RIO DE FLAG WATERSHED PLAN

Community Watershed Planning from the San Francisco Peaks to San Francisco Wash

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Prepared by:

Friends of the Rio de Flag

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(Sustain and Manage America's Resources for Tomorrow)

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EXECUTIVE SUMMARY

The Rio de Flag originates as springs, seeps, and runoff on the slopes of the San Francisco Peaks above the city of Flagstaff, in northern Arizona. The mountain and the watercourse are intertwined in the long and vibrant history of this remarkably geographically diverse and arid region—in the stories of its peoples; in its formation by 'earth fire' and ice; in its immense cultural significance as a modern and ancient crossroads; and in the renowned advances in scientific and planetary understanding derived here, applied worldwide, and even extended out to our own solar system.

The purpose of the Rio de Flag Watershed Plan is to provide a guiding and living document for prioritizing and implementing stewardship/management, outreach, restoration, preservation, and conservation activities on the Rio de Flag. The document should provide insight into the values provided by the Rio and its watershed, the factors affecting those resources and the priorities placed on those resources by the community at large. The document also provides a vision for the Rio de Flag and the watershed that identifies key goals and objectives, goals may differ by reach of the Rio, depending on community needs and the potential of each reach to attain the goals. In the process of developing the plan 116 projects were suggested by the public and stakeholders. Seventeen of those suggestions are prioritized as a starting place for conservation and improvements in the watershed.

This plan and the development of the Watershed Alliance for the Rio de Flag was accomplished through a grant awarded to FoRio under the U.S. Bureau of Reclamation's WaterSMART: Cooperative Watershed Management Program.

ACKNOWLEDGMENTS

This watershed plan for the Rio de Flag reflects the great insight, hard work, and dedication of stewards, advocates, professionals, adventurers, admirers, and community and indigenous leaders, who care about the Rio de Flag—its ecological and cultural history, its peoples, lands and waters. Together, they hold a vision for the watershed's healthy future.

Friends of the Rio de Flag (FoRio) and members of the Watershed Alliance for the Rio de Flag (WARF) wish to acknowledge those who so generously and energetically contributed their time, effort, and ideas to make this collaborative restoration plan possible.

We also extend our deep concern and care for our extended northern Arizona family, especially the Hopi and Diné who have endured great difficulty and irreparable loss during the global SarsCOV2 pandemic that has overshadowed this watershed planning process.

We thank:

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INTRODUCTION

The Rio de Flag and How We Got Here

The Rio de Flag originates as springs, seeps, and runoff on the slopes of the San Francisco Peaks above the city of Flagstaff, in northern Arizona. The mountain and the watercourse are intertwined in the long and vibrant history of this remarkably geographically diverse and arid region—in the stories of its peoples; in its formation by ‘earth fire’ and ice; in its immense cultural significance as a modern and ancient crossroads; and in the renowned advances in ecological and planetary understanding derived here. Northern Arizonans of today find themselves anchored in the stunning beauty of the Peaks, which literally bring down the rain and snow necessary to sustain life in this watershed.

Over 70,000 Flagstaff area residents now rely on the watershed of the Rio de Flag (Fig. 1), as a source of drinking water, for outdoor recreation and connecting to nature, and for a wide array of livelihoods. The Rio de Flag stream corridor hosts valuable riparian habitats fed by periodic runoff flows, natural springs, and city-produced effluent. The Rio also provides other vital services to the community in its capacity to process and absorb floods and stormwater. It is an important open space corridor for City residents, connecting communities and offering aesthetic and recreational enjoyment, making historical links to ancestral indigenous cultures, and providing habitat, cover, and movement corridors for wildlife.

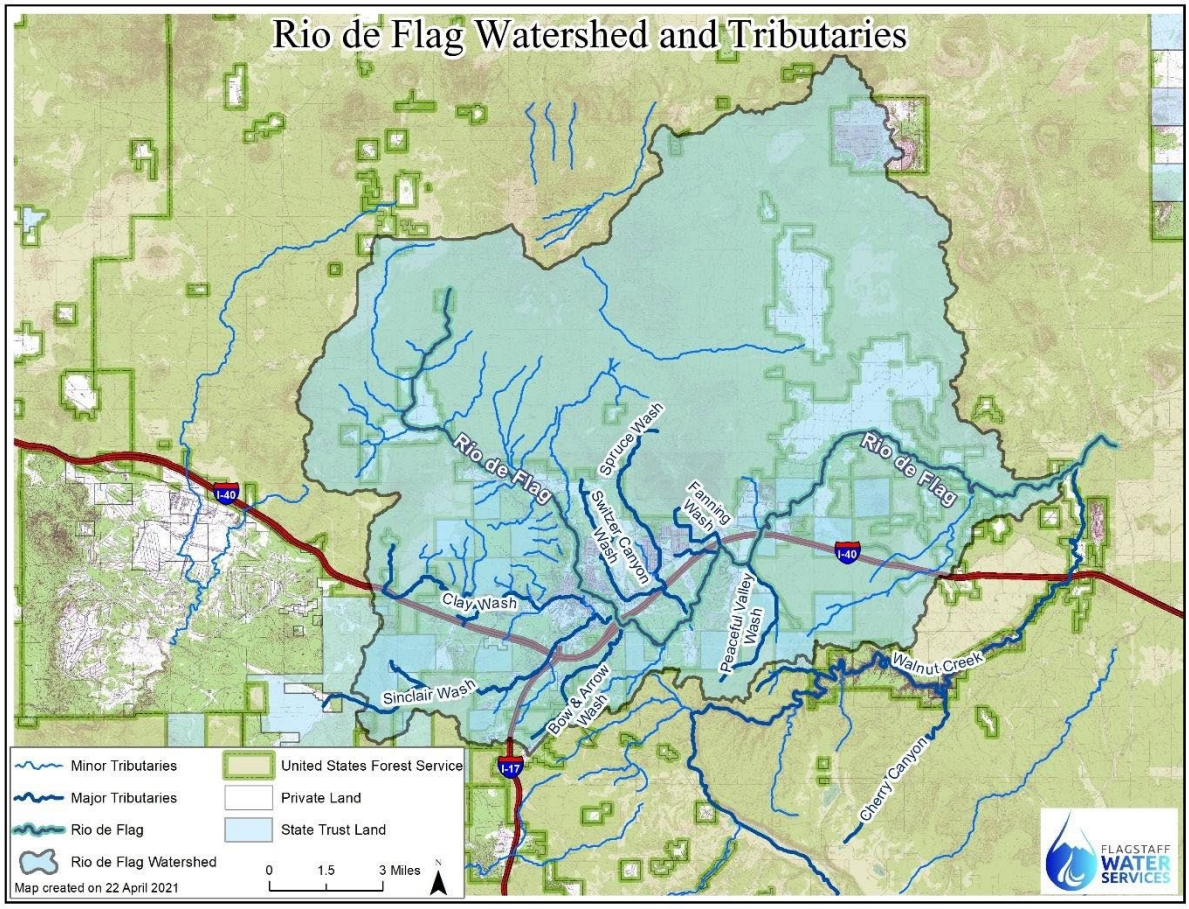

Figure 1. Watershed map of the Rio de Flag and major tributaries. (from Schenk et al. 2021).

Why does the Rio de Flag need a plan?

Interest in the Rio de Flag has increased in the last couple of decades due to the population growth in the watershed, a dramatic expansion of recreation, and increasing and inequitable impacts of flooding. Urban development has resulted in water supply concerns, stream channelization, erosion, and degradation of riparian ecosystems, which in turn increase flood risk and cause water quality concerns. Deeply controversial projects have arisen, such as the large-scale Rio de Flag Flood Control Project and the commoditization of city reclaimed water for snowmaking.

This watershed plan provides a means for coordinating practical, proven, and innovative solutions. Watershed planning for the Rio de Flag also needs to address many specific challenges: lack of awareness among the public, the effects of invasive species on aquatic and riparian ecosystems, trash and water pollution, inconsistent land ownership, regulatory disconnects between surface water and groundwater, and needs for community building, sustainable economies, and education. Likewise, maintaining trails and wildlife movement corridors, restoring and enhancing natural systems, and

supporting environmental justice and education, aesthetics, access to open space, and sustainability are forward-looking aspects of watershed planning.

Over the last several decades, cities such as Albuquerque, Durango, Farmington, Santa Fe, and San Antonio have realized the enormous public benefits provided by their rivers. These cities have invested money in purchasing land and easements, trail systems, in-stream flows rights, and beautification – all of which have led to quality of life improvements for citizens, property value increases, and significant growth in tourist revenues. The Rio de Flag has the potential to be a similar amenity and centerpiece for the City of Flagstaff and surrounding communities.

Bureau of Reclamation WaterSMART Program and the Rio

The U.S. Bureau of Reclamation's WaterSMART: Cooperative Watershed Management Program provides a framework to create a legacy of conservation stewardship and restore trust with local communities, by providing funding to grassroots, local watershed groups, and encouraging diverse stakeholders to develop collaborative solutions that address their water management needs.

Flagstaff-based nonprofit Friends of the Rio de Flag (FoRio) recognized the need for watershed planning, in part as other planning processes, and the pressing climate and social issues in the Rio de Flag's headwaters and along its channel and tributaries, have produced numerous important projects and studies, by multiple entities and agencies. The WaterSMART program presented a compelling opportunity to begin.

A vision for the Rio de Flag Plan

The Watershed Alliance for the Rio de Flag (WARF) watershed stakeholder group formed as a result of the 2018 WaterSMART grant to FoRio, for advancing watershed planning.

The intent for the watershed plan, as recognized by the WARF is to be a living document, to adaptively guide policies/management plans, to increase coordination of projects and studies across jurisdictions, and to increase awareness and engagement in watershed stewardship, preservation, restoration and education in our communities. To ensure a comprehensive approach to planning that would include all of the communities, neighborhoods, and people of the watershed, the watershed was divided into subwatersheds defined by reaches along the main channel of the Rio de Flag (see *Stream Reach Descriptions* below). The reaches reflect variability along the length of Rio de Flag drainage in terms of channel type, land use and ownership, and challenges and opportunities for watershed projects and protections.

The plan provides a vision for the Rio de Flag and the watershed through attaining the following six goals developed by the WARF:

- *Goal 1: Increase integrated cultural, scientific, and historical understanding of the Rio de Flag watershed*
- *Goal 2: Protect and enhance Rio de Flag watershed health to deliver ecosystem services to future generations*
- *Goal 3: Benefit human communities of the Rio de Flag watershed*
- *Goal 4: Benefit native ecological communities of the Rio de Flag watershed*
- *Goal 5: Increase public awareness and engagement to strengthen the community's connection to the Rio de Flag watershed*
- *Goal 6: Create a sustainable funding stream for the Rio de Flag watershed*

This watershed plan first summarizes the plan's foundation within existing plans and studies, provides available background information, and presents the expert, stakeholder, and public input gathered during the watershed planning outreach process. This information collectively informs implementing the WARF vision through a series of 141 conceptual projects.

PLAN SETTING: EXISTING PLANS AND STUDIES

Numerous plans and studies fall within the hydro-geography of the Rio de Flag watershed. This section reviews five key plans that directly relate to watershed plan implementation objectives in the near future. See Appendix 2 for a review of the full suite of plans and studies that provide a larger framework for watershed protection and restoration and may also create opportunities for synergistic integration during WARF Plan implementation.

Coconino County Comprehensive Plan

The Coconino County Comprehensive Plan (CCCP) was adopted in 2015 and provides a broad plan for development, growth, recreation, and environmental stewardship at the county level. The CCCP intersects with the WARF because large portions of the Rio de Flag watershed fall within the county and are affected by this county-wide plan. Future development, parks, open space, and environmental initiatives set by the CCCP will have impacts on implementation of the WARF Plan and on the health of the Rio de Flag watershed in general. Future iterations of the CCCP can incorporate objectives and projects identified in the WARF Plan into county planning and policies. Key overlapping areas of concern include Baderville/Fort Valley development, Doney Park development, Fort Tuthill management, and general forest and watershed

stewardship. The CCCP can be found online at:
https://www.coconino.az.gov/1111/Comprehensive-Plan

Flagstaff Regional Plan 2030

The Flagstaff Regional Plan is a rolling thirty-year plan that is updated every 5 to 10 years. The plan is similar in scope to the Coconino County Comprehensive Plan in that it provides broad guidance for development, recreational opportunities, open space, and environmental stewardship. The Regional Plan can help guide WARF activities but is also an opportunity for WARF input into future versions of the plan through public comment as well as direct conversations with the Planning Division. Portions of the Regional Plan are insightful for strategizing WARF projects. For example, the JW Powell road extension is already broadly planned for southeastern Flagstaff. By analyzing the general goals of the road extension, the WARF can produce potential open space projects or initiatives and also engage city planners regarding the best ways to preserve or enhance riparian corridors. The Regional Plan is administered by the City of Flagstaff. More information about the current plan (ratified in 2014 for 2030 goals) can be found online here:
https://www.flagstaff.az.gov/2936/Flagstaff-Regional-Plan-2030

Northeast Area Master Drainage Plan

The Northeast Area Master Drainage Study (NEAMDS) is a planning document of the City of Flagstaff Stormwater Section that was completed in 2009. NEAMDS is less of a strategic plan and more of a list of potential drainage projects based on known flooding and drainage issues within the city. The plan provides important flood risk perspective to the WARF. Although it is becoming dated as projects are completed, NEAMDS is still important as a historic drainage improvement document. Completed drainage improvements that were based on the NEAMDS plan include the Fanning Wash channel improvement from Lockett to Linda Vista, the Soliere Drive low water crossing at Steve's Boulevard, and the Linda Vista culvert upsizing at Spruce Wash. Future iterations of drainage plans could be developed with input from the WARF plan in terms of ecological health and community stream amenities. Phase 1 of NEAMDS (there were three reports completed in phases) is available online here:
https://www.flagstaff.az.gov/DocumentCenter/View/55395/PhaseIReportFinal?bidId=

Water Conservation Strategic Plan

The Water Conservation Strategic Plan (WCSP) is administered by the Flagstaff Water Services Division and was adopted by City Council in late 2020. This plan provides strategies for reducing water consumption, reusing water, and monitoring future water development. The WCSP is important for the WARF Plan, because it provides one of the only written plans in the watershed for reducing water consumption and it addresses the water reuse. The WCSP can be found online here: **https://www.flagstaff.az.gov/DocumentCenter/View/65417/City-of-Flagstaff-Water-Conservation-Strategic-Plan_2020_FINAL?bidId=**

Flagstaff Trails Initiative

The Flagstaff Trails Initiative (FTI) is a regional plan created in 2019 by the US Forest Service, Coconino County, City of Flagstaff, and local advocacy groups. The plan is administered by a separate non-profit group with the same name as the plan (FTI). The purpose of the FTI is to provide broad and specific planning for future recreational trails in the Flagstaff area that cross jurisdictional boundaries. The FTI share with the WARF a desire for greater community benefits and amenities, recreational opportunities, and sustainable stewardship of the land. Many of the trails that exist or are planned under FTI are along streams and washes of the Rio de Flag watershed. Collaboration between the FTI and WARF could provide synergistic benefits for specific projects as well as future planning and fund raising. More information can be found online at: **http://flagstafftrailsinitiative.org/**

BACKGROUND

History, cultural ties, and human use within the watershed

Despite the scarcity and limited extent of surface water, the streams, wetlands, and springs of the Rio de Flag watershed have been immensely important in the human history of northern Arizona. Indigenous peoples and their ancestors have been continuously bound to the watershed's unique hydrology. Its climate and location influenced the explorations of Europeans that were followed by early natural science expeditions, by trading, ranching and logging operations, and by the siting of the community that eventually became Flagstaff.

The Rio de Flag has had several modern names. The earliest European name was recorded by Amiel Whipple in 1853 where the "Rio San Francisco" was described as a

small stream flowing south from the Peaks into a great valley (Cline 1976). Early (1890 through 1910) Sanborn Fire Insurance Maps simply labeled the Rio “dry creek.” Early newspapers, such as the Coconino Sun, called it “River de Flagstaff”, which eventually metamorphosed into the contemporary use of ‘Rio de Flag’.

The many tributaries of the Rio de Flag remained largely unnamed by modern occupants until the nation-wide development of the National Flood Insurance Program administered by the Federal Emergency Management Agency (FEMA). After the National Flood Insurance Act pf 1968, many tributaries were named for regulatory reasons. The adopted stream names were usually based on nearby streets (e.g. Clay Avenue Wash, Spruce Avenue Wash). Exceptions include Sinclair Wash, Peaceful Valley Wash, Switzer Canyon, and Schultz Creek. All these tributaries were large enough to have been named prior to floodplain regulations.

Native peoples

Nomadic hunter-gathers seasonally occupied the Rio de Flag watershed during the Archaic period (9,000 to 2,400 years before present) (Roberts 2008). The earliest known year-round inhabitants of the Rio de Flag watershed were the Sinagua peoples who occupied nearby Walnut Canyon between 600 and 1400 A.D. Remnants of this time include the cliff dwellings at Walnut Canyon as well as pictographs and petroglyphs within the Rio de Flag watershed, most notably at Picture Canyon (Figure 2) and at several undisclosed sites throughout the watershed. Potsherds found in the Fort Valley area indicate that the Sinagua used the Rio de Flag and associated headwater springs at least seasonally and possibly over a long period (Hailey 2020). More recently, from 1100 to 1250 A.D. the area around Wupatki National Monument, just north of the RDF watershed, was inhabited by Kayenta Ancestral Puebloans, the Sinagua, and the Cohonina (Babbitt and DeGraff, 2009). Inhabitants of the Wupatki area made use of the fertile soils generated by the eruption of Sunset Crater (burnt timbers from cultural features were carbon dated for volcanology studies), and they may have abandoned the area following soil nutrient depletion.

Figure 2. Petroglyphs along the Rio de Flag in Picture Canyon Natural and Cultural Preserve. (Photo credit - Friends of the Rio de Flag).

The San Francisco Peaks have been and continue to be central to cultural identity of at least 12 Native American tribes, whose traditional ceremonies and observations related to the Peaks still occur today. The current lands of the Diné and Hopi are the closest in proximity to the Rio de Flag watershed. The two tribes also have significant numbers of members residing within the Rio de Flag watershed, whose presence creates a link with the landscape, the waters, and watershed values, reaching back to the tribes' origins and forward into the future. The Hopi Tribe highly values native plants in the watershed in the context of ethnobotany and regularly collects plants here for traditional cultural practices.

European settlement

Permanent settlement in the Rio de Flag watershed only began in the 1880s when a small community developed around Antelope Spring (Old Town Spring) near the base of what is now called Observatory Mesa. The ‘sky island’ of ponderosa pine forests provided timber and water that could not be found for hundreds of miles in either direction along the rail route. Consequently, Flagstaff became a focal point for railroad workers, supplies, and trade with the local Indigenous communities.

The first train arrived in the Flagstaff area in 1882. At that time the community consisted of two stores, two hotels, three restaurants, and over 20 saloons and dance halls (Hailey 2020). By 1883, most of the development moved to the more open and flat area that is today’s downtown Flagstaff. This move was made permanent when a large fire destroyed most of Old Town.

Ironically, the flat space of today’s downtown was created as a natural outwash plain from the steeper slopes of the Peaks, Dry Lake Hills, and Observatory Mesa. The town was literally being built on a floodplain.

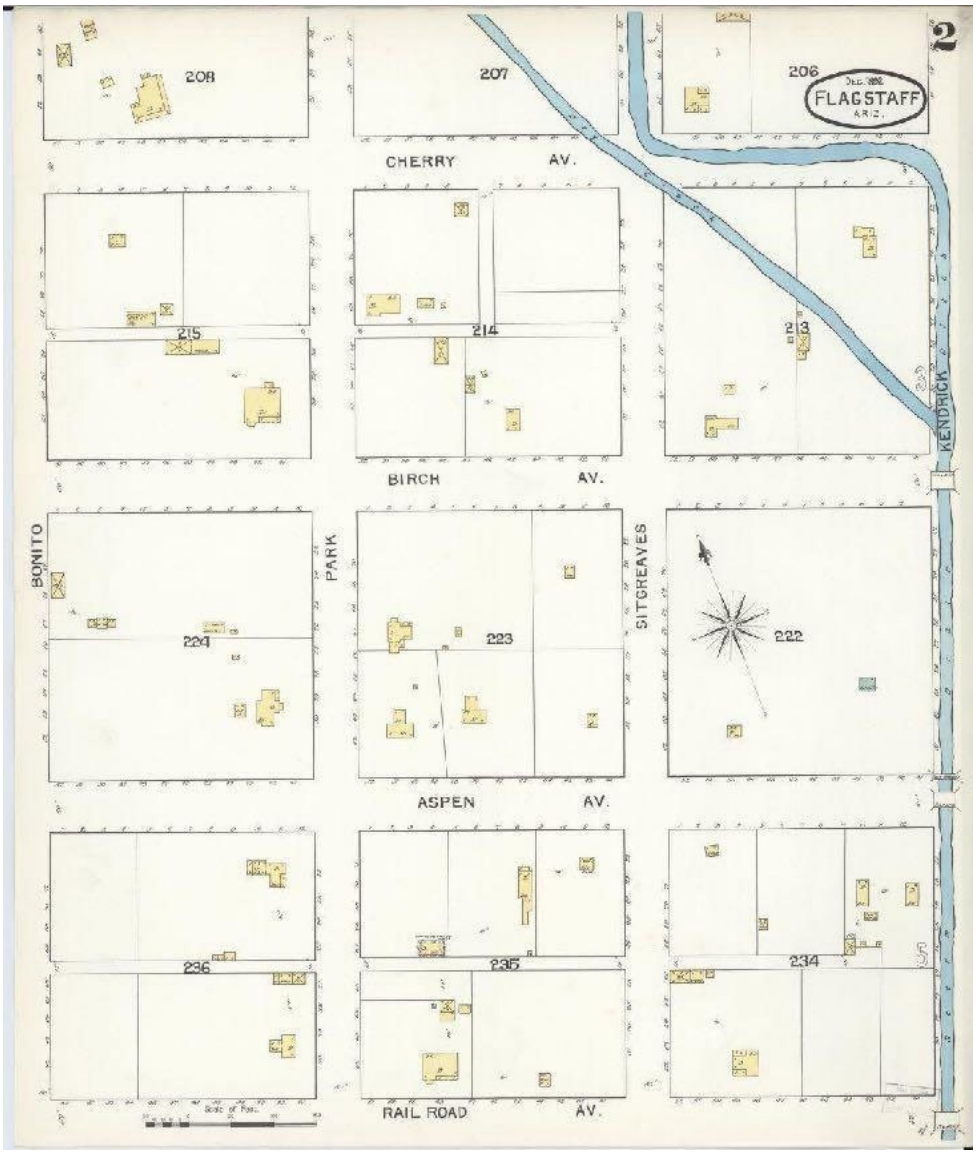

Figure 3. An example of the Rio de Flag and an associated drainage ditch in the middle of the road, Flagstaff 1892. Sanborn Fire Insurance Map 1892.

Nevertheless, when a natural climate shift after 1900 brought much wetter weather to Flagstaff, early residents realized all too soon, the Rio de Flag was a stream to be taken seriously (Figs. 4, 5).

Figure 4. The Rio de Flag in the heart of Flagstaff, 1900. Image from Northern Arizona University, Cline Library Digital Collections NAU.PH.91.21.7.

Figure 5. A view west along Aspen St. during the 1903 flood. Image from Northern Arizona University, Cline Library Special Collectoins: NAU PH 72.

Sanborn Fire Insurance Maps from 1890 and 1892 show the Rio de Flag flowing through the northern part of Flagstaff's Southside neighborhood. The 1892 and 1901

Sanborn maps show the creek running south across the railroad tracks, then southeast from Phoenix Avenue to Leroux Street, then east for six blocks between Cottage and Brannen going toward the railroad yard (Fig. 6).

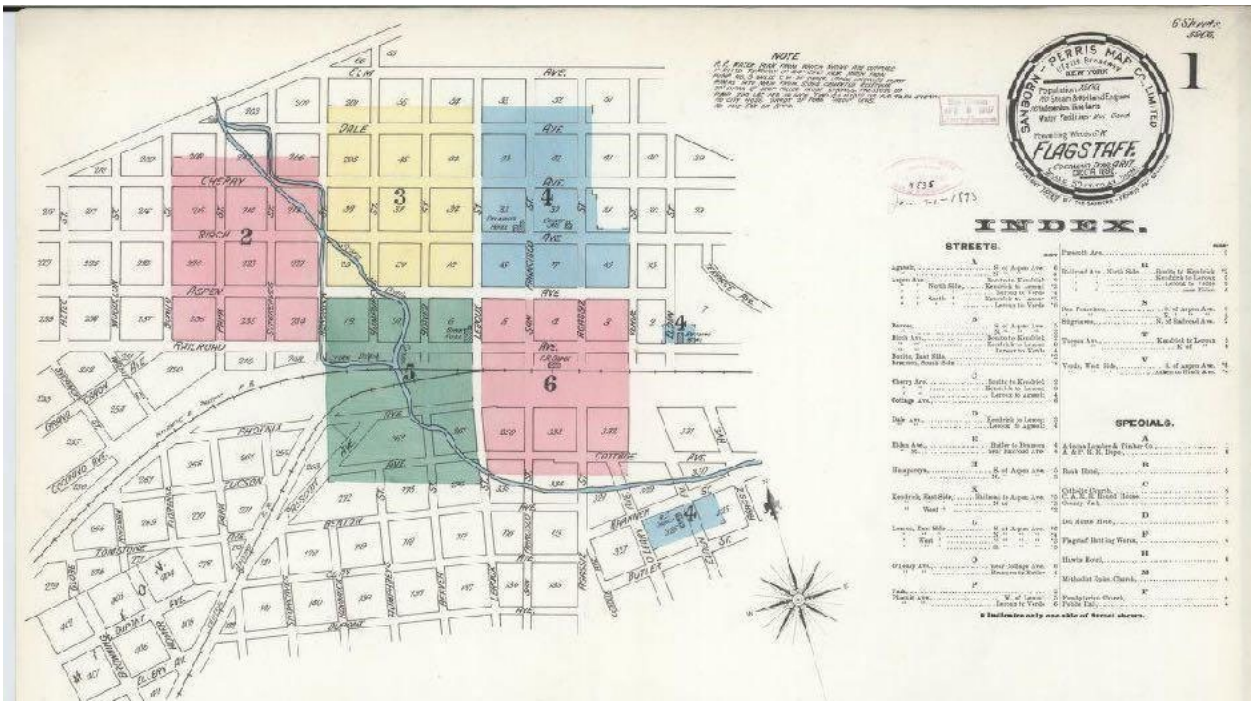

Figure 6. A map of the Rio de Flag and Flagstaff in 1892. (Sanborn Fire Insurance Map 1892). Note the original alignment of the Rio through the Southside neighborhood as well as the diversions north of the tracks.

Scant historical accounts describe relocation of the Rio de Flag channel for varying reasons and in various ways sometime after 1901. They are consistent in saying that the steam was moved into a new hand dug channel running through the southside. Since the channel was relocated, the Southside has experienced many flooding events. However, the Sanborn maps indicate that, while re-alignment of the Rio through the middle and south part of Southside did exacerbate flooding in the Southside, a portion of the neighborhood would have historically been in a floodplain regardless of channel realignment.

The current and ongoing Rio de Flag Flood Control Project will reduce long standing flooding issues for both the downtown and Southside communities.

Water development within the watershed

Most of the early water development in the watershed occurred to support the establishment of Flagstaff.

The largest early project was an inter-basin water transfer, the movement of water from the Inner Basin high on the San Francisco Peaks to the Rio de Flag watershed to provide drinking water to Flagstaff. In the Inner Basin, Jack Smith Spring was the first spring developed for water consumption. In 1898, Mayor Julius Abineau commissioned a crew to build a 6-inch water pipeline from the Inner Basin to Flagstaff (City of Flagstaff Water Services internal files). Improvements and expansion of the pipeline continued through the early 1900s.

From 1903 to 1905, T.A. Riordan developed the dam that created Lake Mary. This reservoir sits within the Walnut Creek drainage. Like the Rio de Flag, Walnut Creek is a tributary to San Francisco Wash that eventually flows into Canyon Diablo. The Lake Mary reservoir originally supplied water to a lumber mill, but later the water was piped into the Rio de Flag watershed to provide a second reliable source of drinking water to Flagstaff.

As of 2018, 5% of the City's water comes from Inner Basin springs, 22% comes from Lake Mary, and 73% comes from groundwater wells. Much of this water is transferred from outside of the Rio de Flag watershed, used as municipal water, treated as wastewater, and released as reclaimed water into the Rio de Flag. The first beneficial use of reclaimed water in the watershed occurred in 1966 when the City ran a line from Wildcat Reclamation Plant to the Continental Golf Course. The reclaimed system expanded slowly after that, providing water to irrigate turf at other golf courses, school ball fields, and the NAU campus, and for snowmaking at the Arizona Snowbowl ski area. The reclaimed water system has since kept up with increasing demand in the past 15 years, as water conservation efforts moved landscaping and parks away from potable water.

When Flagstaff was originally developed around the Atlantic and Pacific Railroad, one of the first products provided to the railroad from the region was timber. The first lumber mill of record was the Ayer Mill created in 1881 near modern-day Lake Mary to provide railroad ties to the new trans-continental railroad (Denis Riordan purchased the mill in 1887 and renamed it the Arizona Lumber and Timber Company (Cline Library 2021). The two largest rail lines were the Arizona Mineral Belt and Central Arizona Railroads, neither of which exists today but their legacies live on in the many forest roads that follow the old rail alignments. Logging and milling operations in and around the

watershed were highly active from the creation of the Arizona Lumber and Timber Company through the early 1950s, with greatest timber activity occurring early in the century. The last active lumber mill in Flagstaff closed in 1993.

Watershed setting

The Rio de Flag watershed is generally situated on the southern portion of the San Francisco Peaks (Mount Humphreys, Agassiz, and Fremont The Rio de Flag is a sub-watershed of the Little Colorado River watershed, which in turn is part of the greater Colorado River watershed. The Rio de Flag watershed abuts the Verde River watershed to the west and the Colorado River watershed to the north. For the purposes of this plan, the focus is on the watershed of the Rio de Flag and its tributaries from their headwaters to the Rio de Flag's confluence with San Francisco Wash (Figure 7).

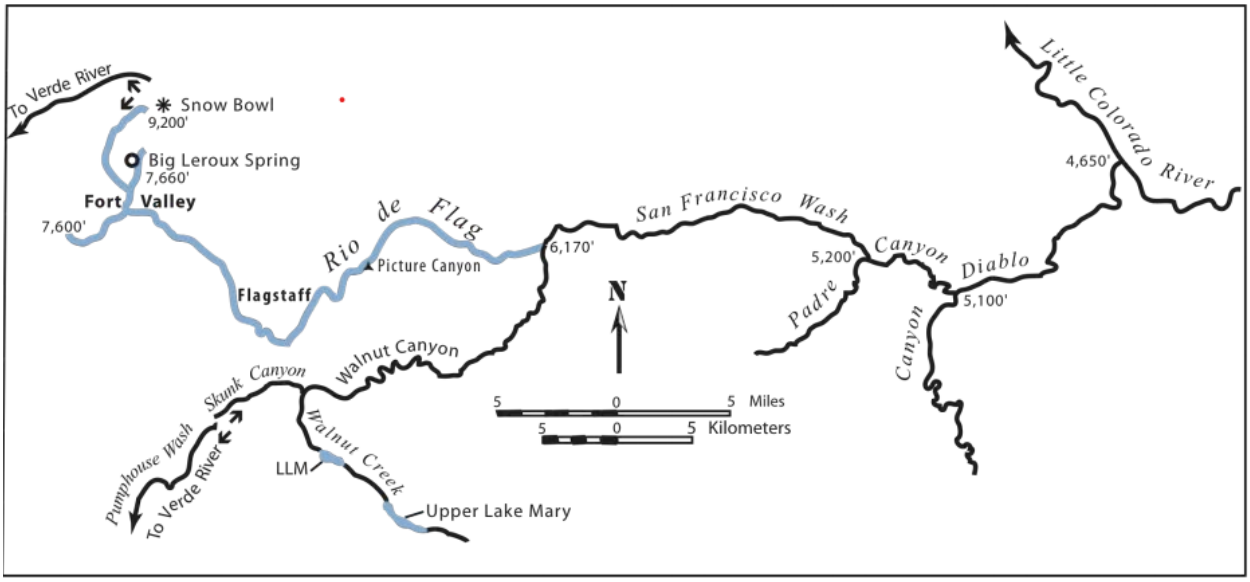

Figure 7. Sketch map showing the Rio de Flag (blue) and associate streams and washes draining to the Little Colorado River. Adapted from Holm (2019).

The Rio de Flag headwaters are dominated by the San Francisco Peaks, Dry Lake Hills, and Mount Elden, a complex of volcanoes, lava domes, and related features within the region's extensive San Francisco Volcanic Field. Volcanic activity began here in the early Pleistocene, about 2.6 million years ago. The most recent eruption formed Sunset Crater only 930 years ago and notably was recorded in the oral traditions of indigenous peoples (Waring 2018). The volcanic flows make up a considerable portion of the watershed and also create a dramatic elevation gradient from the highest point in Arizona at 12,633 feet, down to 6,170 feet at the confluence with the San Francisco Wash (Holm 2019). This gradient not only plays a key role in the biogeography of the watershed (the distribution of plant life), but it also figures in the very history of our scientific understanding of life zones, biomes, and ecosystems. The average

precipitation in the Rio de Flag watershed is 22.4 inches (Leao and Tecle 2005). However, the majority of this rain and snow evaporates and infiltrates into the cinders or karst limestone. Very little surface water, less than 5% of precipitation, flows on the natural landscape.

Ecosystems and ecology

Most of the Rio de Flag watershed falls within the largest contiguous ponderosa pine forest in the world, an ecosystem that stretches across 2 million acres in Arizona and New Mexico. This ecosystem is unique for having a very low rainfall-runoff ratio due to climate, soils, vegetation, and geology. This low rainfall-runoff ratio is part of the reason there are few perennial surface water features despite a relatively high average annual precipitation.

The Rio de Flag watershed encompasses ecosystems that include alpine tundra, spruce-fir forest, ponderosa pine forest, and pinyon-juniper woodlands. Relatively rare habitats found within the watershed include caves, old growth forests, springs, wet meadows, and escarpments.

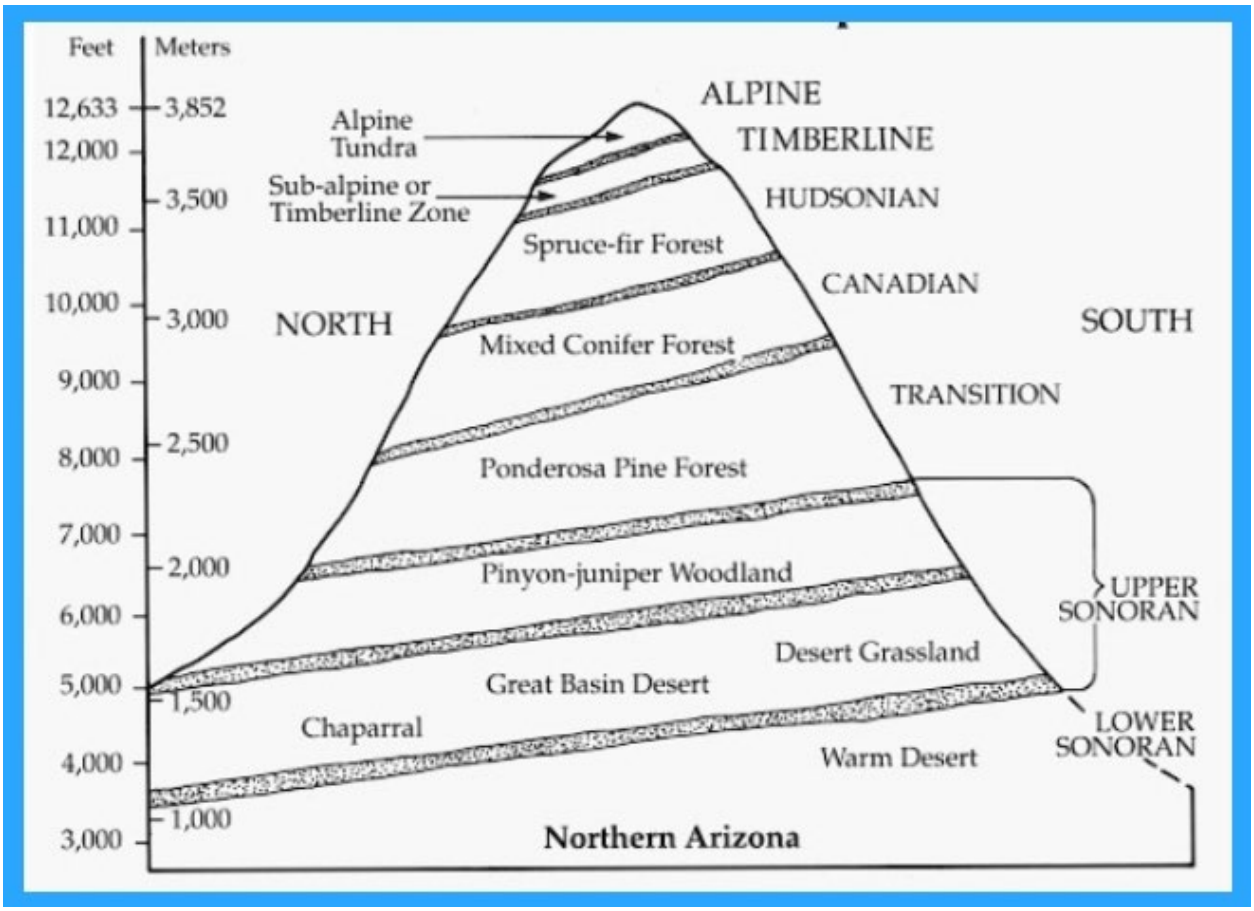

Figure 8. Merriam's life zones in the San Francisco Peaks area. Modified from Merriam (1890).

Hydrogeology (Groundwater)

The hydrogeology of the Flagstaff area and the Rio de Flag is dominated by the igneous rocks of the San Francisco Peaks, related lava flows and cinder fields, debris flows, and alluvial fans, and the sedimentary karstic Kaibab Formation, which underlie the area. Moenkopi Formation is exposed to a limited extent, primarily around the margins of McMillan Mesa. Karst is defined as rock layers that are readily dissolved by weak acids, such as rainwater, and exhibit features such as dissolution cavities and enlarged fractures. The Kaibab Formation (a.k.a. Kaibab Limestone) is mostly made up of highly fractured and weathered limestone. Both the igneous and karst formations have high water infiltration rates, which is one of the reasons that the Rio de Flag is mostly ephemeral or intermittent at best (Hill et al. 2018).

Groundwater flow does not necessarily follow the same pathways as the surface water flow, due to geologic structural controls such as faults, fractures, and the orientation of rock layers. While the Rio de Flag is part of the Little Colorado River surface drainage,

once water sinks into the subsurface it may flow toward the Verde River. The groundwater flow path depends on where water infiltrates within the surface watershed. For example, the upper Sinclair Wash sub watershed overlies the groundwater divide between the Verde River and Little Colorado River groundwater basins, so that water that infiltrates here may flow in groundwater to the Verde Valley.

Surface Water

Surface water resources are strikingly limited along the Rio de Flag and throughout the watershed due to the conditions described earlier. Perennial waters include springs and spring brooks. Reclaimed wastewater effluent discharged from two wastewater treatment plants supports aquatic and riparian habitats along the Rio de Flag in Picture Canyon (maintained through an agreement of the City of Flagstaff with the Arizona Game and Fish Department), the Rio de Flag near Interstate 40, and the Frances Short Pond near downtown Flagstaff. Natural flows occur during most spring seasons as snowmelt allow ephemeral and intermittent channels to flow throughout the watershed. Summer monsoonal storms also produce brief runoff events.

Surface water resources are monitored using streamflow gauges and precipitation gauges operated by the City of Flagstaff, Coconino County, and Northern Arizona University. These gauges replaced US Geological Survey gages that were operated between 1969 and 1980 (Hill et al. 1988).

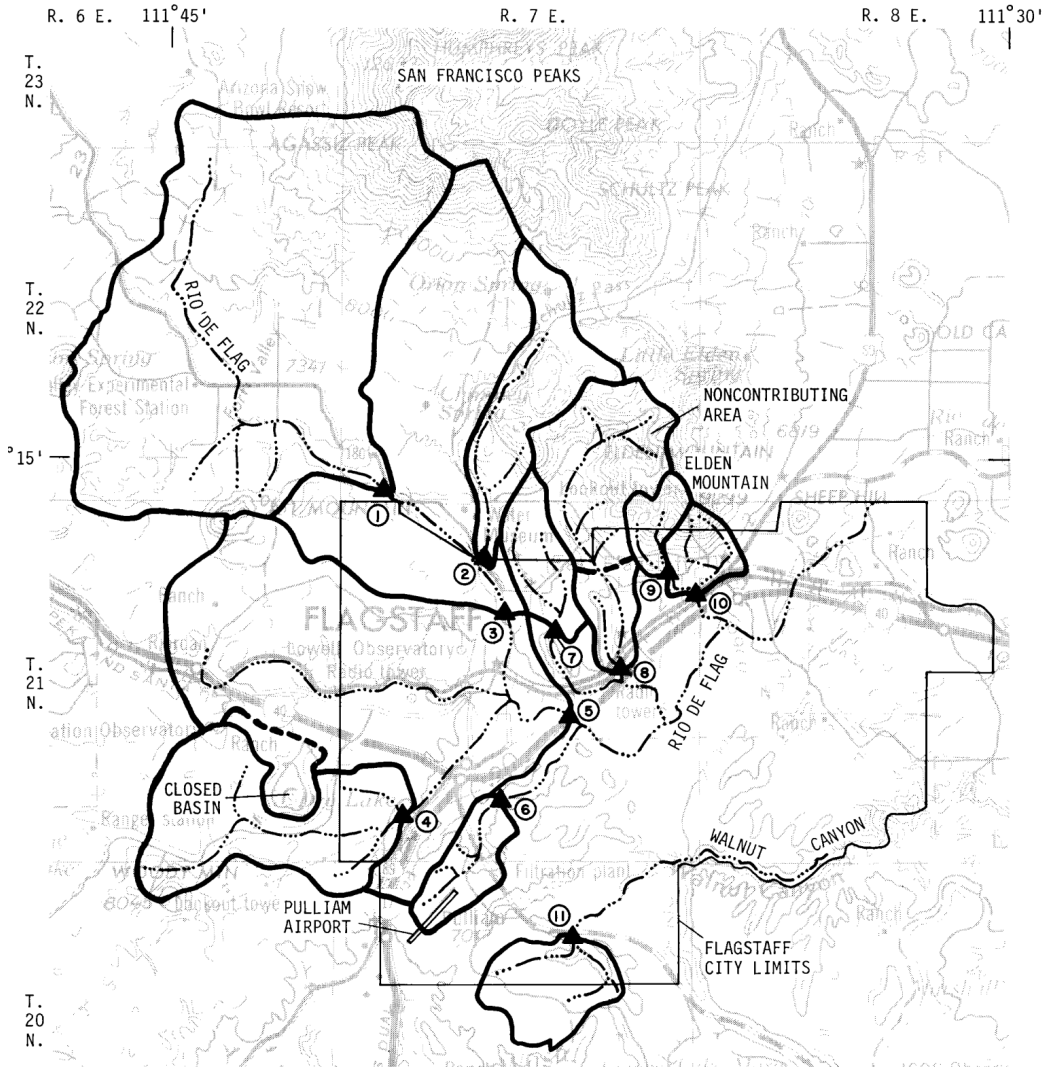

Figure 9. Map of historical streamflow gauges within the Rio de Flag watershed, 1969 -1980 (Hill et al. 1988).

1. *Rio de Flag at Hidden Hollow Road near Flagstaff*
2. *Shultz Canyon at Flagstaff*
3. *Rio de Flag at Flagstaff*
4. *Sinclair Wash at Flagstaff*
5. *Rio de Flag at Interstate 40 at Flagstaff*
6. *Bow and Arrow Wash at Flagstaff*
7. *Switzer Canyon at Flagstaff*
8. *Switzer Canyon tributary at Flagstaff (a.k.a. Spruce Wash)*
9. *Lockett-Fanning diversion at Flagstaff*
10. *Harenberg Wash at Flagstaff*
11. *Fay Canyon near Flagstaff*

A preliminary update to the surface water gauge network was completed in 2021 by the City of Flagstaff. The data report, based on 2008 to 2019 data, indicates that FEMA Flood Insurance Study (FIS)-predicated flows are twice to several times higher than actual flows (FEMA 2010; Schenk et al. 2021). Continued stream monitoring will be required to see if this trend continues during wet years.

Floods

For the Rio de Flag watershed urban areas are primarily in Fort Valley, City of Flagstaff, and Doney Park. Frequently flooded areas are identified, prioritized, and mitigated by the city and county for their respective jurisdictions (Figure 15). These flood hazard areas are consistent with findings of the Coconino County Multi-Jurisdictional Hazard Mitigation Plan (MJHMP) (Coconino County 2021).

The MJHMP contains complete maps of known flood hazards, description of known flood hazards, and discussion of past floods. The MJHMP also includes assessment of less frequent floods, assessment of areas likely to flood, and description of other natural hazards. Each hazard and its community impact is identified in the MJHMP's hazard assessment, including impacts of hazards on the following:

(1) Life, safety, health, procedures for warning and evacuation
(2) Public health including health hazards to floodwaters/mold
(3) Critical facilities and infrastructure
(4) The community's economy and tax base, and
(5) Number and type of affected buildings.

The MJHMP also describes Areas that provide natural floodplain functions, Development/redevelopment/Population Trends, and the impact of future flooding conditions.

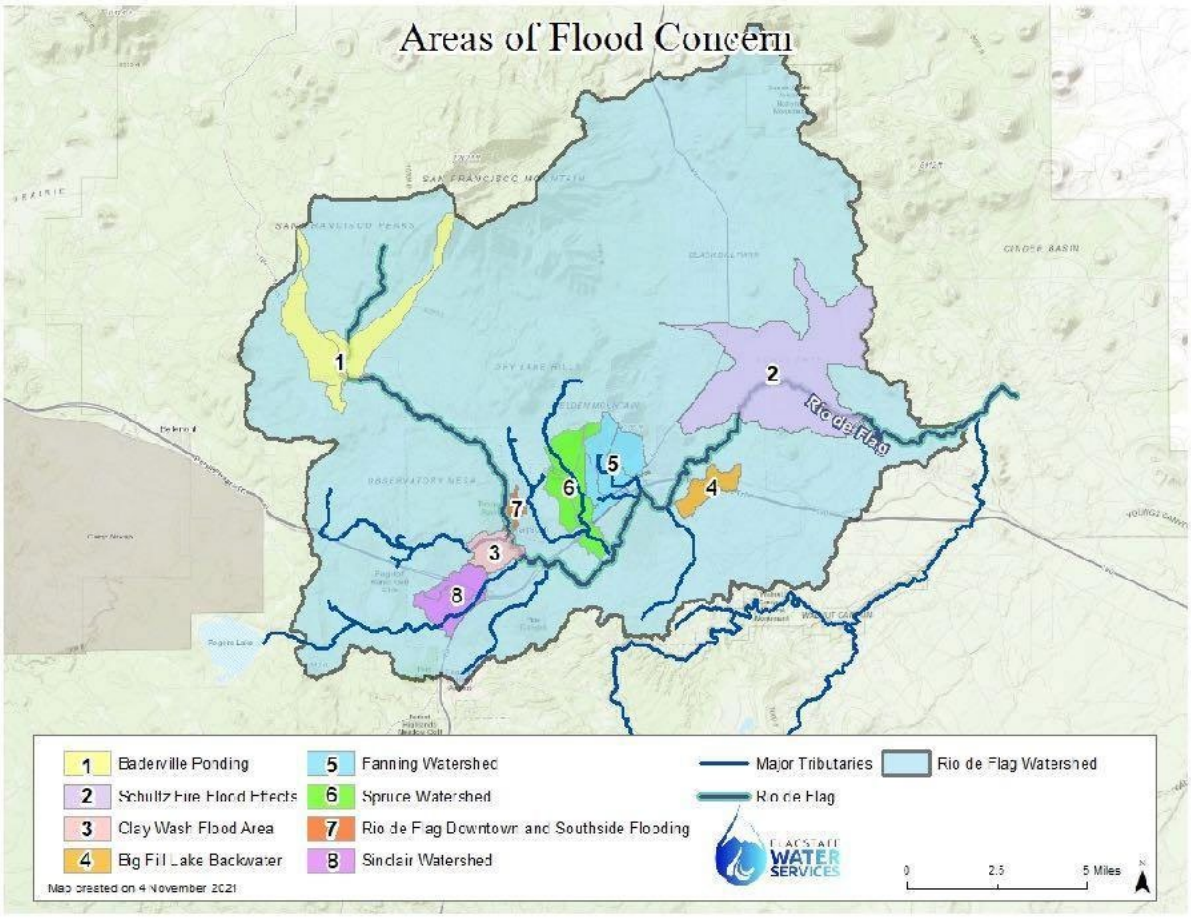

Figure 10. Areas of flood concern within the Rio de Flag watershed

Post-wildfire flooding is a concern in the watershed, primarily in the Spruce Wash drainage downstream of the 2019 Museum Fire (Figures 16 and 17). The nearby 2010 Schultz Fire scar also contributes to flood threats in the periphery of the Rio de Flag watershed (in the northeast non-contributing portion of the watershed). Also, during extreme rainfall events in summer 2021, runoff from the historic 1977 Radio Fire scar on Mount Elden initiated flooding in the Fanning Wash sub watershed. Flood information is collated and assessed by the city and county; examples of historic floods are listed in the FEMA FIS report for Coconino County.

Figure 11. Flooding in the Sunnyside neighborhood from July 2021 monsoon storms on Museum Fire burn scar. (photo credit: Ed Schenk)

Figure 12. Post flood cleanup on Cedar Avenue in Flagstaff following a July 2021 monsoon storm on the Museum Fire burn area (Spruce Wash drainage; photo credit Ed Schenk).

Pre- and post-disaster flood mitigation strategies vary by watershed and by neighborhood. The city maintains a list of mitigation projects identified through the Northeast Area Master Drainage Study (NAMDS) (J.E. Fuller 2008) and a separate but related capital improvements projects prioritization. The County also maintains a

prioritized capital improvements list as well as a set of pre-fire treatment areas. This WARF Plan does not include detailed explanations of flood mitigation projects since they vary with time and would likely be out-of-date by the time the plan is adopted. The goal of all flood mitigation is to reduce flood hazards for the community while preserving natural stream function and/or amenities.

The largest flood control project in the region is the joint project of Flagstaff and Corps of Engineers called the Rio de Flag Flood Control project. This project intends to reduce or eliminate flood damage to downtown and the Southside neighborhood by realigning and moving below ground major portions of the Rio de Flag channel. **https://www.flagstaff.az.gov/4189/Rio-De-Flag-Flood-Control-Project**. This project has been in development for more than twenty years and could have major impacts to downtown and the Southside through flood control and economic effects.

Stream Channels and Riparian Ecology

The Rio de Flag is an ephemeral stream, meaning that it flows only during parts of the year. While ephemeral streams have historically been ignored by science and society, they have recently been found to host high biodiversity and great recreation potential (Goodrich et al. 2018). Perennial, or continuously flowing, reaches of the Rio de Flag are artificially maintained using reclaimed water discharge from the City of Flagstaff's two wastewater treatment plants. These reaches include the "Rio Wetlands" near Interstate I-40 and Picture Canyon at the eastern edge of the city. The city also maintains Frances Short Pond near downtown Flagstaff using reclaimed water.

The riparian ecology of the Rio de Flag is based on species that are adapted to ephemeral or intermittent water sources. Tree species include box elder, arroyo and coyote willow, aspen, and planted cultivars of cottonwood and sycamore. Wetland herbaceous species exist at perennial springs, such as Coyote Spring, as well as perennial reaches of stream channel. Animal species are typically mobile because of the lack of consistent water. Fish are stocked at Frances Short Pond and aquatic macroinvertebrates can be found in perennial springs. Several of the proposed projects in this plan intend to renovate or restore riparian vegetation.

The Rio de Flag and its tributaries have moderately to well defined channels, depending on the underlying geology. In terms of stream classification, they are mostly classified as Rosgen VIII, a moderately confined valley with fine soils and a distinct floodplain (Natural Channel Design 2020). Headwater channels tend to be Rosgen Type II, more confined, steeper, and lacking floodplains (Rosgen 1996). Stream restoration projects in the watershed have used a combination of Rosgen natural channel design stream restoration practices (Rosgen 1997) and quasi-traditional channel stabilization methods loosely based on Native American traditions (Zeedyk and Clothier 2014). Examples of

both types include the cross-vein weirs and check dams below the Schultz Fire and Museum Fire, “Zuni Bowl” channel stabilization in the Rio de Flag in the Cheshire neighborhood, and one-rock check dams in the Rio de Flag, Sinclair Wash, and Bow and Arrow Wash.

Many of the local streams do not show recent history of violent flooding, except within urban areas, and are defined by gravel beds and grassy slopes (Natural Channel Design, 2020). Stream incision, the act of channels down-cutting and abandoning their former floodplains and riparian areas, is thankfully relatively rare in the Rio de Flag watershed except where there has been extreme disturbance. While there are flash floods on the Rio, they are rarer than in desert environments. The water holding capacity of forest detritus, duff, and soils helps reduce violent flooding, so long as soils are not saturated and the precipitation rate does not exceed in soil infiltration rate.

Soil classification is still poor for most of Arizona, relying on low resolution National Resources Conservation Service (NRCS) soil atlases. The soil types that have been mapped are either generally very poor at infiltrating water (high clay contents from the weathering of the basalts and cinders) or are extremely good at infiltrating water (cinders, sands, gravels). There is a lack of well-defined loamy soil except in flat outwashes such as Freidlein Prairie, Baderville, and the Sunnyside neighborhood.

Natural Floodplain Function

Floodplains in the Rio de Flag watershed can absorb flood waters, improve water quality through natural filtering and flood attenuation, and support active and healthy riparian areas (Figure 19). Floodplains, however, can only provide these beneficial functions if they are conserved as natural open space and if hydro-connectivity with the channel is maintained. The City and the County both promote healthy natural floodplain function as part of their FEMA floodplain administrator duties. The City of Flagstaff maintains a rural floodplain designation for certain stretches of floodplain that have been determined to be intact and valuable for natural floodplain function. This designation limits development to protect the floodplain ecological function.

Alluvial fan floodplains that can be found at the base of the Peaks, Mount Elden, and Dry Lake Hills are especially valuable, because they can infiltrate large amounts of water. These areas are protected following wildland fires to enable the maximum amount of water infiltration upstream of post-fire flood flows reaching urban areas. For both the Schultz and Museum Fires, protective measures have included rock cross-vein weirs, channel rock and log dams, and channel bed stabilization. More information about natural benefits of floodplains can be obtained from the City of Flagstaff Stormwater Section or the Coconino County Flood Control District or Community Development Section.

Figure 13. A functioning natural floodplain in July 2021 near the confluence of Spruce Wash and the Rio de Flag (Photo credit Ed Schenk).

Climate Responses and Projections

Rapid, human-activity-driven climate change is already here, and we are not only seeing the impacts in terms of more prolonged drought, flashier floods, and increased temperature, but witnessing these changes accelerating ahead of many modeled predictions. Regionally, the first ever declaration of a water shortage for the Colorado River basin reflects this effect. Local strategies to respond to and become more resilient to climate change are being implemented only recently. These strategies include the Flagstaff Climate Action and Adaptation Plan (City of Flagstaff 2018), the Flagstaff Watershed Protection Plan (a forest thinning plan), and addressing climate change and forest vulnerability in the Coconino County Flood Control District's and Emergency Management Division's strategies and planning.

Climate has always been dynamic in the Rio de Flag watershed, with alternating dry and wet periods and cold and hot cycles throughout geologic history (Waring 2018). Most recently in the Holocene (11,700 years ago to present), the Southwest has heated

up and stranded cool temperature tree species in “sky islands”, high elevation stands surrounded by low elevation deserts. The Rio de Flag watershed is in one of these sky islands, with tree assemblages that resemble forests of the southern Rocky Mountains (Betancourt 2004).

Forest Ecosystems and Fire

Fire has been central to the natural history of forests of the Rio de Flag watershed. Studies show that, prior to the 20th Century, the ponderosa pine forests that cover most of the watershed experienced a fire frequency of once every 2 to 15 years as mostly low intensity fires (Cocke et al. 2005; Margolis et al. 2011). The forests began changing in the 1900s as sheep herders, cattle ranchers, and Flagstaff area residents began to suppress wildfires

More recently, the Forest Service, City of Flagstaff, and Coconino County have attempted to restore the forest stand density to reduce the risk of catastrophic wildfires (Figure 20). The Radio Fire, Schultz Fire, and to an extent the Museum Fire, were all high-severity wildfires in the Rio de Flag watershed that have had profound effects on the wildland-urban interface. Efforts to return the forest to earlier conditions include prescribed fire and mechanical thinning.

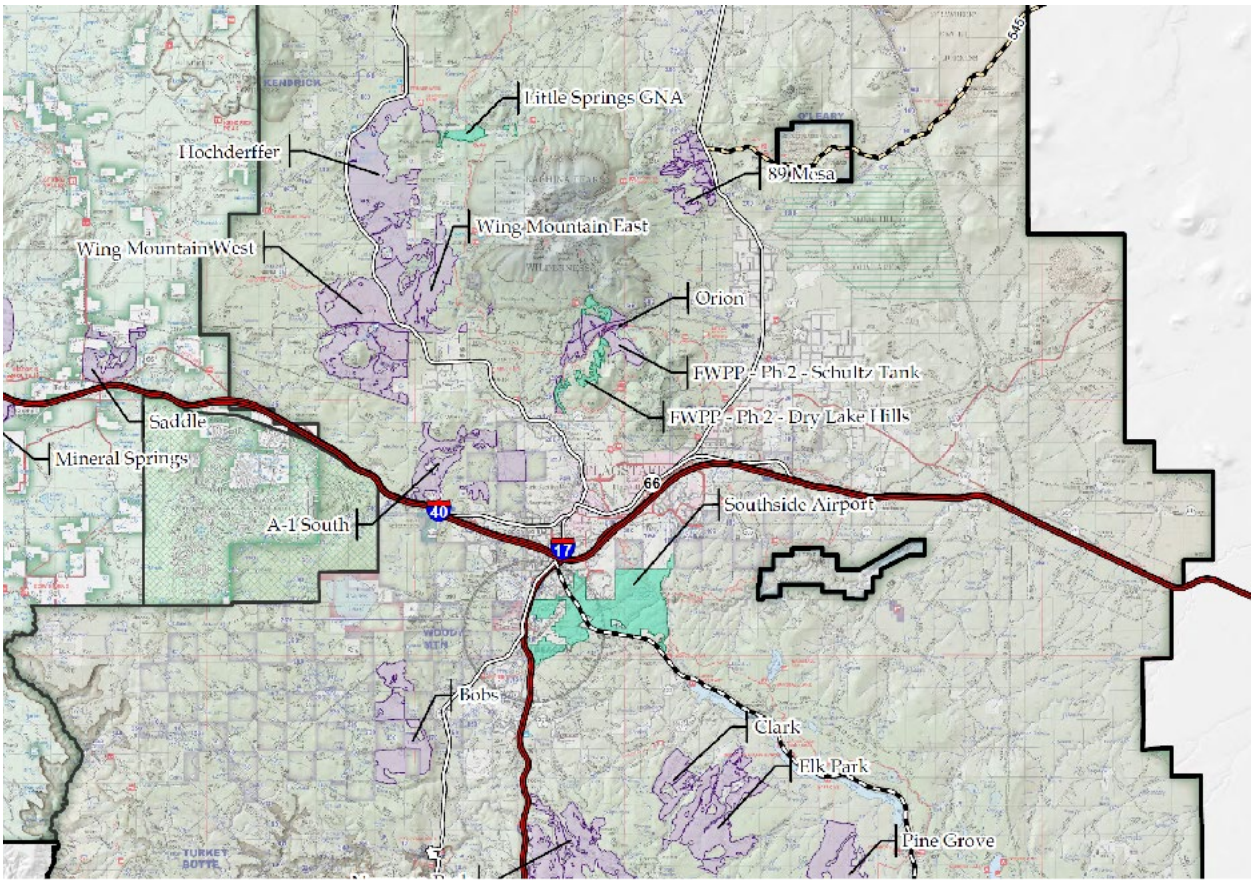

Figure 14. Current (purple) and planned (turquoise) 4FRI mechanical treatments in the Rio de Flag watershed vicinity. Map is from May 2021 and provided by the US Forest Service.

Beneficial plants vs. weeds – How they affect flood plain and watershed health and function

City of Flagstaff commissioned a biologist to develop a list of floodplain plant species found at 12 sites along the Rio de Flag and major tributaries (See https://sites.google.com/site/watershedallianceforthe rio/home). Further research may be conducted on selected species identified in the floodplain species assessment and a more detailed plan may be developed with input and assistance from subject-matter experts. The plan would identify actions the community can pursue to support conservation and recovery of those species.

Unlike beneficial plants that provide habitat, invasive weeds have become a large problem in the watershed and will likely continue to be so, due to human disturbance and transportation. The San Francisco Peaks Weed Management group is a non-profit volunteer organization that tracks and manages weeds in the watershed and Flagstaff area. The group advocates for a consistent weed strategy at the city, county, and federal level, which is needed in the Flagstaff area, and conducts weed control projects.

Weeds can be tracked using the City of Flagstaff Water Services' weed app (https://arcg.is/14CS1e). This app was created to help city and county managers track

and remove weeds, primarily in the floodplains and channels of the Rio de Flag and its tributaries. Noxious, or quick spreading, weeds include musk thistle, diffuse knapweed, yellow starthistle, spotted knapweed, bull thistle, poison hemlock, common teasel, scotch thistle, and Mediterranean sage. Siberian elm is also widespread and is the only tree species that could be considered noxious in the Rio de Flag watershed.

Urban development continues in the Rio de Flag watershed, with development on nearly every privately owned parcel within its boundaries. Most of the main stem channel of the Rio traverses private lands and is therefore influenced by urbanization. Future development is slated to occur as shown in the J.W. Powell Specific Plan; this regional plan shows the urbanization of some of the last privately owned parcels along the mainstem Rio de Flag. Urbanization can impact flood risk, water quality, accessibility, habitat and trail connectivity, as well as riparian ecology. Advanced planning is essential to engage the community and mitigate risks brought about by developing lands in close proximity to the Rio's main channel and floodplains, or in the interface with adjacent wildlands.

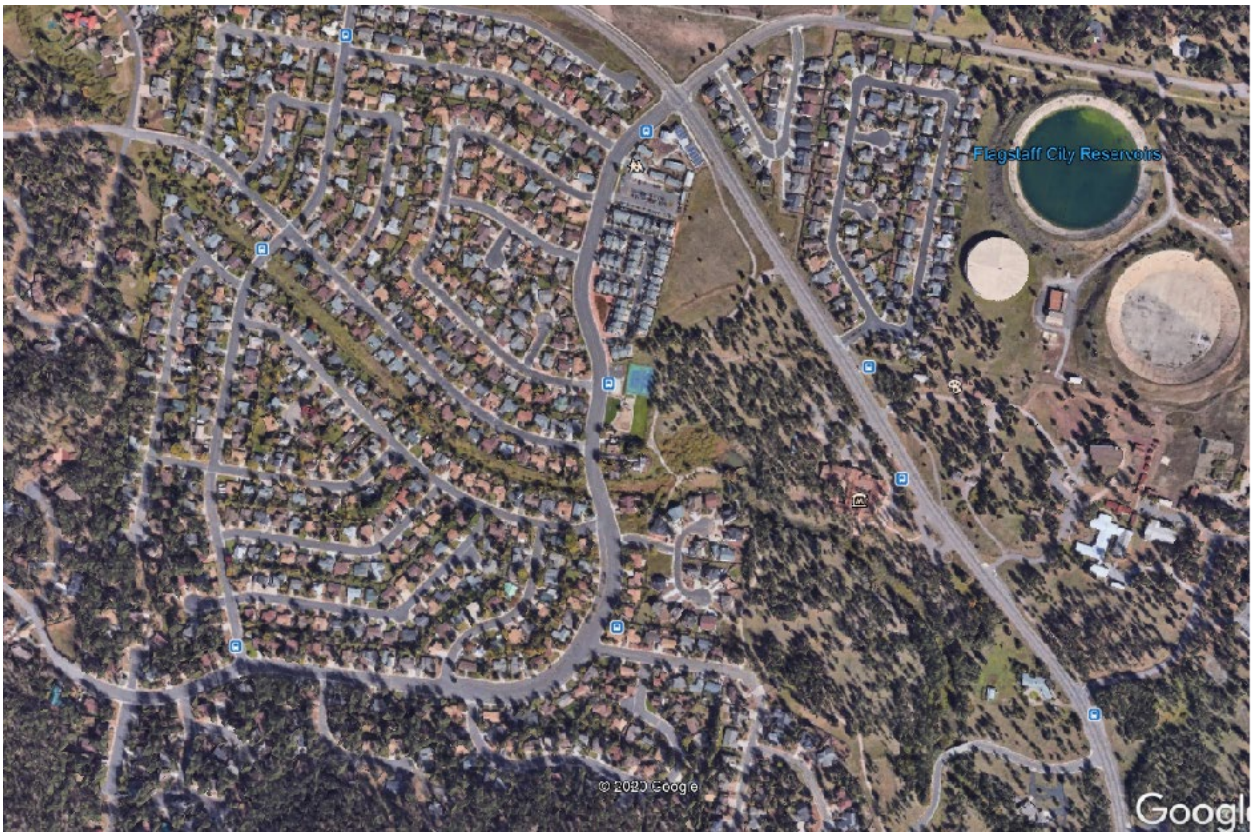

Figure 23. The Rio de Flag (green strip) in Cheshire neighborhood in 2020 (Google Earth).

STREAM REACH DESCRIPTIONS

The Rio de Flag watershed has been divided into sub-watersheds with boundaries defined by seven stream reaches along the main Rio de Flag channel. Each reach is based on unique factors that warrant discussion for planning and management. Reaches are numbered from upstream to downstream with the headwaters reach labeled as Reach 1 and the reach ending at San Francisco Wash on the east side of Flagstaff as Reach 7.

A wealth of background information for each reach could be more fully explored in neighborhood-specific plans and specific restoration plans and designs. This section introduces each reach, but these overviews are expanded upon in later sections of the plan. The later sections include restoration opportunities within each reach and map overlays showing locations for public participation comments and survey results.

Reach 1 – RDF headwaters to Cheshire neighborhood

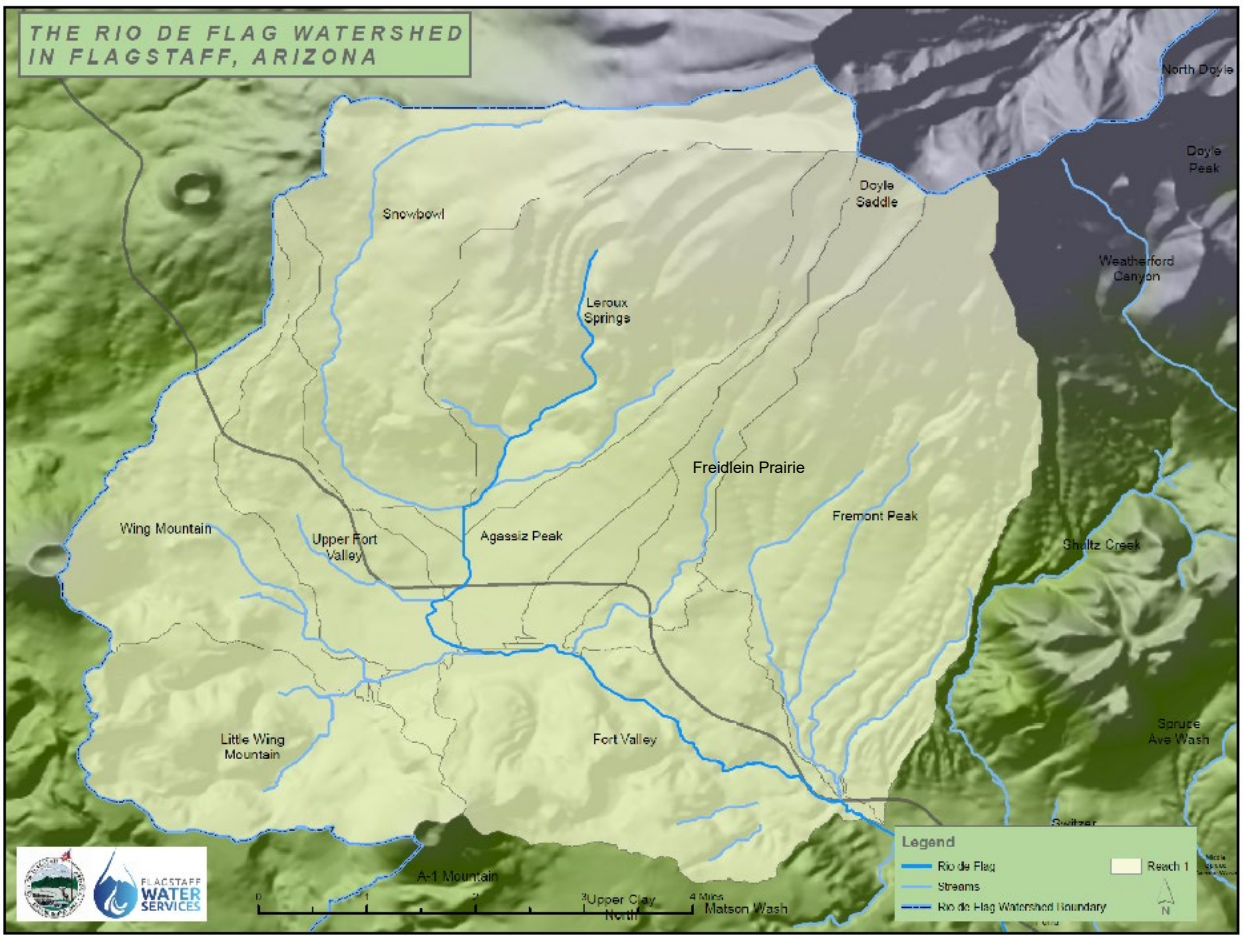

Figure 24. Map of Rio de Flag Reach 1 - Headwaters to Cheshire neighborhood, including sub watersheds

Notable features: Leroux, Viet, and Chimney Springs, the Fort Valley and Freidlein Prairie meadows, and the flanks of the San Francisco Peaks and Wing Mountain.

Threats: Severe wildland fires due to heavy forest loading, development of Fort Valley meadow, drought impacts on forest structure, recreational use of forest resources.

Relevant streamflow gauges: Rio de Flag at Hidden Hollow, operated by the USGS between 1970 and 1982 and by NAU between 2011 and the present.

Major tributaries: Unnamed tributaries off of the Fort Valley trails flowing into the Cheshire meadow, Peak View Street Wash, and unnamed tributaries off of Wing Mountain.

Summary: Reach 1 is the headwater reach for the watershed and consists of the Rio de Flag and tributaries in the Fort Valley area down to the Flagstaff city limits at Cheshire. The majority of development lines Highway 180 and is of relatively low density. Perennial water sources include notable springs and vernal wetlands within the Fort Valley meadow. Besides sites for residential homes, other land uses include recreational hiking, biking, and equestrian activities. Portions of this reach have recently undergone forest thinning actions through the Flagstaff Watershed Protection Plan and by the US Forest Service and The Nature Conservancy. Most of the channels in this reach are ephemeral, flowing only after precipitation or during snowmelt. Following forest thinning some intermittent streamflow has been observed downstream of treatments. Channels tend to be small and not very well developed (i.e. no sand bars, cut banks, or well developed terraces), likely due to steep topography and decades of forest overgrowth intercepting rain before runoff.

Geology, vegetation, land use: The surficial geology of this reach is entirely igneous with andesite, basalt, dacite, and cinders related to eruptions in the San Francisco Peaks, Wing Mountain, and A-1 Mountain. Alluvium is present in depressions such as the Fort Valley meadow and the Cheshire meadow/neighborhood. Vegetation is primarily ponderosa pine forest in lowlands transitioning to mixed conifer, aspen, and alpine tundra as the watershed increases in elevation. Land use is dominated by National Forest land though privately owned areas are largely developed (Fort Valley, Forest Heights, and Cheshire neighborhoods).

Reach 2 –Rio de Flag from Cheshire to Frances Short Pond

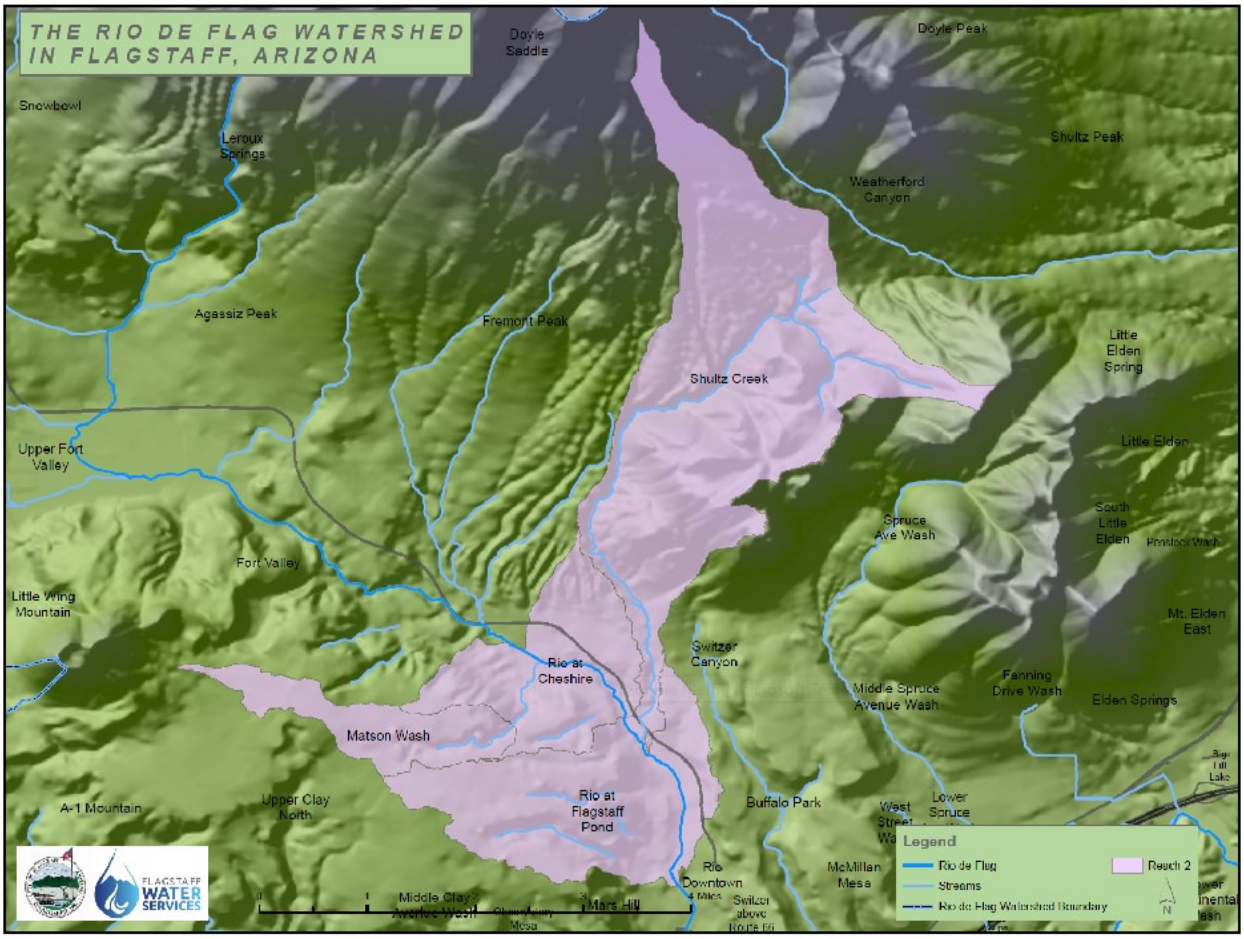

Figure 25. Map of Rio de Flag Reach2 - From Cheshire to Francis Short Pond, including sub watersheds.

Notable features: Schultz Pass, western Dry Lake Hills, Cheshire Pond, Frances Short Pond, water tanks and springs on Observatory Mesa and on south slope of Peaks (Orion, Coyote, Homestead, and other springs).

Threats: Invasive weeds, perched aquifer drawdown in Cheshire and Coconino Estates neighborhoods, recreational use of Schultz Pass, threat of severe wildfires, and continued development on Observatory Mesa in private in-holdings.

Relevant streamflow gauges: Rio de Flag at Peak View Street, operated by the city between 2008 and the present. Schultz Creek at Highway 180 operated by NAU between 2011 and the present and by the City of Flagstaff between 2017 and the present.

Major tributaries: Schultz Creek, Matson Wash

Summary: Reach 2 includes the Cheshire and Coconino Estates neighborhoods, upper Thorpe Park, portions of Observatory Mesa, the Dry Lake Hills, and the southern slopes of the San Francisco Peaks. The Rio mainstem is highly modified by channelization, damming, and dredging. The majority of the mainstem is urbanized while tributaries are protected by National Forest, city of Flagstaff open space, and the Museum of Northern Arizona undeveloped lands. Like Reach 1 most of this reach is ephemeral. The Rio de Flag near Cheshire Pond does flow at a small trickle throughout the year, likely a remnant of the San Francisco Spring that was noted near Cheshire Dam. The Cheshire Dam creates a perennial wetland before the scenic basalt narrows that bisect the Museum of Northern Arizona campus. Flow in the mainstem Rio de Flag can occur for several months following large snow events, especially in the Cheshire neighborhood which benefits from recent forest thinning immediately upstream. Channel development in the tributaries is still poor due to lack of sustained runoff. The mainstem has a well-developed and gynomorphically complex channel except in areas where it has been straightened or modified.

Geology, vegetation, land use: The surficial geology of this reach is entirely igneous with andesite, basalt, dacite, and cinders related to eruptions in the San Francisco Peaks, Wing Mountain, A-1 Mountain, and the Dry Lake Hills upheaval. Alluvium is present in the geologic valley of the Rio de Flag and in meadows. Vegetation is primarily ponderosa pine forest in undeveloped areas. Land use is dominated by National Forest land in the Schultz Creek area but is largely urbanized in the lowlands.

Reach 3 – Frances Short Pond to Sinclair Wash, Including Clay Wash

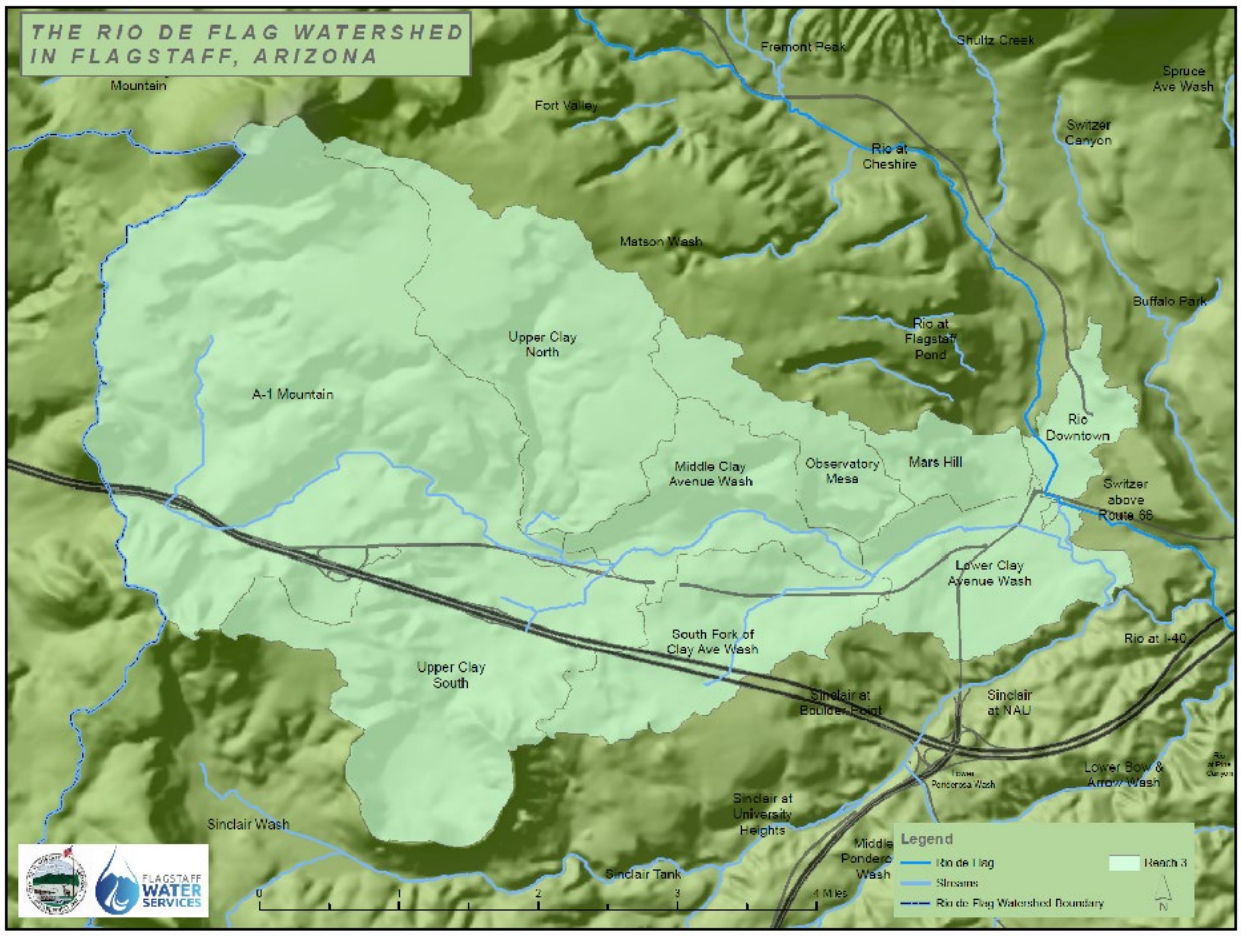

Figure 26. Map of Rio de Flag Reach 3 - Francis Short Pond to Sinclair Wash. Includes Clay Avenue Wash and sub watersheds.

Notable features: Tunnel and Old Town Springs, A-1 Mountain and Observatory Mesa tanks and trails, Clay Wash Dam, downtown and Southside Flagstaff, and the north campus of Northern Arizona University.

Threats: Continued development, recreational use of Observatory Mesa, urban flooding, invasive weeds, and illegal off-road use.

Relevant stream gauges: Clay Wash at the dam, South Fork of Clay Wash at Kaibab Lane, Little Rio at Lone Tree, downtown Rio de Flag NAU crest gauges. Various times of operation, all operating presently.

Major tributaries: Clay Wash

Summary: The mainstem in this reach is intermittent, fed by Frances Short Pond and urban runoff. The channel is highly altered by urbanization as it passes through

downtown Flagstaff and the Southside neighborhood. Although the Rio de Flag mainstem is short in this reach, it is one of the most controversial reaches in the watershed and has a high level of activism. Both neighborhoods lie in a natural depression that leads to flooding. The Rio de Flag Flood Control Project, a multi-million-dollar cooperative endeavor of the City of Flagstaff and U.S. Army Corps of Engineers, intends to relieve flooding pressure in downtown and the adjacent residential neighborhood by placing a large flood-conveyance tunnel under most of the mainstem stream in this reach segment. A newly created surface channel will serve as an amenity between Frances Short Pond and City Hall. From just south of Route 66, the Rio de Flag will be diverted away from the Southside and toward its original channel. When this change is completed, the Rio will flow eastward parallel to the railroad tracks and then south, and it will enter the present-day course near Interstate 40. Altogether, these channel changes are intended to and should relieve flooding in the Southside neighborhood from the Rio de Flag and its tributaries, local flooding is still possible where rain water collects off the streets. As of October of 2023, the city has completed the Clay Avenue Wash Detention Basin, the Butler Tunnel and the Thorpe Bridge all of which are components of the Flood Control Project.

Clay Wash is the only significant tributary in Reach 3. It has history of flooding at Milton Avenue, Butler Ave, and Mikes Pike. As part of the Rio de Flag Flood Control Project, the underground conveyance of Clay Wash will be moved from beneath Butler Ave to beneath Mike's Pike. This will allow tributary water to flow into the new alignment of the Rio de Flag and will also help relieve flooding in the Southside neighborhood. Clay Wash does not have a complex geomorphic channel upstream of the city. The urban section of Clay Wash is like the Rio de Flag, heavily modified for urban stormwater management, incised, and frequently flowing after rain events.

Geology, vegetation, land use: Geology in this reach is a combination of volcanic (igneous) rocks, deep alluvium in flat areas, and rare outcropping of Kaibab Formation sedimentary rock. Vegetation is highly dependent on urban landscaping but is ponderosa pine forest-dominated in the undeveloped areas, especially on Observatory Mesa and A-1 Mountain. Invasive weeds are prevalent, especially in Clay Wash where Scotch thistle can form dense monocultures. Land use is either undeveloped/recreation on national forest land and in the city Open Space program or heavily urbanized (medium- and high-density housing and commercial development) for most private land holdings.

Reach 4: Rio de Flag in the Southside neighborhood to I-40

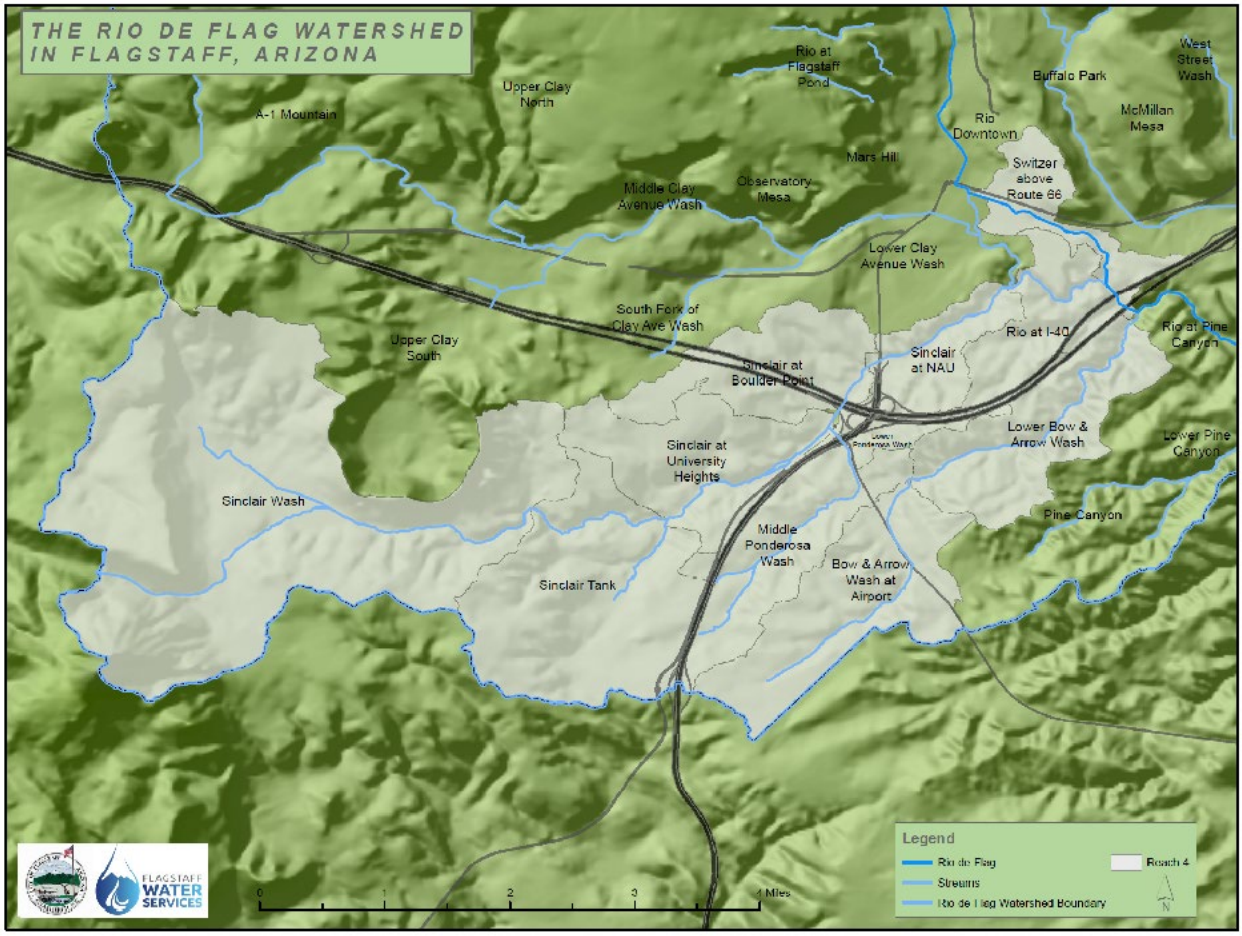

Figure 27. Map of Rio de Flag Reach 4 - Rio de Flag in Sunnyside neighborhood to I-40, including sub watersheds.

Notable features: I-40 Wetlands and Sinclair Wash canyon near Lone Tree Road.

Threats: Continued development, recreational use in Sinclair Wash headwaters, urban flooding, invasive weeds, severe wildfires.

Relevant streamflow gauges: Bow and Arrow Wash at the airport, Bow and Arrow Wash at Coconino Community College, Sinclair Wash at University Heights, Rio de Flag at Butler Tunnel. Bow and Arrow Wash gauge at the airport has operated since 2008, the Sinclair Wash and Rio de Flag two gauges are new as of 2019. An old USGS gauge operated near the Sinclair Wash gauge but the location is not exactly the same, since the channel has been greatly modified.

Major tributaries: Sinclair Wash, Bow and Arrow Wash, Ponderosa Wash

Summary: The Rio de Flag mainstem is short in this reach, like Reach 3. The mainstem is comprised mostly of the Southside neighborhood and a section of canyon

that leads to I-40. The Southside neighborhood lies in a natural depression that leads to flooding. The Rio de Flag Flood Control Project intends to relieve this flooding (see description above for Reach 3). Streamflow from the Rio de Flag and Clay Wash will be diverted away from the Southside neighborhood when the project is complete. This change should alleviate most of the flooding concerns in the Southside neighborhood, but the local flooding from the neighborhood will continue. Sinclair Wash, Bow and Arrow Wash, and Ponderosa Washes are the significant tributaries in this reach. Sinclair Wash has historically been more responsive to rain events, as shown by the well-developed valleys and canyons associated with the water course. Bow and Arrow Wash has urban sections with historical flooding prior to stormwater improvements as well as a relatively long natural canyon before meeting the Rio de Flag downstream of I-40. Ponderosa Wash is mostly urban but does include a small FUTS greenway from near the airport to Ponderosa Trails Park. Reach 4 is largely ephemeral except for the I-40 wetlands that demarcate the end of the reach. The I-40 wetlands are perennial due to discharge of reclaimed wastewater effluent from City of Flagstaff's Rio de Flag Water Reclamation Plant.

Geology, vegetation, land use: Reach 4, unlike the upstream reaches, has significant outcroppings of Kaibab Formation sedimentary rock (mostly cherty or silty limestone). Sinclair Wash canyon downstream of Lone Tree Drive and Bow and Arrow Wash canyon also downstream of Lone Tree are good examples of canyons with extensive outcroppings of Kaibab Formation rock. The headwaters section of Sinclair Wash is mostly igneous transitioning to sedimentary rock shortly after entering the city. Vegetation within the reach is dependent on land use. In urban settings the watershed is dominated by landscaping, though vestigial stands of ponderosa pine forest remain. The undeveloped sections of the watershed are largely ponderosa pine forest. Land use is like Reach 3. National forest, county park, Arizona State Land Trust areas are undeveloped, while city parcels and most private holdings are developed for urban commercial and residential use. This sub watershed includes the intersection of I-40 and I-17, commercial properties along Woodlands and Beulah Boulevards, NAU's south campus, and Pulliam Airport.

Reach 5: Rio de Flag from I-40 to Foxglenn Park

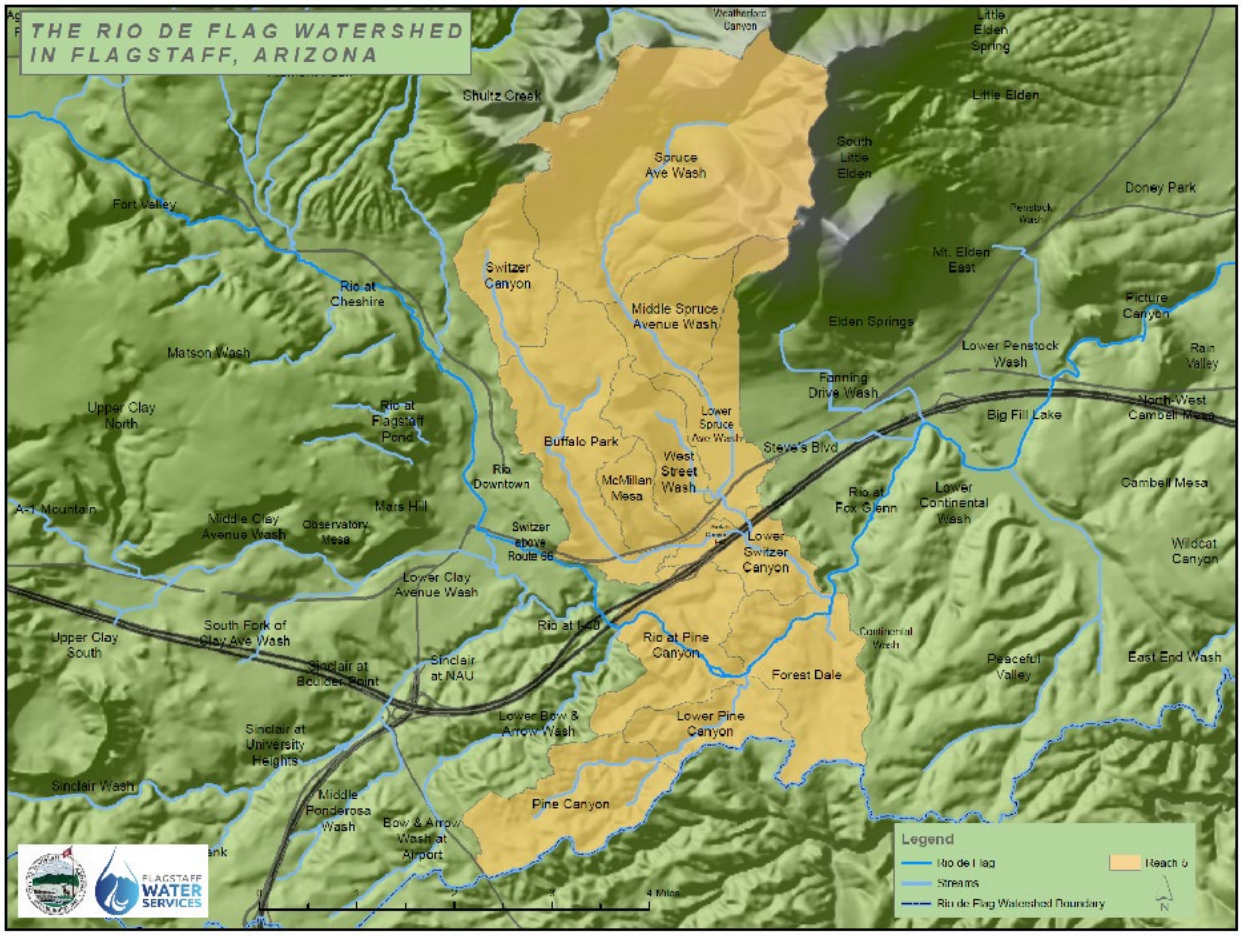

Figure 28. Map of Rio de Flag Reach 5 - From I 40 to Foxglenn Park including sub watersheds.

Notable features: I-40 wetlands, Switzer Canyon, and Buffalo Park.

Threats: Intense development pressure along the mainstem, invasive weeds, post-fire flooding, urban flooding due to development, localized off-road use in undeveloped reaches of the mainstem.

Relevant stream gauges: Rio de Flag at Foxglenn Park, Switzer Canyon at Oak Street, Spruce Wash at Linda Vista. All gauges are currently operational. The Rio de Flag at Foxglenn Park gauge extends back nearly a decade. The rest of the gauges are new as of 2019.

Major tributaries: Spruce Wash, West Wash, Switzer Canyon Wash, Pine Canyon

Summary: At the time of this writing this reach is unique in that the mainstem is perennial due to reclaimed water inputs from the Rio Wastewater Treatment Plant and is also an undeveloped reach that is bracketed upstream and downstream by urbanization. This mainstem reach, however, is slated for future development and will

likely look much different within a decade of this plan's completion. Relevant large tributaries are all urbanized in part or in total. Spruce Wash is notable as being affected by the 2019 Museum Fire. Post-fire flooding is still a serious concern for the Elden Estates, Grandview, and Sunnyside neighborhoods. Because of imminent development, perennial water, and post-fire impacts, this reach is especially important for planning to ensure a healthy multi-use riparian area.

Geology, vegetation, land use: The geology and vegetation of this reach varies from mixed conifer and igneous basalt/dacite at the top of Dry Lake Hills to herbaceous meadows and Kaibab Formation sedimentary rocks in the Rio de Flag lowlands near Foxglenn. Land use is mixed like most of the reaches described in this plan. Unlike other reaches, this area is slated for intensive development in the next decade. Invasive plants are prevalent in this reach, especially along the mainstem and the lower portions of the tributaries. Diffuse knapweed, Scotch thistle, poison hemlock, and teasel are found in abundance.

Reach 6: Rio de Flag from Foxglenn to Route 66 near Flagstaff Mall

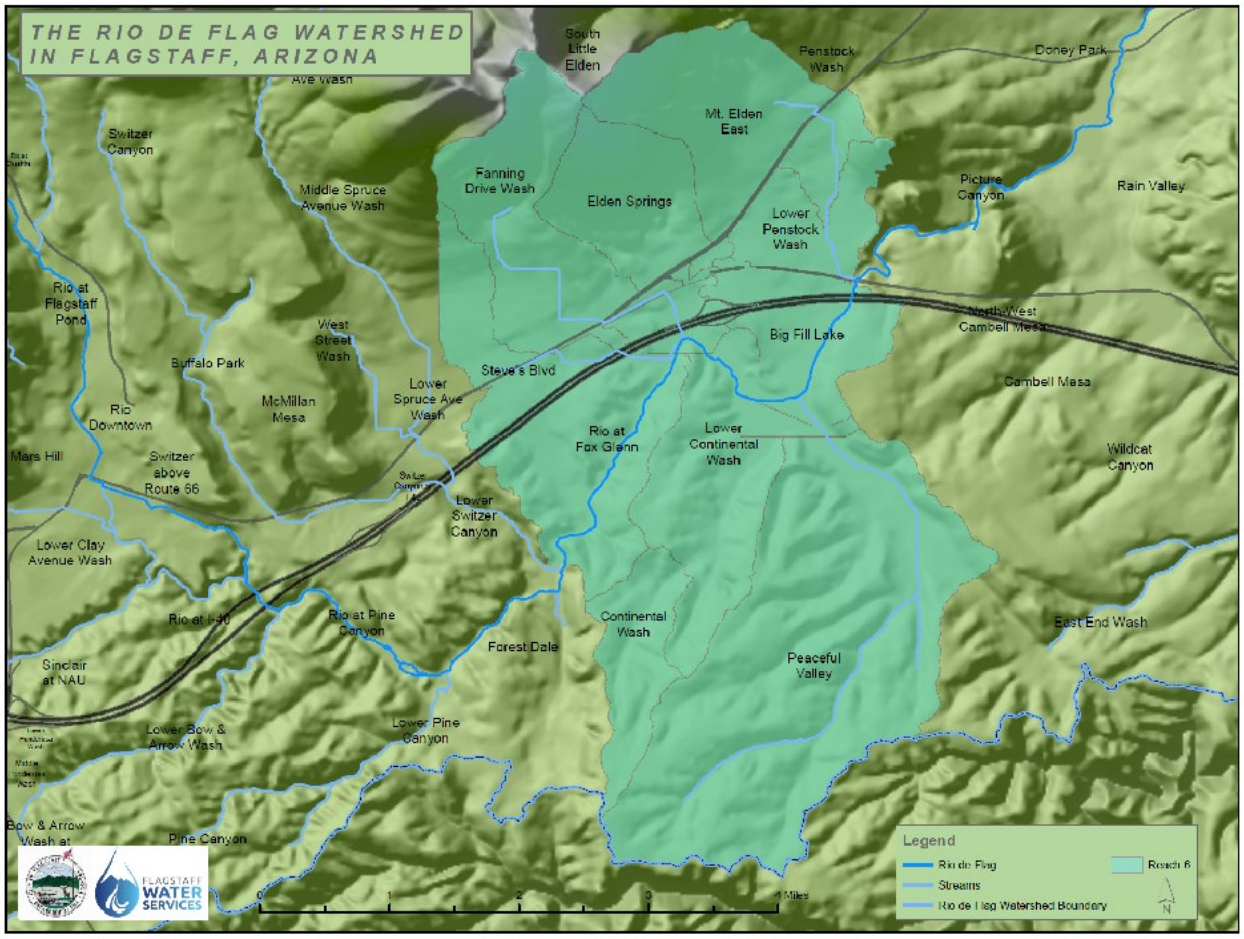

Figure 29. Map of Rio de Flag Reach 6 - From Foxglenn Park to Route 66 near Flagstaff Mall, including sub watersheds.

Notable features: Lake Elaine, Elden Springs, Bottomless Pits, Peaceful Valley

Threats: Invasive weeds, trash, urban flooding, wildfire, recreational use

Relevant stream gauges: Rio de Flag near Flagstaff Mall, Penstock Wash at Dodge Avenue, Fanning Wash at Linda Vista. All gauges are currently operational but are either new or have significant time gaps in their operation (Fanning Wash at Linda Vista).

Major tributaries: Fanning Wash (historically Lockett Diversion), Steve's Wash, Peaceful Valley Wash, Penstock Wash

Summary: The Rio de Flag mainstem is mostly in private property in this reach, however there are significant public lands in the tributaries. Some of the highest biodiversity in northern Arizona is found within this reach on the southern flank of Mount

Elden. Reach 6 includes a large section of eastern Flagstaff and extends north-to-south from the top of Mount Elden to near the rim of Walnut Canyon, encompassing a dramatic change in landscape, scenery, and land use. Most of this reach is ephemeral with infrequent flows except after precipitation events.

Geology, vegetation, land use: Reach 6 has considerably more sedimentary outcroppings than upstream reaches, with igneous basalt and dacite portions along Mount Elden. The karst nature of the Kaibab Formation is in display at the “Bottomless Pits”, a dissolution sinkhole feature near Continental Country Club. Vegetation changes drastically from the peak of Mount Elden to the lowlands near Country Club to the Walnut Canyon rim. The southern flank of Mount Elden contains numerous endemic species due to its unique dry and windy microclimatic habitat. Invasive weeds are prevalent in the low drainages, especially the Rio de Flag mainstem, a contradiction to the biodiversity in the natural parts of the reach. Land use includes the eastern neighborhoods of Flagstaff as well as Forest Service, State Land Trust, and recreational opportunities along Mount Elden and Peaceful Valley.

Reach 7: Rio de Flag from Route 66 near Flagstaff Mall to the confluence of San Francisco Wash

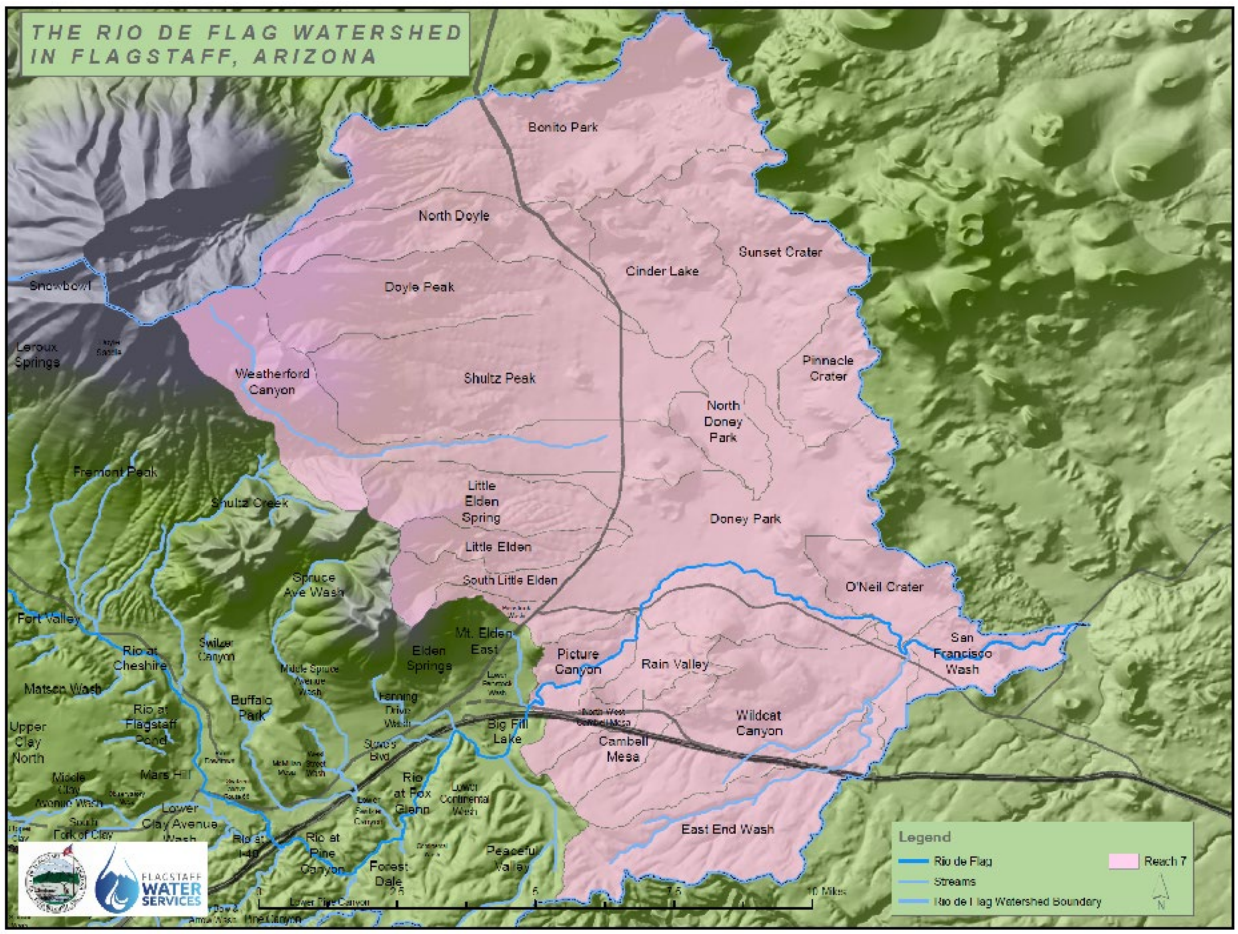

Figure 30. Map of Rio de Flag Reach 7 - From Rt. 66 near mall o the confluence of San Francisco Wash, including sub watersheds

Notable features: Picture Canyon, O'Neil Crater, Sunset Crater and cinder hills

Threats: Continued development, especially in Rain Valley and Doney Park, post-fire flooding from the Schultz Fire, invasive weeds

Relevant stream gauges: Rio de Flag near Flagstaff Mall, operational as a rain gauge for a decade and as a stream flow gauge starting in 2020.

Major tributaries: None, this reach is highly permeable with no significant tributary surface water inputs to the Rio de Flag.

Summary: This downstream-most reach of the Rio de Flag is unlike any of the other reaches. The watershed is characterized by a much warmer, drier climate with hobby farms, large residential lots, and little surface runoff due to the climate, vegetation, soils, and geology. The Rio de Flag is a contradiction in this reach as it is perennial due to

sustained outflows from the Wildcat Wastewater Reclamation Plant. The flows tend to remain perennial for a couple miles beyond the plant before soaking into the soil. The Rio de Flag ends as an ephemeral wash at its confluence with Wildcat Canyon Wash (a.k.a. San Francisco Wash). There are small discrepancies among map sources regarding mouth of the Rio de Flag. Some maps show the mouth of the Rio de Flag at its confluence with Walnut Creek (Figure 34). Either interpretation provides a similar watershed size, since the two confluences are within 4 miles of each other. San Francisco Wash continues downstream, eventually becoming Canyon Diablo before connecting with the Little Colorado River. Most of the channel downstream of the Rio de Flag is ephemeral, much like the Rio de Flag.

Geology, vegetation, land use: The geology of Reach 7 is predominantly cinders in the northern section and sedimentary rock in the southern section. Both types of surficial geology are extremely permeable with little surface water runoff. Vegetation is predominantly pinyon-juniper woodland except in high elevation areas or basalt outcrops. These slightly wetter areas maintain ponderosa pine forests. Land use is mostly dispersed residential lots and small hobby farms though considerable sections of national forest land exist within the reach.

PUBLIC INPUT PROCESS FOR THE RIO DE FLAG WATERSHED PLAN

Stakeholder engagement and interviews

A planning committee made up of stakeholders conducted a planning process that involved multiple public meetings at the beginning and throughout the planning process, including a public meeting held on the draft plan. Several public information activities encouraged input. The planning committee coordinated with multiple communities and other agencies, including City of Flagstaff, Coconino County, the Southside Community Association, Coconino National Forest, Arizona Game and Fish Department, and more. As a culmination of the watershed planning process, this plan will be formally adopted by the two community governing boards in the watershed, which are Flagstaff City Council and Coconino County Board of Supervisors.

Stakeholder and public engagement for developing this watershed plan began with identifying experts and community leaders interested in watershed planning for the Rio de Flag. A core working team was formed as a first step which consisted of representatives from Friends of the Rio de Flag, City of Flagstaff, Coconino County, Coconino National Forest, and The Hopi Tribe, and facilitators from Southwest Decision Resources. This core team reflected all the entities with direct land stewardship

authority in the watershed, including City of Flagstaff Community Development, which is the office responsible for community planning in Flagstaff. Unfortunately, the Covid-19 pandemic severely impeded outreach to the heavily impacted Navajo Nation, and ultimately it truncated participation by The Hopi Tribe also.

In 2018, Friends of the Rio de Flag conducted a public survey to determine where public interest was centered in and about the watershed, and the City of Flagstaff conducted a poll concerning the Flagstaff Urban Trail System (FUTS), much of which follows the Rio de Flag. Themes, project ideas, and lessons gleaned from those survey responses were integrated into the stakeholder approach for this watershed plan and helped to prepare for stakeholder interviews. The stakeholder interviews addressed processes and tried to identify key issues/opportunities. The responses provided a wealth of information about issues and needs related to water quality, quantity, restoration, planning, implementation, and evaluation to adaptively move forward. Fortuitously, many of the interviewees agreed to join the expanded watershed group to help guide the public process and construct the watershed plan.

Stakeholder and public workshops

In preparation for writing this plan, a series of stakeholder workshops and public workshops were organized to centrally inform the watershed planning process. The These workshops were designed to both better inform participants about the watershed and associated issues and to solicit input on experiences, problems, solutions, and opportunities. Because of the Covid-19 pandemic, public engagement pivoted from a planned series of in-person public meetings to a series of webinars/workshops that employed digital tools including Zoom® meetings and Mentimeter® interactive surveys.

Public workshops

Between November 2020 and February 2021, we conducted 6 virtual bi-weekly public workshops tied to the 6 watershed plan goals, in place of geographically based in-person meetings (see Appendix 5 for details). Each webinar featured multiple expert presenters who addressed watershed plan goal topics. Southwest Decision Resources facilitated the webinars. Paradoxically, providing the public workshops in a virtual space, which was necessary for safe social distancing during the pandemic, made it easier for people to join. The public workshops successfully brought together voices from across the watershed. The Zoom events were all well-attended by community members with a range of backgrounds and interests, as well as locations in the watershed where they reside.

Table 15. ***Explore the Watershed: Speaker Series (public meetings)***

November 10, 2020 - Hosted by: Friends of the Rio de Flag

Understanding Our Changing Watershed

Speakers: Max Taylor (Hopi Tribe), Laura Jo West (Coconino National Forest), Tom Whitham (Northern Arizona University), Larry Stevens (Museum of Northern Arizona), Travis Woolley (The Nature Conservancy), Sara Dechter (City of Flagstaff – Community Development), and Matt Nelson (Arizona Trail Association)

December 2, 2020 - Co-hosted by: City of Flagstaff Sustainability Program

Let's Get on Down to the Rio de Flag - Community Awareness, Celebration, and Engagement

Speakers: Maggie Twomey (City of Flagstaff), Art Babbott (Coconino County), and Moran Henn (Willow Bend Environmental Education Center)

December 16, 2020 - Co-hosted by: Wild Arizona

Nature Elevated: Benefitting Native Ecosystems of the Rio de Flag Watershed

Speakers: Larry Stevens (Wild Arizona), Tom Whitham (Northern Arizona University), Hannah Griscom (Arizona Game and Fish Department), Max Taylor (Hopi Tribe), Paul Beier (Friends of the Rio de Flag)

January 6, 2021 - Co-hosted by: NAU School of Earth and Sustainability

Sustaining and Healing Our Watershed

Speakers: Abe Springer (Northern Arizona University), Allen Haden (Natural Channel Designs), Denielle Perry (Northern Arizona University/Friends of the Rio de Flag)

January 20, 2021 - Co-hosted by: Southside Community Association

Rio for the People

Speakers: Deborah Harris (Southside Community Association), Martin Ince (City of Flagstaff), Matt Muchna (Northern Arizona University)

February 3, 2020 - Co-hosted by: Arizona Hydrological Society

Implementation and Beyond...Creating Stewardship

Speakers: Ed Schenk (City of Flagstaff - Stormwater), Josh Peck (Coconino National Forest), Nicole Antonopoulis (City of Flagstaff - Sustainability)

Attendance at the public meetings ranged from 25 to 45 people not counting presenters or staff. The presentations at these meetings and results of the public input from these meetings served in large part as the basis for this plan. Summary notes, PowerPoint presentations, and Zoom recordings for each session are posted online on the WARF website here: https://sites.google.com/site/watershedallianceforthe rio/public-meetings/presentations-and-notes

RECOMMENDATIONS & CONCEPTUAL PROJECTS

Overview

The WARF collected project recommendations and conceptual projects from the public through the virtual workshops and associated outreach, as well as from the WARF and presenters themselves. The projects were grouped by five themes (tied to goals; see Table 1.) and prioritized using a scoring matrix. The results follow below with an overview map (Fig. 37), reach summaries, recommendations/projects by goal, and priority conceptual project tables. The most numerous site-specific project suggestions were for trash pickup and weed control projects, these were lumped for prioritization but all the site-specific locations were retained and can be accessed when we are planning specific efforts. While not all of the 116 projects are included in our priorities for the immediate future, any or all of them could be implemented over time.

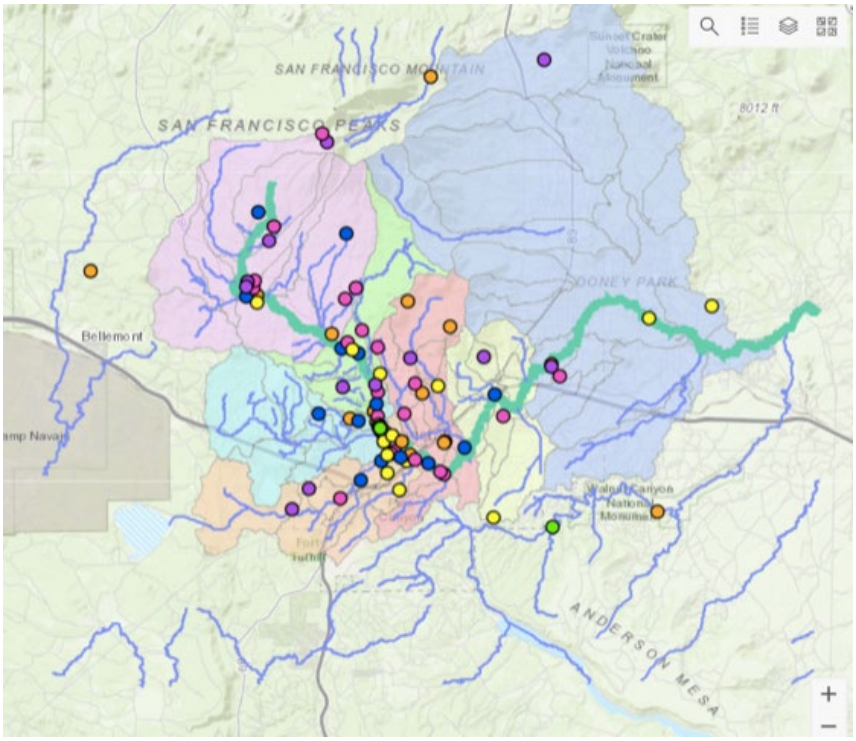

Figure 3116. Summary map of 116 site specific potential projects throughout Rio de Flag Watershed suggested by the public and stakeholders. Dots are color-coded according to theme (See pie chart at bottom left. magenta = Sustain and Restore, purple = Research, orange = Awareness, blue = Rehabilitate, yellow = Community Enhancement, green = Other).

Table 1. **Themes and associated goals generated through public involvement for Rio de Flag Watershed Restoration Plan.**

Research
Goal 1: Increase integrated cultural, scientific, and historical understanding of the Rio de Flag watershed.

Sustain and Restore
Goal 2: Protect and enhance Rio de Flag watershed health to deliver ecosystem services to future generations.

Community Enhancement
Goal 3: Benefit human communities of the Rio de Flag watershed.

Rehabilitation
Goal 4: Benefit native ecological communities of the Rio de Flag watershed.

Awareness

Goal 5: Increase public awareness and engagement to strengthen the community's connection to the Rio de Flag watershed.

Scoring criteria

Urgency/Timeliness
How critical/central is the project to the goal. How time-sensitive is the project—opportunities, threats. Is the project required before other projects can be completed? Is the project timely for the circumstances (crystalizing moment)?

Feasibility
How feasible is this project? is it contentious or broadly supported? Are necessary components in place? Has this project been determined as potentially successful (metrics of success)? Do we know what success looks like for this project?

Social Salience
Marketability, potential to generate more public support and engagement for the Rio watershed efforts, addressing community values and needs?

Cost
Is the cost reasonable and budgeted? Does a funding source (line item, grant, etc.) exist? Evaluate cost: benefit

Scale
a) temporal b) spatial (average the two scores)
What is the scale of the project? Is this a project that can be completed quickly and with readily available funding? Is this a project that has potential large scale benefit, broadly effective?

Relationship to other goals
How many other goals does it leverage?

Partner Priority
Is this project a high priority for one or more of the WARF partner agencies/organizations?

Suggested project results by reach and theme:

Reach 1 had a total of 20 unique proposals. The proposed projects were centered around Forest Service management and Baderville/Fort Valley community management. *Sustain and restore* was the most targeted goal with several suggestions to protect or restore headwater springs, meadows, and wetlands. *Increase awareness* and *research* on these values were also consistent themes within this reach.

Reach 2 had 12 unique proposed projects. While there was a good spread of themes/goals represented the majority of the projects focused on enhancing or preserving existing riparian or local park amenities (6 of the 12 projects). These amenities range from Frances Short Pond to the Cheshire wetlands.

Reach 3 had 15 unique projects proposed with the most projects being in *community enhancement*. Nearly all the projects were focused on improving access and programs along the Rio de Flag.

Reach 4 had 18 unique projects listed with the greatest share in themes of *sustain and restore* and *community enhancement*. Nine (9) of the 18 projects are directly attributed to Sinclair Wash, a major tributary to the Rio de Flag. The other nine projects are mixed between increased research and more community amenities along the Rio de Flag.

Reach 5 has 14 unique projects, the majority are *sustain and restore* related although there is a strong component of *increase awareness*. Nearly all of the *sustain and restore* projects are located on tributaries, mostly Switzer Canyon and Spruce Wash. The *increase awareness* category comprises projects on the mainstem Rio de Flag.

Reach 6 is a smaller reach and not surprisingly has the least number of proposed projects among the reaches. The stream reach includes 4 projects that range from Mount Elden to the mainstem.

Reach 7 has seven projects identified. Three (3) of the seven projects were directly related to reclaimed water flows from the Wildcat Reclamation Plant, emphasizing the importance of this perennial water source, and in one project, the water quality of that source.

Watershed-wide Suggested Projects

The interactive map surveys resulted in another 25 projects entered that were watershed-wide or general in content and could not be placed on a map. These projects were relatively equally spread among the themes/goals. Most projects were general in scope, as would be expected with watershed-wide concerns. Examples of these projects include; research into water rights and water quality, improving stream maintenance programs, consistent branding of community amenity locations, development of ecological refugia, and the development of more trails and community access.

Setting Goals: Recommendations and Projects

The WARF reviewed the recommendations and conceptual projects compiled across the watershed. The WARF planning committee identified 58 recommendations and concepts (out of 116 total) that are helpful for fulfilling the top 10 priorities of one or more of the WARF partners. Subsequent, the planning committee set overarching goals and objectives that are discussed below. Partner priority projects/recommendations are summarized under the watershed goals and objectives they address. Additional descriptions of reach-specific project concepts are included at the end of each summary. Possible activities in the watershed include the following:

a. Preventive measures (e.g. codes)
b. Property protection (e.g. elevation)
c. Natural resource protection
d. Emergency services
e. Structural flood control projects
f. Public information

- *Goal 1: Increase integrated cultural, scientific, and historical understanding of the Rio de Flag watershed*
- *Goal 2: Protect and enhance Rio de Flag watershed health to deliver ecosystem services to future generations*
- *Goal 3: Benefit human communities of the Rio de Flag watershed*
- *Goal 4: Benefit native ecological communities of the Rio de Flag watershed*
- *Goal 5: Increase public awareness and engagement to strengthen the community's connection to the Rio de Flag watershed*
- *Goal 6: Create a sustainable funding stream for the Rio de Flag watershed*

Goal 1. Increase integrated cultural, scientific, and historical understanding

Projects submitted under this goal were broad in scope, with several related to research and science and several others directed toward public outreach and trail/access education. Existing educational and outreach locations along the Rio de Flag corridor are mentioned infrequently, and the majority of projects listed were situated in new diverse locations such as Mount Elden, McMillan Mesa, and the Soliere floodplain.

Frances Short Pond, Picture Canyon Natural and Cultural Preserve, and Sinclair Wash at Willow Bend are three conventional sites along the Rio de Flag currently utilized for their immense educational opportunities. Many schools, businesses, and neighborhoods are located along the banks of the Rio and its tributaries and would benefit from enhanced educational opportunities at these sites.

Education should focus on place-based learning, service learning, and citizen science through:

- Site enhancement (signage, hands on installations, wildlife viewing platforms, etc.);
- Educational programs that incorporate site visits (targeted at K-12, residents, and visitors);
- Online educational resources (lesson plans, maps, audio guides, etc.);
- Ongoing service learning and citizen science programs that inspire a deeper understanding of the watershed while simultaneously giving residents and visitors a chance to give back to their river (invasive weed pulls, trash cleanups,

Adopt-the-Rio de Flag Stewardship program, ADEQ's Arizona Water Watch data collection, Master Watershed Stewardship program, etc.).
- Improved trail access with integrated signage and community activities (e.g. trail run days, Rio talks, etc).

Informal scientific research has occurred throughout the Rio de Flag for decades. Formalized research sites for conducting research on the Rio could strengthen our understanding of the various aspects of the watershed.

Scientific Research Recommendations:

1. Identify secure funding source to support science and education that could include Fish and Wildlife Service grants, Arizona Water Protection Fund, WaterSMART, EPA STAR, and other funding sources. Identify areas of public ownership that could be used for outdoor classrooms and research sites, and make this information available to schools . Each reach should be evaluated for educational opportunities including proximity to schools and sites of exceptional educational value (Frances Short Pond, Willow Bend, etc.).
2. Create a system for tracking research endeavors.
3. Create an online network for communicating research and identifying potential partnerships for research projects.

Watershed-wide studies and outreach

Objective 1.1 Compile studies, highlight gaps, and provide strategies and funding opportunities

- Establish an Earth Observatory
- Create an interdisciplinary program at NAU for Rio de Flag watershed studies and learning
- Build online repository for data/studies/references
- Compile the human history of change in the watershed
- Other research projects could involve ground water recharge which the city has expressed an interest in,
- local springs and seeps, which the Museum of Northern Arizona has already begun, local plant communities and archeology along the Rio which has been ongoing since the Colton's first worked at Picture Canyon.

Reach specific projects to increase watershed understanding

Reach 1 - Elevational vegetation transects to relate predicted vegetation community shifts to fire response.

Reach 6 - Examine base level controls and erosion, cycles of downcutting and aggradation related to Little Colorado River system.

Goal 2. Watershed health

This goal received 19 individual projects under rehabilitation (maintenance/flood mitigation) and 21 individual projects under sustaining and restoring the watershed. Nine (9) of the rehabilitation projects are directly tied to urban hydrology and channel restoration, the rest of the rehabilitation projects are a mix of wetlands preservation, invasive plant management, reclaimed water management, and pond preservation.

Eight of the “sustain and restore” projects were related to springs and wetlands, making up the largest proportion of the projects. The other 13 projects were spread between invasive weed work, channel maintenance/flood mitigation, rare plant preservation, and illegal trail/use management. Goal 2 received 40 projects out of the 116, indicating a high amount of interest in watershed health, either in terms of preservation or restoration.

Groundwater recharge can help to refill our aquifers and can be accomplished either by natural seepage through the ground or by pumping water back into the ground. Either way groundwater recharge can provide future water for our use. The City of Flagstaff has discussed creating a groundwater recharge program. Some issues need resolution before groundwater recharge becomes a reality. One issue has to do with the presence of chemicals in reclaimed water. Not enough is known about the persistence of endocrine disrupting chemicals and partially oxidized radical in the water and their health effects.

Recommendations

1. Promote forest health and watershed integrity, protect water quality, mitigate for extreme climate events.
   - Forest restoration
   - Post-Wildfire response
   - Water quality (pollution) mitigation

2. Restore, rehabilitate, and sustain effective hydrologic and geomorphic function.
   - Protect natural channel and floodplain geometry.
   - Rehabilitate damaged channel and floodplain areas.
   - Mitigate urban stormwater impacts.

3. Maintain past watershed work and recently completed projects
   - Provide long term maintenance for ecological restoration and channel improvement programs.

4. Restore climate change impacts to soils, vegetation, rainfall-runoff, migration, and precipitation patterns--craft and test management strategies.
   - Restoring watershed ecosystems

5. Increase watershed protection through special designations
   - Rural and/or Administrative Floodplain designations within the City of Flagstaff

- Create and maintain study areas on Forest Service lands
- Create and maintain parks and reserves within County parcels

6. Create comprehensive plan for forest, stream, springs, and riparian management and restoration access.
   - This WARF plan is striving to begin fulfilling this need.

7. Continue efforts to monitor chemicals in reclaimed water and knowledge of the impact of these chemicals. Apply best available science to determine the chemical compounds in reclaimed wastewater, the physiological effects of exposure to different concentrations, and the effects of chronic low concentration exposure to reclaimed water to both environmental and human health.

Goal 3. Benefit human communities

This goal aims for improving access to the watershed amenities, improving and creating amenities, and promoting recreation. This goal received 15 individual project proposals via the stakeholder survey. Thirteen (13) of the 15 projects involved walking, hiking, or biking. The majority of projects involved active recreational opportunities though there were mention of interpretative signage and themed events. Additional fishing opportunities was only mentioned one time. Frances Short Pond being the only fishing site along the Rio de Flag.

Recommendations
Support any stakeholder group that actively promotes compatible, diverse, and informed recreation and public use of stream corridors within the watershed.

Improve and enhance recreational connectivity along the Rio de Flag and between the Rio and surrounding open space and neighborhoods.
- Support FUTS and Open Space: connectivity, access, commutability
- Promote providing benches, shade rain shelters

Re-create and/or maintain a full array of natural surroundings (e.g., wetlands, open or moving water, observable wildlife, forests),

Remove trash to promote community health and well-being.

Address roots of community health problems along the Rio including homelessness, weeds and waste/sewage.

- *Goal 1: Increase integrated cultural, scientific, and historical understanding of the Rio de Flag watershed*
- *Goal 2: Protect and enhance Rio de Flag watershed health to deliver ecosystem services to future generations*

- *Goal 3: Benefit human communities of the Rio de Flag watershed*
- *Goal 4: Benefit native ecological communities of the Rio de Flag watershed*
- *Goal 5: Increase public awareness and engagement to strengthen the community's connection to the Rio de Flag watershed*
- *Goal 6: Create a sustainable funding stream for the Rio de Flag watershed*

Recreation, trails, and public use

Objective: Provide residents and visitors opportunities for recreation with an emphasis on passive recreation such as hiking, biking, cross country skiing, enjoying nature etc. enhancing our quality of life and sense of community.

Description: The Rio de Flag has been called the backbone of the Flagstaff's Urban Trails System and Open Space Programs. Along the way the Rio offers abundant opportunities for walking, hiking, biking, cross country skiing, snowshoeing, enjoying nature, exercising, and seeking peace and quiet.

The existence of this interconnected system means that residents can recreate or exercise close to home and go as little or as far as their ambition takes them. Our intent is to reinforce the connectivity and attractiveness of the Rio and its tributaries thereby enhancing our quality of life and sense of community while providing recreation for residents and visitors. The system of trails often allows visitors to exercise or enjoy their leisure often near their lodgings. Trails are also used by some residents to commute from work school or shopping by bike, foot, or even skis.

The FUTS is connected to Coconino National Forest Service trails, Coconino County trails (at Fort Tuthill) and the Arizona Trail in theory linking residents to surrounding landscape and all of Arizona. A few unique areas along the Rio de Flag and its tributaries offer special recreational opportunities such as the chance to fish at Frances Short Pond or to bird watch along more natural sections of the Rio. At least seven city parks (Cheshire Park, Thorpe Park, Wheeler Park, Colton Park, Coconino Park, Sawmill Park, Fox Glenn Park) are enhanced by the Rio de Flag running through them providing unique opportunities for play or contemplation.

Much of Flagstaff's Open Space including the Picture Canyon Natural and Cultural Preserve is also found along the Rio. An opportunity exists developing more Green Belt segments along the Rio to provide for a more extended experience that is less urban and more natural.
Examples of areas which can function as green belt segments are from Coconino Park to Beale Road south to Thorpe Park, from Lone Tree Road southeast to Interstate 40, and from US 89A across NAU campus to Lone Tree Road.

Recommendations

1. Build on to the existing FUTS trail to create a connected trail system along the length of the Rio de Flag and its major tributaries connecting with surrounding public lands, trails and parks and open space.
1. In channel restoration, use an open, stepped channel design where possible practical in order to provide for multiple uses (including flood control, recreation, scenic views, educational uses, riparian habitat, etc.)
2. Where opportunities exist develop Open Space or Green Belt segments along the Rio de Flag and its tributaries. Enhance these areas to provide a better recreational experience. Include new areas as Flagstaff grows to allow new connections to developing areas and to maintain connections to surrounding public lands. Create connectivity using the FUTS along the Rio where possible and along any new development along the Rio or its tributaries.
3. Emphasize passive recreation (walking, hiking, running, biking, cross country skiing, snowshoeing, enjoying nature, bird watching, seeking peace and quiet) along the drainages.
4. Use the Rio de Flag as a backbone for FUTS and Flagstaff Open Space system.
5. Develop parking informational signs, access, rest areas as needed to support recreational uses.
6. At major hubs where group use is common and trails converge consider providing parking, drinking water and toilets. Example of potential hubs are Fort Tuthill, Picture Canyon, and the Schultz “Y”.

Goal 4. Benefit native ecological communities

This goal is focused on improving native ecology, biodiversity, and ecosystem function within the watershed.

Objective 6.1: Manage the Rio de Flag to maintain, recover, and maintain or increase diversity of native ecological communities and to reduce or eliminate non-native species.

One of the most exciting potential scientific research projects is development of a genetic repository for riparian plants. The idea was presented by Dr Tom Whitham at one of the seminars leading up to this plan. The idea amounts to growing cultivars of woody plants from a number of sites in the region along the Rio De Flag in order to facilitate research into their adaptability to climate change and various growth traits. Dr. Whitham has begun this type of work with cottonwoods and willows and has shown cultivars vary widely in their adaption to growing sites and insect communities. Plants from this genetic repository could then be used to restore sites through the region. A natural site for this work is the Sinclair Wash as it crosses the NAU campus.

Perennial stream segments
Objective 6.2: Maintain sections of the Rio de Flag that have ephemeral and perennial water flow, and enhance flows where appropriate, to support a variety of native ecological communities.

Maintain perennial or near perennial flows for short segments in the Rio de Flag below springs and reclaimed water outlets to provide riparian habitat, scenic beauty and increased diversity of native vegetation and wildlife and, groundwater recharge.

Description: Most of the flow both in duration and in volume in the Rio de Flag has probably always been and will be ephemeral. However, some segments are perennial or close to perennial either naturally (i. e. below Leroux Springs) or artificially as reclaimed water below discharge points. These segments offer a special opportunity for diverse native vegetation, wildlife and scenic beauty. They also may offer some of the best sites for a riparian genetic repository for cottonwoods as has been proposed by Dr. Tom Whitham.

Native riparian plants have a range of tolerances for drying, some requiring true permanent water and others being very tolerant of drying. By providing a range of conditions, we can increase the diversity of plants and animals along the Rio de Flag. Research has demonstrated that plant diversity provides for greater ecosystem resiliency and services. Also by maintaining a few short segments of perennial flows the scenic beauty can be enhanced and the ability of residents and visitors to find peaceful and tranquil setting is enhanced. Perennial flows also can allow increased natural groundwater recharge to take place thereby benefiting our water table.

The Leroux Springs complex is the original source of the Rio de Flag. This complex of springs is named for Antoine Leroux who guided government and private parties of explorers and often stopped at this spring. The Rio de Flag is a perennial stream for a short distance downstream of Leroux Springs, and downstream of two city water treatment plants, but most of the stream reaches along the Rio de Flag are best characterized as ephemeral. Other small springs and seeps, such as at Cheshire Park, and old Town Springs, are also perennial and contribute flow to the Rio de Flag as it progresses downstream.

The City produces reclaimed water and discharges these waters at selected locations. These discharge points include Frances Short Pond, the I-40 wetlands below the Rio de Flag WTP, and above Picture Canyon from the Wildcat WTP. The City has minimum obligations to discharge at all three locations, but flows generally do not extend very far downstream, with the exception of the Wildcat Plant. The I-40 wetlands and Picture Canyon have become very popular sites for recreation in part due to the presence of water and the resulting vegetation and wildlife.

Recommendations:

1. Dedicate at least 5% of reclaimed water to instream flow in the Rio de Flag or its tributaries (natural seepage from this flow may be credited to groundwater recharge).
2. Use instream flows for natural groundwater recharge choosing release points for multiple benefits including suitability for groundwater recharge, as well as enhancing recreation, restoration, education, and scenic beauty.

3. Evaluate impacts of existing discharge points including Frances Short Pond, the I-40 wetlands (Rio de Flag WTP) and the main discharge at Picture Canyon from the Wildcat WTP as part of evaluation of new discharge points.
4. Maintain and enhance where practical surface flow from springs and downstream from springs. Maintain, restore and enhance native riparian in these areas.

Goal 5. Public awareness and engagement

Strengthen collaboration and communication, and identify shared interests to build bridges between diverse stakeholders through the watershed planning process and plan implementation.

Provide economic, education (e.g. outdoor classroom, youth programs), and volunteer opportunities and create incentives for businesses in the community to take actions to benefit the watershed.

- Existing opportunities to enhance: Frances Short Pond, Picture Canyon Natural and Cultural Preserve, and Sinclair Wash at Willow Bend
- Opportunities: recreation, green tourism, restoration and creative projects and events

Cooperate with other NGOs and governmental organizations in providing educational materials and opportunities concerning the watershed

Develop and implement signage for both the watershed and the channel.

Identify opportunities for community events, celebrations, and the arts centered around the Rio de Flag watershed

Goal 6. Sustainable funding stream

This goal, understandably, received very few proposed projects by the stakeholder group. The goal is intended less as a project specific goal and more as an overarching interest in finding consistent funding for watershed themed programs. The WARF and other stakeholders can jointly or separately seek funding for projects within the watershed. The 141 projects suggested during development of this plan do not constrain future efforts. In addition to project funding there is a need for ongoing monitoring, administration, enhancement and maintenance. The WARF intends to seek both project funding from grants and funding on going needs

Priority conceptual projects:

As part of the process of developing this plan the WARF undertook prioritizing the projects suggested by the public and stakeholders. The intent is not to eliminate any suggestion but rather to provide a starting place for work. The WARF also intends to add new project suggestions to

our list as time goes on. The following are the scoring criteria we used to reach this initial priority ranking.

Scoring criteria

Urgency/Timeliness
How critical/central is the project to the goal. How time-sensitive is the project—opportunities, threats. Is the project required before other projects can be completed? Is the project timely for the circumstances (crystalizing moment)?

Feasibility
How feasible is this project? is it contentious or broadly supported? Are necessary components in place? Has this project been determined as potentially successful? Do we know what success looks like for this project?

Social Salience
Marketability, potential to generate more public support and engagement for the Rio watershed efforts, addressing community values and needs?

Cost
Is the cost reasonable and budgeted? Does a funding source (line item, grant, etc.) exist?

Scale
a) temporal b) spatial (average of two scores was used)
What is the scale of the project? Is this a project that can be completed quickly and with readily available funding? Is this a project that has potential large-scale benefit, broadly effective?

Relationship to other goals
How many other goals does it leverage?

Partner Priority
Is this project a high priority for one or more of the WARF partner agencies/organizations?
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Table 2. Initial Priority Projects derived from public meetings and WARF review.

Project Name	Description
Museum Fire Restoration	Restoration and rehabilitation in Museum Fire scar and areas that haven't been thinned
Trash and Weed Removal Watershed Plan and Implementation	Create a watershed scale invasive plant and trash removal plan and funding mechanism for treatments

Use of reclaimed water for riparian restoration	Use of reclaimed water for amenity value on stream reaches that have high diversity of native plants and wildlife and that run along highly-used FUTS trails.
Sinclair Wash connectivity/restoration	Sinclair Wash: improve channel function, prepare for more flows with increasing development, riparian restoration with cottonwoods and willows; Restore channel-floodplain connectivity in Sinclair Wash, address erosion and downcutting
Channel Maintenance Program for the watershed	Well funded open channel program: Trash, weeds, channel morphology, bank erosion

Increase Awareness of Springs, Wetlands amd Alluvial Plains	Increase awareness and protection of upper-watershed springs, wetlands and alluvial plains
State of the Watershed panel	State of the Watershed panel discussions between scientists and public
Annual Rio De Flag Festival	An Annual Rio de Flag Art Walk and Festival

Water Rights Research	Research water rights for any waters needed for RDF watershed restoration.
Plan for Aesthetic and Riparian Values Along RDF	Create a plan for improving aesthetic and riparian values in tandem with the RDF flood control project along its entire extent
Springs Studies	Increase springs studies within the watershed (e.g. Leroux)

Facilitate coordination across the entire watershed	**Facilitate coordination among all stakeholders and jurisdictions within the Rio de Flag watershed**
General Rio de Flag connectivity/restoration	Improve channel function, prepare for more flows with increasing development, riparian restoration with cottonwoods and willows; Restore channel-floodplain connectivity, address erosion and downcutting

PLAN IMPLEMENTATION, EVALUATION, AND REVISION

Implementation of this watershed plan will be coordinated and undertaken by the WARF collaboratively and adaptively. Other groups may join the Alliance at any time by a vote of the membership. We would especially like to recruit member organizations who are stakeholders with links to the watershed through stewardship, history or common interest. Since the effort to form the WARF coincided with the Covid pandemic our efforts to recruit organizations have been less successful than we wished. The Hopi Tribe and Navajo Nation were especially hit hard by Covid and have only been able to have minimal participation so far.

The WARF intends to harness the collective knowledge and networks of community members working cooperatively on watershed land and waters preservation, water and flood security, ecosystem preservation, watershed function, and climate change adaptation and mitigation. Through these efforts, the WARF seeks to ensure continuing the many important environmental and public health benefits of green and open space conservation. This plan will act as a guiding document for the WARF. While our initial efforts will focus on the original priority list of projects, the projects which came out of the planning process remain of interest and new projects can be added to that list over time. We recognize that other stakeholders have responsibility for, and ownership of, many things within the watershed. We do not want to interfere in those responsibilities.

The WARF's intent is to keep the plan a living document. The WARF may propose to add, delete, or modify projects or change the priority of projects listed in this watershed plan as becomes appropriate over time. Any amendments to the plan will be submitted to the stakeholders for approval. The WARF may partner with other organizations to accomplish its objectives and complete projects. Projects will be led by the most appropriate stakeholder, for instance the city or county would lead on infrastructure projects requiring their authority, ownership, or expertise, and the WARF's role could be simply writing a letter in support of the project to the funding agency. We expect the WARF or Friends of the Rio might lead on smaller projects not requiring city or county authority or expertise. The Friends of the Rio have agreed to Act as a fiscal sponsor of the WARF.
The activities of the WARF can include

- Quarterly meetings to address progress on projects.
- Monitoring of the Rio and metrics of success,
- Assessment of outcomes,
- Providing opportunities to address subjects including:
    - Climate change
    - Fire and fire security
    - Precipitation and water security
    - Clean water
    - Biodiversity and restoration
    - Recreation along the Rio
    - Funding
    - Future growth

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