to raise public awareness.

Public Workshops

With an aware citizenry will come greater support and participation in watershed protection and enhancement efforts. To achieve this, the WIC will hold a series of community workshops, encouraging the participation of broad watershed stakeholders. Ideally, these workshops will be held in conjunction with the Arizona Department of Environmental Quality as part of the Total Maximum Daily Load analysis (TMDL) in the watershed, or the workshops could build off community meetings held as part of the State's TMDL process. These workshops will share information about the watershed and may include stakeholders in a "visioning" process to determine public priorities for the future of the watershed.

Stream Care Guide

The WIC would like to develop a "Stream Care Guide" specific to the central Arizona and the Granite Creek Watershed to use as a tool at public workshops as well as to be distributed to creekside property owners. The Steam Care Guide would provide property owners and residents with clear, simple steps that they can take to help protect local water ways from nonpoint source pollution. This includes recommendations for buildings and roads, septic systems, stream bank stabilization, riparian vegetation, yard and pasture maintenance, livestock and pets, household debris and chemical disposal.

Community Groups

The Watershed Residents' Survey found a link between social involvement, knowledge about watershed issues, and commitment to watershed efforts. It suggested that one way to increase public support for water quality improvements is through outreach to community groups already engaged in community activities. Homeowner and neighborhood groups, garden clubs, hiking clubs, civic and faith-based groups are ideal audiences to engage around their specific interests.

Educational articles

The survey found that local media was a common source of water quality information for residents. The respondents that relied on local media as opposed to government agency or organization reports were less likely to favor a watershed protection fee and scored low on commitment to other restoration or protection efforts. In order to increase public support by raising awareness, the WIC could target these respondents through local media articles about watershed and water quality issues. By providing these residents with reliable information through their preferred news outlet, the WIC may be able to reach a group characteristically outside the reach of the WIC. The WIC plans to write and publish a series of articles on watershed topics in The Daily Courier, Prescott's local newspaper.

The WIC published a column in *The Daily Courier* in April 2010 (**Appendix E**) recognizing the importance of the public and volunteers in the Watershed Improvement Planning effort. The WIC submitted another column in May 2011 on the topic of nutrient pollution that fuels unsightly algal and aquatic plant blooms on the lakes during the summer. This column is expected to be published in June or July 2011.

Potential Project Sites

At this time, the WIC is unable to recommend BMPs and project locations to specifically target sources of nutrients and bacteria in the Upper Granite Creek Watershed. However, given our current understanding of our urban water quality issues, the WIC can recommend general projects that mitigate stormwater volumes and encourage bio retention of stormwater as well as several sites around the watershed that present opportunities for such projects due to property ownership, access, undeveloped floodplains, etc. The following sites are being listed as opportune locations for water quality improvement projects, specific or conceptual.

<u>City of Prescott 6th Street Open Space</u>

Near the confluence of the North Fork Granite and Granite Creeks lies just over five acres of undeveloped floodplain (**Fig. 23**). Donated as open space, this property is owned by the City of Prescott and is bordered by the 6th Street Industrial District and the Yavapai-Prescott Indian Reservation. This area is an ideal location for a green infrastructure project because the property is owned by the City, a WIC partner, there is access to this property from 6th Street, and the undeveloped floodplain is inhabited by native vegetation. Because this property is downstream of downtown and the major tributaries to Granite Creek and upstream of Watson Lake, the potential for mitigating pollutant loading to the lake is substantial. The challenge with this site is that it is a consistent camping spot for the area's homeless and transient population.

This location is ideally suited for a stream restoration and constructed wetlands project. An area is needed that is large enough to slow flood waters to a manageable level for uptake of water and pollutants to occur. Native vegetation would be used to absorb the pollutants and metabolize them for growth rather than moving on downstream to cause algae blooms. The primary pollutants of concern are nitrogen, phosphorus, and *E. coli*

Figure 23: 6th Street Open Space

The City of Prescott Open Space property at the confluence of the North Fork Granite Creek and Granite Creek is downstream of downtown and the major tributaries to Granite Creek and upstream of Watson Lake. Bordered by the 6th Street Industrial District and the Yavapai-Prescott Indian Tribe land, the open space preserves an undeveloped floodplain comprised of native vegetation.

bacteria. These pollutants are able to be absorbed and metabolized by plants and bacteria in the soil.

The conceptual design will be to divert floodwaters coming into the site from the North Fork Granite and Granite Creeks and spread it out through large, constructed "cells" in the floodplains of the two creeks. The "cells" would be capable of holding large amounts of water in order to slow it down considerably before discharging it to the main channel of Granite Creek. Each cell would be contained by a berm that is vegetated with appropriate native riparian and/or wetland vegetation species. The soils would be treated or vegetated to absorb phosphorous.

The North Fork Granite Creek floodplain would be enhanced with vegetation plantings for bank stabilization, slowing overland flow, pollutant absorption, and habitat. The channel itself would be realigned in a manner to allow for the natural architecture of pools, riffles, and sand bars. Runoff from the existing industrial facilities would be routed through small detention or infiltration treatment systems prior to release to the floodplain. Rocks and gravel can be used to provide for flow channels through the berms that form the "cells" in a manner to act as weirs to allow controlled volumes of stormwater to flow from cell to cell before discharge to Granite Creek.

After the construction of the water quality ponds (cells), elevated walkways and bike trails can be built on top of the berms for public recreation through the constructed wetland-riparian area in normal or dry flow days. These trails could connect to the Greenways Trail System through downtown Prescott as well as the Peavine Trail on the east side of Watson Lake. Along these trails there could be points of interest and interpretive signage explaining the functions of wetlands, identifying native vegetation species and the fauna that relies on them, as well as other natural features as part of a public education/recreational aspect of the Prescott area.

Other cultural points of interest could be identified within the site indicating historical relevance to Prescott or the Yavapai Indian Tribe.

Butte Creek between Willow and Garden Streets

A Prescott College group is currently interested in restoring of a highly-urbanized stretch of lower Butte Creek adjacent to the Prescott College campus between Willow and Garden Streets (**Fig. 24**). The goal of this project is to improve the ecological condition of lower Butte Creek and to promote stewardship of

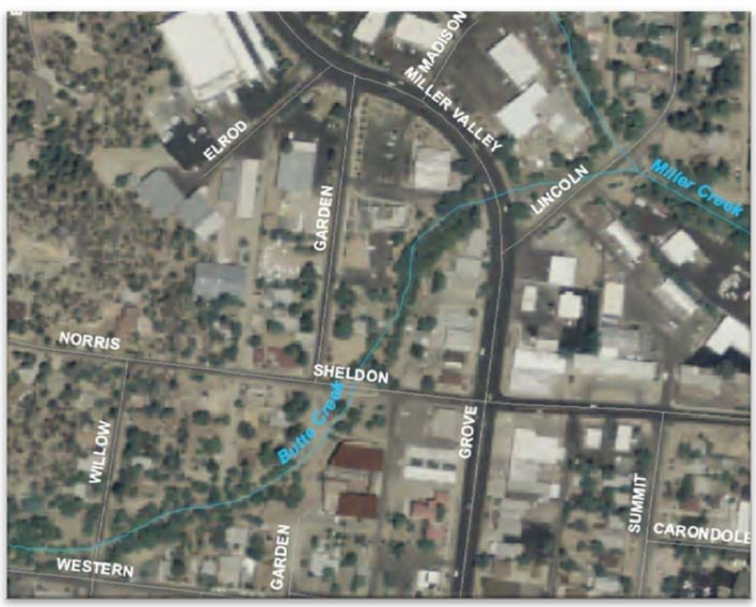

Figure 24: Butte Creek Behind Prescott College

An urban section of Butte Creek behind Prescott College is the site of a proposed riparian restoration project to improve the overall health of the creek, its riparian habitat, and downstream water quality.

the creek preceding changes to the Prescott College campus, including the construction of student housing off of Willow Street. Located approximately 1,000 feet upstream from the confluence with Miller Creek, water quality monitoring indicates that lower Butte Creek has consistently high bacteria concentrations during high flow events. The Upper Granite Creek Riparian Buffer Assessment gave this section of creek “moderate” to “bad” riparian scores coupled with high bare soil scores.

For more information, see the 1997 document titled “An Ecological and Historical Account of Butte Creek” by Deva Taylor, Dazzle Ekblad, and Christine Cantwell.

<u>Stricklin Park</u>

This 5-acre forest preserve is located in the upper portion of the Lower Butte subwatershed (**Fig. 25**). Stricklin Park has hiking trails and access to the Butte Creek Tail. The area is designated City of Prescott Open Space and supports a healthy riparian area and mostly undeveloped floodplain.

Above: Stormwater flows down Sherwood Drive after a rain storm.

The border of Stricklin Park along Sherwood Drive provides an ideal location for green street practices, such as a series curb cuts and vegetated basins, to slow and filter the stormwater and associated sediment that flows down Sherwood Drive and empties directly into Butte Creek upstream of the Hassayampa Village Lane Bridge. In addition to addressing stormwater quality, these practices would beautify the park boundary and the neighborhood and may help to alleviate downstream flooding.

Above: Stormwater pools along Sherwood Drive before discharging to Butte Creek.

Butte Creek flows through the Hassayampa Golf Club before reaching Stricklin Park. Because of the open floodplain and open space designation of the park, this is as a potential project site for constructed wetlands to improve water quality. In addition, channel realignment may be necessary. Constructed wetlands can remove pollutants from stormwater and upstream sources (golf course) through the microbial breakdown of pollutants; plant uptake; retention; and absorption. The intermittent natural of local creeks may pose a challenge to the success of constructed wetlands at this site.

Figure 25: Stricklin Park

The 5-acre Sticklin Park is located in the upper portion of the Lower Butte Creek subwatershed. Butte Creek flows through the Hassayampa Golf Club before reaching Stricklin Park. The border of Stricklin Park along Sherwood Drive is a potential site for green street stormwater practices. The park itself is an ideal location for constructed wetlands to remove pollutants from upstream sources.

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