2020 REPORT TO THE WATER COMMISSION

Activities of Calendar Year 2019

CITY OF FLAGSTAFF WATER SERVICES DIVISION

WATER, WASTEWATER, REUSE AND STORMWATER

Annual Report

February's storms brought heavy precipitation, causing spillover at the Upper Lake Mary Dam in early March 2019. The increase in surface water production reduced the groundwater demand, saving the aquifer for drier times. Photo by Joelle Sawaya

REPORT TO THE WATER COMMISSION

INFORMATION YEAR 2019

WATER, WASTEWATER, REUSE

and STORMWATER

ANNUAL REPORT

Including Historical Data &

Graphical Trends

May 07, 2020

CITY OF FLAGSTAFF
WATER SERVICES DIVISION
2323 N. Walgreens Street, Suite 1
Flagstaff, AZ 86004

FLAGSTAFF
WATER
SERVICES
We are Water

Water Services Staff at the 2018 Spring Meeting.

We are Water

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In April 2020 Water Services reached the one year anniversary in the new Administration building (WSAB)!

ACKNOWLEDGEMENTS

2020 Water Commission

Commission Members	Executive Members	Commission Liaisons
Elizabeth Christy	John Malin Chair	Marie Jones P & Z Representative
Ben Ruddell	Ward Davis Vice Chair	
Malcolm Alter		Jamie Whelan Council Representative
Timothy Bowers		

Staff Contributions

To acknowledge those responsible for providing data and assembling the 2019 Annual Report to the Water Commission

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Lab Director

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Regulatory Compliance Manager

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Water Production Manager

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SCADA Administrator

Jim Huchel
Water Reclamation Manager

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Interim Conservation Program Manager

Mark Richardson
Operations Manager

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Joelle Sawaya
Communications Aide

Debby Valencia
Administrative Specialist

Lee Williams
Water Services Supervisor

Erin Young, R.G.
Water Resources Manager

1 ADMINISTRATION

Water Services is responsible for water production and distribution, wastewater collection and treatment, reclaimed water distribution, and stormwater management. The Division is also responsible for water resource management, water conservation, engineering, and regulatory compliance programming. This report provides an annual summary of operations, planning, and programming and is distributed throughout the year in response to various requests for information on the Water Services Division's programs. Water Services provides Master Planning documents for Water Policies, Water Resources, Infrastructure, SCADA, and Solids Handling. These documents can be found at the Water Services website at ***www.flagstaff.az.gov/waterservices***.

MISSION STATEMENT OF THE WATER SERVICES DIVISION:

"Professionally and cost effectively providing water, wastewater and stormwater services that meet the present and future environmental, health, and safety needs of the community and our co-workers. Committed to a goal of 100% customer satisfaction achieved by a dedication to exceed customer expectations by continuously improving our operations."

1-1 A Message From Bradley M. Hill, R.G., Water Services Director

Water Commission Members,

It is with excitement and some trepidation that after 12.5 years with the City of Flagstaff, it is time for this "old Water Buffalo" to retire. The Commission and Water Services staff have collectively accomplished a lot during my tenure with the City and I would like to share some of those highlights below:

2020

Water Services Strategic Plan 2025: The management team of the Water Services Division developed a strategic plan, that among other things, identified the top 10 most significant issues facing the division over the next five (5) years. Given my impending retirement, I asked the team to develop this plan in order to help the future Director and the public to understand what needs to be accomplished. The management team won the City Manager's Aspen Award.

Stormwater Maintenance: The Commission supported the proposed elimination of the fund transfer from Stormwater to HURF in order to better serve the citizens of Flagstaff. Once approved by Council, the maintenance of critical stormwater infrastructure, such as street catch basins, culverts, etc. will now be conducted within the Water Services Division starting in FY21.

Reclaimed Water: The Commission started the public conversation about what the City should do with its unused reclaimed water in both the short-term (e.g., groundwater recharge) and long-term (e.g., Direct Potable Reuse).

Rio de Flag Army Corps Flood Control Project: The Rio project was placed in the FY21 Federal budget, after decades of planning. The project aims to mitigate the effects of a 100-year flood in the Rio de Flag, protecting homes and businesses.

2019

Water Resources Master Plan: The Commission approved the Scope of Work for an update to the City's 2011 Water Resource Master Plan that will represent a long-term commitment to ensure Flagstaff's water future through collaboration, innovation and public involvement embracing the One Water concept.

Biosolids Master Plan: The Commission heard the results of this planning effort conducted by Carollo Engineers. The purpose of this effort was to identify a long-term plan to determine current and future liquid and solids treatment capacity and solids disposal alternatives at Wildcat Hill and Rio de Flag Water Reclamation Plants.

History of Red Gap Ranch: The Commission was provided a history of this future water supply starting with the purchase authorized by City Council in 2005

Water Conservation Strategic Plan: The Commission was provided the results of this planning effort conducted by Maddaus Consulting. The Plan will set water conservation targets, identify and prioritize actions to achieve goals based on criteria such as community preference and economic impacts while considering the potential impacts to our wastewater operations.

1-1 Director's Message, continued

Water Services Move: The administrative functions of Water Services Division moved out of City Hall and into its new home on Walgreens Street known the Water Services Administration Building, aka WSAB (or wah-saw-bee).

Reorganization–SCADA/IS: Water Services created a new Section 307, SCADA/Information Systems comprised of staff located within operations. The purpose of this change was to better account for and track the expansion and conversion of our SCADA control & monitoring systems for our treatment plants as well as the management of our Information Systems (CMMS, GIS, data management, SCADA programming, project management).

President's Award: The Director received this award from the statewide WateReuse Arizona professional organization for his stewardship of water resources in Arizona during his 32-year career in the water industry.

Water Resources Utility of the Future Today Award: The Division received this recognition from a group of national water associations. The award acknowledges our outstanding and efficient water supply management, development of proactive relationships with stakeholders, the establishment of a resilient community and environmental sustainability practices.

2018

Enforcement Response Plan: The Commission approved the development of an escalating enforcement procedures and penalties process for code violations of Water Services Pre-Treatment and Stormwater programs.

Advanced Treatment Feasibility Study: The Commission heard an update on this feasibility study conducted by Brown & Caldwell. The study identified costs and location options of an "inside the treatment plant fence" analysis to potentially construct additional treatment facilities to purify recycled water into potable drinking water at some point in the future.

Stormwater Rate Increase: The Commission approved an increase in stormwater service charges to maintain the Capital Improvement program as well as funding the Rio de Flag Army Corps Flood Control Project

Upper Lake Mary Watershed Monitoring: The Commission was provided an update from Salt River Project on the City's partnership from 2012 to begin record and document hydrological conditions prior to any proposed forest thinning.

2017

Utilities Division Name Change: The Commission supported staff's recommendation to change the Division's name from Utilities to Water Services. The purpose of the name change was to better convey what services are provided by the Division and to become more transparent with what we do when communicating to the public.

Pure Water Brew Challenge: The Commission was provided an update to Flagstaff's participation in Arizona's first multi-barrier, advanced water purification process for potable reuse; culminating in an event that multiple local brewers took part in a statewide Brew Challenge using purified recycled water.

Environmental Stewardship Award: The Director received this award for his contribution to the protection and enhancement of the environment and sustainable practices in the water industry. AZWater is a statewide water/wastewater organization of over 2,000 professionals.

2016

Water Conservation Program Goals: The Commission weighed-in on the conversation on what success looks like within the Conservation Program and the policy question of "how low should we go?" in water use measured by GPCD.

ADOT/City ROW Agreement Red Gap Ranch: The City signed a first-ever agreement with the Arizona Department of Transportation to allow a longitudinal water line to be located within an interstate highway, specifically I-40.

2015

Rate Increases: Numerous Commission meetings in 2015 were dedicated to water, sewer, reclaimed, stormwater and capacity rate and fee increases. Ultimately, the Commission recommended increases.

Director of the Year Award: The Director received the City Manager's Director of the Year Award.

1-1 Director's Message, continued

2014

Principles of Sound Water Management – Water Policies: City Council approved the first comprehensive set of water policies designed to preserve the public's trust in our water, wastewater, reclaimed water and stormwater systems.

Stormwater Credit Manual: Numerous Commission meetings were dedicated to discussing and approving changes/updates to how stormwater credits are calculated and applied to customers.

Reorganization–Regulatory Compliance: The Utilities Department created a new Section 306, Regulatory Compliance from staff located within operations given the operational and regulatory challenges with Wildcat Hill Water Reclamation Facility at the time. The purpose of this change was to ensure better accountability and compliance with water quality and other environmental regulations, reporting to the Director.

Project of the Year Award: The City was awarded the Arizona Public Works Association award for the reconstruction of the Inner Basin Pipeline completed in 2012 that was severely damaged after the Schultz Fire.

2013

Reclaimed Water Shortage: The Commission provided guidance on what alternatives staff should take during times of reclaimed water shortages.

Rate Study Policy Guidance: The Commission provided guidance on policy issues associated with the upcoming rate study, such as Debt Service percentage, tiered rates beyond residential, separate out energy costs on wastewater, ratio of fixed costs v. commodity costs and whether reclaimed rates should continue to be subsidized by water customers.

Utilities Director Recruitment: Brad Hill was the successful candidate in May of that year after a national, open recruitment was completed.

Designation of Adequate Water Supply: The City of Flagstaff obtained its first ever 100-Year Designation of Adequate Water Supply from the Arizona Department of Water Resources that identified long-term water supplies to support anticipated future growth projected in the voter approved Regional Plan.

City Manager's Compounds of Emerging Concern Advisory Panel: The Panel was created to address the community's concern over antibiotic resistance genes detected in the City's reclaimed water. The Utilities Department helped the City Manager with the creation of an advisory panel of local, state and national experts.

Advisory Panel Emerging Contaminants: The Utilities Department was invited to represent the City of Flagstaff on a statewide panel convened by the Arizona Department of Environmental Quality to address Compounds of Emerging Concern.

2012

Inner Basin Waterline: Reconstruction of the pipeline and road was completed.

Principles of Sound Water Management – Water Policies: The Commission voted to approve the multiple water policies that staff and the Commission had been working on for the past several years for City Council consideration.

Arizona Snowbowl : Reclaimed water deliveries began.

2011

Interim Utilities Director: Brad Hill was appointed Director on an interim basis in May.

Water Resources Master Plan: The Commission was presented an overview of the City's first ever draft Water Resources Master Plan. This plan remained in draft form since Brad was promoted from Water Resources Manager to Director.

Water Policies: The Commission spent numerous meetings providing guidance on a variety of policies including Financial, Adequate Water Supply and Leadership.

2010

Blue Ribbon Panel on Water Sustainability: The City was invited to participate on Governor Brewer's Statewide Blue-Ribbon Panel that focused on water conservation and recycling as strategies to improve water sustainability in Arizona.

Snowbowl Reclaimed Water Agreement: The Commission voted to amend Snowbowl's agreement to enable either direct delivery or indirect delivery (i.e., recovered reclaimed water) as potential water supply options. Nearly 700 people were in attendance at Sinagua Middle School for this discussion. Note that City Council subsequently voted to not amend the Snowbowl reclaimed water agreement

1-1 Director's Message, continued

Reclaimed Water Agreements: The Commission approved changes to the City's reclaimed water agreements to include better management, tracking and prioritized goals for the sale and use of reclaimed water in Flagstaff.

Economic Benefit of Water: The Commission was introduced to the concept of evaluating the economic value of water for varying types of land uses.

2009

Rate Increases: The Commission approved the proposed increases to water, sewer and reclaimed water rates.

Rainwater Harvesting Ordinance: The Commission approved new rainwater harvesting requirements of capturing the first one inch of rain from residential and non-residential roof tops.

Water Demand Study: Internal staff within the Utilities Department completed the City's first GIS & Regional Plan Land Use-based water demand study to quantify the City's long-term water needs at build-out.

Report to the Water Commission the report was significantly revamped to include a better layout format, Stormwater Management and historical and graphical trends

Employee of the Year Award: Brad Hill was recognized by the City Manager with the highest employee award, known at that time as the Humphreys Award

2008

Report to the Water Commission: The annual report included for the first time a "Water Management Summary" that contains on a single page, annual water production by source, water use by sector, lost & unaccounted for water and average residential & non-residential water use measured in GPCD

Bow & Arrow Agreement: The Commission voted to approve the agreement with the Arizona Game & Fish for discharge of reclaimed water into the Rio de Flag "for payment" in exchange for a transfer of ownership of a community park within the Bow & Arrow subdivision to the City.

2007

Water Resources Manager: The City hired Brad Hill as its first water resources manager. Brad was previously employed by the City of Peoria, Arizona Department of Water Resources, U.S. EPA and CH2M Hill.

1-2 2019—Planning for the Next Decade

2025 Water Services Strategic Plan

In 2019 Water Services completed the 2025 Strategic Plan. The plan summarizes the major issues facing the Division and the community over the next five years. It outlines ten Strategic Objectives that provide a basis for further community dialogue about risks, needed investments, and opportunities related to water issues. Among the critical concerns addressed in the plan are:

1. Use Standards and Data to Drive Decision Making
2. Address Wildcat Hill Water Reclamation Plant Capacity
3. Protect the Water System for Wildfire Threat
4. Upgrade Stormwater System and Increase Maintenance
5. Accelerate Infrastructure Maintenance and Replacement
6. Ensure Adequate Water Resources and Plan for Climate Change
7. Maintain Excellent Water Quality
8. Improve Compliance with Environmental Standards and Protections
9. Enhance Communications and Customer Service
10. Address Critical Workforce Issues

1-3 Notable Awards and Events

AZ WateReuse Association President's Award

AZ WateReuse Association recognized Brad Hill for his efforts as a steward of water resources in Arizona with the President's Award on July 29, 2019. Brad has not only led our City in the effective management of our water supplies, but his commitment to water recycling initiatives has set the City on a path toward long-term sustainability.

Recognition: Water Resource Utility of the Future Today

At the national level, Flagstaff Water Services was recognized as a *Water Resource Utility of the Future Today* for water reuse strategies implemented in our community, and the organizational culture that supports it. This includes ranking operations, staff participation and training, agency partnerships, technological advancements and involvement with the community, as well as our ability to provide a blueprint for other municipal utilities to follow.

Water Services Receives the City Manager's "Aspen Award" in Leadership

The City Manager's Aspen Award in Leadership recognizes the Water Services Team for creating the Strategic Plan 2025. The award highlights the Plan for setting a tone, identifying standards, and establishing goals to maintain water quality, reliability, and environmentally responsible practices for Flagstaff's water in the long term.

From left to right: Lisa Deem, Timothy Harrington, Jim Janecek, Steve Camp, Erin Young, Jim Huchel, Brian Huntzinger, Mark Richardson

Notable Events in 2019

Due to a record setting 71.3 inch snowfall in February**, Upper Lake Mary** overflowed, resulting in increased surface water production in March and April. On February 3, Lake Mary was 25% full, reaching full capacity on March 8. Lake Mary surface water produced 3.75 million gallons in the second week of January 2019, compared to 16.25 million gallons in the second week of March.

On July 11, a lightning strike three miles south of Upper Lake Mary ignited the **Newman Fire** which extended into Newman Canyon, a tributary that flows directly into Upper Lake Mary. USFS fire personnel took steps to protect the lake and our groundwater infrastructure in the area surrounding Upper Lake Mary while allowing the fire to burn in a safe manner. At full containment in late July, nearly 5,000 acres had burned. We're still monitoring the impacts on water quality.

The **Museum Fire** began on Sunday, July 21 in the Dry Lake Hills, along the Spruce Wash drainage just north of town. Fire personnel utilized water from the North Reservoir for fire relief efforts. Water Services joined County partners for post fire flooding mitigation in the area. (see more in Section XX)

Our director, **Brad Hill**, officially retired in December after twelve dedicated years with Water Services. Brad remains at the helm under contract through June 2020. We thank him for his significant contributions to the Divi-

2 2019 PRODUCTION & TREATMENT SUMMARY

2-1 Population

Year	1990	1995	2000	2005	2010	2015	2019
Population	45,403	52,701[1]	52,894[2]	61,270[4]	65,870[3]	70,643[4]	76,338[4]

1. The Census Staff during a special census in 1995 completed the documented population count
2. Disputed census population
3. 2010 Census
4. Population estimate as of July 1 of that year from the Office of Economic Opportunity, as per City of Flagstaff Planning Section; includes NAU

2-2 Potable Water Production in the City of Flagstaff

	Acre-Feet Per Year[1]	Average Day (MGD)[2]	Peak Day (MGD)[2]
2019	8,129	7.3	10.8
2018	8,035	7.2	10.5
2017	8,065	7.1	10.8

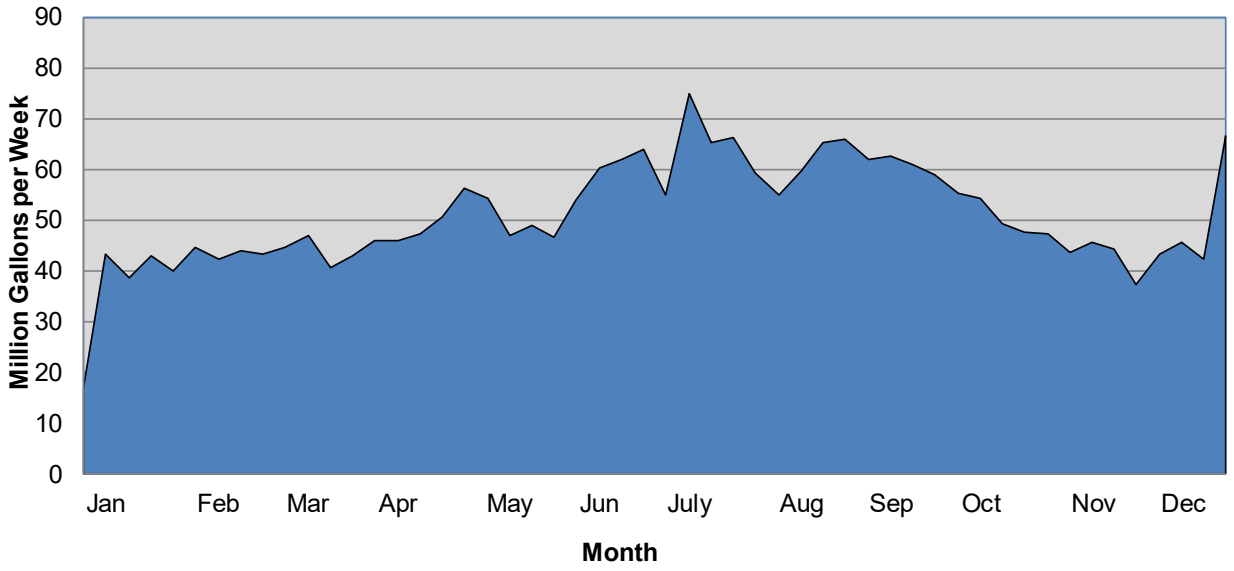
1. An acre-foot of water is equal to 325,851 gallons
2. MGD = million gallons of water per day

The **peak day production** occurred on June 21, 2019 with 10.83 million gallons (MG) produced. The sources of water used to meet peak production came from:

Peak Production Source	06/21/2019
Local Wells	2.7
Woody Mountain Wells	0.82
Lake Mary Surface Water	5.36
Lake Mary Wells	1.13
Inner Basin Water	0.82
Total Produced	10.83

In a dry year, Water Services has a peak capacity of ~13.2 million gallons per day (details in **Section 7**). This assumes 15% system redundancy (85% of the firm well capacity) and no surface water sources (Inner Basin and Upper Lake Mary). The wet year peak capacity is ~21 million gallons per day including the Inner Basin (2 MGD) and Upper Lake Mary (5.5 MGD).

Water Production by Week—2019



Water use is higher from April to October due primarily to outdoor watering. Efforts by the community and Water Services over time, aimed to reduce waste and increase water efficiency, directly impact the need for more expensive water resources and infrastructure projects. 2019 was an unusual year with higher water use in July and August due to historically low monsoon precipitation.

2-3 Wastewater Treatment

Maximum Month & Day[1] Wastewater Volume Treated

Water Reclamation Plants (WRP)

Rio de Flag WRP		**Wildcat Hill WRP**		**Total Peak Day, MGD**
Peak Month , MG | Peak Day, MGD		Peak Month , MG | Peak Day, MGD		
March 2019	60.4 MG|2.2 MGD 3/22/19	March 2019	163.5 MG | 8.6 MGD 03/01/19	10.8 MGD
July 2018	56.8 MG|2.0 MGD 1/19/18	October 2018	116.9 MG | 5.9 MGD 10/04/18	7.9 MGD
January 2017	64.8 MG | 2.2 MGD 1/15/17	February 2017	139.3 MG | 6.7 MGD 2/14/17	8.9 MGD

AVERAGE PER CAPITA INFLOW	**1990**	**105**	**GPCD**
	2019	**72[2]**	**GPCD**

1. Maximum day units are in million gallons per day (MGD) and maximum month are in million gallons (MG). Flows are based on the influent metering system.
2. Total influent (2.014 million gallons in 2019) divided by population (76,338) divided by 365 days.

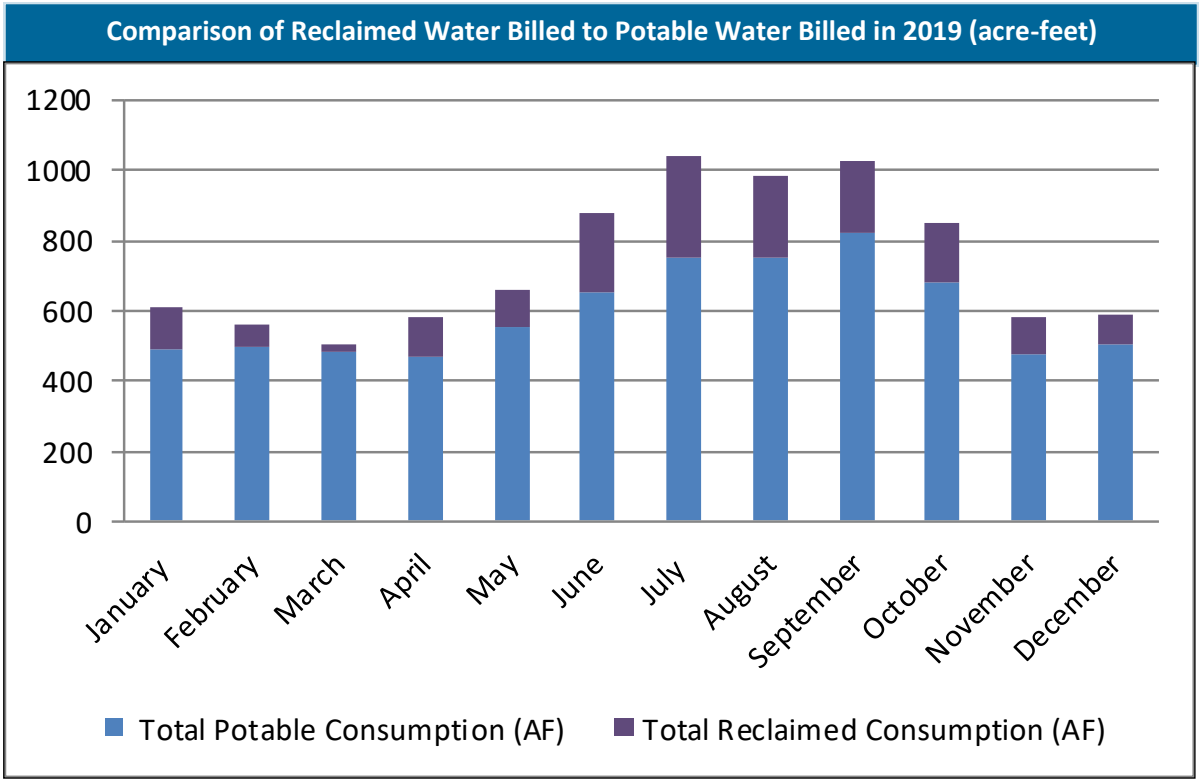
The treatment capacity of the Wildcat Hill Water Reclamation Plant is 6.0 MGD and the Rio de Flag Water Reclamation Plant is 4.0 MGD. The combined treatment capacity of the two plants is 10 MGD with occasional managed exceedance due to inflow and infiltration (I&I). This capacity is projected to serve the City of Flagstaff until 2035 or approximately a population of 100,000 (Sewer Master Plan, 2015 Brown & Caldwell).

2-4 Reclaimed Water Deliveries

Maximum Month & Day Reclaimed Volume Delivered Water Reclamation Plants (WRP)				
Rio de Flag WRP Peak Month , MG | Peak Day, MGD		**Wildcat Hill WRP** Peak Month , MG | Peak Day, MGD		**Total Peak Day, MGD**
September 2019	35.6| 1.6 MGD 8/30/19	July 2019	69.3 | 1.3 MGD 07/23/ 19	2.9 MGD
December 2018	36.9 | 1.8 MGD 10/13/18	April 2018	68.0 | 1.4 MGD 11/6/18	3.0 MGD
January 2017	64.8 MG | 2.5 MGD 2/28/17	February 2017	139.3 MG | 6.7 MGD 2/14/17	9.2 MGD

1. Maximum day units are in million gallons per day (MGD) and maximum month are in million gallons (MG). Direct deliveries to customers only, does not include discharge to Rio de Flag.

Currently, the maximum reclaimed water supply available from the Rio de Flag WRP is 1.8 MGD and 3.4 MGD from the Wildcat Hill WRP. The supply availability at the Rio de Flag WRP is limited by the amount of inflow into the plant. The supply availability from the Wildcat Hill WRP is limited by the capacity of infrastructure between the plant and the Buffalo Park Tank. The Bushmaster Pump Station was completed in 2018, resulting in providing additional flow from Wildcat Hill WRP.



The monthly production graph above demonstrates the importance of reclaimed water in reducing the demand on potable water during spring and summer months. In July, reclaimed water accounted for 28% of total water demand. Reclaimed water continues to account for ~ 20% of water supplies delivered to customers on an annual basis (see summary on Page 9).

3 2020 WATER PRODUCTION PLAN

This section describes the strategy Water Production will follow in order to meet anticipated water demands for 2020. Due to a disinfection by-product (DBP) exceedance in 2015, a conservative approach of limiting the ratio of surface water to ground water at 25% was adopted during 2016 and 2017. After extensive monitoring over the past four years it has been shown that a higher ratio of surface water to ground water may be used without harmful levels of DBPs produced. In 2019, as much as 50% surface water was produced while maintaining DBPs well below maximum contaminant levels (MCLs).

In 2019, Water Production produced more surface water than in any of the previous 8 years. Due to a relatively good snowpack, more spring water was harvested off the San Francisco Peaks (without the use of Inner Basin Wells) than 24 of the last 31 years. Due to this increased use of surface and spring water less Lake Mary Wellfield groundwater was utilized less than in any of the previous 31 years; reducing demand on that aquifer.

In 2020 Water Production will continue to maximize surface water production from Upper Lake Mary and minimize groundwater from the Lake Mary Wellfield, while maintaining DBPs well under MCLs and keeping all sources viable. A shift in focus to infrastructure rehabilitation and replacement will also commence. In the fall of 2020, the Woody Mountain Booster Station Sand Clarifier will be rehabilitated, replacing equipment there that has been in service since the 1960's. Additionally, plans for the rehabilitation of the Lake Mary Water Treatment Plant sedimentation basins (also with equipment from the 60's) will be completed; with the work to occur in 2021. These infrastructure rehabilitation projects will surely decrease the availability of water from the respective sources while the projects are underway.

By dividing supply between available sources, we will optimize capital investments while maintaining surface water production around 30% of the supply in 2020. Optimizing the water supplies in this manner will make it possible to respond quickly to unplanned needs, utilize equipment investments, manage system wide disinfection, disinfection by-products and water age, and begin infrastructure rehabilitation and replacement that is overdue in Water Production.

2019 Quarterly Operations Plan

1st Quarter (actual)				2nd Quarter (estimated)		
	Avg MGD	MG	AF	Avg MGD	MG	AF
Surface	2.3	180	587	3.0	270	880
LM Wells	0.6	65	212	0.6	65	212
WM Wells	0.9	90	293	1.2	110	358
Local Wells	2.3	200	652	2.5	275	896
IB	0.0	0	0	0.2	20	65
Total	6.1	535	1744	7.5	740	2411
3rd Quarter (estimated)				**4th Quarter (estimated)**		
	Avg MGD	MG	AF	Avg MGD	MG	AF
Surface	3.2	290	945	2.2	160	521
LM Wells	0.7	70	228	1.2	140	456
WM Wells	1.2	110	358	0.8	80	261
Local Wells	3.0	275	896	2.3	200	652
IB	0.7	55	179	0.0	0	0
Total	8.8	800	2606	6.5	580	1890

Peak Day and Total Annual Operations Plan

	Peak	Annual Estimate	
Source	Day MGD	MG	AF
Upper Lake Mary	6.0	900	2933
Local Wells	5.0	950	3096
Lake Mary Wells	3.2	340	1108
Woody Mountain Wells	5.0	390	1271
Inner Basin	1.5	75	244
Total	20.7	2655	8652
Minus 15% Well Redundancy	**17.6**		

4 2019 SUMMARY

4-1 2019 Notable Capital Investments

Wastewater Operations - Wildcat Hill Water Reclamation Plant

1. Installed more security systems, including door locks and cameras
2. Installed a COD analyzer on the Primary effluent
3. Purchased a 4 inch pump for the Wildcat Facility
4. Professionally calibrated all flow meters and gas detection systems
5. Rebuild the screen on the septage Station
6. Purchased gas detectors for staff lone worker devices
7. Multiple pumps rebuilt or repaired
8. Continued to work on improving safety of staff (Web Safety Plus Software)
9. Worked on Emergency Plan for both facilities
10. Purchased diagnostic tools to help with predictive maintenance program
11. Repair grit line
12. Repair weir supports on the primary clarifiers

Wastewater Operations - Rio de Flag Water Reclamation Plant

1. Installed more security systems, including door locks and cameras
2. Purchased a 4 inch pump for the Wildcat Facility
3. Purchased gas detectors for staff lone worker devices
4. Professionally calibrated all flow meters and gas detection systems
5. Rebuilt the screen on the septage station
6. Multiple pumps rebuilt or repaired
7. Continued to work on improving safety of staff (Web Safety Plus Software)
8. Cleaned the influent piping prior to the influent pump station and installed a wet well wizard that keeps material in suspension
9. Worked on emergency plan for both facilities
10. Purchased diagnostic tools to help with predictive maintenance program
11. Repaired concrete structures and replaced valves

Water Production Operations

1. Ordered two new trailer-mounted diesel-powered back-up generators for use in surface water production & distribution during a catastrophic power loss scenario to the City of Flagstaff
2. Completed a remodel of the operations control room with server room addition and climate control at the Lake Mary Water Treatment Plant (LMWTP)
3. Re-equipped (submersible pump, motor and seal) Woody Mtn. #5 groundwater well
4. In response to the Newman fire, installed a new raw water turbidimeter at the Raw Water Pump Station, upstream of the LMWTP, to alert plant operations of any deterioration in surface water quality at Upper Lake Mary (ULM) due to wildfire and/or runoff
5. Replaced and/or calibrated all chlorine leak detecting sensors and replaced all emergency leak mitigation kits and/or seals at all chlorine storage sites in water production and added the sensor calibrations to new computerized maintenance management software system
6. Completed the installation of 7 new turbidimetrs (HACH TU5300s) and associated controllers (SC200s) with re-routing or reconfiguration of sample lines and communication for increased responsiveness, accuracy, precision, and communication in water quality monitoring, data collection and control.

4-1 2019 Notable Capital Investments, continued

Water Production Operations, continued

7. Replaced/upgraded the finished water (post clear-well) chlorine analyzer at the LMWTP
8. Tuned and upgraded all Inner Basin groundwater well diesel-powered motors (adjusted top ends, replaced rocker boxes, modified/upgraded air intakes, upgraded antifreeze and all hoses & belts)
9. Replaced the transformers at Woody Mountain Well #9 & Lake Mary Well #5
10. Repainted the Coagulant Building at the LMWTP, Inner Basin weir building, ULM aerator building, Lake Mary #2, #4, and #5 well houses and associated piping
11. Replaced two surface water soft stops at Raw Water Pump Station
12. Replaced uninterruptible power supplies (UPSs) at Woody Mtn. Booster Station (2) Woody Mountain Well #3, Woody Mountain Well #10 and Shop Well

Engineering

1. Aging Water Infrastructure Replacement (AWIR) Program Summary: Water Services replaced over 4,280 linear feet (LF) of aging water main during the 2019 calendar year, including:

    - David Line: Replaced 1,700 LF of 6-inch asbestos cement water main originally installed in 1961 along David Drive from Hutcheson Drive to William Drive
    - Canyon Terrace Waterline Replacement: Replacement of 1,450 LF of 6-inch asbestos cement water main originally installed in 1967 along Canyon Terrace Drive from Switzer Canyon Drive to End of street in Central Flagstaff
    - Hutcheson Waterline Replacement: Replacement 1,130 LF of 6-inch cast iron water line with new 8-inch PVC water main from Fine Avenue to David Drive. Installed 180 LF new 8-inch PVC water main in Fine Avenue and Apollo Way for the water main connectivity to existing distribution system. Infrastructure replacement included all pavement, curb & sidewalk and edge improvements.

2. Aging Sewer Infrastructure Replacement (ASIR) Program Summary: Water Services replaced over 4,815 feet of aging sewer main during the 2019 calendar year, including:

    - Westside Interceptor Thompson to Kaibab: Replacement of 2,990 LF of undersized 8- inch VCP sewer line, along Thompson and Kaibab Street with 18-inch and 21-inch diameter pipe. Oversizing is required to support council approved growth on the west side of Flagstaff. This new sewer interceptor will serve new development and infill on the Westside of Flagstaff, including Timber Sky development, WL Gore Woody Mountain Campus, and Railroad Springs Crestview neighborhood. Project is funded through new user capacity fees.
    - Hutcheson, David and Canyon Terrace Sewer line Replacements: Replacement 1,300 LF of 6-inch cast iron and asbestos cement sewer line with new 8-inch PVC sewer mains. Infrastructure replacement included all pavement, curb & sidewalk and edge improvements.
    - Mountain Meadow Sewer Extension: Installed 265 LF of new 8-inch PVC sewer line along Mountain Meadow drive in East Flagstaff. Sewer extension allowed several customers to connect to City sewer collection system and abandon existing septic tanks.
    - ADOT Switzer Canyon Roundabout Sewer Replacement: Replaced 150 LF of existing sewer line in conflict with the Arizona Department of Transportation Switzer Canyon Road Roundabout improvement project. The project funding reflects financial reimbursements to ADOT for utility relocation work required to accommodate ADOT road improvement.

4-2 2019 Water Management Summary

City of Flagstaff Water Management Summary 2019

A. WATER PRODUCTION			
I. C Aquifer Groundwater		**5,279 AF**	*(52% of Total Water Produced)*
Lake Mary wells	1,053 AF		*(65% of Total Potable Produced)*
Woody Mtn wells	1,311 AF		
Local wells	2,915 AF		
II. Upper Lake Mary Surface Water		**2,593 AF**	*(25% of Total Water Produced)*
			(32% of Total Potable Produced)
III. Inner Basin Water		**257 AF**	*(3% of Total Water Produced)*
Inner Basin wells	0 AF		*(3% of Total Potable Produced)*
Inner Basin spring water	257 AF		
2019 TOTAL POTABLE PRODUCED			**8,129 AF**
III. Reclaimed water (direct delivered)		**1,740 AF**	*(18% of Total Water Produced)*
Golf Courses	921 AF		
Manufacturing	20 AF		
Municipal parks, schools	120 AF		
Commercial, NAU, Snowbowl	633 AF		
Construction	44 AF	*(reclaimed hydrant meters & standpipes)*	
Residential	2 AF		
Discharged to Rio de Flag	*4007 AF*	*(not included in total)*	
2019 TOTAL WATER PRODUCED			**9,869 AF**
B. POTABLE WATER USED			
I. Residential		**4,087 AF (57%)**	
Single-Family	2,439 AF		*(15,674 household meters)*
Multi-Family	1,648 AF		*(3,022 multi-family meters)*
II. Non-Residential		**3,038 AF (43%)**	
Commercial, CCC, NAU	2,473 AF		*(1,650 commercial meters)*
Manufacturing	210 AF		*(39 meters)*
Landscape/Lawn	275 AF		*(326 meters)*
Standpipe	79 AF		
2019 TOTAL WATER BILLED			**7,125 AF**
C. NON-REVENUE WATER [produced – billed/produced]:			**1,004 AF or 12%**
Water main flushing	10 AF		
System leaks detected and repaired	77 AF		
Other	917 AF	*(i.e., system flushing, water meter inaccuracy)*	
D. AVERAGE WATER USE			**Total GPCD or GPHD**
I. Gallons per capita per day (gpcd) is the potable water used in gallons / 76,338 population			
Residential =48 gpcd & Non-Residential = 36 gpcd = 84 Total gpcd (does not include Non-Revenue)			
			Total - 95 gpcd (includes Non-Revenue)
II. Single family residential water use: 0.16 AF/house/year or 139 gallons/house/day (GPHD)			
[2439AF/15,674 meters] or [2439 AF * 325,851 gallons/AF]/15,674 meters			

5 WATER SERVICES COMMUNICATIONS

5.1 Outreach methods

CityScape—Water Services was well represented in the three 2019 editions of CityScape**.** Topics include:

- Leak Detection Reaches a New Level Through GIS Technology
- The Ultimate Recycling – Salvage and Repurpose a Concrete Vault
- Flagstaff Flood Safety & Awareness
- Frozen Pipes – Ward off Winter Woes
- Weigh in on Water Conservation
- Stream Cleanup Event dates
- Safety First – Lone Worker Device, Wet Well Inspection
- Rio de Flag Blower Project
- Conservation Watering schedule
- Water Conservation Plan Update
- We Moved! New Water Services Building
- Lake Mary Dam Spillover
- Low Water Landscape Rebate Program
- Recycled Water Survey Results & Next Steps
- Flagstaff Monsoon Safety & Flood Awareness
- The Impact of Fire on Flagstaff's Water
- Get Ready for Winter Weather
- City Hall Lawn Goes Green
- Community Partnerships
- Flagstaff Water Services Recognized as a National Leader in Reuse Management

Facebook—Communications and Water Conservation used this platform to promote events, blogs, news items, workshops, Water Commission meetings, and anything of interest to the public.

Outreach and Presentations—Our staff gave over 30 presentations to the public and water groups in 2019. A full list of the presenters and the groups, along with their presentations, can be found on the website, under the Presentations tab. Topics included climate change and water resource planning, watershed health, water quality, water conservation, post-fire flooding, and Flagstaff's water history.

Communication Aides, Mary Samar and Joelle Sawaya give a talk to a class of NAU students at Upper Lake Mary.

Partnerships—We partnered with **Roving Rangers**, a group of National Park Service (NPS) and U.S Forest Service (USFS) volunteer rangers to develop a water-related curriculum for Flagstaff-area visitors. Roving Rangers present information at campgrounds and visitor centers regarding the regional water supply. Water Services also partnered with the **Sierra Club** to spread awareness about stormwater pollution.

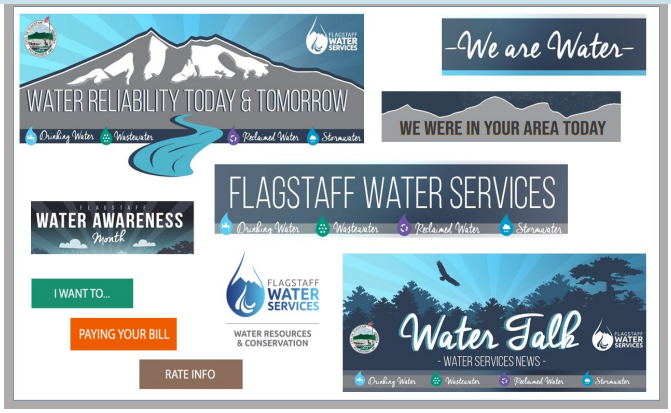
Customer Point of Contact materials— Communications created a series of fdirect outreach materials to answer customer questions about their services.

- **Easements door hanger —** informs residents of the importance of allowing clear access to city-owned easements on their property.
- **Leak Detection Program rack card —** A tool for staff to distribute to interested customers when performing leak maintenance in residential areas.
- **Radio Read Program door hanger —** Is left with customer after staff replaced their water meter with a smart meter.
- **Backflow Prevention FAQs brochure —** Informs customers about proper backflow device installation and maintenance.

5.2 Website

Significant effort went into updating and making the website easier to use. We created new pages, updated the old pages, and expanded on the Capital Improvement Projects Map page to also include Story Maps.

We added two new **Education webpages;** one on Advanced Treatment FAQs, discussing treatment processes and possible future uses. The Water Awareness webpage speaks to protecting stormwater and wastewater quality.



News—The News webpage was updated regularly to keep the public informed about:

Wet Well Inspection at Rio Water Reclamation Plant – Staff member safely lowered 30 feet into wet well to perform maintenance.

Precipitation Causes Spillover at Lake Mary – High lake levels reduced the demand for groundwater, conserving the aquifer for drier times.

Honoring AWWA Groundwater Awareness Week: A Tribute to Flagstaff Area Well Drillers & Scientists – an event to educate the public on Flagstaff's groundwater well drilling history.

Brief Summary of the Recycled Water Survey Results – An infographic with the initial results.

Emergency Addressed – Disaster Averted: "Rag" Ball Causes Digester Pipe Failure at Wildcat Hill WRP – Staff responded to the emergency quickly, corrected the problem, and maintained safety protocols.

Brief & Informative E-blogs

The Effects of Fire on Water in Flagstaff – The potential for threatened water quality as a result of the Newman and Museum Fires, flood mitigation, emergency resources, and monsoon preparation.

Flagstaff Water Services Recognized as a National Leader in Water Reuse – Two awards highlighting the Division and the Director for efficient water reuse management.

Water Conservation in Action – City Hall Lawn Goes Green: Terra BIRDS Leads Lawn Conversion Pilot Project to reduce water demand with drought tolerant, native plants.

Upgrades at Rio Water Reclamation Plant Improve Efficiency & Safety – The new Ultraviolet (UV) disinfection technology provides energy efficiency savings,, while providing safer routine maintenance into the next decade.

Control Room Modernization at Lake Mary Water Treatment Plant – SCADA technology controls water and wastewater treatment, water quality monitoring, chemistry, and flow rates. Lake Mary upgrades isolate malfunctions without disrupting other processes and trigger early warnings of potential issues to maintain peak function.

Inner Basin Pipeline Repaired Just in Time to Aid in Fire Operations – Water Services repaired a burst concrete pipeline to restore flows to the North Reservoir and help supply firefighting efforts.

Capital Improvement Map (CIP) — The CIP map was updated to follow water projects around the city. Viewers can find details on the cost, location, manager, description, timeline and contractor of each City project location pinned on the map.

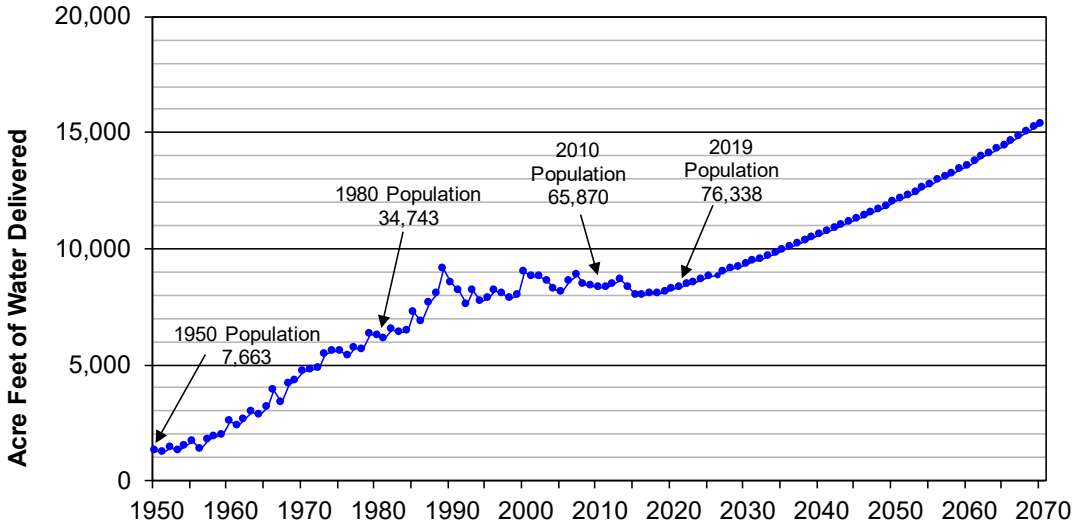
Story Maps — Two story maps were developed to follow the progress of UV upgrades at the Rio de Flag Water Reclamation Plant, and the lawn conversion project at City Hall. They provide the project story, through photos and captions.

Stormwater Quality brochure — Discusses threats to stormwater quality, offers ways to prevent pollution, and shares resources for monsoon preparedness.

Residential & commercial F.O.G. (Fats, Oils, and Grease) brochures, rack cards, and kitchen posters (bilingual) — Negative impacts of F.O.G., how to prevent sewer blockages with best management practices in the kitchen.

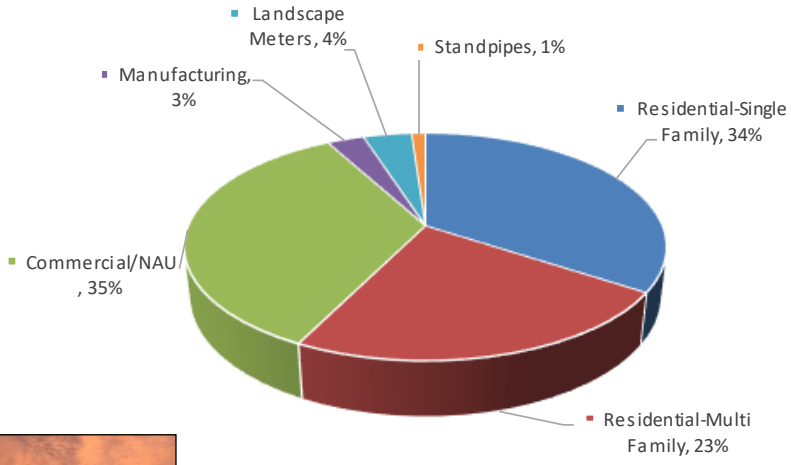
6 WATER CONSUMPTION & PROJECTED NEEDS

6-1 Projected Potable Water Demand from 2019 to 2070



The graph above illustrates water production (in acre-feet per year) and population for Flagstaff from 1950 through 2019. The annual percentage increase in population over the 69 year period has been 1.30% per year while water production has increased 1.22% per year over the same time period. Projected water demand assumes population growth and water use will continue at these same rates.

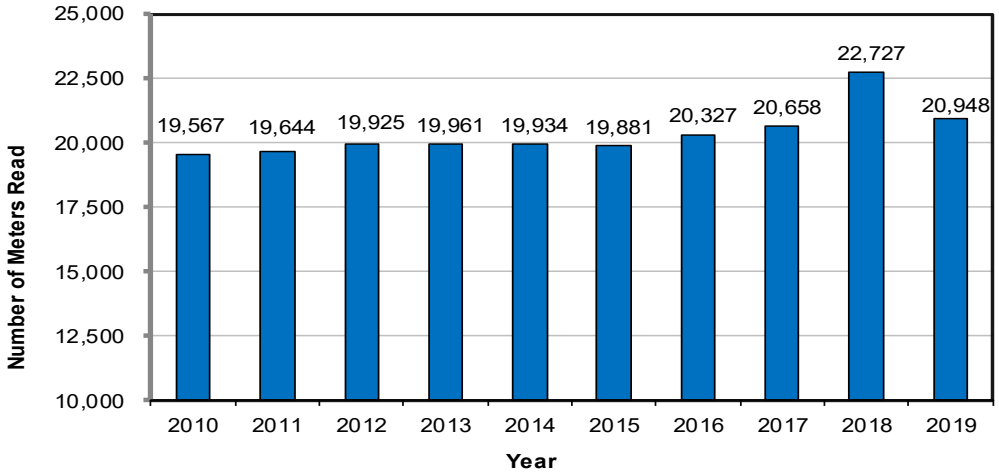
6-2 2019 Potable Water Use by Customer Class



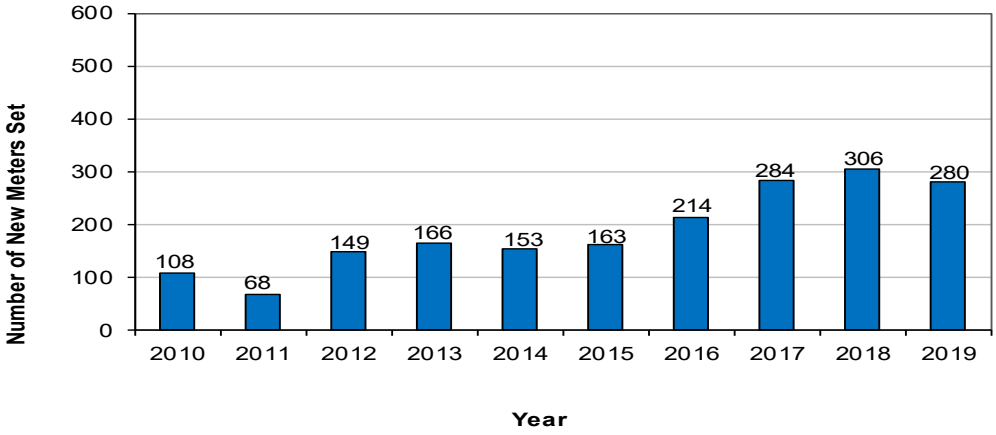
Lake Mary Water Treatment Plant

6-3 Water Meters

Meters Read—Highest Month Each Year for Last 10 Years



New Meter Sets in Last 10 Years



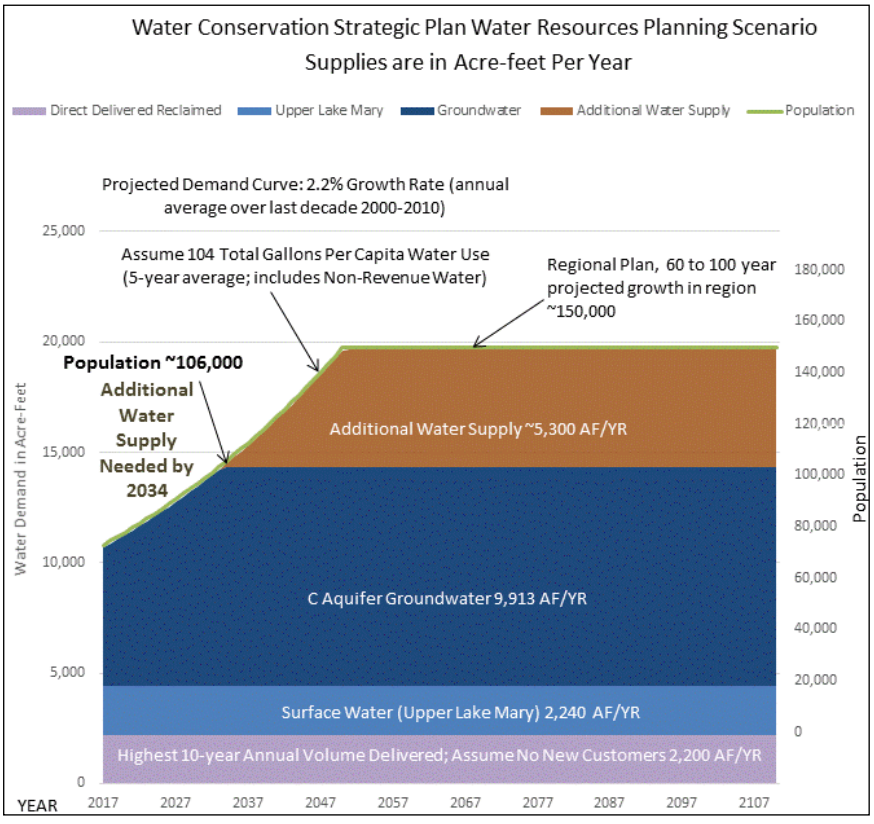
Water Distribution staff replace outdated water meters with smart meter technology.

6-4 Designation of Adequate Water Supply

The Arizona Department of Water Resources (ADWR) issued the City a Designation of Adequate Water Supply in 2013. The Designation identified 9,913 AF/YR (acre-feet per year) of local groundwater (Lake Mary, Woody Mountain and Local well fields), 3,585 AF/YR from Upper Lake Mary, 16,500 AF/YR from Red Gap Ranch, and 2,212 AF/YR of reclaimed water as available supplies to meet 100 years of projected water demand. The supply from Red Gap Ranch is limited to 8,000 AF/YR after the City entered into an agreement with the Navajo Nation in 2011. The Designation of Adequate Water Supply is based upon a historical population growth projection of 1.44% annually, which is slightly lower than the last from the voter-approved Regional Land Plan 2030, water supply availability as demonstrated using a groundwater computer model developed by the U.S. Geological Survey, and records of direct delivered reclaimed water use.

Flagstaff is required to provide annual updates to ADWR that document current, committed and projected water demands for the community.

Reporting Year	Current Demand Potable	Current Demand Reclaimed	Total Current Demand[1]	Committed Demand[2]	10-Year Projected Demand[3]	Remaining Designation Volume[4]
2019	8,129	1,740	9,869	N/A[7]	N/A[7]	N/A[7]
2018	8,036	1,870	9,906	1,118	11,428	4,282
2017	8,065	2,189	10,254	1,263	11,830	4,193
2016	7,979	1,817[5]	9,795[5]	686	11,300[5]	5,229[5]
2015	8,013	1,921	9,934	833	11,461	4,943
2014	8,347	1,934	10,281	1,058	11,629	4,371
2013	8,565	2,252	10,817	819	9,881	4,074
2012	8,384[6]	2,050	10,434[5]	707	9,673	4,569[5]
2011	8,249	2,212	10,461	859	9,517	4,390

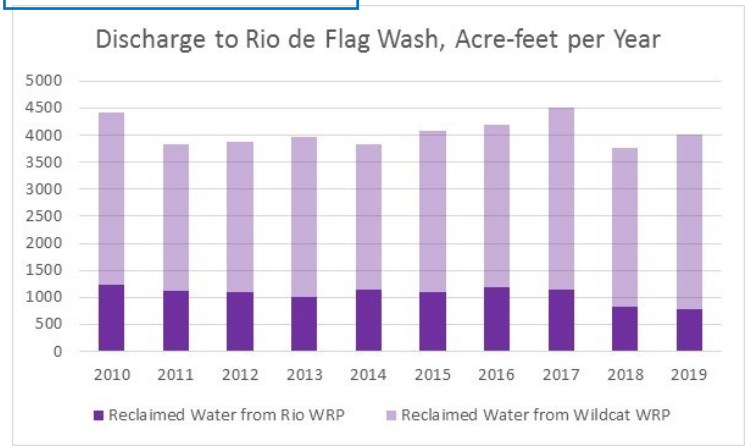


1. Total current demand reported to ADWR is the sum of potable production and reclaimed water delivered in that calendar year.
2. Committed demand is Council-approved plats, building permits and rezones approved but not served.
3. 10-year projected demand is re-assessed each year and is the demand from the current year (2019) to meet the historic 60-year growth rate of 1.44% at time DADE was submitted in 2011, including reclaimed water.
4. Total Designation Volume (15,710 AF) - Total Current Demand - Committed Demand. This Total Designation Volume does not include the 8,000 AF/ year available from Red Gap Ranch.
5. Corrected from 2016 Report to the Water Commission; corrected to the value submitted to ADWR.
6. Correction was made due to difference in individual meter totals reported to ADWR vs. master meter totals in 2012 Water Management Summary.
7. *N/A = Data reported annually to ADWR by June 1 and was not available to submit in this report.*

6-5 Aquifer Seepage Study 2019-2020

Natural Channel Design staff setting up weirs for seepage flow monitoring at Switzer Canyon Wash. Photo by Mary Samar

The Arizona Department of Water Resources (ADWR) offers additional water management tools under the Adequate Water Supply Program that could bring Flagstaff closer to its water management sustainability goals. The management goal is to use every drop of treated water for community benefit as many times as possible, including its treated groundwater, treated surface water, and treated reclaimed water sources. Flagstaff's seasonal demand for reclaimed water leaves a large volume of reclaimed water flowing down the Rio de Flag and into the county in the off season. At this point the water is no longer available as a benefit to residents. The City is investigating the Department's Recharge and Recovery programs as options to put 100% of reclaimed water to community benefit. The Managed Recharge Program is the specific program for recharge through surface water conveyance.

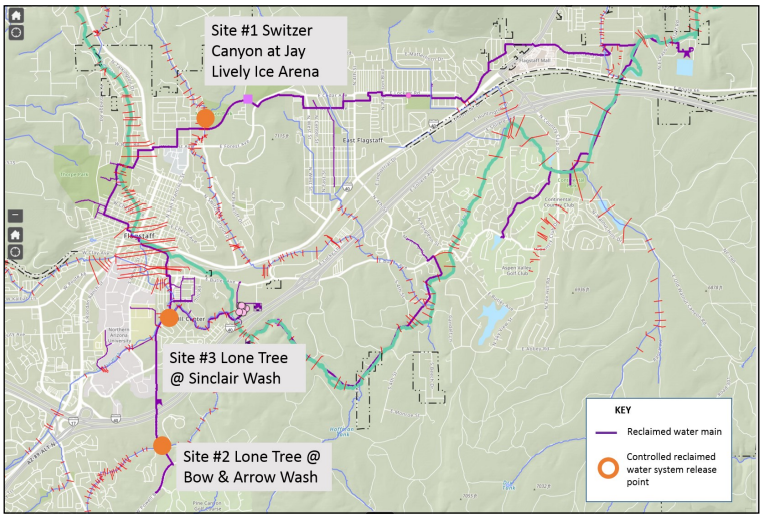


How much reclaimed water is available for a recharge project?

The Rio de Flag Water Reclamation Plant (WRP) releases about 1,000 acre-feet of water per year into the Rio de Flag wash. The Wildcat Hill WRP discharges another 3,000 acre-feet to the Rio de Flag wash. Therefore roughly half of the water produced for drinking water in a year (8,000 acre -feet) could be recharged back to the aquifer at locations where the water mixes with raw groundwater for recovery. Recharging 4,000 acre -feet a year would greatly reduce the impact that pumping groundwater has on the aquifer.

Where are the potential recharge locations?

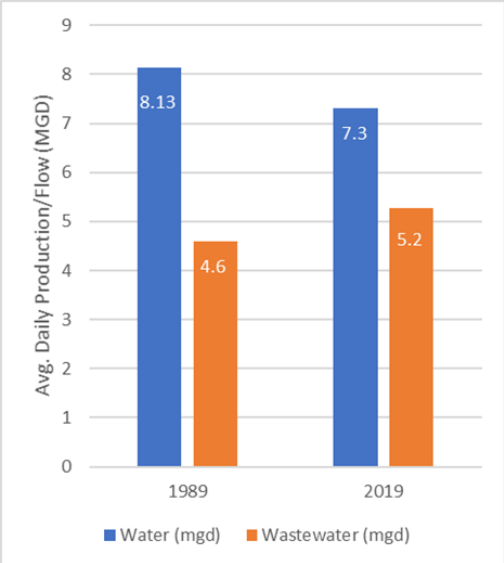
City staff identified three locations where the City's reclaimed water distribution system intersects a drainage and a controlled-flow test could be conducted. Staff installed a new fire hydrant at two of the locations (Sites #1 & 3) in order to release water from the distribution system into the drainage. Two flow rates, 500 and 1,000 gallons a minute, were tested at each site, each for no longer than a one week period. The City retained a local consulting firm, Natural Channel Design, to measure flow at several locations downstream of the release point. Losses or gains in flow rate between each monitoring point were recorded for later analysis.

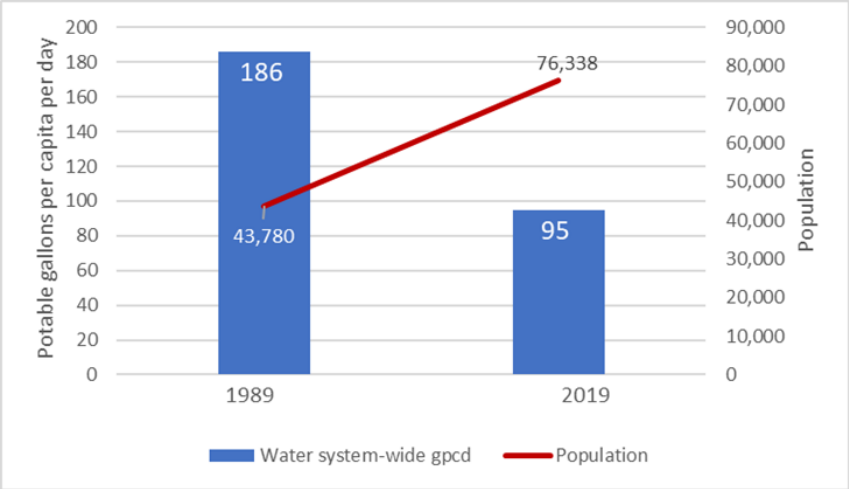


How will the results be used?

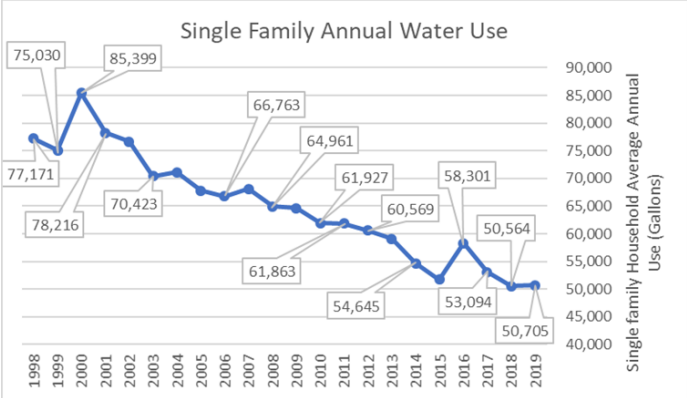
Natural Channel Design will prepare a report late in 2020 containing a relative comparison of seepage losses at each location. Should one or several locations indicate a favorable seepage rate, the City may conduct a longer-term test to confirm water is recharging the deeper C aquifer. If aquifer recharge is feasible, the City would then begin an application process with ADWR.

6-6 Water Resources Planning Data Trends



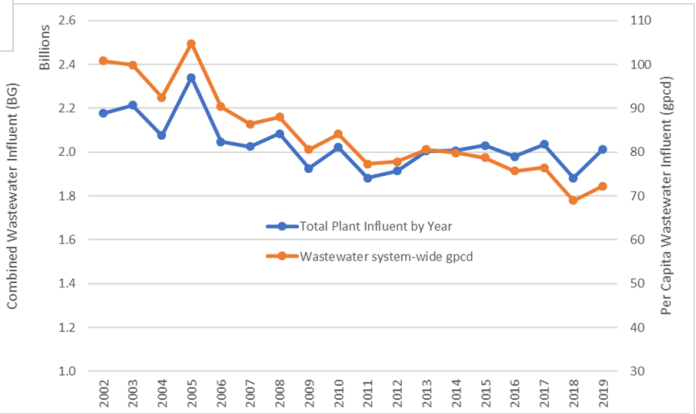


Above: Population has increased significantly since 1989. While community water consumption has decreased, the amount of wastewater generated has increased. The average daily production for water was less in 2019 than 1989, while average daily production on the wastewater side has gone up.

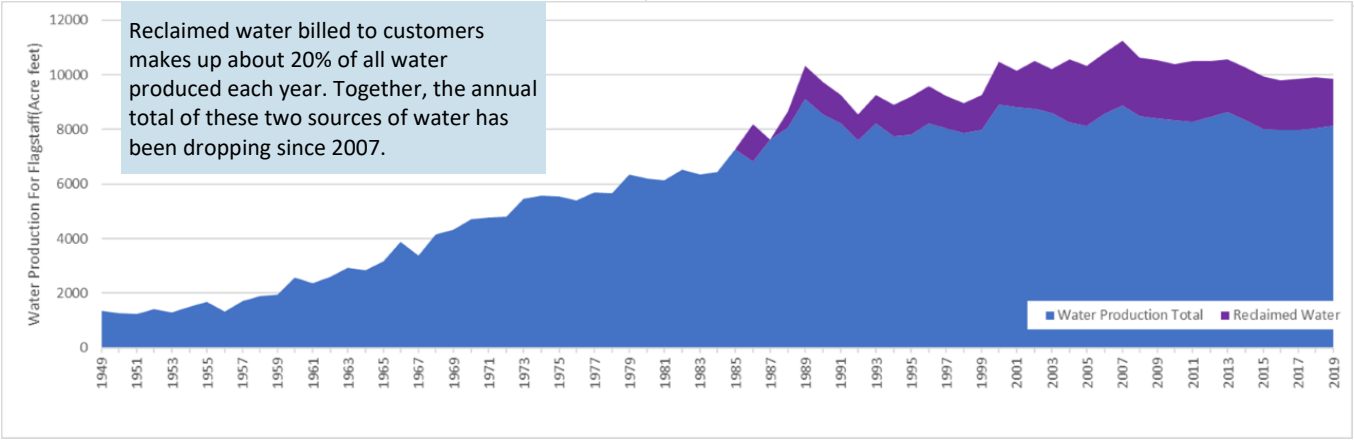


Left: Annual average water use in the single-family residential sector has dropped by 35,000 gallons a year per account since 1989.

One issue facing Water Services and the wastewater treatment section is the decoupling of wastewater inflow and per capita contribution. In the last 7 years, inflow is relatively consistent each year (with the exception of 2018) even with a growing population, while the gallons per day per-capita of inflow has been dropping. This relationship demonstrates that sewage concentration is increasing. Concentration is a growing concern for the industry as it becomes more difficult to process with conventional treatment.



Reclaimed water billed to customers makes up about 20% of all water produced each year. Together, the annual total of these two sources of water has been dropping since 2007.



7 WATER PRODUCTION

7-1 Water Wells Peak Capacity

Staff re-equipped Woody Mountain Well #5.

2020 Estimated Wells Peak Capacity					
Local Wells Maximum Production (GPM)		**Lake Mary Wells Maximum Production (GPM)**		**Woody Mountain Wells Maximum Production (GPM)**	
Continental-2	310	LM 1	110	WM 1	120
Foxglenn	285	LM 2	337	WM 2	217
Sinagua	300	LM 4	437	WM 3	572
Shop	860	LM 5	299	WM 4	315
Ft. Tuthill	1,195	LM 8	720	WM 5	304
Interchange	192	LM 9	236	WM 6	396
Rio	195			WM 7	572
McAllister	On Hold			WM 9	420
*Foxglenn/Sinagua pumphouse limited to max volume of 600 GPM				WM 10	282
				WM 11	349
Total GPM	**3,337 GPM**	**2,139 GPM**			**3,547 GPM**
Total MGD	**4.81 MGD**	**3.08 MGD**			**5.11 MGD**
				TOTAL PEAK WELL CAPACITY	**13.0 MGD**
				WITH ONE HIGH-CAPACITY WELL REDUNDANCY (15%)	**11.01 MGD**

7-2 Historical Production By Source Data

YEAR	Lake Mary Surface		Inner Basin Spring		Inner Basin Wells		Woody Mtn. Wells		Lake Mary Wells		Local Wells		TOTAL		Calendar Precip in inches	Snow (Oct-April) inches
	AF	MG	AF	MG	AF	MG	AF	MG	AF	MG	AF	MG	AF	MG		
1949	278.75	90.83	1077.98	351.26									1356.72	442.09	26.40	
1950	775.02	252.54	488.81	159.28									1263.83	411.82	10.76	63.30
1951	1131.68	368.76	102.90	33.53									1234.58	402.29	25.79	73.40
1952	210.89	68.72	1219.88	397.50									1430.78	466.22	20.60	105.90
1953	1044.71	340.42	262.08	85.40									1306.79	425.82	12.81	60.00
1954	1182.29	385.25	321.31	104.70									1503.60	489.95	19.55	89.00
1955	1488.75	485.11	190.27	62.00									1679.02	547.11	17.97	67.80
1956	825.35	268.94	114.47	37.30			383.70	125.03					1323.52	431.27	10.37	42.70
1957	1159.67	377.88	476.91	155.40			87.52	28.52					1724.10	561.80	24.59	53.00
1958	616.29	200.82	1191.65	388.30			97.90	31.90					1905.84	621.02	21.24	71.50
1959	1591.95	518.74	301.67	98.30			49.19	16.03					1942.82	633.07	21.46	63.80
1960	1745.37	568.73	547.49	178.40			275.99	89.93					2568.84	837.06	16.60	77.60
1961	1618.62	527.43	352.92	115.00			388.15	126.48					2359.70	768.91	18.95	53.90
1962	1519.44	495.11	890.59	290.20			209.79	68.36					2619.82	853.67	18.11	128.90
1963	1663.37	542.01	118.15	38.50			1145.58	373.29					2927.10	953.80	14.52	47.30
1964	1303.69	424.81	342.18	111.50			1184.19	385.87					2830.07	922.18	19.04	89.40
1965	1713.51	558.35	1164.34	379.40			291.54	95.00					3169.39	1032.75	36.59	166.70
1966	2361.39	769.46	919.13	299.50	2.15	0.70	598.56	195.04					3881.22	1264.70	20.58	83.40
1967	2906.82	947.19	444.99	145.00	3.38	1.10	34.74	11.32					3389.92	1104.61	22.27	63.10
1968	2988.54	973.82	772.75	251.80	165.32	53.87	213.63	69.61					4140.24	1349.10	16.53	150.40
1969	2722.07	886.99	930.18	303.10	324.20	105.64	296.76	96.70	42.41	13.82			4315.62	1406.25	23.41	134.70
1970	3206.56	1044.86	686.51	223.70	477.49	155.59	349.24	113.80	0.00	0.00			4719.80	1537.95	24.02	95.70
1971	2600.39	847.34	188.12	61.30	497.56	162.13	999.87	325.81	477.06	155.45			4763.01	1552.03	21.01	56.60
1972	1953.04	636.40	235.69	76.80	538.56	175.49	1625.50	529.67	459.69	149.79			4812.48	1568.15	24.67	50.30
1973	3594.59	1171.30	1043.42	340.00	366.00	119.26	464.63	151.40	0.00	0.00			5468.63	1781.96	19.71	210.00
1974	3999.44	1303.22	189.26	61.67	411.45	134.07	821.51	267.69	144.79	47.18			5566.44	1813.83	17.41	70.00
1975	2209.84	720.08	711.52	231.85	429.64	140.00	1038.27	338.32	1160.65	378.20			5549.93	1808.45	20.10	141.10
1976	3415.92	1113.08	489.00	159.34	543.19	177.00	942.15	307.00	0.00	0.00			5390.26	1756.42	20.12	131.60
1977	2606.99	849.49	66.66	21.72	518.92	169.09	1755.96	572.18	744.63	242.64			5693.15	1855.12	18.77	70.20
1978	2754.63	897.60	629.12	205.00	480.31	156.51	1197.45	390.19	602.42	196.30			5663.94	1845.60	30.72	116.20
1979	3782.83	1232.64	1049.90	342.11	449.35	146.42	773.42	252.02	288.32	93.95			6343.82	2067.14	19.68	145.50
1980	3863.91	1259.06	1128.12	367.60	652.05	212.47	512.38	166.96	56.19	18.31			6212.66	2024.40	29.30	177.10
1981	3308.75	1078.16	181.77	59.23	740.92	241.43	1041.95	339.52	865.12	281.90			6138.51	2000.24	23.37	92.40
1982	3775.56	1230.27	796.47	259.53	603.65	196.70	741.14	241.50	611.32	199.20			6528.14	2127.20	31.09	96.90
1983	2892.27	942.45	1148.93	374.38	427.22	139.21	1038.05	338.25	858.46	279.73			6364.93	2074.02	29.47	142.60

7-2 Historical Production By Source Data, continued

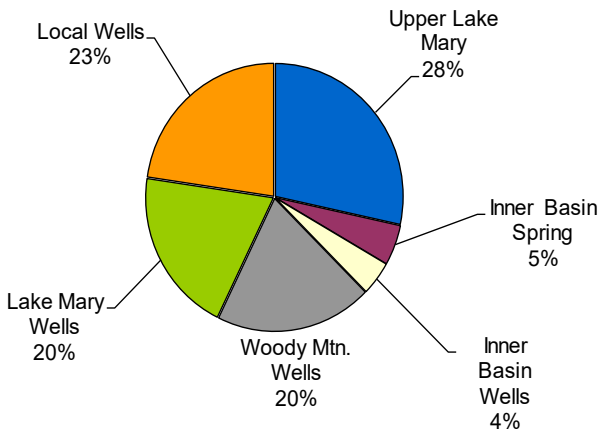
YEAR	Lake Mary Surface		Inner Basin Spring		Inner Basin Wells		Woody Mtn. Wells		Lake Mary Wells		Local Wells		TOTAL		Calendar Precip in inches	Snow (Oct-April) inches
	AF	MG	AF	MG	AF	MG	AF	MG	AF	MG	AF	MG	AF	MG		
1984	2770.16	902.66	253.52	82.61	726.25	236.65	1967.28	641.04	717.87	233.92			6435.09	2096.88	20.09	32.00
1985	4540.94	1479.67	721.16	234.99	398.83	129.96	663.86	216.32	934.45	304.49			7259.24	2365.43	26.67	136.00
1986	4235.89	1380.27	541.35	176.40	715.70	233.21	268.40	87.46	1055.05	343.79			6816.40	2221.13	32.39	105.40
1987	5701.38	1857.80	467.27	152.26	637.16	207.62	7.55	2.46	822.58	268.04			7635.94	2488.18	23.98	121.60
1988	5339.25	1739.80	86.91	28.32	778.52	253.68	125.30	40.83	1731.71	564.28			8061.69	2626.91	21.68	104.50
1989	355.99	116.00	0.00	0.00	839.71	273.62	3371.79	1098.70	4539.10	1479.07			9106.59	2967.39	14.44	77.70
1990	101.89	33.20	35.11	11.44	279.27	91.00	3411.38	1111.60	4713.35	1535.85			8540.99	2783.09	25.67	113.40
1991	3512.34	1144.50	134.69	43.89	38.36	12.50	2313.33	753.80	2217.88	722.70			8216.61	2677.39	21.83	127.90
1992	3012.42	981.60	214.82	70.00	293.69	95.70	1267.14	412.90	2817.55	918.10			7605.62	2478.30	34.71	159.40
1993	4130.42	1345.90	550.56	179.40	194.26	63.30	1624.06	529.20	1718.27	559.90			8217.56	2677.70	35.25	147.10
1994	3428.87	1117.30	236.00	76.90	271.90	88.60	1901.18	619.50	1903.94	620.40			7741.88	2522.70	21.91	149.20
1995	3400.02	1107.90	432.71	141.00	303.51	98.90	1426.73	464.90	2256.55	735.30			7819.52	2548.00	17.79	109.50
1996	1900.41	619.25	0.00	0.00	345.13	112.46	3115.60	1015.22	2849.19	928.41			8210.32	2675.34	11.81	33.70
1997	1784.04	581.33	0.00	0.00	730.52	238.04	2709.37	882.85	2835.01	923.79			8058.93	2626.01	16.40	132.20
1998	3363.19	1095.90	482.15	157.11	129.60	42.23	1510.20	492.10	2393.12	779.80			7878.26	2567.14	27.36	137.00
1999	1186.49	386.62	151.20	49.27	240.11	78.24	3189.77	1039.39	3224.05	1050.56			7991.63	2604.08	15.79	63.00
2000	784.78	255.72	23.07	7.52	681.13	221.95	4013.39	1307.77	3410.12	1111.19			8912.49	2904.14	15.40	74.40
2001	946.75	308.50	162.25	52.87	267.42	87.14	3530.60	1150.45	3690.57	1202.58	206.55	67.30	8804.14	2868.84	17.59	125.10
2002	195.67	63.76	0.00	0.00	24.77	8.07	4779.91	1557.54	3334.68	1086.61	432.90	141.06	8767.93	2857.04	12.88	38.90
2003	615.77	200.65	18.81	6.13	188.71	61.49	4136.09	1347.75	3111.45	1013.87	543.47	177.09	8614.31	2806.98	17.91	54.90
2004	900.96	293.58	0.00	0.00	200.67	65.39	3625.86	1181.49	2213.25	721.19	1308.51	426.38	8249.26	2688.03	23.61	50.30
2005	3670.33	1195.98	302.65	98.62	325.06	105.92	1775.60	578.58	1108.45	361.19	945.46	308.08	8127.55	2648.37	24.01	138.00
2006	1553.51	506.21	73.89	24.08	508.75	165.78	2551.64	831.46	2576.73	839.63	1324.73	431.66	8589.25	2798.82	15.59	44.50
2007	294.70	96.03	38.82	12.65	336.00	109.49	4050.78	1319.95	2591.47	844.43	1573.15	512.61	8884.92	2895.16	17.46	49.90
2008	2929.50	954.58	265.22	86.42	161.01	52.47	2352.76	766.65	1502.99	489.75	1273.19	414.87	8484.67	2764.74	18.85	90.80
2009	3744.16	1220.04	262.09	85.40	0.00	0.00	1662.50	541.73	1412.75	460.35	1317.95	429.45	8399.44	2736.97	11.65	138.20
2010	3987.93	1299.47	198.67	64.74	0.00	0.00	1460.55	475.92	1132.62	369.07	1571.85	512.19	8351.63	2721.39	27.89	140.50
2011	3416.24	1113.19	0.00	0.00	0.00	0.00	1536.10	500.54	1109.53	361.54	2234.85	728.23	8296.72	2703.49	20.67	103.60
2012	934.52	304.51	0.00	0.00	0.00	0.00	3063.61	998.28	1439.86	469.18	3020.44	984.21	8458.42	2756.19	14.89	69.70
2013	1572.73	512.48	99.00	32.26	0.00	0.00	2774.00	903.91	1680.86	547.71	2518.33	820.60	8644.92	2816.96	24.79	44.00
2014	1037.90	338.17	18.00	5.87	237.60	77.42	2574.60	838.87	1726.80	562.64	2752.10	896.70	8347.00	2719.67	20.67	57.00
2015	1854.16	604.18	175.97	57.34	66.99	21.83	2096.88	683.27	1524.47	496.75	2294.61	747.70	8013.08	2611.07	27.25	62.90
2016	1625.08	529.53	90.27	29.41	110.48	36.00	2064.12	672.60	1453.76	473.71	2634.98	858.61	7978.69	2599.86	25.80	95.50
2017	1782.60	580.86	367.74	119.83	0.00	0.00	2126.15	692.81	1101.49	358.92	2613.75	851.69	7991.74	2604.12	18.00	37.40
2018	2131.74	694.63	17.14	5.59	173.70	56.60	1759.25	573.25	1190.58	387.95	2763.33	900.43	8035.75	2618.46	21.57	117.20
2019	2592.77	844.86	257.08	83.77	0.00	0.00	1311.28	427.28	1052.88	343.08	2914.61	949.73	8128.62	2648.72	26.10	70.30
Historic Average	**2255.61**	**734.99**	**386.67**	**126.00**	**330.30**	**107.63**	**1573.08**	**512.59**	**1596.20**	**520.12**	**1802.35**	**587.30**	**5940.37**	**1935.67**	**21.38**	**94.78**
Percent of total	28.4%		4.9%		4.2%		19.8%		20.1%		22.7%					
Historic Median	1953.04	636.40	262.08	85.40	313.86	102.27	1369.00	446.09	1412.75	460.35	1573.15	512.61	6528.14	2127.20	20.67	90.10
Ave of last 5 yrs	1997.27	650.81	181.64	59.19	70.24	22.89	1871.54	609.84	1264.64	412.08	2644.26	861.63	8029.58	2616.45	23.74	76.66
Percent of total		24.9%		2.3%		0.9%		23.3%		15.7%		32.9%				

7-3 2019 Weekly Production By Source (Million Gallons)

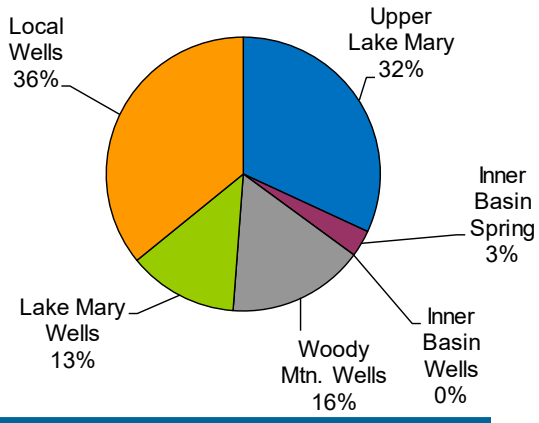
MONTH	WEEK	TOTAL	LM SURFACE	LM WELLS	WM WELLS	R F P	LOC WELLS
January	1	16.83	0.327	2.671	4.039	0.000	9.795
	2	43.17	3.794	8.950	9.312	0.000	21.115
	3	38.51	3.466	8.340	7.833	0.000	18.869
	4	42.85	4.193	9.354	7.681	0.000	21.626
	5	40.12	4.161	8.829	7.738	0.000	19.394
February	1	44.68	4.150	9.553	7.965	0.000	23.009
	2	42.42	4.087	8.820	7.573	0.000	21.935
	3	44.06	8.394	7.490	6.631	0.000	21.545
	4	43.36	14.620	5.753	4.157	0.000	18.834
March	1	44.50	16.141	5.501	4.180	0.000	18.677
	2	46.99	17.902	4.717	4.058	0.000	20.309
	3	40.75	13.606	4.744	3.972	0.000	18.428
	4	43.09	12.057	5.379	4.149	0.000	21.505
April	1	45.87	20.315	4.714	4.168	0.000	16.671
	2	45.92	19.418	5.016	4.063	0.000	17.425
	3	47.29	18.464	5.701	4.079	0.000	19.044
	4	50.73	15.963	9.772	4.006	0.000	20.987
	5	56.42	19.535	10.943	3.956	0.000	21.983
May	1	54.43	20.598	9.344	4.034	1.152	19.305
	2	46.90	23.609	4.399	5.683	2.140	11.072
	3	48.99	18.312	4.426	7.547	2.531	16.169
	4	46.60	18.596	4.508	5.899	1.325	16.276
June	1	53.92	25.365	4.220	5.870	2.589	15.879
	2	60.20	27.562	4.401	5.756	3.939	18.539
	3	61.90	27.884	4.388	5.696	4.981	18.947
	4	64.08	26.976	8.317	5.822	4.373	18.597
July	1	55.10	20.273	5.510	3.998	11.011	14.312
	2	75.14	29.408	7.704	4.899	13.515	19.609
	3	65.20	25.810	7.128	4.423	8.997	18.844
	4	66.45	21.169	7.799	13.122	4.320	20.045
	5	59.18	13.713	6.565	16.201	4.497	18.205
August	1	54.96	15.663	6.314	13.547	3.593	15.840
	2	59.57	22.946	6.572	10.785	3.345	15.918
	3	65.32	19.655	10.245	12.590	2.461	20.371
	4	66.10	16.385	13.584	16.305	2.220	17.604
September	1	62.09	13.555	12.188	13.503	1.792	21.053
	2	62.66	18.600	8.382	13.482	1.645	20.551
	3	60.86	18.261	7.913	12.836	1.363	20.490
	4	58.89	17.051	7.570	12.442	1.287	20.536
October	1	55.22	18.544	5.009	12.127	0.693	18.845
	2	54.23	17.753	5.954	13.597	0.000	16.926
	3	49.30	12.106	4.519	13.431	0.000	19.247
	4	47.74	11.212	4.380	13.834	0.000	18.316
	5	47.29	13.122	4.547	10.497	0.000	19.122
November	1	43.61	14.909	4.618	8.713	0.000	15.370
	2	45.82	14.929	4.525	8.453	0.000	17.909
	3	44.18	19.077	4.463	8.301	0.000	12.336
	4	37.28	16.536	4.133	6.783	0.000	9.824
December	1	43.26	10.249	6.695	8.890	0.000	17.429
	2	45.66	17.714	4.296	7.712	0.000	15.939
	3	42.48	16.834	4.406	7.738	0.000	13.501
	4	66.57	19.891	7.812	13.213	0.000	25.654
Total year, 2019 (MG)		**2648.72**	**844.86**	**343.08**	**427.28**	**83.77**	**949.73**
	Acre-Feet	**8128.62**	**2592.77**	**1052.88**	**1311.28**	**257.08**	**2914.61**
Total year, 2018 (MG)		**2632.580**	**709.027**	**387.951**	**573.254**	**61.913**	**900.435**
		TOTAL	**LM SURFACE**	**LM WELLS**	**WM WELLS**	**RFP**	**LOC WELLS**
2019 % of 2018		**101%**	**119%**	**88%**	**75%**	**135%**	**105%**
2019 % By Source			**32%**	**13%**	**16%**	**3%**	**36%**
AVG DAILY (mgd)		**7.26**	**2.31**	**0.94**	**1.17**	**0.23**	**2.60**

RFP = Reservoir Filtration Plant
Difference between total and sum of individual wells on page 19 & 20 is due to meter inaccuracies.

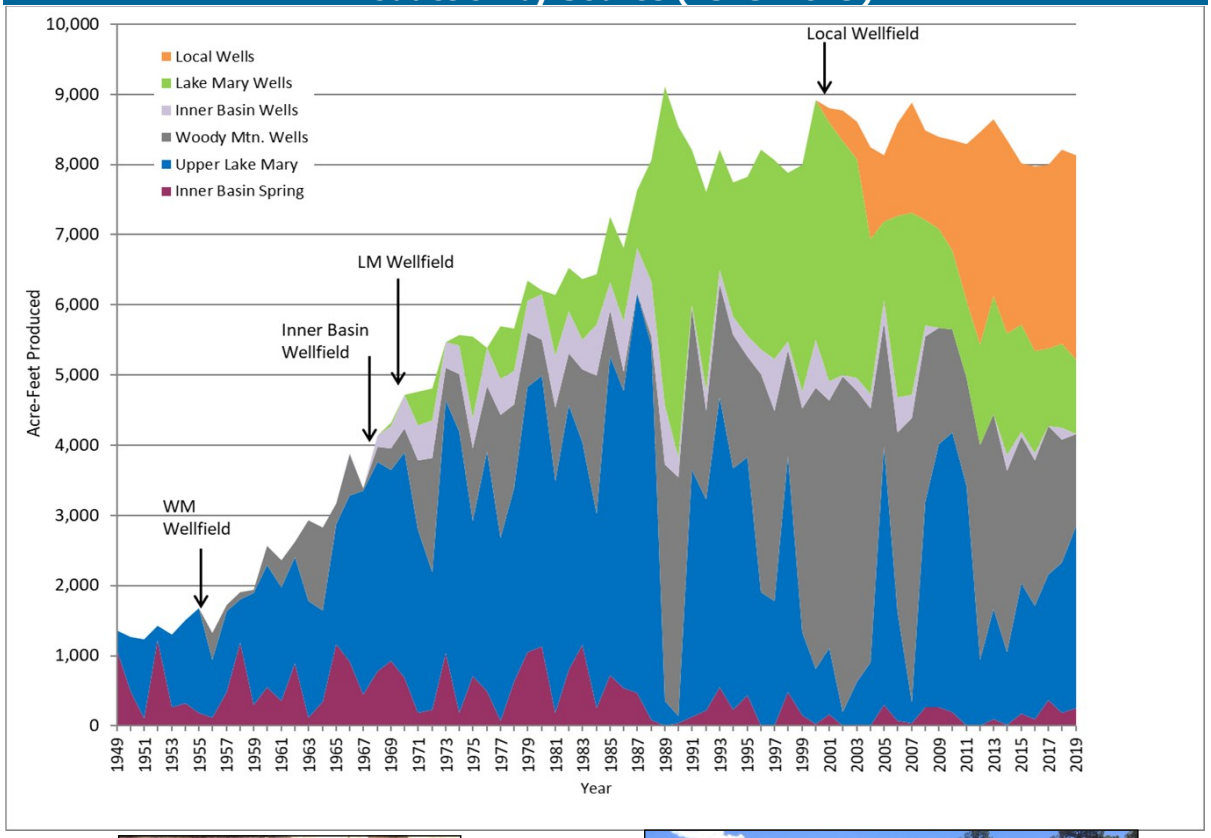
Historic Average (1949-2019)



Potable Water Supply 2019



Production by Source (1949-2019)



Inner Basin Pipeline repairs, summer 2019

Lake Mary Sedimentation basin maintenance

7-4 Most Recent Distribution System Water Quality at Each EPDS (Entry Point to the Distribution System)

	unit	MCL	Year	EPDS 001 Woody Mtn.	Year	EPDS 002 N. Res. Plant	Year	EPDS 003 Lake Mary	Year	EPDS 004 Foxglenn	Year	EPDS 005 Continental	Year	EPDS 006 Interchange	Year	EPDS 007 Shop	Year	EPDS 008 Rio	Year	EPDS 009 Ft.Tuthill
Arsenic	mg/L	0.01	2017	0.0075	2017	<0.001	2015	0.0026	2015	0.003	2015	0.0017	2015	0.0021	2017	0.0017	2015	0.001	2019	0.0055
Barium	mg/L	2	2017	0.64	2017	0.007	2015	0.18	2015	0.18	2015	0.52	2015	0.28	2017	1.1	2015	0.14	2019	0.43
Cadmium	mg/L	0.005	2017	<0.0005	2017	<0.0005	2015	<0.0005	2015	<0.0005	2015	<0.0005	2015	<0.0005	2017	<0.0005	2015	<0.0005	2019	<0.0005
Chromium	mg/L	0.01	2017	0.0013	2017	<0.001	2015	<0.001	2015	0.0023	2015	0.0029	2015	0.0023	2017	0.0014	2015	0.001	2019	0.0016
Fluoride	mg/L	4	2017	0.09	2017	0.097	2015	0.087	2015	0.056	2015	0.12	2015	0.093	2017	0.1	2015	0.1	2019	0.075
Mercury	mg/L	0.002	2017	<0.0002	2017	<0.0002	2015	<0.0002	2015	<0.0002	2015	<0.0002	2015	<0.0002	2017	<0.0002	2015	<0.0002	2019	<0.0002
Nitrate	mg/L	5	2019	0.17	2019	<0.1	2019	<0.1	2019	0.038	2019	1.6	2019	0.64	2019	0.96	2019	1	2019	0.16
Nitrite	mg/L	0.5	2018	<0.05	2018	<0.05	2019	<0.05	2018	<0.05	2018	<0.05	2018	<0.05	2018	<0.05	2018	<0.05	2018	<0.05
Selenium	mg/L	0.05	2017	<0.005	2017	<0.005	2015	<0.005	2015	<0.005	2015	<0.005	2015	<0.005	2017	<0.005	2015	<0.005	2019	<0.005
Antimony	mg/L	0.006	2017	<0.001	2017	< 0.001	2015	<0.001	2015	<0.001	2015	<0.001	2015	<0.001	2017	<0.001	2015	<0.001	2019	<0.001
Beryllium	mg/L	0.004	2017	<0.001	2017	<0.001	2015	<0.001	2015	<0.001	2015	<0.001	2015	<0.001	2017	<0.001	2015	<0.001	2019	<0.001
Cyanide	mg/L	0.2	2017	<0.005	2017	<0.005	2015	<0.005	2015	<0.005	2015	<0.005	2015	<0.005	2017	<0.005	2015	<0.005	2019	<0.005
Nickel	mg/L	0.1	2017	<0.005	2017	<0.005	2013	<0.005	2012	<0.005	2015	<0.005	2015	<0.005	2017	<0.005	2015	<0.005	2019	<0.005
Thallium	mg/L	0.002	2017	<0.001	2017	<0.001	2015	<0.001	2015	<0.001	2015	<0.001	2015	<0.001	2017	<0.001	2015	<0.001	2019	<0.001
Sodium	mg/L	na	2019	5.2	2019	2.4	2019	5.2	2019	6.8	2019	6.7	2019	4.1	2019	5.2	2019	4.7	2019	3.9
Asbestos	MFL	7	2012	<0.2	2018	<0.2	2018	<0.2	2012	<0.2	2012	<0.2	2015	<0.2	2012	<0.2	2015	<0.2	2012	<0.2
Adjusted Gross Alpha	pCi/L	15	2017	3.0 ± 0.7	2016	0.6 ± 0.5	2012	<1.0	2015	1.8 ± 0.8	2012	< 1.0	2015	1.0 ± 0.7	2017	1.7 ± 0.6	2015	0.1	2017	1.7 ± 0.6
Combined Uranium	µg/L	30	2017	0.9 ± 0.4	2016	< 0.5	2012	1.8 ± 0.7	2015	1.2 ± 0.5	2012	1.5 ± 0.5	2015	0.8 ± 0.5	2017	1.0 ± 0.5	2015	2.0 ± 0.7	2017	1.0 ± 0.5
Combined Radium	pCi/L	5	2017	0.6 ± 0.2	2016	<0.3	2012	0.4 ± 0.1	2015	0.5 ± 0.2	2012	< 0.4	2015	0.4	2017	< 0.6	2015	1.1	2017	< 0.6

mg/L = milligrams per liter
MFL = million fibres per liter
pCi/L = picocuries per liter. Picocuries per liter is a measure of the radioactivity in water.
µg/L = micrograms per Liter
Drinking water regulations only call for sampling every couple of years depending on the EPDS.

7-5 City Supply Wells & ADWR Registration Information

CADASTRAL	NAME	ADWR REGISTRATION NUMBER	DATE OF COMPLETION
A (21-06) 35 cbd	Woody Mtn Well #1	55-606201	Dec-54
A (21-06) 35 ccb	Woody Mtn Well #2	55-606202	Jul-56
A (21-06) 35 bcc	Woody Mtn Well #3	55-606203	Oct-57
A (21-06) 35 ccc	Woody Mtn Well #4	55-606204	Nov-57
A (20-06) 02 bbc	Woody Mtn Well #5	55-606205	Jun-63
A (20-06) 02 bdb	Woody Mtn Well #6	55-606206	Mar-68
A (20-06) 11 bab	Woody Mtn Well #7	55-606207	Apr-78
A (20-06) 11 cab	Woody Mtn Well #9	55-509026	Nov-85
A (20-06) 02 bcb	Woody Mtn Well #10	55-548560	Mar-96
A (20-06) 11 baa	Woody Mtn Well #11	55-559574	Jun-98
A (20-08) 18 bbb	Lake Mary Well #1	55-606195	Oct-62
A (20-08) 18 ccb	Lake Mary Well #2	55-606196	Dec-64
A (20-07) 12 dda	Lake Mary Well #3	55-606197	Sep-65
A (20-08) 19 aba	Lake Mary Well #4	55-606198	Jan-72
A (20-08) 20 dbc	Lake Mary Well #5	55-606199	Dec-75
A (20-08) 27 bdc	Lake Mary Well #7	55-606200	Dec-78
A (20-08) 20 cca	Lake Mary Well #8	55-501228	Mar-82
A (20-08) 30 cdb	Lake Mary Well #9	55-532282	Sep-91
A (23-07) 33 aab	Inner Basin Well #9	55-606209	Aug-68
A (23-07) 27 cca	Inner Basin Well #11	55-606210	Aug-71
A (23-07) 28 ddb	Inner Basin Well #14	55-606211	Aug-70
A (21-07) 24 aac	Foxglenn Well (EPDS 4)	55-559572	Jan-97
A (21-08) 17 bca	Continental Well-2 (EPDS 5)	55-560805	Feb-97
A (21-08) 07 dbb	Interchange Well (EPDS 6)	55-588998	Nov-02
A (21-08) 05 dca	Shop Well (EPDS 7)	55-588257	Dec-02
A (21-07) 23 cbb	Rio Well (EPDS 8)	55-599535	Nov-03
A (20-07) 06 adc	Ft. Tuthill Well (EPDS 9)	55-907084	Jan-08
A (21-07) 24 acd	Sinagua Well (EPDS 4)	55-907085	May-08
A (21-07) 19 bbd	McAllister Well	55-908260	Apr-09

* EPDS – Wells that are tested as an entry point to the distribution system (EPDS). See page 18 for drinking water quality data regulated by the Arizona Department of Environmental Quality. Other EPDS points include the Woody Mountain booster site (EPDS 001), Inner Basin water at the North Reservoir Plant (EPDS 002), and water from Upper Lake Mary (EPDS 003).

7-6 Potable Power Cost—CY 2019

POTABLE Water Source	Electricity $/Kgal Source	Raw Pump	Booster	Final Cost	Total Power Cost	Water Produced (MG)	Total Megawatt	Cost Per Acre-foot
Lake Mary Plant	$0.16	$0.08	$0.00	$0.24	$205,232.72	844.86	2578.10	$79.16
Lake Mary Wells	$0.51	$0.08	$0.00	$0.59	$201,438.86	343.08	1705.75	$191.32
Local Wells	$0.92	$0.00	$0.04	$0.96	$910,497.95	949.73	10212.08	$312.39
Woody Mountain Wells	$0.88	$0.00	$0.04	$0.92	$395,074.63	427.28	3783.11	$301.29
Inner Basin Wells & Springs	$0.00	$0.00	$0.04	$0.04	$3,468.24	83.77	24.53	$13.49
Weighted Avg				**$0.65**				**$211**
Total					**$1,715,712**	**2,648.72**	**18,303.56**	

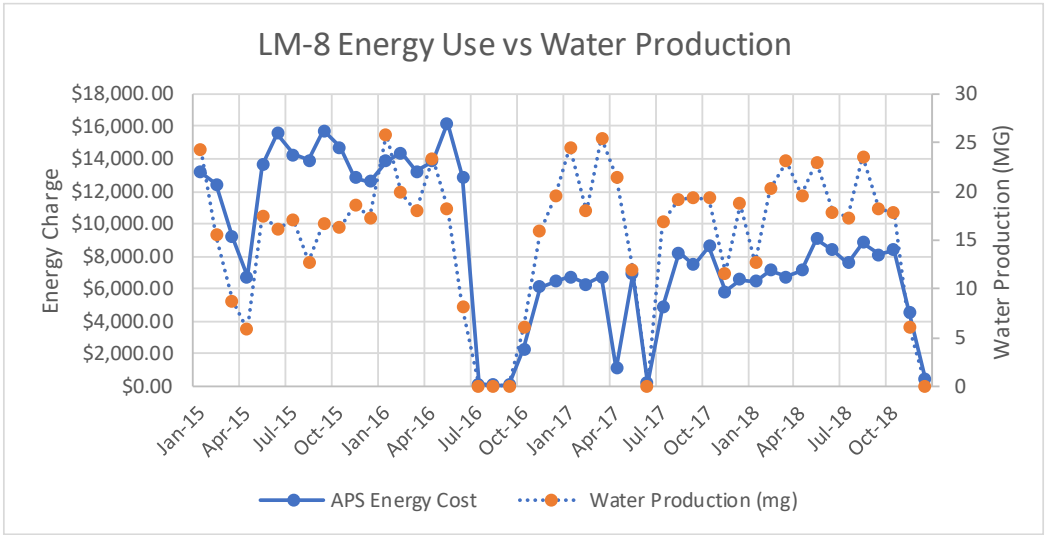
- Total electricity cost = Electricity Cost Data from Sustainability + Booster Station Cost Data from Water Production Section.
- Costs do not include operation and maintenance, staffing, or chemical treatment.
- Electrical charges to boost the water to homes in Flagstaff were distributed across WM, IB, and Local Wells only.
- No well water was produced from the Inner Basin in 2019.

Reclaimed Power Cost—CY 2019

Water Reclamation Plant	2019 Electricity Used to Treat Influent to Plants (kWh) APS	Solar	AZ Power Auth	Co-Gen	Volume Treated (gallons)	Electricity Used to Deliver Reclaimed Water (kWh)	Total Reclaimed Delivered (gallons)
Wildcat Hill	4,285,489		634,000	0	1,348,809,942	377,763	286,343,876
Rio de Flag	2,732,953		N/A	N/A	658,343,100	213,382	254,02,620
Totals	7,018,442	0	634,000	0	2,007,153,042	591,145	540,356,496
Cost to Utility	$697,074	$176,125	$25,760	$0		$65,025	
Cost / acre-foot					$146		$39.21

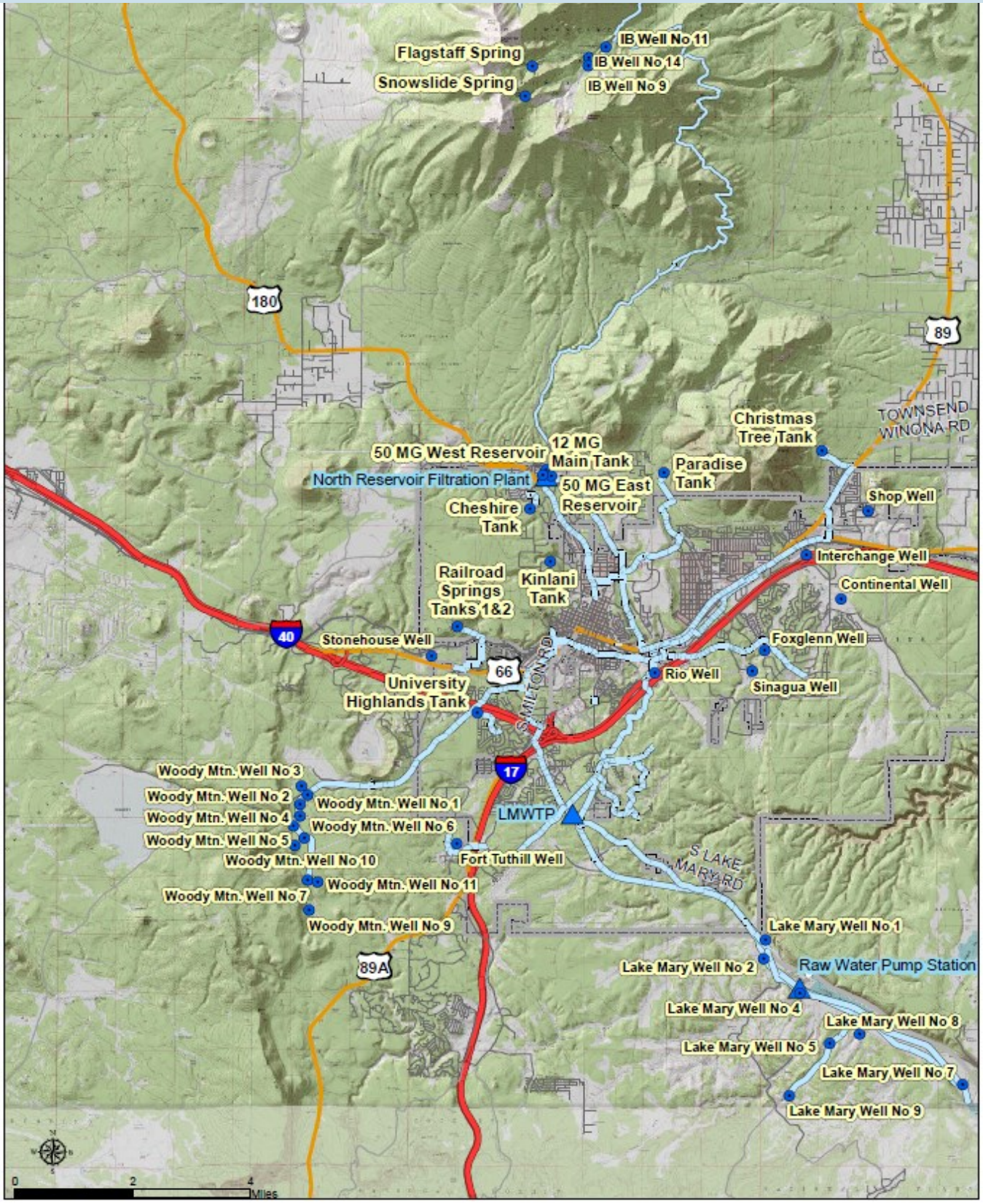
- Data from Water Services Division, Wastewater Treatment Section, March,2020
- Note the energy cost above for reclaimed water is only the cost to pump reclaimed water into the reclaimed water system. Wastewater is considered a commodity as reclaimed water once the wastewater treatment process meets its permitted water quality to discharge into the Rio de Flag.

Right: Example of energy savings with improvements in ground-water pumping technologies. A new groundwater pump was installed in the well in 2016, and the resulting savings speaks for itself.



8 2019 WELL FIELDS

8-1 Well Fields & Infrastructure



8-2 City of Flagstaff Well Production History 1997-Present (million gallons)

YEAR	FOXGLN	CONTL	SHOP	INTRCH	RIO	SINAGUA	TUTHILL	LOCAL	IB9	IB11	IB14	IB TOTAL
1997									55.870	59.120	14.460	129.450
1998									8.550	19.330	15.340	43.220
1999	5.010	3.230						8.240	51.380	26.080	0.780	78.240
2000	0.000	29.565						29.565	77.189	90.945	46.294	214.428
2001	66.149	1.560						67.709	0.000	31.323	55.815	87.138
2002	56.860	77.748						134.608	0.000	3.004	2.145	5.149
2003	72.821	67.674	17.909	18.683				177.087	0.000	51.057	10.435	61.492
2004	35.972	49.939	243.317	97.148				426.376	0.000	35.240	27.951	63.191
2005	34.637	23.189	196.500	53.758				308.084	64.602	39.444	1.870	105.916
2006	47.892	87.574	195.908	100.290				431.664	32.675	78.434	54.667	165.776
2007	126.331	63.106	217.610	69.060	45.310			521.417	0.000	45.476	64.011	109.487
2008	1.507	26.311	283.149	40.980	62.926			414.873	0.000	16.209	36.257	52.466
2009	0.000	0.000	400.700	6.860	28.494			436.054	0.000	0.000	0.000	0.000
2010	0.916	3.530	332.100	13.360	33.151	9.816	119.317	512.190	0.000	0.000	0.000	0.000
2011	29.726	8.138	339.660	7.360	16.680	18.389	308.334	728.287	0.000	0.000	0.000	0.000
2012	46.527	22.945	341.300	6.820	8.999	81.859	475.765	984.215	0.000	0.000	0.000	0.000
2013	20.172	16.327	270.500	3.800	16.848	65.110	427.843	820.600	8.163	24.695	0.000	32.858
2014	40.430	53.900	271.510	12.170	8.960	44.330	465.440	896.740	0.000	33.914	43.493	77.407
2015	20.840	21.580	273.880	16.720	34.730	20.200	359.740	747.690	21.835	0.000	0.000	21.835
2016	30.280	29.235	240.546	23.215	13.567	76.801	444.966	858.609	0.000	19.744	16.257	36.001
2017	16.100	20.043	299.298	4.391	6.334	100.669	404.856	851.691	0.000	0.000	0.000	0.000
2018	15.202	0.616	384.364	1.470	0.867	44.839	448.373	895.731	56.601	0.000	0.000	56.601
2019	36.853	0.000	374.468	2.390	18.990	101.526	422.365	956.592	0.000	0.000	0.000	0.000

YEAR	LM1	LM2	LM4	LM5	LM7	LM8	LM9					LM TOTAL
1997	0.000	84.540	147.960	135.620		511.090	107.590					986.800
1998	17.590	2.460	85.860	92.270		487.110	135.370					820.660
1999	8.800	46.210	213.470	120.000		530.750	85.290					1004.520
2000	18.049	171.246	256.658	95.156		548.086	109.017					1198.212
2001	31.236	193.036	331.506	48.201		533.297	110.915					1248.191
2002	18.043	141.507	303.165	100.531	3.155	532.376	65.262					1164.039
2003	18.062	124.797	259.479	92.900	0.000	453.701	100.860					1049.799
2004	5.457	124.023	79.160	130.041	0.000	338.451	176.190					853.322
2005	11.002	44.665	63.565	24.370	0.000	200.544	40.717					384.863
2006	10.895	80.049	189.037	89.718	0.000	334.613	117.689					822.001
2007	33.275	91.488	233.631	100.913	16.447	305.751	72.482					853.988
2008	3.977	26.072	103.224	109.768	6.941	249.638	8.788					508.408
2009	4.103	35.694	112.210	3.526	0.000	252.675	49.133					457.341
2010	0.000	0.000	103.180	31.535	0.000	186.186	38.731					359.632
2011	0.000	0.000	134.570	22.095	0.000	133.152	65.001					354.818
2012	0.000	0.000	217.764	121.153	0.000	58.394	73.206					470.517
2013	0.000	0.000	149.343	59.407	0.000	251.275	83.193					543.218
2014	0.000	0.630	224.490	18.930	0.000	245.160	73.450					562.660
2015	0.000	61.929	128.494	55.409	0.000	186.722	63.372					495.926
2016	0.000	72.512	139.961	33.554	0.000	154.823	70.649					471.499
2017	0.000	30.883	46.956	22.451	0.000	206.451	49.245					355.986
2018	0.000	55.633	77.443	8.411	0.000	199.578	34.959					376.024
2019	0.000	43.684	41.464	16.537	0.000	198.787	33.223					333.695

YEAR	WM1	WM2	WM3	WM4	WM5	WM6	WM7	WM9	WM10	WM11		WM TOTAL
1997	37.560	127.310	161.340	94.810	63.410	184.890	102.720	123.810	74.100			969.950
1998	0.000	28.860	31.080	34.190	67.490	104.280	221.090	52.740	20.630			560.360
1999	72.130	47.830	167.510	105.150	107.960	142.730	228.990	113.670	91.210			1077.180
2000	108.875	98.554	222.164	106.091	145.106	212.489	181.241	111.777	138.465			1324.762
2001	79.803	139.872	283.900	109.490	70.137	187.515	91.275	57.525	125.001	101.162		1245.680
2002	107.903	101.841	288.102	153.620	88.919	154.482	223.042	153.087	122.189	166.234		1559.419
2003	54.234	48.651	48.651	62.113	14.955	98.042	286.197	322.218	140.888	147.873		1223.822
2004	70.978	55.726	293.108	108.986	38.876	124.902	164.845	116.272	114.012	78.764		1166.469
2005	28.143	10.887	117.863	77.798	20.303	49.420	119.721	141.219	24.155	16.429		605.938
2006	65.498	80.910	142.982	25.047	55.920	128.174	74.025	125.994	79.033	37.299		814.882
2007	31.433	118.277	285.269	103.927	62.540	113.881	170.067	150.048	113.680	137.164		1286.285
2008	1.197	46.644	149.636	34.252	8.789	61.866	151.793	114.561	13.991	160.537		743.266
2009	3.199	3.249	100.105	7.054	1.615	123.519	147.408	120.969	1.788	19.648		528.554
2010	0.379	12.449	78.100	2.430	0.509	50.999	116.248	132.377	11.759	11.759		417.009
2011	4.499	2.902	120.155	6.948	2.975	65.582	178.185	70.566	0.000	39.779		491.591
2012	0.000	29.521	301.868	8.292	45.413	144.554	146.182	111.161	34.845	150.802		972.638
2013	0.000	18.430	169.470	31.094	11.720	158.563	272.729	94.067	34.211	91.083		881.367
2014	0.000	52.290	170.170	38.250	31.940	101.290	119.240	137.980	22.400	165.310		838.870
2015	0.000	59.110	93.718	11.118	20.983	155.571	89.978	120.278	17.909	109.322		677.987
2016	0.000	4.723	231.889	0.000	0.000	158.761	144.885	86.199	13.086	43.066		682.608
2017	0.000	4.428	242.207	0.000	14.277	83.479	84.253	129.472	51.962	69.683		679.762
2018	0.000	3.059	145.656	16.158	14.190	40.612	109.338	121.629	35.846	81.836		568.324
2019	0.000	24.108	37.223	9.683	18.642	127.584	20.513	90.079	30.043	62.169		420.044

TOTAL ALL SOURCES

YEAR	MG	YEAR	MG	YEAR	MG	YEAR	MG	YEAR	MG	YEAR	MG
1996	2204.590	2000	2766.967	2004	1342.889	2008	1719.013	2012	2427.370	2016	2048.717
1997	2086.200	2001	2648.718	2005	1404.801	2009	1421.949	2013	2278.043	2017	1887.439
1998	1424.240	2002	1303.796	2006	2234.322	2010	1288.831	2014	2375.677	2018	1896.679
1999	2168.180	2003	1288.378	2007	2771.177	2011	1574.696	2015	1943.438	2019	1710.331

Quantities are in MILLION GALLONS from individual well meters. Totals will not necessarily match cumulative well field master meters due to unknown meter inaccuracies.

8-2 City of Flagstaff Well Production History 1997-Present (acre-feet) continued

YEAR	FOXGLN	CONTL	SHOP	INTRCH	RIO	SINAGUA	TUTHILL	LOCAL	IB9	IB11	IB14	IB TOTAL
1997								0	171.46	181.43	44.38	397.27
1998								0	26.24	59.32	47.08	132.64
1999	15.38	9.91						25.29	157.68	80.04	2.39	240.11
2000	0	90.73						90.73	236.88	279.10	142.07	658.06
2001	203.00	4.79						207.79	0	96.13	171.29	267.42
2002	174.50	238.60						413.10	0	9.22	6.58	15.80
2003	223.48	207.68	54.96	57.34				543.46	0	156.69	32.02	188.71
2004	110.39	153.26	746.71	298.14				1308.50	0	108.15	85.78	193.93
2005	106.30	71.16	603.04	164.98				945.48	198.26	121.05	5.74	325.04
2006	146.98	268.75	601.22	307.78				1324.73	100.28	240.71	167.77	508.75
2007	387.70	193.66	667.82	211.94	139.05			1600.17	0	139.56	196.44	336.00
2008	4.62	80.75	868.95	125.76	193.11			1273.20	0	49.74	111.27	161.01
2009	0	0	1229.70	21.05	87.44			1338.20	0	0	0	0
2010	2.81	10.83	1019.18	41.00	101.74	30.12	366.17	1571.85	0	0	0	0
2011	91.23	24.97	1042.38	22.59	51.19	56.43	946.24	2235.03	0	0	0	0
2012	142.79	70.42	1047.41	20.93	27.62	251.22	1460.07	3020.44	0	0	0	0
2013	61.91	50.11	830.13	11.66	51.70	199.81	1313.00	2518.33	25.05	75.79	0	100.84
2014	124.08	165.41	833.23	37.35	27.50	136.04	1428.38	2751.99	0	104.08	133.48	237.55
2015	63.96	66.23	840.51	51.31	106.58	61.99	1104.00	2294.58	67.01	0	0	67.01
2016	92.93	89.72	738.21	71.24	41.64	235.69	1365.55	2634.98	0	60.59	49.89	110.48
2017	49.41	61.51	918.51	13.48	19.44	308.94	1242.46	2613.74	0	0	0	0.00
2018	46.65	1.89	1179.57	4.51	2.66	137.61	1376.01	2748.90	173.70	0	0	173.70
2019	113.10	0.00	1149.20	7.33	58.28	311.57	1296.19	2935.67	0.00	0	0	0.00

YEAR	LM1	LM2	LM4	LM5	LM7	LM8	LM9					LM TOTAL
1997		259.44	454.07	416.20		1568.48	330.18					3028.38
1998	53.98	7.55	263.49	283.17		1494.89	415.44					2518.51
1999	27.01	141.81	655.12	368.27		1628.81	261.75					3082.76
2000	55.39	525.53	787.65	292.02		1682.01	334.56					3677.18
2001	95.86	592.41	1017.35	147.92		1636.63	340.39					3830.56
2002	55.37	434.27	930.38	308.52	9.68	1633.80	200.28					3572.30
2003	55.43	382.99	796.31	285.10	0	1392.36	309.53					3221.71
2004	16.75	380.61	242.93	399.08	0	1038.67	540.71					2618.75
2005	33.76	137.07	195.07	74.79	0	615.45	124.96					1181.10
2006	33.44	245.66	580.13	275.33	0	1026.89	361.17					2522.63
2007	102.12	280.77	716.99	309.69	50.47	938.32	222.44					2620.79
2008	12.20	80.01	316.78	336.87	21.30	766.11	26.97					1560.25
2009	12.59	109.54	344.36	10.82	0	775.43	150.78					1403.53
2010	0	0	316.65	96.78	0	571.38	118.86					1103.67
2011	0	0	412.98	67.81	0	408.63	199.48					1088.90
2012	0	0	668.29	371.80	0	179.20	224.66					1443.96
2013	0	0	458.32	182.31	1.00	771.13	255.31					1668.07
2014	0	1.93	688.93	58.09	0	752.37	225.41					1726.74
2015	0	190.05	394.33	170.04	0	573.03	194.48					1521.94
2016	0	222.53	429.52	102.97	0	475.13	216.81					1446.98
2017	0	94.78	144.10	68.90	0	633.57	151.13					1092.48
2018	0	170.73	237.66	25.81	0	612.48	107.29					1153.97
2019	0	134.06	127.25	50.75	0	610.05	101.96					1024.07

YEAR	WM1	WM2	WM3	WM4	WM5	WM6	WM7	WM9	WM10	WM11		WM TOTAL
1997	115.27	390.70	495.13	290.96	194.60	567.41	315.24	379.96	227.40			2976.67
1998	0	88.57	95.38	104.93	207.12	320.02	678.50	161.85	63.31			1719.68
1999	221.36	146.78	514.07	322.69	331.32	438.02	702.74	348.84	279.91			3305.74
2000	334.13	302.45	681.80	325.58	445.31	652.10	556.21	343.03	424.93			4065.55
2001	244.91	429.25	871.26	336.01	215.24	575.46	280.11	176.54	383.61	310.45		3822.85
2002	331.14	312.54	884.15	471.44	272.88	474.09	684.49	469.81	374.98	510.15		4785.68
2003	166.44	149.31	149.31	190.62	45.90	300.88	878.31	988.85	432.37	453.81		3755.77
2004	217.82	171.02	899.52	334.47	119.31	383.31	505.89	356.83	349.89	241.72		3579.76
2005	86.37	33.41	361.71	238.75	62.31	151.66	367.41	433.39	74.13	50.42		1859.56
2006	201.01	248.30	438.80	76.87	171.61	393.35	227.17	386.66	242.54	114.47		2500.78
2007	96.46	362.98	875.46	318.94	191.93	349.49	521.92	460.48	348.87	420.94		3947.46
2008	3.67	143.15	459.22	105.12	26.97	189.86	465.84	351.57	42.94	492.67		2281.00
2009	9.82	9.97	307.21	21.65	4.96	379.07	452.38	371.24	5.49	60.30		1622.07
2010	1.16	38.20	239.68	7.46	1.56	156.51	356.75	406.25	36.09	36.09		1279.75
2011	13.81	8.91	368.74	21.32	9.13	201.26	546.83	216.56	0	122.08		1508.64
2012	0	90.60	926.40	25.45	139.37	443.62	448.62	341.14	106.94	462.79		2984.92
2013	0	56.56	520.08	95.42	35.97	486.61	836.97	288.68	104.99	279.52		2704.82
2014	0	160.47	522.23	117.38	98.02	310.85	365.93	423.45	68.74	507.32		2574.40
2015	0	181.40	287.61	34.12	64.39	477.43	276.13	369.12	54.96	335.50		2080.67
2016	0	14.49	711.64	0	0	487.22	444.64	264.54	40.16	132.16		2094.85
2017	0	13.59	743.31	0	43.82	256.19	258.56	397.33	159.47	213.85		2086.11
2018	0	9.39	447.00	50	43.55	43.55	335.55	373.27	110.01	251.15		1663.03
2019	0	73.98	114.23	30	57.21	57.21	62.95	276.44	92.20	190.79		954.74

TOTAL ALL SOURCES (ACRE-FEET)

YEAR	AF	YEAR	AF	YEAR	AF	YEAR	AF	YEAR	AF	YEAR	AF
1996	6765.64	2000	6653.90	2004	4121.18	2008	5275.46	2012	7449.32	2016	6287.28
1997	6402.31	2001	8491.51	2005	4311.18	2009	4363.80	2013	6991.06	2017	5792.34
1998	4370.83	2002	4001.20	2006	6856.88	2010	3955.28	2014	7290.69	2018	5739.60
1999	6653.90	2003	3953.89	2007	8504.43	2011	4832.56	2015	5964.19	2019	4914.48

Quantities are in MILLION GALLONS converted to ACRE FEET from individual well meters. Totals will not necessarily match cumulative well field master meters due to unknown meter inaccuracies.

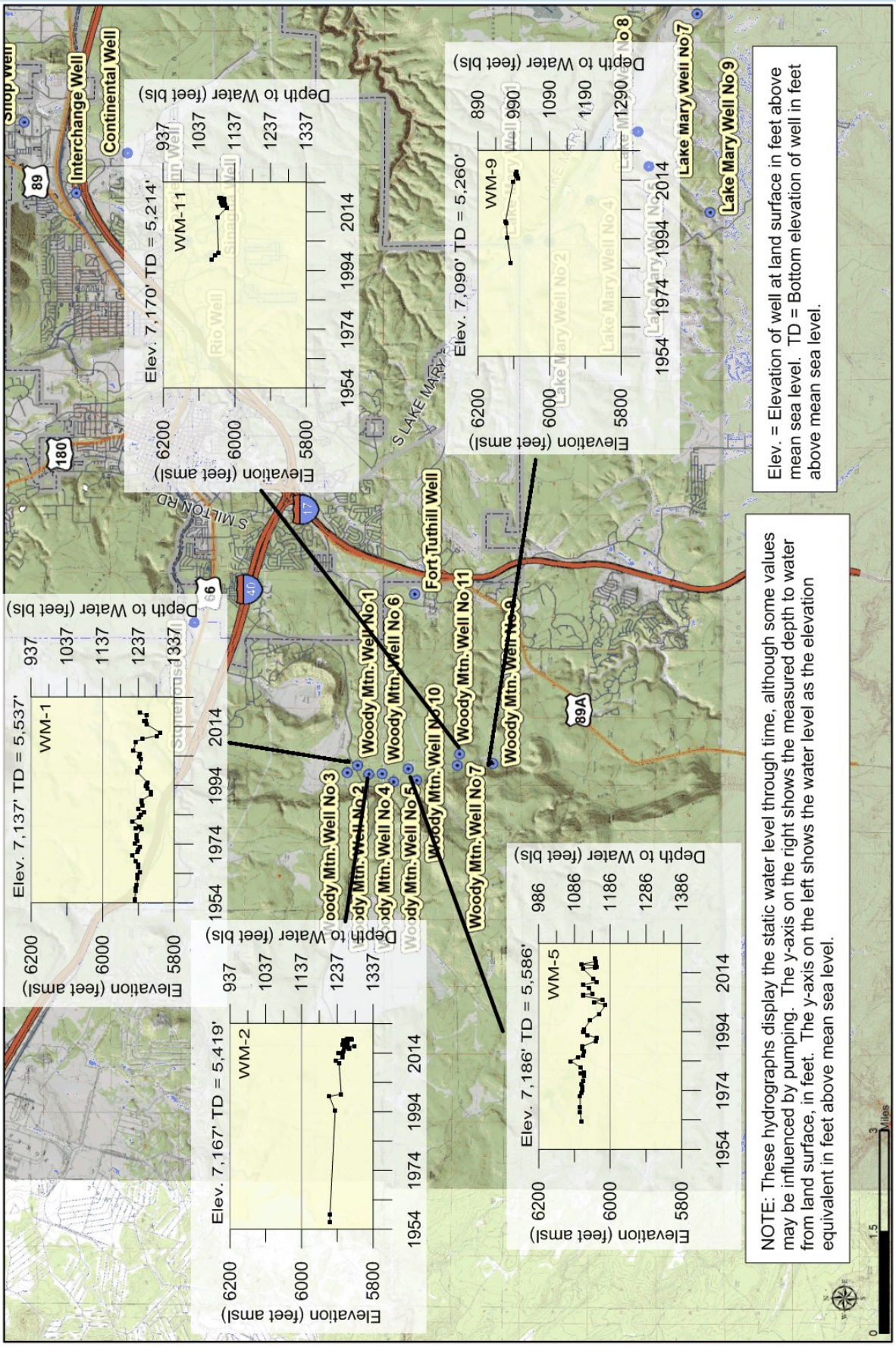
8-3 Water Supply Sources and Wells Specific Capacity

LAKE MARY SURFACE WATER PRODUCTION DESIGN CAPACITY	8.0 MGD						
RESERVIOR FILTRATION PLANT (INNER BASIN WATER) CAPACITY	**2.0 MGD**	**2019**					
LAKE MARY WELLS (year last modified)	Surface Elevation (feet)	Static Level (feet bls)	Pumping Level (feet bls)	Current yield (gpm)	Current yield (MGD)	Drawdown (feet)	Specific Capacity (gpm/ft)
LM #1, 2002 Pump & Motor	6838	671	DNR	DNR	DNR	DNR	DNR
LM #2, 2008 Pump & Motor	6837	602	883	337	0.49	281	1.2
LM #4, 2009 Pump & Motor	6809	561	802	437	0.63	241	1.8
LM #5	6816	525	649	299	0.43	124	2.4
LM #8, 2016 250 HP Pump and Motor	6818	578	829	608	0.88	251	2.4
LM #9, 2009 Pump & Motor	6875	353	711	236	0.34	358	0.7
MAXIMUM YIELD FOR WELLFIELD (MGD)	**3.08**	**3.08**					
WOODY MTN. WELLS (year last modified)	Surface Elevation	Static Level	Pumping Level	Current yield	Current yield	Drawdown	Specific Capacity
WM #1	7137	1253	DNR	DNR	DNR	DNR	DNR
WM #2, 2020 Pump & Motor	7167	1294	1341	217	0.31	47	4.6
WM #3, 2015 Pump & Motor	7129	1214	1303	572	0.82	89	6.4
WM #4, 2018 Pump & Motor	7163	1114	1214	315	0.45	100	3.1
WM #5, 2019 Pump & Motor	7186	1138	1272	304	0.44	134	2.3
WM #6	7201	1083	1338	396	0.57	255	1.6
WM #7, 2009 Pump & Motor	7171	1126	1293	572	0.82	167	3.4
WM #9, 2014 Pump & Motor	7088	997	1387	420	0.61	390	1.1
WM #10, 2017 Pump & Motor	7240	1149	1343	282	0.41	194	1.5
WM #11, 2011 Pump & Motor	7170	1125	1401	349	0.50	276	1.3
MAXIMUM YIELD FOR WELLFIELD (MGD)	**5.11**	**5.11**					
LOCAL WELLS (year last modified)	Surface Elevation	Static Level	Pumping Level	Current yield	Current yield	Drawdown	Specific Capacity
Continental, 2006 Pump&Motor	6751	1315	DNR	DNR	DNR	DNR	DNR
Foxglenn, 2018 Pump & Motor	6775	1303	1483	285	0.41	180	1.6
Shop, 2016 Motor, 2017 pump	6799	1475	1679	820	1.18	204	4.0
Sinagua, 2020 Pump & Motor	6770	1280	1429	246	0.35	149	1.6
Ft. Tuthil, 2015 Pump & Motor	7000	1095	1207	1101	1.59	112	9.8
*McAllister, Design Completed 2016	7060	*	*	*	*	*	*
Interchange, 2003	6790	1396	1522	192	0.28	126	1.5
Rio, 2006	6858	1114	DNR	DNR	DNR	DNR	DNR
MAXIMUM YIELD FOR WELLFIELD (MGD)	**4.81**	**4.81**					

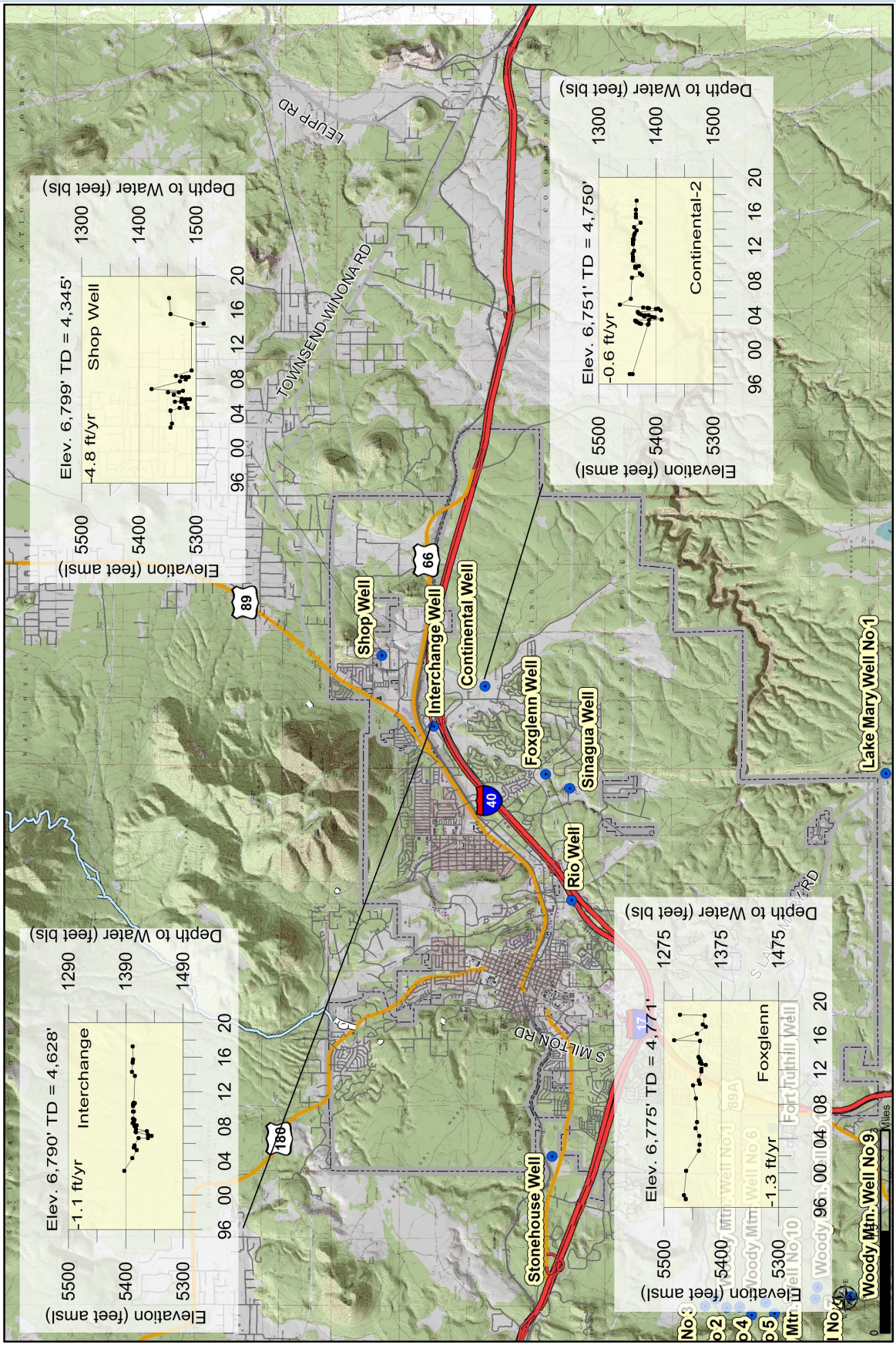
DNR-Well Did Not Run

Sum of current yield may be different maximum yield for well field reported as peak yield on page 6 and page 17

8-4 Water Level Hydrographs Woody Mountain Wells



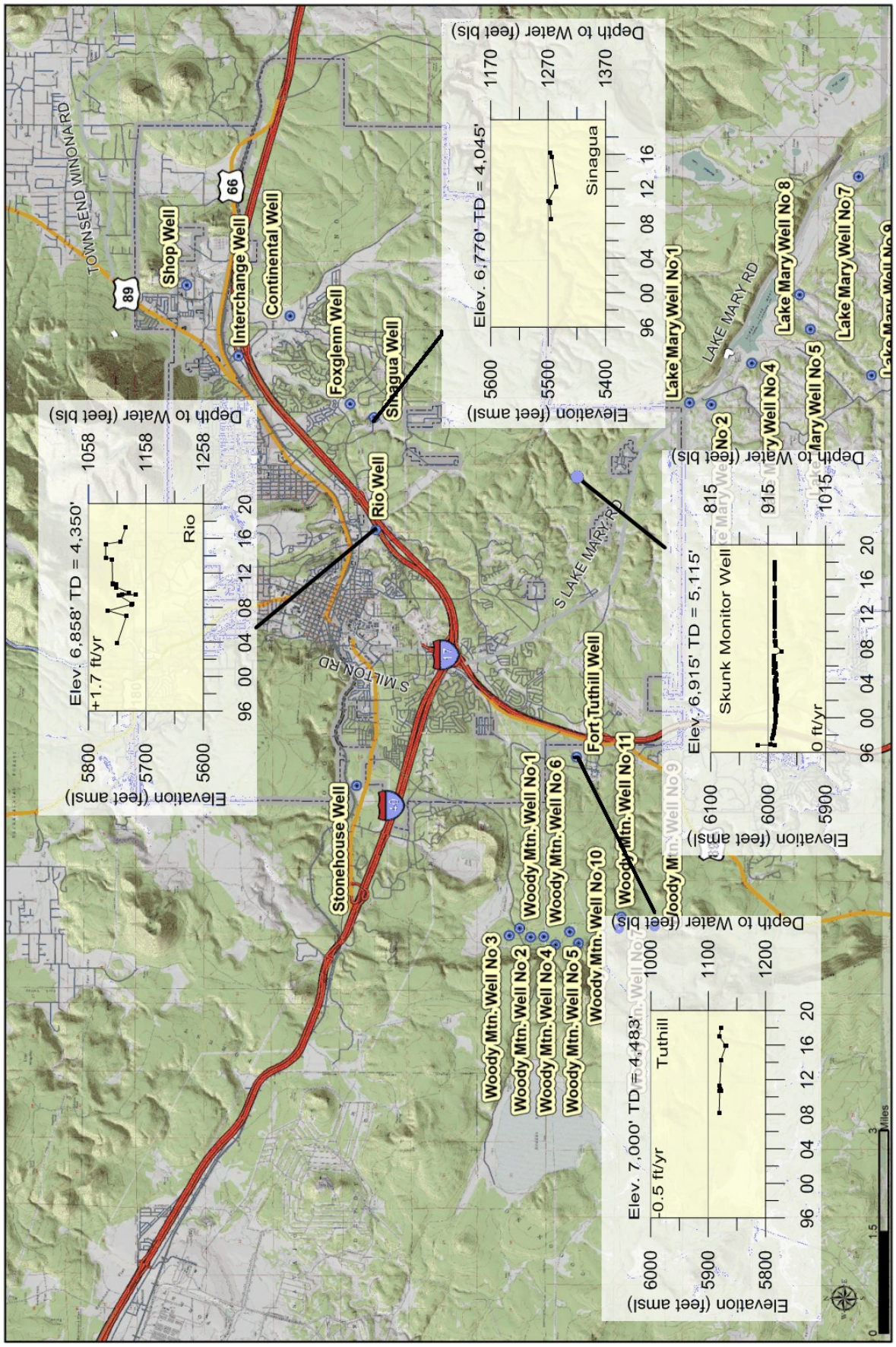
8-4 Water Level Hydrographs Local Wells East



Elev. = Elevation of well at land surface in feet above mean sea level.
TD = Bottom elevation of well in feet above mean sea level.

NOTE: These hydrographs display the static water level through time, although some values may be influenced by pumping. The y-axis on the right shows the measured depth to water from land surface, in feet. The y-axis on the left shows the water level as the elevation equivalent in feet above mean sea level.

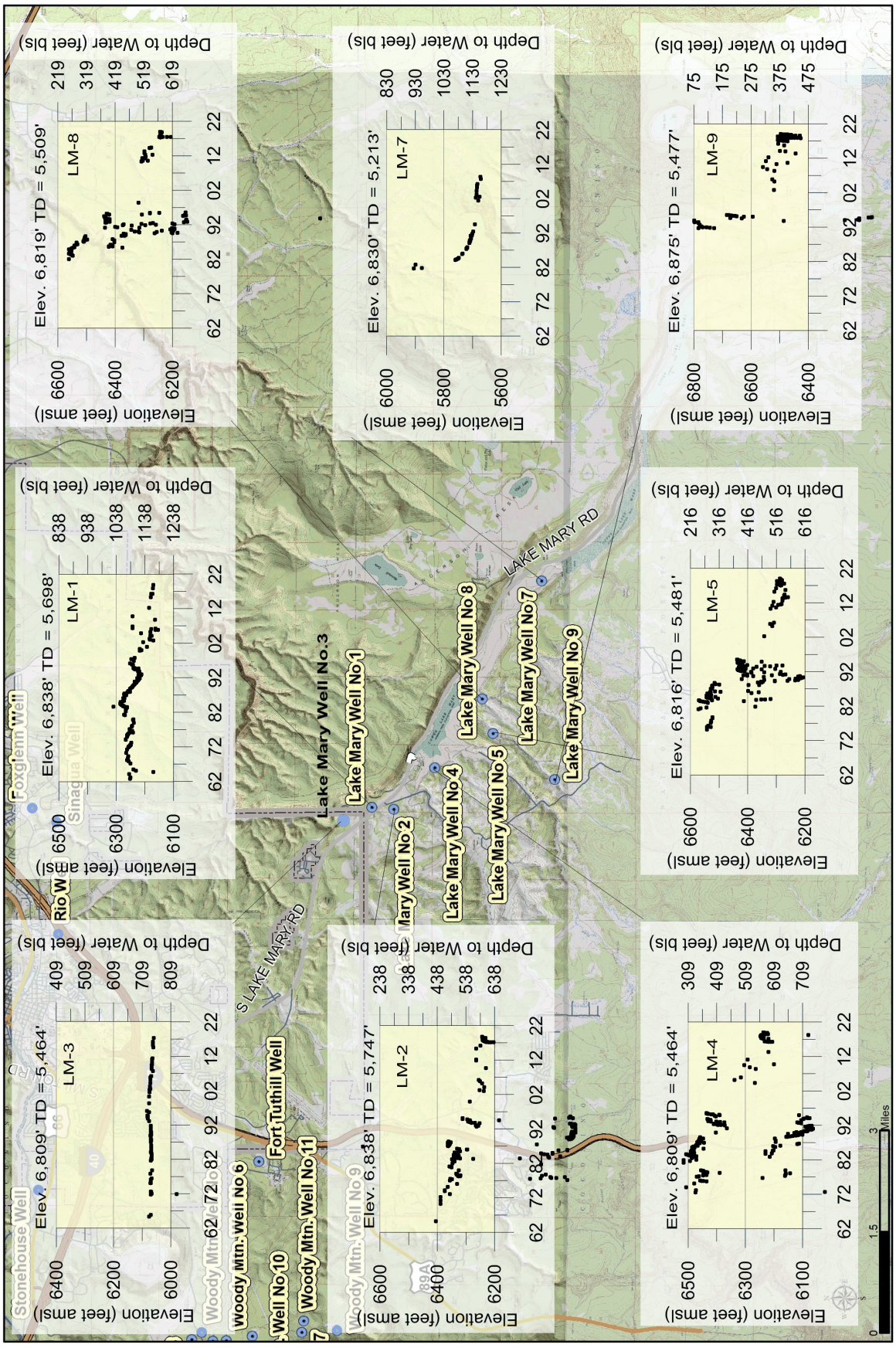
8-4 Water Level Hydrographs Local Wells West



NOTE: These hydrographs display the static water level through time, although some values may be influenced by pumping. The y-axis on the right shows the measured depth to water from land surface, in feet. The y-axis on the left shows the water level as the elevation equivalent in feet above mean sea level.

Elev. = Elevation of well at land surface in feet above mean sea level.
TD = Bottom elevation of well in feet above mean sea level.

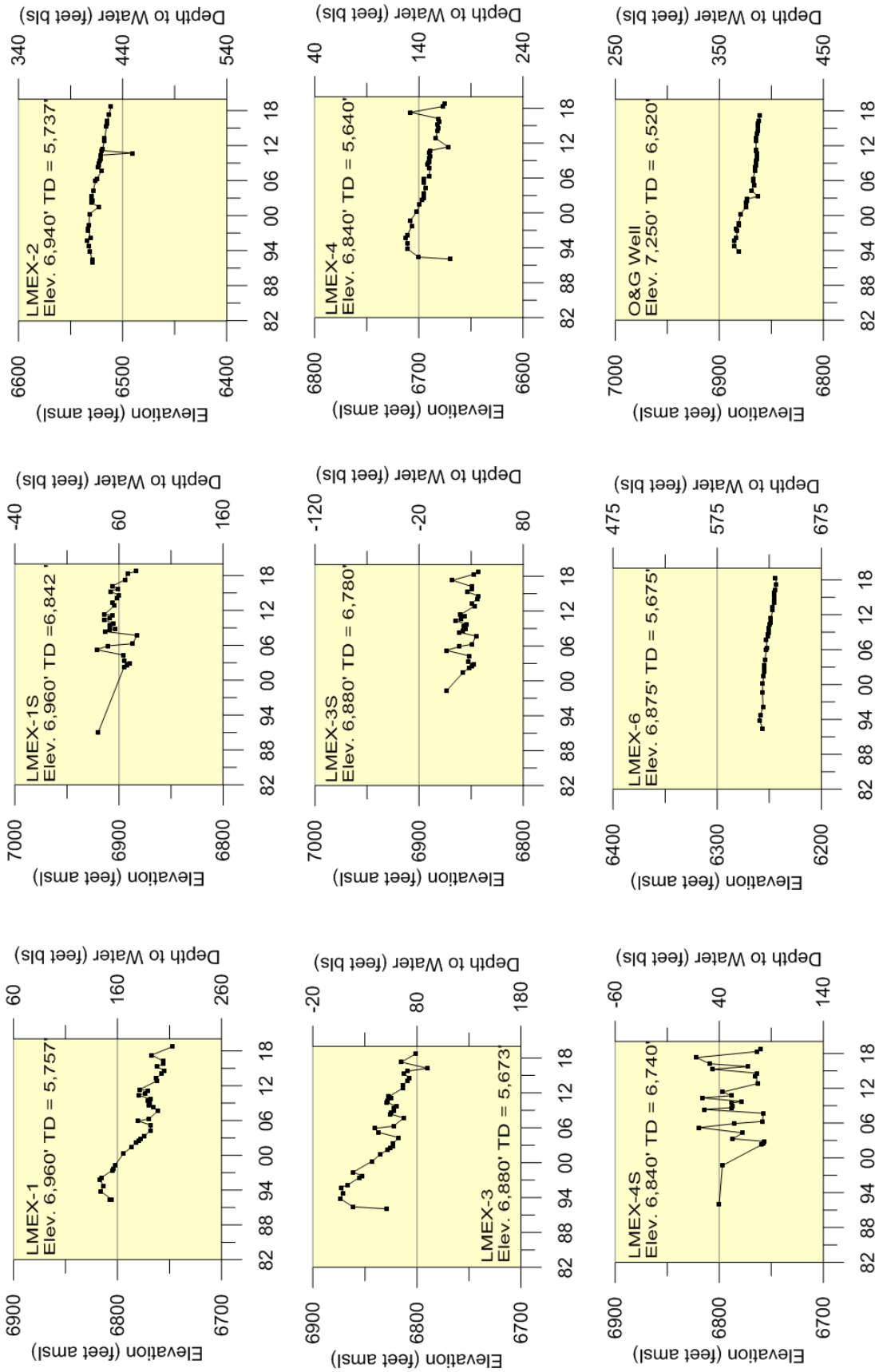
8-4 Water Level Hydrographs Lake Mary Wells



NOTE: These hydrographs display the static water level through time, although some values may be the pumping water level. The y-axis on the right shows the measured depth to water from land surface, in feet. The y-axis on the left shows the water level as the elevation equivalent in feet above mean sea level. The y-axis spread on all graphs is 400 feet.

Elev. = Elevation of well at land surface in feet above mean sea level.
TD = Bottom elevation of well in feet above mean sea level.

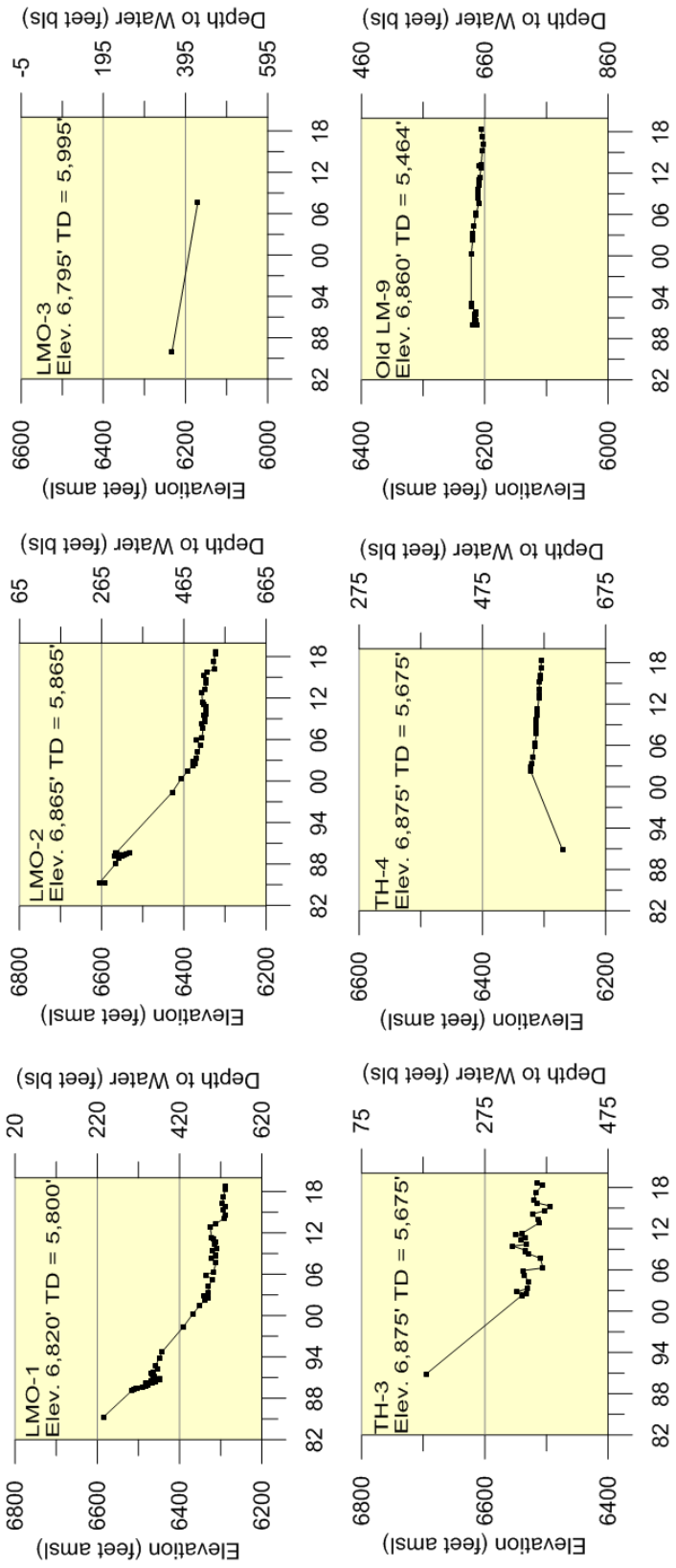
8-4 Water Level Hydrographs Lake Mary Observation Wells



NOTE: These hydrographs display the static (non-pumping) water level through time. The y-axis on the right shows the measured depth to water from land surface, in feet. The y-axis on the left shows the water level as the elevation equivalent in feet above mean sea level.

Elev. = Elevation of well at land surface in feet above mean sea level.
TD = Bottom elevation of well in feet above mean sea level.

8-4 Water Level Hydrographs Lake Mary Observation Wells (continued)



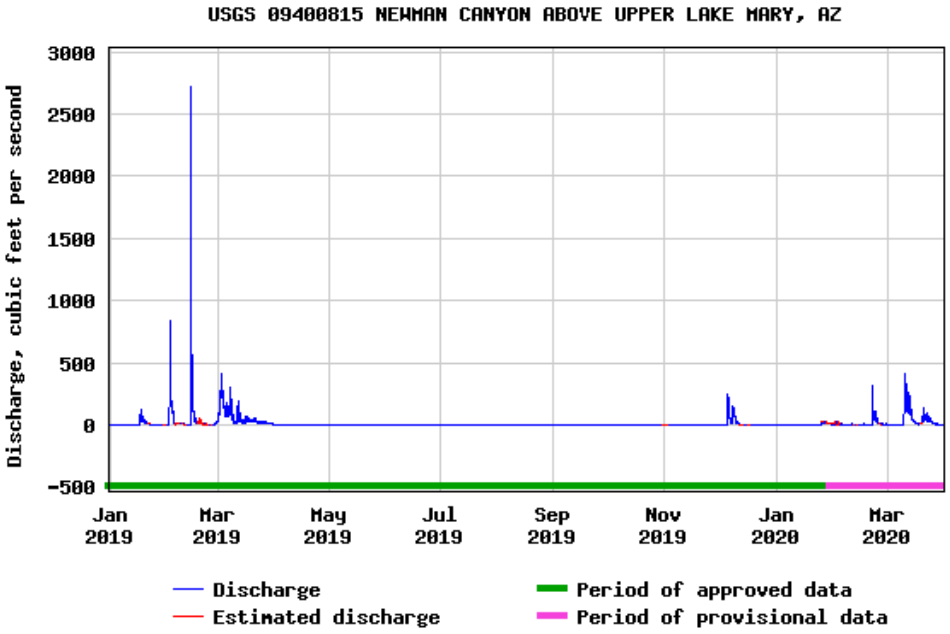
NOTE: These hydrographs display the static (non-pumping) water level through time. The y-axis on the right shows the measured depth to water from land surface, in feet. The y-axis on the left shows the water level as the elevation equivalent in feet above mean sea level.

Elev. = Elevation of well at land surface in feet above mean sea level.
TD = Bottom elevation of well in feet above mean sea level.

9 DATA FOR LAKE MARY WATERSHED

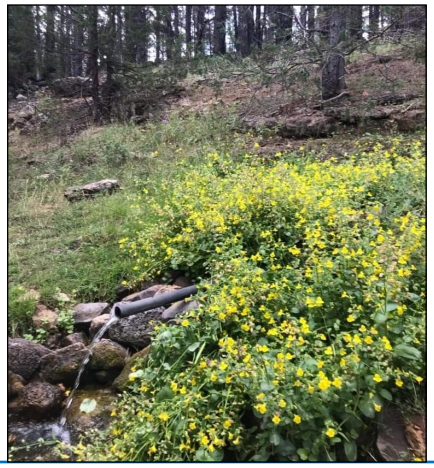
9-1 Upper Lake Mary Monitoring at Newman Canyon—2019 Summary

The Water Services Division, Flagstaff Watershed Protection Project & the Lake Mary—Walnut Canyon Technical Advisory Committee partnered with the US Geological Survey to install a stream flow gage and sediment sampler in Newman Canyon in 2014. Newman Canyon is the largest tributary to Upper Lake Mary. Sediment data are available at http://cida.usgs.gov/sediment/ and stream gage data are available at http://waterdata.usgs.gov/nwis/rt Stream Gage 09400815. A turbidity sensor was added to the site in January, 2020.



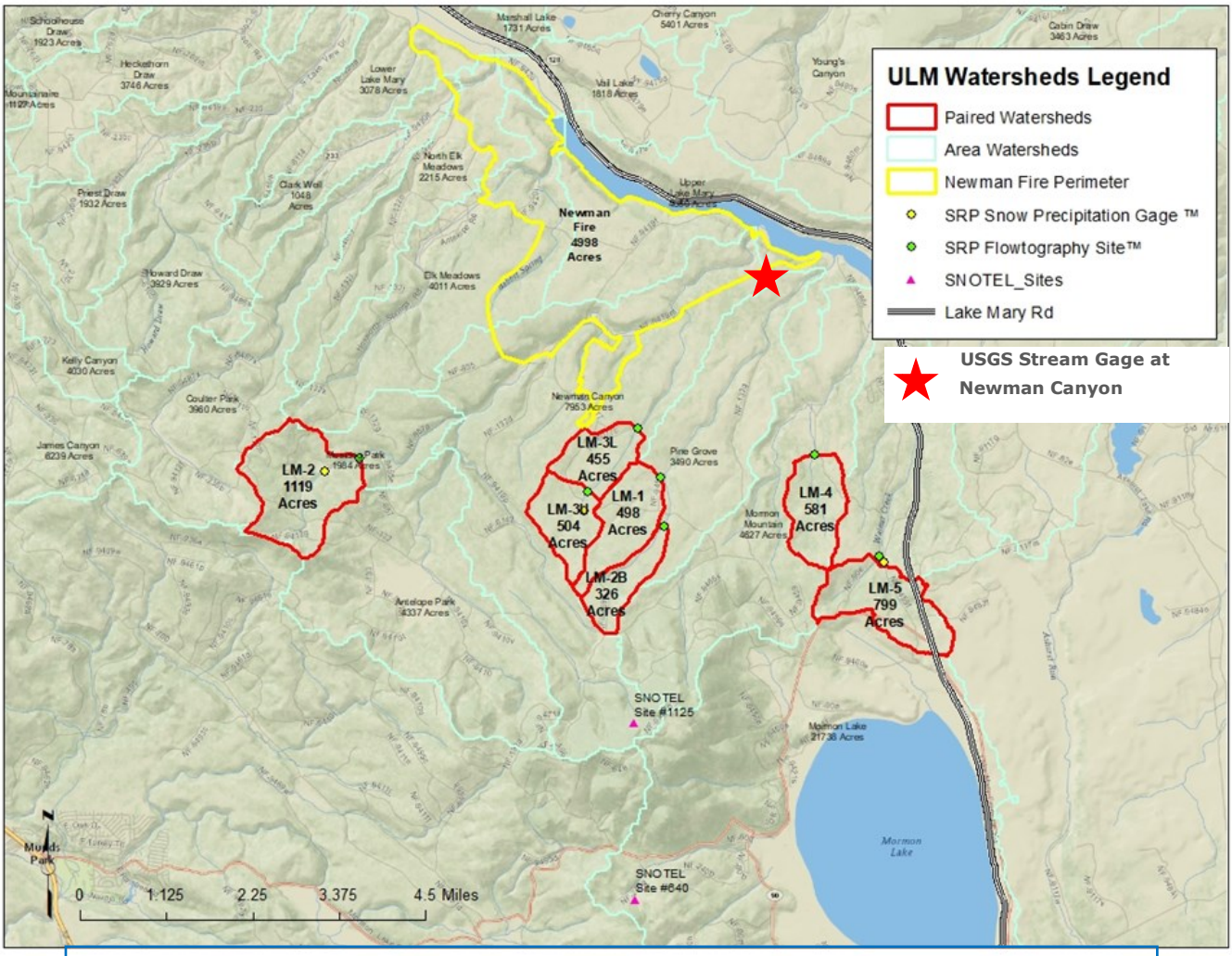
The lake level coming into 2019 was at 22 percent full. The lake spilled in March 2019 and was 68% full coming into 2020 after water production processed 2,593 acre-feet of water in the 2019 calendar year. The lake came up from 61% in November with rain-on-snow events that occurred in December 2019.

Forest Service scientists testing the soil hydrophobicity after the Newman Fire. Photo by Erin Young



Babbit Spring and surrounding area was largely untouched by the Newman Fire. Photo by Erin Young

9-2 Upper Lake Mary Watershed Monitoring Project Instrumentation Sites

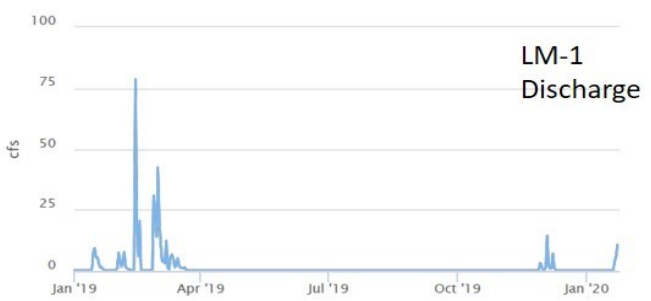


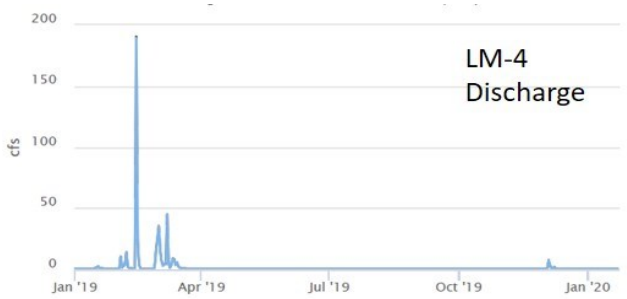
Extent of the 2019 Newman Fire with respect to Upper Lake Mary and the City's instrumented paired watersheds. Map developed by Peter Morrow, Water Resources Technician

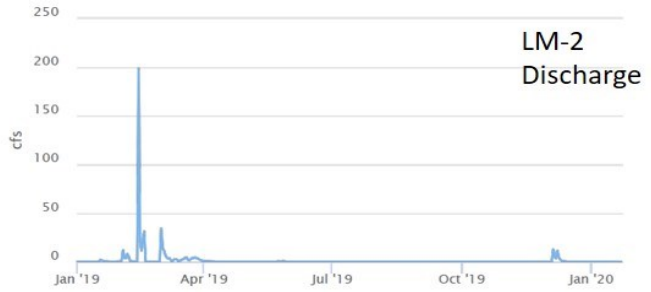
Newman Fire smoke column to the southwest of Lake Mary. Photo credit: InciWeb

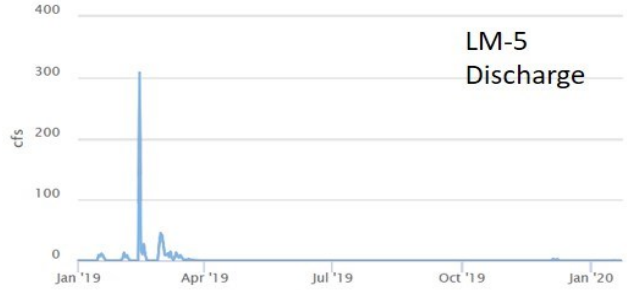
Firefighters wrap sensitive well equipment during the Newman Fire. Photo credit: InciWeb

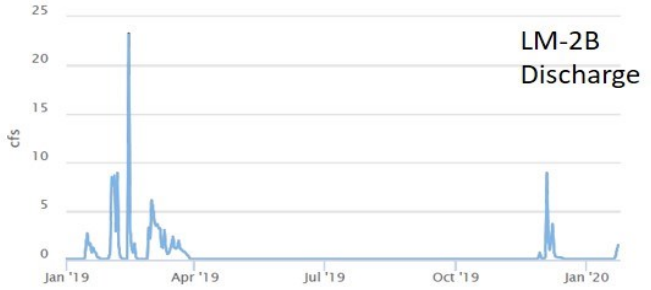
9-2 SRP Flowtography™ ULM Paired Watersheds Discharge & Precipitation (Jan 2019-April 2020)

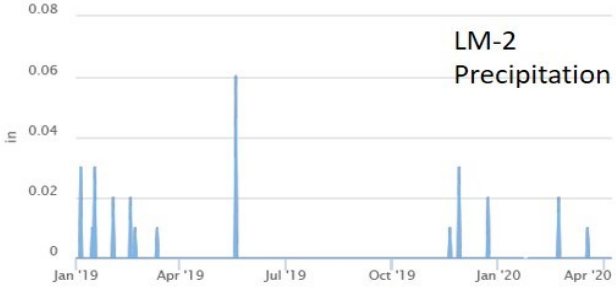


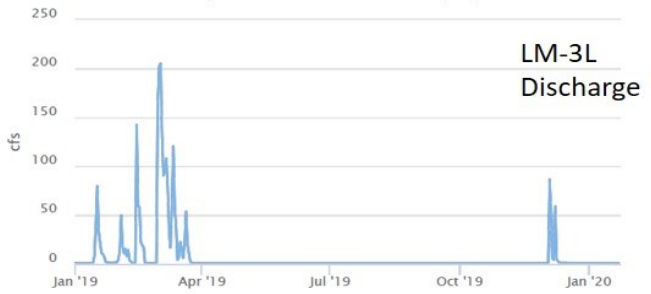


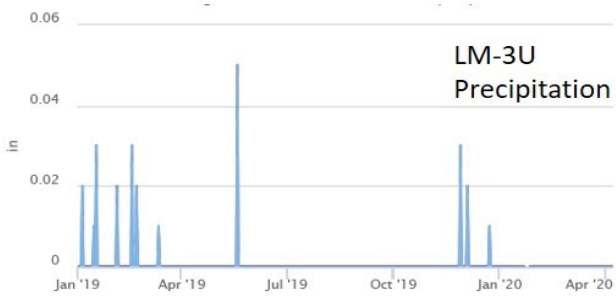


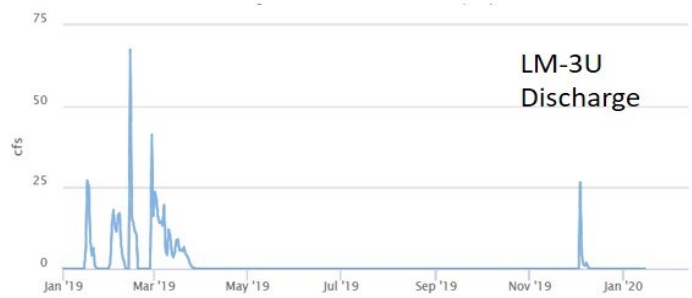


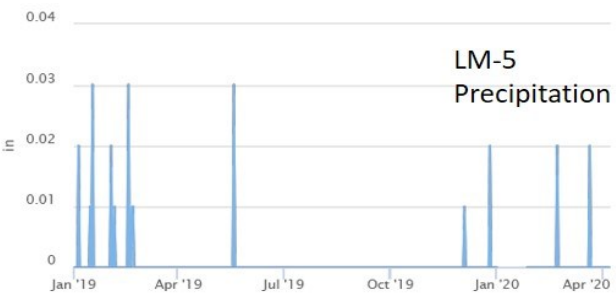












9-3 Upper Lake Mary Monthly Water Level History, Jan 1960—Dec 2019

LAKE % FULL	January	February	March	April	May	June	July	August	September	October	November	December
1960	15%	13%	12%	47%	43%	38%	34%	28%	26%	23%	21%	19%
1961	17%	16%	15%	22%	21%	17%	14%	13%	11%	9%	8%	7%
1962	6%	6%	35%	66%	68%	62%	55%	49%	43%	39%	35%	32%
1963	30%	28%	26%	23%	21%	18%	15%	12%	12%	10%	8%	7%
1964	7%	5%	5%	11%	24%	21%	17%	16%	14%	12%	10%	9%
1965	8%	21%	25%	43%	85%	81%	71%	67%	62%	56%	52%	79%
1966	100%	100%	99%	100%	97%	87%	80%	72%	65%	59%	53%	50%
1967	100%	95%	89%	84%	81%	74%	65%	64%	61%	55%	50%	46%
1968	44%	41%	62%	91%	99%	86%	78%	72%	66%	61%	56%	50%
1969	48%	86%	84%	100%	97%	88%	81%	75%	70%	65%	59%	56%
1970	52%	47%	46%	55%	57%	49%	43%	39%	35%	45%	39%	36%
1971	33%	29%	27%	26%	22%	18%	14%	11%	11%	9%	11%	10%
1972	38%	35%	33%	29%	26%	22%	20%	17%	16%	15%	64%	65%
1973	69%	66%	69%	87%	100%	99%	87%	82%	74%	66%	61%	55%
1974	51%	49%	45%	45%	40%	32%	25%	22%	18%	14%	12%	9%
1975	7%	5%	8%	24%	38%	34%	30%	28%	24%	22%	18%	16%
1976	14%	10%	33%	49%	62%	59%	51%	46%	40%	37%	33%	29%
1977	26%	24%	22%	19%	17%	14%	11%	8%	5%	3%	3%	3%
1978	2%	3%	57%	100%	96%	88%	77%	71%	65%	58%	54%	65%
1979	100%	97%	93%	100%	100%	95%	84%	76%	67%	60%	55%	51%
1980	48%	54%	100%	100%	100%	92%	84%	77%	67%	61%	55%	51%
1981	47%	42%	38%	38%	39%	33%	28%	23%	20%	18%	15%	13%
1982	12%	13%	40%	100%	96%	87%	78%	70%	66%	62%	56%	67%
1983	84%	83%	100%	100%	100%	94%	85%	79%	73%	82%	79%	76%
1984	91%	90%	85%	80%	74%	68%	59%	54%	51%	46%	43%	39%
1985	43%	41%	51%	100%	100%	92%	78%	70%	62%	59%	58%	60%
1986	57%	66%	84%	78%	71%	63%	57%	54%	52%	59%	53%	49%
1987	46%	57%	85%	87%	81%	71%	62%	56%	51%	45%	46%	43%
1988	38%	48%	50%	61%	54%	46%	39%	34%	31%	25%	23%	22%
1989	21%	26%	34%	32%	31%	23%	21%	20%	18%	17%	15%	15%
1990	15%	15%	19%	18%	17%	14%	14%	13%	13%	12%	12%	12%
1991	12%	14%	29%	52%	61%	54%	47%	40%	33%	29%	25%	21%
1992	21%	21%	42%	68%	66%	63%	56%	50%	48%	41%	38%	37%
1993	62%	100%	100%	100%	95%	87%	80%	71%	67%	59%	54%	53%
1994	49%	44%	46%	56%	58%	53%	43%	37%	33%	29%	26%	25%
1995	25%	25%	100%	97%	97%	91%	82%	75%	70%	66%	62%	56%
1996	54%	50%	46%	41%	36%	30%	26%	25%	23%	21%	20%	19%
1997	18%	23%	25%	45%	49%	44%	38%	33%	30%	28%	25%	23%
1998	22%	26%	21%	70%	91%	83%	73%	67%	57%	55%	51%	46%
1999	43%	40%	38%	37%	37%	34%	32%	30%	29%	40%	36%	33%
2000	30%	29%	49%	33%	32%	26%	22%	21%	18%	19%	19%	19%
2001	16%	16%	18%	38%	38%	34%	30%	27%	25%	24%	23%	22%
2002	19%	18%	17%	17%	15%	13%	11%	11%	9%	9%	9%	9%
2003	9%	9%	22%	39%	34%	32%	28%	28%	28%	27%	26%	26%
2004	26%	26%	26%	40%	37%	33%	28%	26%	25%	24%	23%	29%
2005	64%	100%	100%	100%	99%	91%	84%	76%	72%	67%	63%	58%
2006	54%	51%	48%	47%	44%	39%	35%	32%	30%	27%	25%	23%
2007	22%	22%	21%	21%	19%	17%	15%	14%	13%	12%	11%	12%
2008	25%	39%	55%	100%	98%	85%	76%	73%	70%	65%	62%	59%
2009	57%	56%	71%	75%	69%	62%	54%	49%	42%	38%	35%	32%
2010	30%	31%	32%	86%	99%	90%	82%	77%	70%	64%	59%	54%
2011	49%	53%	65%	61%	53%	46%	41%	36%	33%	31%	30%	29%
2012	28%	27%	30%	36%	32%	27%	24%	23%	22%	20%	19%	18%
2013	21%	29%	40%	41%	36%	31%	28%	27%	24%	33%	32%	31%
2014	30%	28%	41%	39%	36%	31%	28%	27%	27%	26%	24%	23%
2015	24%	32%	66%	66%	62%	57%	52%	48%	44%	42%	42%	43%
2016	42%	48%	55%	51%	50%	46%	41%	39%	36%	33%	31%	33%
2017	57%	82%	102%	98%	92%	82%	79%	75%	70%	66%	62%	58%
2018	55%	53%	50%	46%	42%	36%	33%	30%	27%	25%	24%	22%
2019	23%	55%	102%	98%	87%	80%	74%	69%	67%	64%	61%	68%
Historic Avg	37.7%	41.0%	50.5%	60.1%	60.3%	54.4%	48.3%	44.2%	40.5%	38.2%	36.3%	35.4%
Historic Med	30.4%	33.4%	45.5%	53.6%	57.5%	50.9%	42.5%	38.9%	34.3%	34.9%	33.5%	32.0%

9-4 Upper Lake Mary Inflow Report & Predicted Water Budget 1960-2020

YEAR	LOWEST LEVEL OCT-APRL	DATE	HIGHEST LEVEL SPRING	DATE	RUN-OFF GAIN	TOTAL YEARLY LOSS %	SURFACE WATER PROD (MG)	SW PROD LOSS OF LAKE	EVAP LOSS OF LAKE	CALENDAR YR PRECIP INCHES	SNOW SEASON, OCT-APRL
1960	11.1%	3/4/1960	46.4%	4/1/1960	35.3%	-32.9%	568.72	-11.17%	-21.73%	16.60	77.60
1961	13.5%	3/3/1961	21.8%	4/7/1961	8.3%	-16.6%	527.43	-10.36%	-6.24%	18.95	53.90
1962	5.2%	2/2/1962	66.9%	5/4/1962	61.7%	-39.3%	495.11	-9.73%	-29.57%	18.00	128.90
1963	27.6%	2/1/1963	27.6%	2/1/1963	0.0%	-23.7%	542.01	-10.65%	-13.05%	14.52	46.20
1964	3.9%	3/6/1964	23.5%	5/1/1964	19.6%	-15.8%	424.81	-8.34%	-7.46%	19.04	89.40
1965	7.7%	1/1/1965	82.1%	5/7/1965	74.4%	-30.8%	558.35	-10.97%	-19.83%	36.59	166.70
1966	51.3%	11/5/1965	100.0%	4/1/1966	48.7%	-51.0%	769.46	-15.11%	-35.89%	20.58	83.40
1967	49.0%	12/2/1966	95.6%	1/6/1967	46.6%	-54.8%	947.19	-18.61%	-36.19%	22.27	63.10
1968	40.8%	2/2/1968	94.5%	5/3/1968	53.7%	-46.4%	973.82	-19.13%	-27.27%	16.53	150.40
1969	48.1%	1/3/1969	100.0%	4/4/1969	51.9%	-53.6%	866.99	-17.03%	-36.57%	23.41	134.70
1970	46.4%	3/6/1970	56.8%	5/1/1970	10.4%	-27.5%	1044.86	-20.52%	-6.98%	24.02	95.70
1971	29.3%	2/5/1971	29.3%	2/5/1971	0.0%	-19.1%	847.34	-16.64%	-2.46%	21.01	56.60
1972	10.2%	12/3/1971	37.6%	1/7/1972	27.4%	-22.6%	636.40	-12.50%	-10.10%	24.67	50.30
1973	15.0%	10/6/1972	100.0%	5/4/1973	85.0%	-51.4%	1171.30	-23.01%	-28.39%	19.71	210.00
1974	48.6%	2/1/1974	48.6%	2/1/1974	0.0%	-43.6%	1303.22	-25.60%	-18.00%	17.41	70.00
1975	5.0%	2/7/1975	37.6%	5/2/1975	32.6%	-27.4%	720.08	-14.14%	-13.26%	20.10	141.10
1976	10.2%	2/6/1976	62.5%	5/7/1976	52.3%	-39.0%	1113.08	-21.86%	-17.14%	20.12	131.60
1977	23.5%	2/4/1977	23.5%	2/4/1977	0.0%	-21.2%	849.49	-16.69%	-4.51%	18.77	70.20
1978	2.3%	1/6/1978	100.0%	4/7/1978	97.7%	-46.0%	897.60	-17.63%	-28.37%	30.72	116.30
1979	54.0%	11/3/1978	100.0%	5/4/1979	46.0%	-52.3%	1232.64	-24.21%	-28.09%	19.68	145.50
1980	47.7%	1/4/1980	100.0%	5/2/1980	52.3%	-61.6%	1259.06	-24.73%	-36.87%	29.30	177.10
1981	38.4%	3/6/1981	38.7%	5/1/1981	0.3%	-26.2%	1078.16	-21.18%	-5.02%	23.37	92.40
1982	12.5%	1/8/1982	100.0%	4/2/1982	87.5%	-44.1%	1230.27	-24.17%	-19.93%	31.09	121.60
1983	55.9%	11/5/1982	100.0%	5/6/1983	44.1%	-24.0%	942.45	-18.51%	-5.49%	29.47	142.60
1984	76.0%	12/2/1983	90.7%	1/6/1984	14.7%	-52.0%	902.66	-17.73%	-34.27%	20.09	32.00
1985	38.7%	12/7/1984	100.0%	5/3/1985	61.3%	-43.2%	1479.67	-29.06%	-14.14%	26.67	136.00
1986	56.8%	1/24/1986	84.2%	3/28/1986	27.4%	-38.3%	1380.27	-27.11%	-11.19%	32.39	105.40
1987	45.9%	1/30/1987	86.9%	4/25/1987	41.0%	-49.3%	1857.80	-36.49%	-12.81%	23.98	121.60
1988	37.6%	1/24/1988	61.0%	4/28/1988	23.4%	-40.3%	1789.80	-35.16%	-5.14%	21.68	104.50
1989	20.7%	2/23/1989	34.8%	3/30/1989	14.1%	-19.6%	116.00	-2.28%	-17.32%	14.44	77.70
1990	15.2%	1/11/1990	19.2%	3/29/1990	4.0%	-7.1%	33.00	-0.65%	-6.45%	25.67	113.40
1991	12.1%	12/5/1990	63.4%	4/11/1991	51.3%	-42.4%	1144.50	-22.48%	-19.92%	21.83	127.90
1992	21.0%	1/30/1992	70.3%	4/9/1992	49.3%	-33.5%	981.60	-19.28%	-14.22%	34.71	158.90
1993	36.8%	12/28/1992	100.0%	4/15/1993	63.2%	-54.9%	1345.90	-26.44%	-28.46%	35.60	149.70
1994	45.1%	2/24/1994	58.7%	5/1/1994	13.6%	-34.9%	1117.30	-21.95%	-12.95%	21.91	149.20
1995	23.8%	2/12/1995	100.0%	4/27/1995	76.2%	-51.4%	1107.90	-21.76%	-29.64%	17.79	99.10
1996	48.6%	2/8/1996	48.6%	2/8/1996	0.0%	-30.2%	619.25	-12.16%	-18.04%	11.81	28.50
1997	18.4%	1/1/1997	51.8%	4/17/1997	33.4%	-30.9%	581.33	-11.42%	-19.48%	15.61	107.50
1998	20.9%	2/19/1998	90.7%	4/27/1998	69.8%	-53.5%	1095.90	-21.53%	-31.97%	27.30	136.70
1999	37.2%	4/1/1999	41.6%	4/15/1999	4.4%	-13.8%	386.62	-7.59%	-6.21%	15.72	72.00
2000	27.8%	9/9/1999	34.8%	4/4/2000	7.0%	-19.1%	255.77	-5.0%	-14.08%	15.38	74.40
2001	15.7%	1/1/2001	38.5%	4/16/2001	22.8%	-21.8%	308.50	-6.1%	-15.74%	17.55	125.10
2002	16.7%	3/30/2002	16.7%	3/30/2002	0.0%	-8.1%	63.76	-1.3%	-6.84%	12.88	38.90
2003	8.6%	2/6/2003	40.4%	3/27/2003	31.8%	-15.7%	200.65	-3.9%	-11.73%	17.85	54.90
2004	24.7%	2/22/2004	40.4%	3/26/2004	15.7%	-18.3%	293.58	-5.8%	-12.53%	23.61	48.10
2005	22.1%	10/20/2004	100.0%	4/7/2005	77.9%	-48.7%	1195.98	-23.5%	-25.20%	24.01	131.70
2006	51.3%	2/1/2006	51.3%	2/1/2006	0.0%	-30.6%	506.21	-9.9%	-20.66%	15.56	44.60
2007	20.7%	4/1/2007	20.7%	4/1/2007	0.0%	-10.2%	96.03	-1.8%	-8.4%	17.46	50.40
2008	10.5%	11/27/2007	100.0%	3/27/2008	89.47%	-45.7%	954.58	-17.94%	-27.76%	18.85	99.50
2009	54.3%	1/16/2009	76.7%	3/11/2009	22.40%	-47.2%	1220.04	-22.93%	-24.26%	11.65	86.00
2010	29.5%	1/8/2010	101.7%	4/11/2010	72.19%	-51.1%	1299.95	-24.44%	-26.66%	27.89	140.5
2011	50.6%	1/27/2011	65.8%	3/26/2011	15.19%	-38.9%	1113.185	-20.92%	-17.97%	20.67	88.4
2012	26.9%	3/8/2012	37.3%	3/27/2012	10.40%	-19.6%	304.513	-5.72%	-13.88%	14.89	102.9
2013	17.7%	1/16/2013	43.6%	3/21/2013	25.90%	-16.2%	512.476	-9.63%	-6.53%	24.79	69.7
2014	27.4%	2/28/2014	42.3%	3/8/2014	14.85%	-20.3%	338.17	-6.36%	-13.93%	20.67	44.4
2015	22.0%	12/31/2014	69.9%	3/17/2015	47.9%	-28.5%	604.13	-11.36%	-17.14%	27.25	62.9
2016	41.4%	10/9/2015	55.8%	3/3/2016	14.4%	-26.8%	529.53	-9.95%	-16.88%	25.8	78.3
2017	29.0%	12/16/2016	100.0%	4/6/2017	71.0%	-45.0%	580.86	-10.92%	-34.08%	18.00	96.5
2018	55.0%	4/19/2018	55.0%	4/19/2018	0.0%	-33.4%	694.63	-13.06%	-20.34%	21.58	38.0
2019	21.6%	1/10/2019	100.0%	3/7/2019	78.4%	-40.0%	734.99	-13.82%	-26.18%	21.57	118.7
2020	60.0%	11/19/2019	90.0%	3/31/2020	30.0%	-40.0%	900	-16.92%	-23.08%	26.10	70.3
2021	50.0%										
Historic Average %	30.3%		65.2%		34.9%	-34.3%	814	-15.8%	-18.4%	22	98
5 yr. average	34%		80%		39%	-37%	628.83	-12%	-23%	22.61	80.36

NOTES

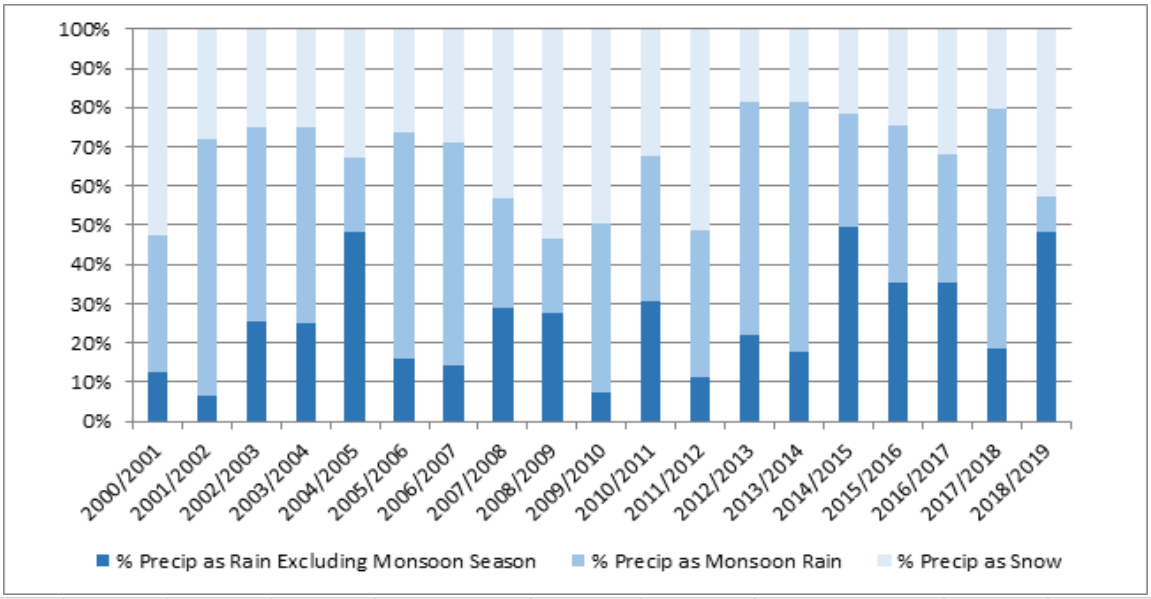
Evaporation accounts for ~50% of total loss

Bold=low level occurred in fall of previous year

Cells highlighted in red are projected values used to determine approximate evaporation loss for coming year. Stats on precip and snow amount are through 5/15/2019 from the National Weather Service NOAA Online Weather Data for Flag Area. Surface water production is in million gallons

9-5 Precipitation Trends

Water Services is interested in snowpack and summer precipitation patterns. The graph below shows the water-year precipitation received as a rain to snow relationship for the past 19 water years. Four of the past seven water years have been dominated by more rain than snow as compared to all other years going back to the 2000/2001 water year. Water year 2018/2019 was a record setting dry monsoon. As indicated in the bar graph, very little precipitation was received as rain during monsoon season. The water year overall was above average, due to a very wet Spring season. A warming climate is a concern for the southwestern US as winter snowpack is significant for aquifer recharge and snowmelt to surface water reservoirs. Water Services will incorporate these and other climate data and projections into its next Water Resources Master Plan. Data converted to determine rain/snow ratio assumes 1" of rain is equal to 12" of snow. The period of annual average is based on the 30 year average yearly records from 1981-2010 (NOAA Technical Memorandum NWS WR-273).

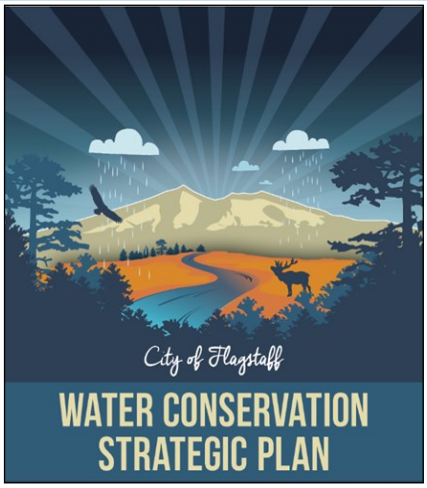


Annual Average	NWS Snow (inches)	NWS Monsoon Rainfall (inches)	NWS Total Precip (inches)	Non-Monsoon Rain converted (calculated)	Total Rain converted (inches)	Snow as precip converted (inches)	% Precip as Rain Excluding Monsoon Season	% Precip as Snow	% Precip as Monsoon Rain
2018/2019	118.7	2.08	23.16	11.19	13.27	9.89	48%	43%	9%
2017/2018	38.00	9.59	15.67	2.91	12.50	3.17	19%	20%	61%
2016/2017	96.50	8.19	25.07	8.84	17.03	8.04	35%	32%	33%
2015/2016	78.30	10.47	26.31	9.32	19.79	6.53	35%	25%	40%
2014/2015	62.90	7.06	24.42	12.13	19.18	5.24	50%	21%	29%
2013/2014	44.4	12.73	19.98	3.55	16.28	3.70	18%	19%	64%
2012/2013	58.9	15.67	26.39	5.81	21.48	4.91	22%	19%	59%
2011/2012	102.9	6.3	16.73	1.86	8.16	8.58	11%	51%	38%
2010/2011	88.4	8.43	22.82	7.02	15.45	7.37	31%	32%	37%
2009/2010	140.5	10.29	23.71	1.71	12.00	11.71	7%	49%	43%
2008/2009	86	2.51	13.38	3.70	6.21	7.17	28%	54%	19%
2007/2008	99.5	5.44	19.27	5.54	10.98	8.29	29%	43%	28%
2006/2007	50.4	8.32	14.59	2.07	10.39	4.20	14%	29%	57%
2005/2006	44.6	8.14	14.14	2.28	10.42	3.72	16%	26%	58%
2004/2005	131.7	6.38	33.49	16.14	22.52	10.98	48%	33%	19%
2003/2004	48.1	7.94	15.9	3.95	11.89	4.01	25%	25%	50%
2002/2003	54.9	9.05	18.33	4.71	13.76	4.58	26%	25%	49%
2001/2002	38.9	7.61	11.63	0.78	8.39	3.24	7%	28%	65%
2000/2001	125.1	6.94	19.88	2.52	9.46	10.43	13%	52%	35%

10 WATER CONSERVATION

10-1 Program Overview & 2019 in Review

The City recognizes water conservation as an important component of the overall Water Services management program. Water conservation continues to be an important proactive action to temper peak demand and to defer the infrastructure costs of developing new supplies. Over the past 30+ years Flagstaff has seen an incredible reduction in water use on a per capita basis.



In 2019 The Conservation Staff completed a comprehensive Water Conservation Strategic Plan, in which was first purposed to City Council in December. The plan utilized expert advice and community input to provide the Water Conservation Program with pragmatic goals and strategies, which was warmly received by Council. During this process the Conservation Staff continue to implement the following programs:

Low-water Landscape Program: In 2018 the Low-Water Landscape Program was piloted and continues to evolve. The Program provides recommended, neighborhood specific, low-water use plants, consultation with staff, and a rebate for a conversion of an irrigated lawn to a low-water landscape. No residents participated in the Low-Water Rebate program in 2019.

Container Reuse & Rainwater Rebate Programs: In 2019, Conservation Staff gave away 93 rain barrels and 11 totes as part of the Container Reuse Program. In order to receive their container, they must first attend a free educational workshop that provides information on water conservation and how to set up a home rainwater catchment system.

Commercial Rebate Program: Four businesses participated in the Commercial Rebate Program during 2019 equaling a total of $43,934 disbursed.

Toilet Rebate Program: In 2019 the team issued 72 Toilet Rebates equating to $3,600 disbursed, with use of the WaterWays software platform, which allows online rebate submissions.

10-2 Water Awareness Month 2019

The conservation vehicle received an up-grade in 2019!

April is Arizona's Water Awareness Month, and staff went big again in 2019!

- Outreach to an estimated 950 people in person, at 18 events around Flagstaff.
- Advertised on local radio stations.
- Placed ads in newspapers, placed banners at City facilities and around Flagstaff, schools, and hung banners on light posts along streets of downtown.
- Facilitated tours of the Lake Mary Water Treatment Plant and the Rio de Flag Water Reclamation Plant with their staff.
- Flagstaff got 2nd Place in the National Mayor's Challenge for Water Conservation for two consecutive years!

10-3 2019 Water Festival Summary

The City of Flagstaff Water Conservation Program has continued their ongoing partnership with Arizona Project WET (Water Education for Teachers) with hosting the popular fourth grade water festival on September 20, 2019 at Foxglenn Park. Nearly 750 fourth grade students from Flagstaff public, charter, and home schools participated in the event. Conservation Program and Arizona Project WET.

Students used interactive models to discuss watersheds, the water cycle, groundwater flow and water conservation. The event was sponsored by the City of Flagstaff Water This event would not have been successful without the help of volunteers from the City of Flagstaff, Northern Arizona University, and the Coconino Plateau Watershed

	2005	2006	2007	2008	2012	2013	2014	2015	2016	2017	2018	2019
Schools	17	17	15	17	10	11	ND	ND	12	14	14	9
4th Grade Classes	37	39	36	38	22	26	ND	ND	32	36	37	30
4th Grade Students	887	932	862	923	538	667	1,080	735	849	908	918	736
Teachers	40	40	36	42	47	28	39	28	67[3]	35	36	30
Teacher Training Hours	80	272	228[1]	111	190[2]	7	119	35	14	70	84	56
Parent Volunteers	30	90	35	80	0	65	156	68	88	73	90	24
Festival Volunteers	148	59	59	68	40	37	60+		15	70	82	80

ND = no data

1. Includes a Project WET 6 hour workshop for 17 NAU student teachers-in-training, participating as instructors at the Water Festival and Project WET 6 hour workshop for 21 FUSD teachers.
2. Includes a Project WET 2 hour workshop for 23 NAU student teachers-in-training, participating as instructors at the Water Festival and Project WET 6 hour workshop for 24 FUSD teachers.
3. 36 NAU Preservice Teachers & 31 teachers

Fourth grade students learn about watersheds during the Flagstaff Water Festival. Photo by Joelle Sawaya

10-4 Non-Revenue Water—System Leaks

In 2019, an estimated 12% of water produced was considered Non-revenue water. Of the 12%, or 1,004 acre-feet, an estimated ten acre-feet was used for flushing water mains and 77 acre-feet attributed to leaks detected and repaired. The remaining 917 acre-feet is attributed to undocumented flushing, undetected leaks, meter inaccuracies, billing inaccuracies.

While the Water Services Division practices many water loss controls (annual leak detection, hydrant replacement, aging infrastructure replacement program, customer-meter replacement program), Water Resources staff will focus on implementing a water loss control program that includes adoption of the IWA/AWWA Water Audit Method. The water audit process provides the best management tool to guide our division towards understanding, categorizing, and where to focus on real (i.e. leaks) and apparent (i.e. metering inaccuracies) losses between water produced and water sold. Adoption of the AWWA Water Audit Method is one outcome of the Water Conservation Strategic Plan, slated for Council consideration for adoption in 2020.

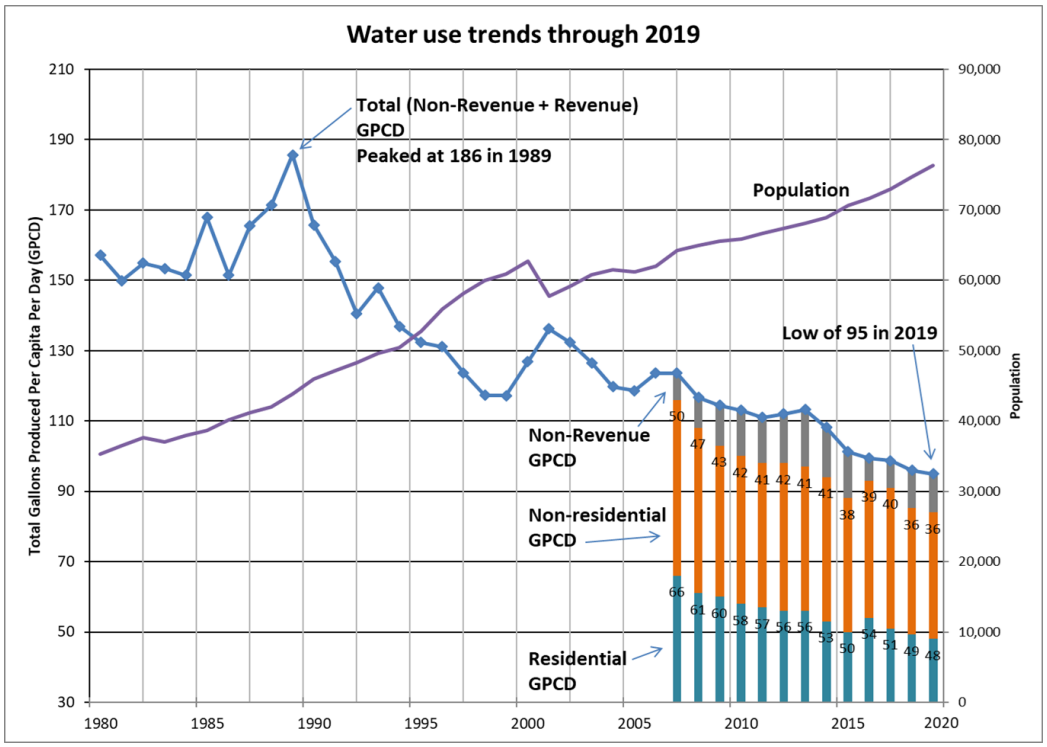
Water Services invests annually in the following programs that reduce water waste:

- $30,000 annually towards system leak detection
- $3.4 million towards aging infrastructure
- $45,000 towards hydrant replacement
- $400,000 towards customer meter replacement

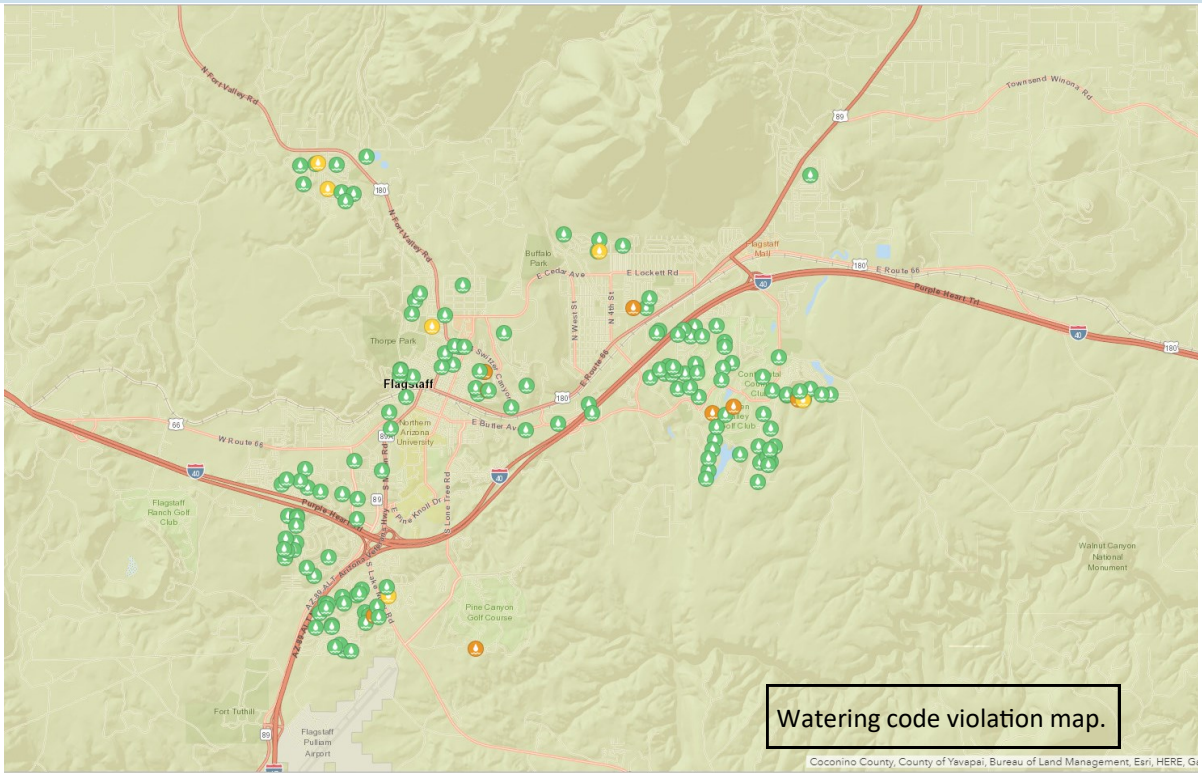
10-5 Water Conservation Program History & Customer Use Trends

Since 1989, Flagstaff has seen a drop in total per capita water use by 52% (below). During this same time, population has almost doubled while annual water used is less than what it was in 1990 (below). Below is a summary bullet list of what's contributed to an estimated saving of **95,800 AF of water in 25 years**:

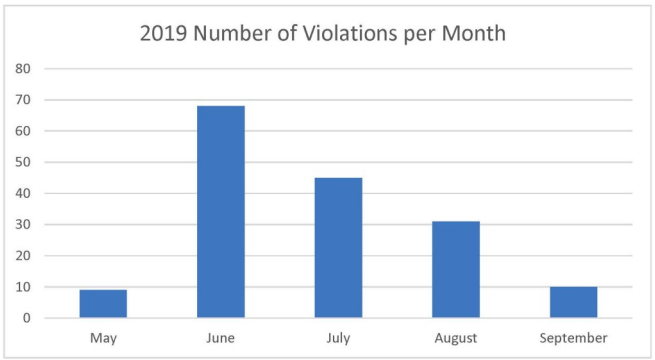
- 1988 City Council adopted a Water Conservation Ordinance that included an odd/even watering day schedule & Water Availability Strategies (on page 51), developed in order to reduce peak summer demand
- 1990 Council adopted tiered residential rates (0-12K and >12K gallons) and created customer classes
- 1991 inception of Low Flow Toilet Rebate Program
- 1993 Rate increase adopted
- 1994 Rio Reclamation Plant online & reclaimed waterline constructed to serve summer irrigation
- Sometime between 1994 & 2003 tiered residential rate structure changed to 0-5K, 5-15K & >15K gallons & rate increase
- 2002 First and only time in history of the ordinance (see page 51) the Water Availability Strategy was elevated above Level I, Water Awareness. Level II went into effect May 10, 2002, Level III was in effect from June 21-Sept. 23, 2002. Ordinance was modified from 4 to 3 levels in May, 2003.
- 2003 Water Conservation Program established with program manager & 2 temporary enforcement staff
- 2005 Rebate program expansion to include turf removal & xeriscape, high-efficiency clothes washers, hot water re-circulators, pre-rinse spray nozzle installations, waterless urinal installations
- 2006 Tiered residential rate structure changed to 0-5K, 5-15K, 15-25K and >25K with rates increase
- 2009 & 2010 Water Conservation Program was cut from budget; from $191,500 to $21,000
- 2011 Tiered residential rate structure changed to 0-3.7K, 3.7-6.4K, 6.4-11.7K, >11.7K gallons
- 2011 Rebates for toilets, turf to xeriscape and rain water tanks funded since program was cut
- 2014 Two temporary enforcement staff added into the budget
- 2016 Program funding increased and added a full-time Water Conservation Specialist
- 2016 Water rate increase adopted
- 2017 Budget increase; new Low-Water Landscape Rebate Program; Water-Wise Business Program; Container to Rainwater Reuse Program
- 2018 Begin Water Conservation Strategic Plan; new Commercial Rebate Program
- 2018 Water Distribution began installing new smart water meters
- 2019 Water Conservation offered a refresh opportunity for Water Conservation Program Manager.
- 2020 Water Conservation Strategic and Implementation Plans proposed to Council

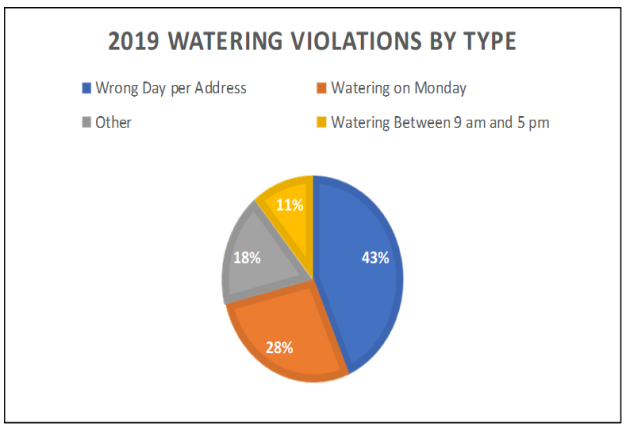


10-6 Water Conservation Code Enforcement—2019



ENFORCEMENT SUMMARY: Between the months of May and October 2019, Water Conservation Aides patrolled the city for violations of the City water conservation code. 163 citations were made, almost half the violations in 2018. Of the citations made in 2019, the Water Conservation Aides noted the following violations: 45 watering on Monday's, 18 watering between 9am—5pm, 71 watering on the wrong day per address, and 29 other miscellaneous violations. Considering 2019 was one of the driest summers on record, receiving a total rainfall amount of 20.69 inches, for the year the conservation team was pleased to see the drop in violations from the previous years. With seeing a huge drop in violations (residential and commercial) brings home the point that with the conservation efforts in place and the enforcement actions the staff are taking is working efficiently and effectively. Enforcement in 2019 ran smoothly apart from an issue that arose in 2018 regarding private wells. Private wells are not subject to the City water conservation code watering schedule, and therefore should not be cited for any violations. The issue was resolved by the summer 2019 of enforcements, by importing all known well locations into the GIS app to assist the Water Conservation Aides patrolling the city for watering violations.





10-7 Drought Preparedness—Water Availability Strategies

STRATEGY I

Water Awareness: In effect when water demand is equal to or less than safe production capability.

1. Implements Odd / Even Watering Schedule; Odd addresses are allowed to water T, Th, and Sa, even addresses on W, F, Su. No watering Mondays. Watering by hand allowed any day of the week. No watering between 9am and 5pm.
2. Prohibits unauthorized use of fire hydrants
3. Prohibits wasting water
4. Prohibits golf courses from irrigating with potable water
5. Provides for New Landscape Permits

STRATEGY II

Water Emergency: In effect when water demand exceeds safe production capability for five (5) consecutive days.

1. Continue rules established by Strategy I
2. New Landscape Permits not issued
3. Adds vehicle washing to watering schedule (exception for commercial car washes)
4. Prohibits washing buildings and paved areas
5. Prohibits filling fountains, ponds, pools with potable water
6. Prohibits use of potable water for construction activity
7. Implements Drought Rate Structure
    - Single Family Residential: Water Consumption between 6,401and 11,700 gallons billed at 150% the established rate. Water Consumption in excess of 11,700 gallons billed at 200% the established rate.
    - Multi-Family, Commercial, Industrial, and Institutional: Billed at 120% the established rate.
    - Standpipes: Billed at 130% the established rate. Use limited to 25 mile radius.

STRATEGY III

Water Crisis: In effect when water demand exceeds total production capability, and the amount of water in storage may impair fire protection for the City.

1. Continue rules established by Strategy I and Strategy II
2. Prohibits all outdoor water use
3. Authorizes additional measure as deemed necessary

***Safe Production Capability*:** 90% of total water resources available measured in million gallons per day, based on potable water production and distribution components.

This information is covered in City Code 7-03-001-0014 Water Conservation

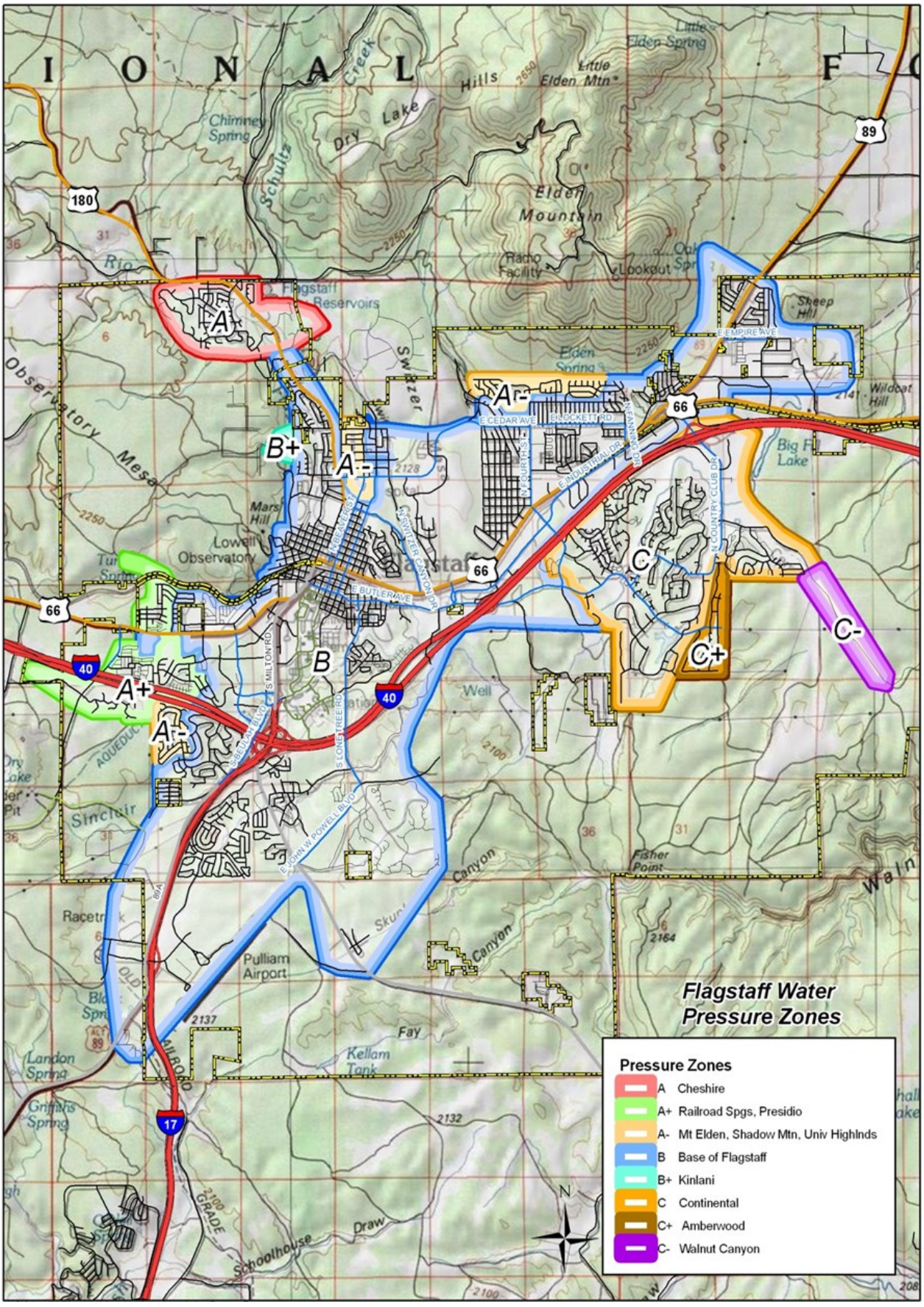
11 WATER STORAGE & DISTRIBUTION

11-1 Water Storage Reservoirs

Name	Type	Dimensions	Tank Capacity	Floor Elv	HWL	Range
Main	circular, concrete	260d x 30h	12 MG	7106.00	7136.14	30.14
Christmas Tree	circular, concrete	210d x 20h	5.0 MG	7120.33	7139.11	18.78
Airport	circular, steel	48d x 24h	300 KG	6989.00	7012.17	23.17
Railroad Springs	circular, steel	86d x 24h	1.0 MG	7301.00	7324.00	23.00
Railroad Springs #2	circular, steel	86d x 24h	1.0 MG	7301.00	7324.00	23.00
Cheshire	circular, steel	90d x 24h	1.3 MG	7235.00	7260.00	25.00
Paradise	circular, concrete	132dx 25h	2.5 MG	7235.75	7260.33	24.58
Kinlani	circular, steel	34d x 24h	156 KG	7220.00	7243.00	23.00
Other Storage						
University Highlands	circular, steel	60d x 24h	500 KG	7057.50	7081.10	23.60
Raw Water Pump Station	square, concrete	35w x 18h	140 KG	6791.83	6806.00	14.17
LMWTP Clearwell	circular, concrete	130d x 16h	1.2 MG	6952.00	6967.00	15.00
LMWTP Backwash Tank	sphere, steel	36d x 30h	200 KG	7000.50	7030.50	30.00
LMWTP Filter Wetwell	rectangle, concrete	17w x 24L x 9h	32 KG	6952.45	6964.93	12.48
Woody Mtn. Clarifier	circular, concrete	70d x 16h	304KG	7173.25	7192.00	18.75
Woody Mtn. Forbay	circular, steel	21d x 24h	60 KG	7165.00	7189.50	24.50
Reservoir Filtration Plant, Clearwell	rectangle, concrete	47w x 70L x 10h	240 KG	7103.50	7115.67	12.17
Sinagua/Foxglenn	circular, steel	25w x 10h	33 KG	6804.00	6993.00	7.00
Ft. Tuthill	circular, steel	25	33 KG	6984.00	6993.00	7.00
Shop Well	rectangle, concrete	12w x 27L x 8h	19.5 KG	6791.00	6799.25	8.25
Interchange Well	rectangle, concrete	12w x 27L x 8h	19.5 KG	6784.66	6793.00	8.34
Rio Well	rectangle, concrete	12w x 27L x 8h	19.5 KG	6852.17	6860.50	8.33

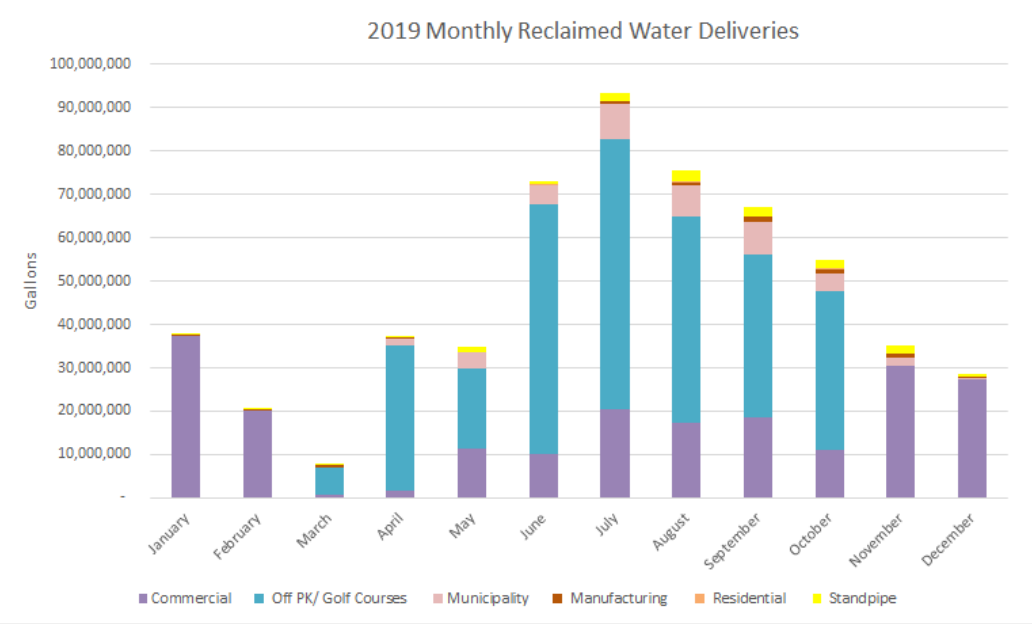
Water is drawn from the North Reservoir for fire relief efforts on the Museum Fire.

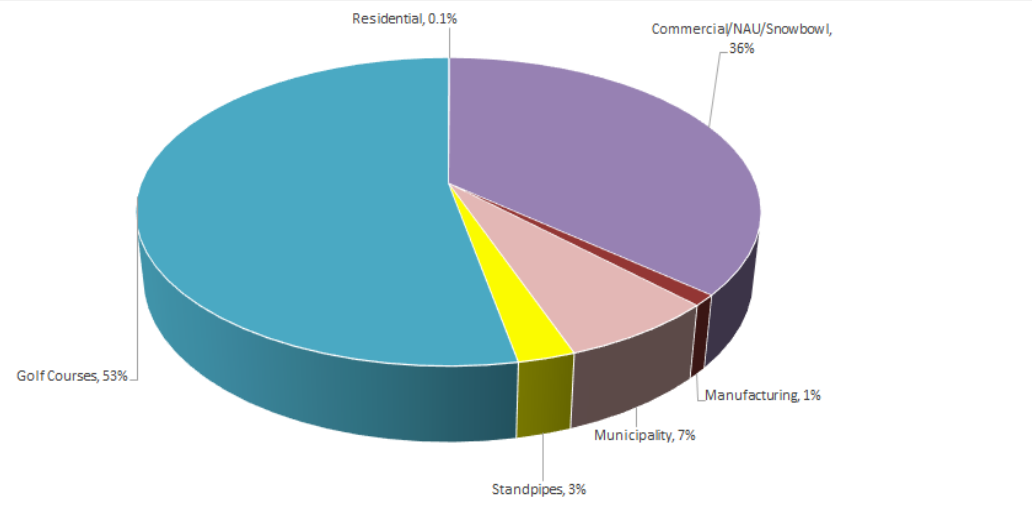
11-2 Flagstaff Water Pressure Zones



12 RECLAIMED WATER

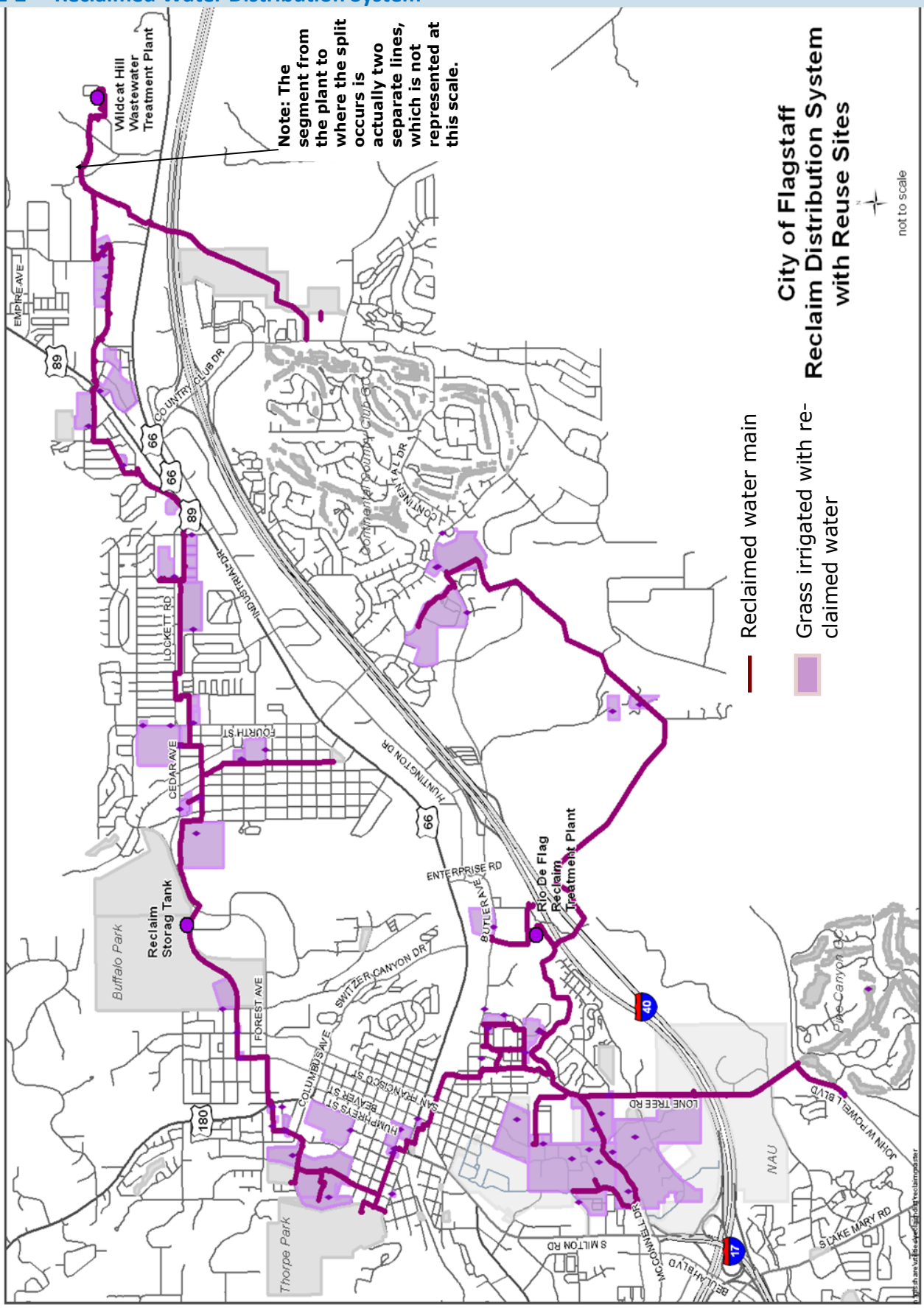
12-1 Reclaimed Water Used by Customer Class





A look inside the pump room at Rio de Flag Water Reclamation Plant. Photo by Brad Hill

12-2 Reclaimed Water Distribution System



12-3 2019 Water Reclamation Plant Flow Report

WILDCAT PLANT MONTH	PLANT INFLUENT FLOW (GAL)	TOTAL OF ALL TREATED EFFLUENT (GAL)	PLANT DISCHARGE RIO DE FLAG (GAL)	RECLAIM DELIVERED REUSE SYSTEM FLOW (GAL)	RECLAIM DELIVERED CONTINENTAL FLOW (GAL)
JAN	106,622,000	103,785,000	103,785,000	0	0
FEB	127,934,000	135,598,000	134,534,000	1,064,000	0
MAR	163,470,000	170,460,000	164,291,000	0	6,169,000
APR	111,707,000	107,688,000	84,350,000	1,019,000	22,319,000
MAY	113,492,000	108,876,000	92,721,000	723,000	15,432,000
JUNE	99,302,000	93,697,000	38,264,000	17,146,000	38,287,000
JULY	99,959,000	94,478,000	25,117,000	26,034,000	43,327,000
AUG	101,966,000	99,619,000	53,531,000	13,502,000	32,586,000
SEPT	104,419,000	103,050,000	74,646,000	1,907,000	26,497,000
OCT.	104,072,000	104,596,000	75,522,000	2,475,000	26,599,000
NOV.	104,653,000	101,499,000	93,654,000	2,266,000	5,579,000
DEC	114,620,000	111,857,000	108,444,000	3,346,000	67,000
	1B	**2B = 3B+4B+4B1**	**3B**	**4B**	**4B1**
WCH TOTAL	**1,352,216,000**	**1,335,203,000**	**1,048,859,000**	**69,482,000**	**216,862,000**

RIO PLANT MONTH	PLANT INFLUENT FLOW (GAL)	TOTAL OF ALL TREATED EFFLUENT (GAL)	PLANT DISCHARGE RIO DE FLAG (GAL)	RECLAIM DELIVERED REUSE SYSTEM FLOW (GAL)
JAN	56,437,000	47,469,000	30,210,000	17,259,000
FEB	43,995,000	38,639,000	33,750,000	4,889,000
MAR	60,403,000	51,562,000	47,170,000	4,392,000
APR	56,856,000	47,158,000	19,550,000	27,608,000
MAY	58,264,000	48,724,000	24,250,000	24,474,000
JUNE	53,772,000	44,247,000	9,904,000	34,343,000
JULY	52,235,000	42,266,000	6,919,000	35,347,000
AUG	56,457,000	47,042,000	13,950,000	33,092,000
SEPT	55,041,000	46,197,000	10,570,000	35,627,000
OCT.	56,382,000	47,238,000	19,220,000	28,018,000
NOV.	54,587,000	46,208,000	15,570,000	30,638,000
DEC	57,576,000	51,804,000	25,720,000	26,084,000
	1A	**2A = 3A+4A**	**3A**	**4A**
RIO TOTAL	**662,005,000**	**558,554,000**	**256,783,000**	**301,771,000**
	1 = 1A + 1B	**2 = 2A + 2B**	**3 = 3A + 3B**	**4 = 4A + 4B + 4B1**
TOTAL (2) PLANTS	**2,014,221,000**	**1,893,757,000**	**1,305,642,000**	**588,115,000**
Acre-Feet	**6,181**	**5,812**	**4,007**	**1,805**

Notes: Total Reuse Delivered (1,805 AF) does not match Utility billing data of total "billed" (1,740 AF)

Wildcat no longer has site specific load out stations for city or county haulers. All reclaim users, except Continental, get water from the reclaim distribution system.

Total Processed/Unmetered = 1 - 2 = 2 2,014,221,000 - 1,893,757,000 = 120,464 gallons

a) Rio Plant Sludge/Septage - Not metered on main influent flow meter and self reported by haulers. Calculated at Wildcat.

b) Septage/Grease/Mud Sump - Grease received does not enter the wastewater treatment process. Mud is deposited into a drying bed and allowed to settle out, then any water is drained off into the treatment process.

c) Wildcat Unmetered - During the winter WC decants the water off the top of the Solids Stabilization Basins/SSBs and return it to the treatment plant to maintain acceptable levels in the SSBs. That could account for some 10 to 15 MGY unmetered. Unmetered stormwater also enters the SSBs, the 60 acre sludge injection field, and some smaller areas around the plant.

d) Wildcat flow meter(s) - In 2017, the Continental flow meter failed and flows were estimated for about one month. Starting in 2018, flow meters will be calibrated on an annual basis. A discrepancy in flow totals may occur after the meters are calibrated.

Hydrogen sulfide removal vessel

Chemical detection and removal equipment at Wildcat Hill keeps staff and community safe.

New sulfur dioxide detector

13 SCADA INFORMATION SYSTEMS

SCADA/IS (System Control and Data Acquisition/ Water Information Systems) formed a new section of Water Services in 2019. This Section manages a huge volume of complex data projects throughout the Division. Examples of data management include: the work order management system, GIS, meter data, field sensors, security systems, and the SCADA system. SCADA drives the remote-control processes of water production, field distribution and wastewater treatment plant operations.

A 2014 SCADA Masterplan demonstrated that Water Services needed improvements to our SCADA system, recommending additional dedicated to SCADA projects and a position to manage them. A SCADA Administrator position was created in 2017, reclassified to capture Information System *(IS)* in 2019 when the SCADA/IS section was created. This Section manages and oversees all data projects in Water Services, including SCADA. The two Instrumentation and Electrical (I&E) Supervisors require very specialized skills, moving from other sections where they continue to manage every aspect of water as it moves through the system; from drilling and production to releasing A+ reclaimed water. Maintaining, upgrading and growing these data-driven systems has challenged the Team, stretching resources and staff while building needed skills and leveraging both internal and external expertise.

The Information System *(IS)* Administrator develops and maintains work order management system, sewer inspection van, and web applications, creating dashboards that display and collect new data in real time, such as the leak detection dashboard.

SCADA/IS Section pursues three standards:

1) **Resilience:** Ensure continuity of operations for the entire system, including preparedness for disasters and emergencies such as fire, cyber-attack, or power outage. Maintain backup for all systems, ensure all service packs, updates, patches and firmware are up to date.

2) **Serviceability**: Retain expertise and skillsets to effectively maintain our systems through ongoing training and contracts with vendors. Every part of SCADA and IS systems need qualified personnel that can track and perform maintenance.

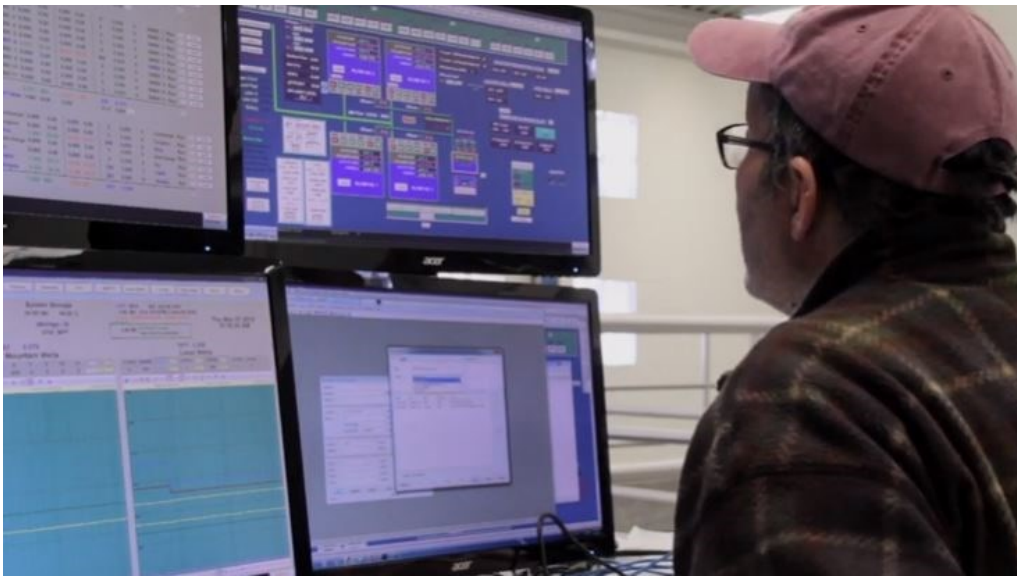
3) **Data-driven**: Provide Sections the best available data to allow informed decision-making by Managers, Directors and other City leadership.

One of the Collector App Dash Boards

13-1 SCADA Information Systems—2019 Achievements

2019 Achievements:

- Information Security Officer position developed in partnership with IT.
  - ♦ Recruited and hired in 2020.
  - ♦ Recommended in a 2014 Homeland Security audit.
  - ♦ Incumbent to analyze SCADA and City business networks
- Hydrant inspection program developed in our workorder management system (Cityworks).
- Manhole inspection integrated into work order management system using a new manhole inspection camera.
- The new sewer-line inspection program was integrated into the workorder management system.
- Multiple applications and dashboards were developed, providing mangers data in a visually easy-to-use management tool.
- Created a new stormwater data model to verify old data and serve as the base for the newly- implemented stormwater maintenance work order management system.
- Launched the work order management system in water production and wastewater treatment plants. The first task was to set-up gas detectors at each plant, set to autogenerate a workorder one month before their scheduled calibration date.
- Develop Collector applications for stormwater, reclaimed system, SCADA, industrial pre-treatment, and others. These apps map and share data in real time.
- Created a SCADA Steering Committee consisting of Plant Managers, Operations Manager, and Director to address emerging SCADA issues and needs.
- Upgraded security door controller software to a centrally managed system throughout the Division.



Plant operator monitors treatment process

14 STORMWATER MANAGEMENT

The City's Stormwater Management program includes projects and programs that address stormwater quantity (flood control), stormwater quality (AZPDES Municipal Permit), FEMA floodplain administration and watershed management and restoration.

The Stormwater Section is funded by the stormwater utility that was established in 2003. The Utility currently provides for a Capital Improvement Program (CIP), stormwater infrastructure maintenance, development permit review, drainage investigations and floodplain administration.

14-1 Key Program Summary (descriptions are provided on subsequent pages)

1. Capital Improvement Program
2. Construction Site Inspections
3. Drainage Investigation Response
4. Development Review
5. Floodplain Administration
6. Open Channel Maintenance
7. Watershed Planning & Museum Fire Response

14-2 Capital Improvements Program (CIP)

City Stormwater staff are responsible for maintaining Stormwater's Capital Improvements Program, which is funded at $600,000 per year. In addition to the annual funding for capital projects the Stormwater Section received funding though the Road Repair and Safety Tax Initiative.

Capital Improvement projects included Rio de Flag Flood Control design review, Wildwood Hills detention-retention pond, Phoenix Avenue Bridge replacement design, Linda Vista Culvert improvement design, and Aspen Ave. drainage design.

14-3 Construction Site Inspections

The Stormwater Section is tasked with conducting inspections of commercial and multi-unit residential projects approved within the City. These inspections are intended to ensure compliance with stormwater development requirements and to provide direction on appropriate Best Management Practices (BMPs) installation and maintenance in accordance with the Stormwater Pollution Prevention Plan (SWPPP) or Erosion Control Plan (ECP). This past year the Stormwater Inspector visited 64 individual sites with a total of 782 individual inspections.

MS4 Program

The City of Flagstaff's MS4 program was audited by ADEQ and received top marks regarding best management practice (BMP) inspection for erosion and sediment control, post-construction BMPs, and drainage complaint response.

BEFORE:
Inspector observed unstable slope which could cause erosion around foundation.

AFTER:
Corrective measures included an erosion control mat.

14-4 Drainage Investigation Response

The Stormwater Section conducted **79 drainage investigation** during the last year. These investigations include illicit discharge, floodplain, private and public flooding reports. These investigations can result in the identification maintenance or projects that are addressed through the City's Streets Department. During investigations on private property, staff provides guidance to home owners detailing how to improve drainage on their lots.

Stormwater staff respond to drainage problems.

Inspectors ensure that storm sewer system is protected.

14-5 Development Review

The rate of development in Flagstaff continued at a fast pace for another year. The Stormwater Section participates in the City Interdivision Staff (IDS) process. This process provides review for all Concept and Site Plans submitted to the City. The Stormwater Section reviewed 67 new Site Plans this year. Each site plan goes through a multiple review process that starts with Concept Plan and end with an approved Site Plan. This IDS process also reviews all plats, both preliminary and final, zoning amendments, both concept and direct to ordinance in conjunction with a site plan, and annexations. The Stormwater Section also reviews all Civil Plan submittals both for City Capital projects as well as private development Civil Plans and outside agency Civil Plans that are within City Floodplain areas. This review process requires a detailed review of all civil construction drawings and submitted engineering drainage reports for compliance with City Code. This Stormwater also reviews all building permits submitted to the City.

2019 Permit and Plan Review	**2018**	**2019**
Pre-application meetings	82	79
New Concept Plans (not including resubmittals)	65	67
New Site Plans	29	27
Total first review Concept and Site Plans	65	94
Engineering Plan Review (not including resubmittals)	28	56
Building Permit Submittals (not including resubmittals)	738	987
Grading Permits	29	28
New zoning map amendment review submittals	5	4
New final Plat Submitted in 2019	1	14
New Annexation Submittal	1	1
Temporary Use Permit Reviews	41	43
Floodplain use permits review	14	20

14-6 Floodplain Administration

The Stormwater Section is tasked with the administration of the FEMA floodplains throughout town. We participate in the National Flood Insurance Program (NFIP), which reduces flood insurance premiums by 25% for our residents. The Stormwater Section also administers the Floodplain Regulations adopted by City Council. In addition, stormwater provides assistance to citizens considering development in the floodplain in the form of Flood Zone Determination. These determination provide specific information in writing to the customer allowing them to better understand the restriction on projects proposed in the floodplain. This past year the Section completed **46 flood zone determinations**. Stormwater also issues floodplain use permits for allowed activities within the floodplain. This effort requires review of submitted construction documents and reports to determine compliance with floodplain codes. The section issued **25 floodplain use permits** this last year.

The Stormwater Section passed two mandatory audits of their Floodplain Administration program, a FEMA audit in spring 2019, required every 4 years, and a State ADWR audit in fall 2019. These audits help set the community rating service standard for Flagstaff, ensuring a 25% reduction in flood insurance rates for Flagstaff residents.

Spruce Wash vegetation maintenance between July (left) and August (right) 2019, the asterisk indicates the same tree.

Stormwater staff regularly provide public outreach on floodplain health, flood prevention, and flood insurance.

14-7 Open Channel Maintenance

The Stormwater Section maintains 44 miles of open channel within City limits. These stream reaches consist of City owned properties, public right-of-way, public easements, and private drainage easements.

Maintenance in 2019 included:

- 5 volunteer stream clean up days in the Rio de Flag and Sinclair Wash
- A clean up of the Southside Neighborhood for Make a Difference Day
- Larger projects, including:
    - The removal of invasive elms in Penstock Wash that were buckling the concrete channel liner and the subsequent replacement of broken concrete panels
    - An erosion control project on the upper Rio de Flag
    - In-channel vegetation removal in the Coconino Estates and Cheshire neighborhoods of the Rio de Flag

Penstock Wash: Invasive elm tree removal and concrete repair. Photo by: Ed Schenk

Before **After**

Channel erosion control project in the Rio de Flag Cheshire neighborhood. See below.
"Zuni Bowl" stabilization during construction (Left) and after construction (Right). Photo by: Ed Schenk

14-8 Watershed Planning and Museum Fire Response

The Stormwater Section assists with watershed planning and management in the City and at areas used by Water Services. Activities included being a core member of the Watershed Alliance for the Rio de Flag (WARF), assisting with the Southside Community Specific Plan, assisting Water Resources with Upper Lake Mary Watershed monitoring, collecting rain, stream, and sediment data in select washes, and assisting with the Museum Fire emergency operations and post-fire flood response.

The Museum Fire started July 21st and spread to include over 1900 acres of Dry Lake Hills. Stormwater response included assisting at the Emergency Operation Center (EOC), providing in-stream mitigations to protect utility crossings, localized hydrologic modeling, and funding the upsizing of the Linda Vista Culvert. Stormwater also monitors the fire scar in coordination with the Arizona Geological Survey, NAU, and the Rocky Mountain Research Center. The Section has considerable collaboration with other Section and Divisions within the City as well as the Coconino County Emergency Management and Flood Control District. Future mitigation projects will be partially funded by grants from FEMA and AZ DEMA.Stormwater has funded channel erosion monitoring, post-fire soil surveys, and debris flow risk monitoring. Survey and monitoring work continues by Stormwater, NAU and AZ Geological Survey staff.

Museum Fire from Elden Lookout Road. Photo by Ed Schenk.

Museum Fire mitigation planning.

Forest runoff across cross-vein weir for channel protection

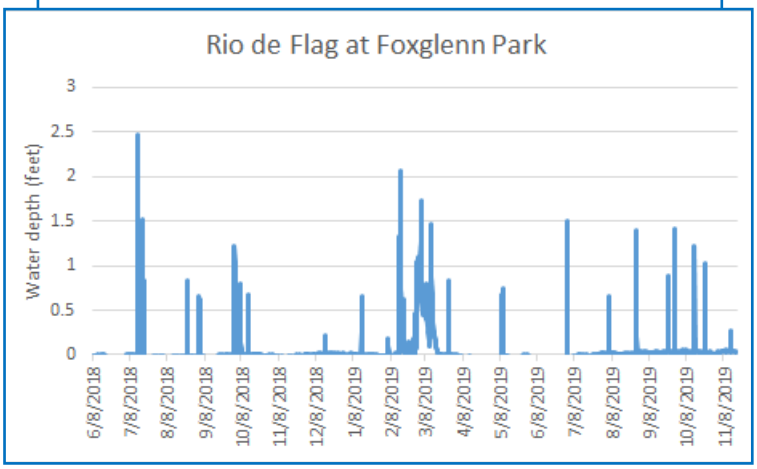
14-8 Watershed Planning and Museum Fire Response (continued)

Stormwater maintains a series of rain and stream gauges for public safety, drainage design, and hydrologic studies. The gauge network can be viewed in real time at: https://rain.flagstaffaz.gov/jefmap/

The following improvements to the network were instituted in 2019: the expansion of the network to include a gauge at Fanning Wash on Linda Vista Drive, a gauge on the South Fork of Clay Wash at Kaibab Lane, and a new gauge on Sinclair Wash at University Heights Drive. Additionally a new data server has been installed at City Hall and the data is being shared over a new database and web application (JEFDAQ and JEFMAP respectively). The network has also benefited from three new rain gauge only sites within the Museum Fire burn, these were funded by the Coconino County Flood Control District.

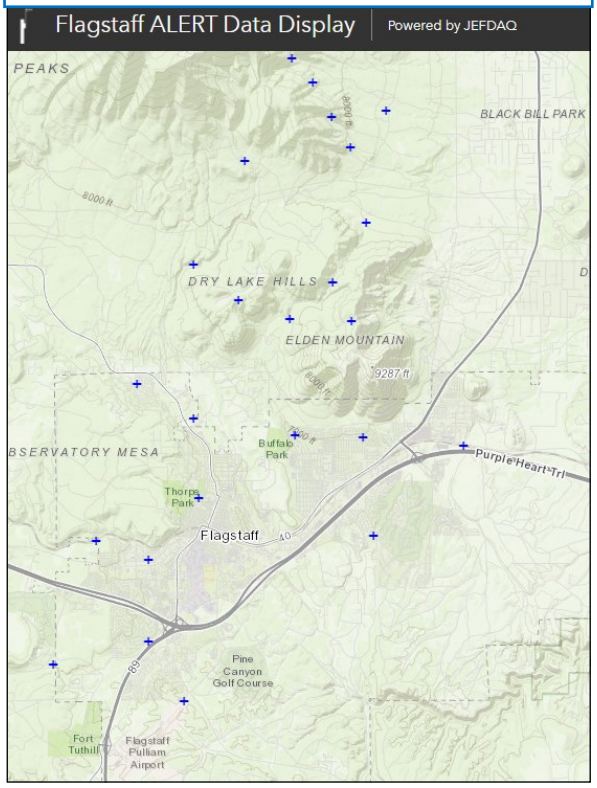
Gauge installation at the South Fork of Clay Wash.

A gauge data chart, depicting water depth in the Rio de Flag at Foxglenn Park.



Rain gauge located at Frances Short Pond.

Flagstaff vicinity flood alert network.
Blue crosses indicate gauge locations.



15 REGULATORY COMPLIANCE

The mission of the Regulatory Compliance Section of the Water Services Division is to ensure that the City of Flagstaff is compliant with all sampling and reporting requirements and best management practices (BMPs) as directed under state and federal regulations and permits for our drinking water, wastewater, recycled water, surface water, stormwater, industrial pretreatment and backflow programs. The Regulatory Compliance Section is also responsible for ensuring each facility in Water Services is properly permitted and any discharge is correctly reported to the state Arizona Department of Environmental Quality. Staff philosophy is responsiveness, performing duties with honesty and integrity, and a commitment to meeting industry standards of excellence.

The section is committed to a goal of 100% customer satisfaction. This is achieved by dedication to exceeding customer expectations and by continuously improving our programs. We value co-worker input and strive to maintain high motivation by providing an environment that encourages improvement and teamwork.

Core functions of the Regulatory Compliance Section include sampling, testing, documenting and reporting the quality of the City's drinking water, wastewater, reclaimed water, and industrial pretreatment and backflow systems as directed under state and federal regulations and permits. The core functions of the section include overseeing the following:

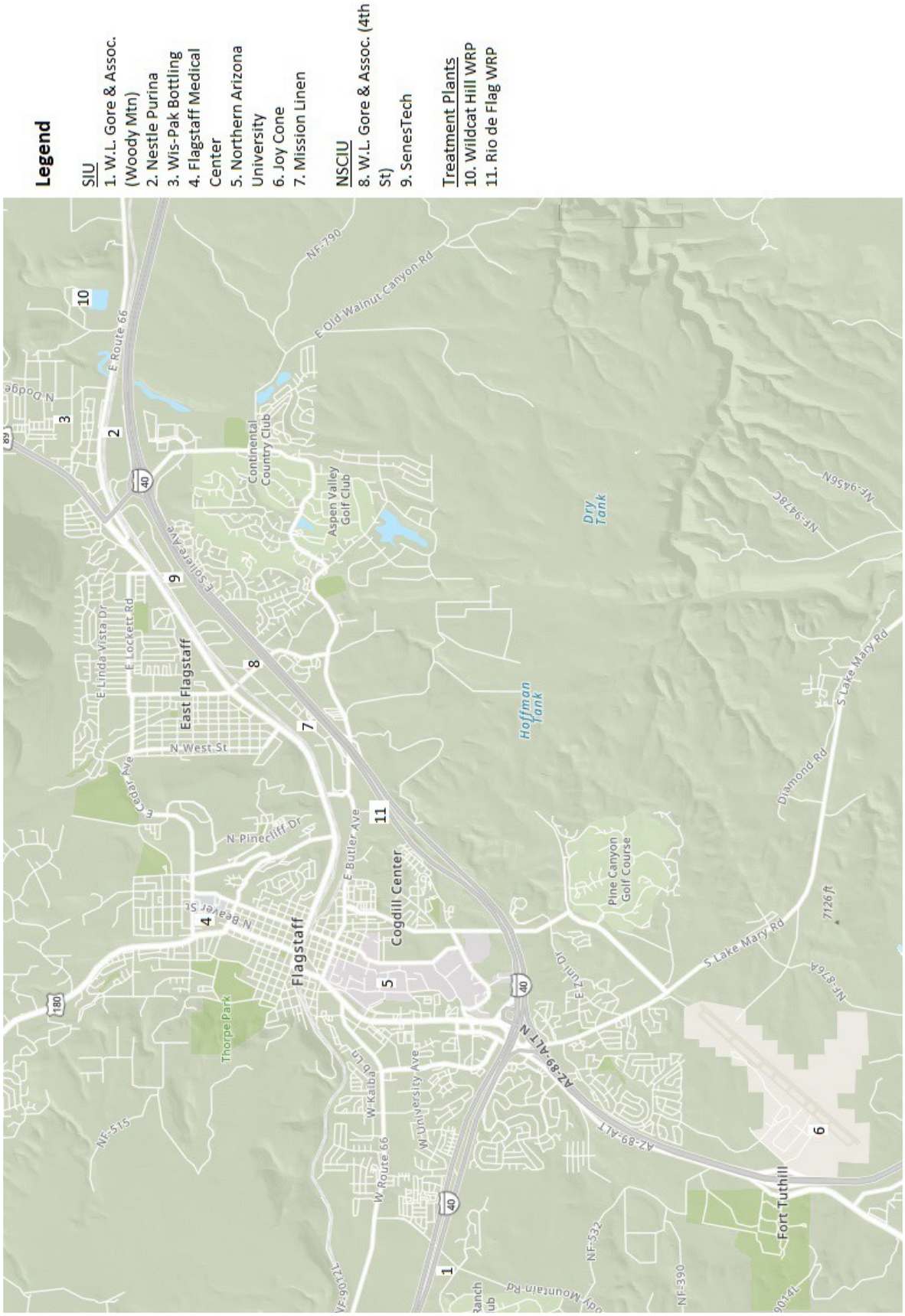
- Two State licensed laboratories at the Lake Mary Water Treatment Plant and the Wildcat Water Reclamation Plant.
- Surface Water and Aquifer Protection Permits at the Rio de Flag Water and Wildcat Hill Reclamation Plants.
- City's Industrial Pretreatment Program.
- City's Fats, Oils and Grease (FOG) Program.
- City's Cross Connection Program.
- City's Municipal Separate Storm Sewer System (MS4) program.

City Area Wide de Minimis permit for small discharges.
The City of Flagstaff currently has seven permitted industries under the Industrial Pretreatment Program. The largest industries include an ice cream cone manufacturer, pet food manufacturer and soft drink bottler. The Section also administers the Multi-Sector General Permit (MSGP) at the Wildcat Hill and Rio de Flag Water Reclamation Plants and works with regulatory agencies to update permits.

The Regulatory Compliance Section represents the City by maintaining relationships with other professionals in the water and environmental compliance field and participating in or hosting meetings and workshops. The section is a liaison with numerous outside agencies and organizations that include the United States Environmental Protection Agency (USEPA), Arizona Department of Environmental Quality (ADEQ), Arizona Department of Water Resources (ADWR), and Environmental Laboratory Advisory Committee. In addition, staff review proposed water quality legislation and provide input to State Agencies, City Council and Legislators. Staff also provides water quality regulatory permit administration for all programs within the Regulatory Compliance Section for various Federal (USEPA) and State (ADEQ) programs including: Safe Drinking Water Act, Clean Water Act, Clean Air Act, National Pollutant Discharge Elimination System (NPDES), Arizona Pollutant Discharge Elimination System (AZPDES), Arizona Aquifer Protection Permit (APP), Reclaimed Water Permit, Multi-Sector General Permit (MSGP), Municipal Separate Storm Sewer System (MS4), and Emergency Operations and Safety Programs as required.

The section authored and passed an Enforcement Response Plan for the Industrial Pretreatment, Stormwater and Cross-Connection programs through City Council in 2018. The ERP clearly outlines the enforcement processes that will be followed by staff in instances of non-compliance.

15-1 Industrial Waste Significant Industrial Users



16 RED GAP RANCH

16-1 Red Gap Ranch

Red Gap Ranch was identified and purchased as a future City water resource in 2005. The City commissioned a pipeline feasibility study by Jacobs Engineering in June of 2008 to analyze alternative pipeline alignments to convey water from the ranch to the City. This feasibility study was delayed for many years due to right-of-way and access negotiations with the Arizona Department of Transportation. The feasibility study is currently in Phase 2, involving cultural and environmental resource evaluation and excavating geological test pit at 41 locations, additional full-time monitoring at test pit locations, and additional public outreach support. This pipeline feasibility study is scheduled for completion in Fall 2020.

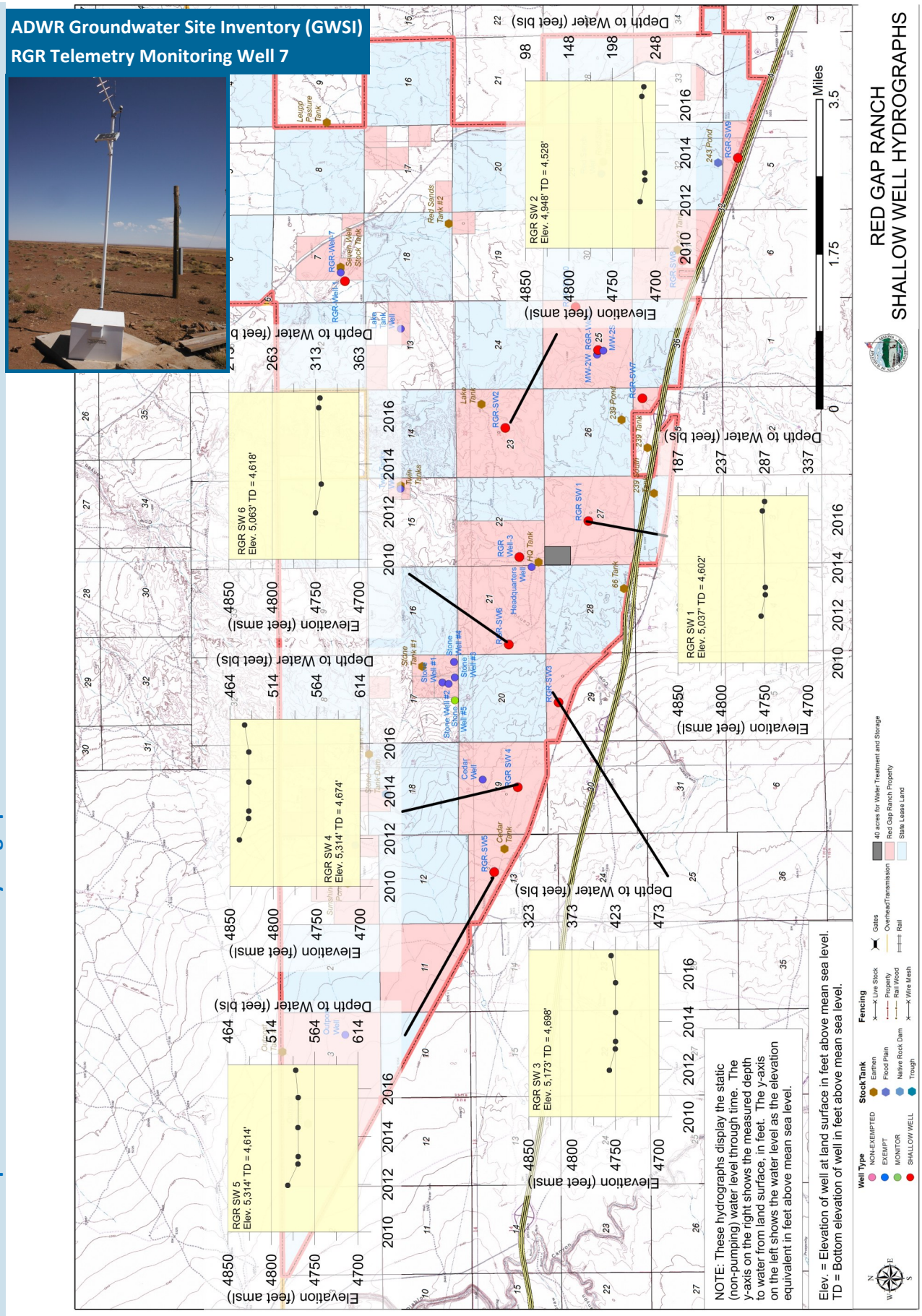
16-2 Red Gap Ranch Well Data

Local Name	Reg. Number	Surf. Elevation (feet amsl)	Most Recent Depth to Water (feet)	Most Recent Water Elevation (feet amsl)	Data[1] Source	Date Measured	Well Depth (feet)	Diameter (inches)	Perf. Interval (feet)	Date Well Complete
Sunshine Well	601277	5230								
Outpost Well	597831	5330	572.65	4757	COF	3/1/2019	930	5	690-890	2003
Lake Tank Well	590957	4870	171.24	4699	H.S.I.	11/19/2002	570	6		2002
Twin Tanks Well	597832	4950	252.07	4698	COF	3/1/2019	880	5	660-860	2003
Red Sands Well	601276	4951	240.53	4710	H.S.I.	11/18/2002				
Stone-1	601273	5045								
Stone-2	601274	5065								
Stone-3	601275	5055	316.44	4739	H.S.I.	5/15/2003				
Stone-4	601272	5045								
Stone-5	809401	5055	342.4	4713	COF	9/13/2012				
Cedar Well	597833	5180	441.33	4739	COF	5/10/2019	910	5	590-690, 790-890	2003
Headquarters Well	601278	5030	131.48	4899	COF	5/10/2019				
RGR - Well-1	590153	4835					180	12	OPEN	Incomplete
RGR - Well -2	590823	4970	220	4750	COF	4/1/2015	695	12	380-460, 540-600, 640-660	2002
MW-2W	590821	4970	242.5	4728	COF	5/11/2016	500	5	380-480	2002
MW-2S[4]	590822	4970	237	4733	COF	5/11/2016	500	5	380-480	2002
RGR - Well -3	590338	5030	278.5	4752	COF	5/11/2016	840	12	460-520, 660-720, 760-800	2002
RGR - Well -7[2]	601271	4832	167.8	4664	ADWR	1/7/2015	440	4.5	OPEN	Deepened in 2002
RGR SW Well 1[3]	912928	5037	284.85	4752	COF	5/10/2019	435	16	OPEN	2011
RGR SW Well 2	912929	4948	232.98	4715	COF	3/1/2019	420	16	OPEN	2011
RGR SW Well 3	912930	5173	420.13	4753	COF	3/1/2019	475	16	OPEN	2011
RGR SW Well 4	912931	5314	482.87	4831	COF	3/1/2019	640	16	OPEN	2011
RGR SW Well 5	912932	5314	541.95	4772	COF	3/1/2019	700	16	OPEN	2011
RGR SW Well 6	912933	5063	316.57	4746	COF	3/1/2019	445	16	OPEN	2011
RGR SW Well 7	913556	4995	N/A				38	24		Incomplete
RGR SW Well 8	913557	4996	N/A				38	24		Incomplete
RGR SW Well 9	913560	5012	N/A				38	24		Incomplete
RGR SW Well 10	913561	4964	N/A				38	24		Incomplete

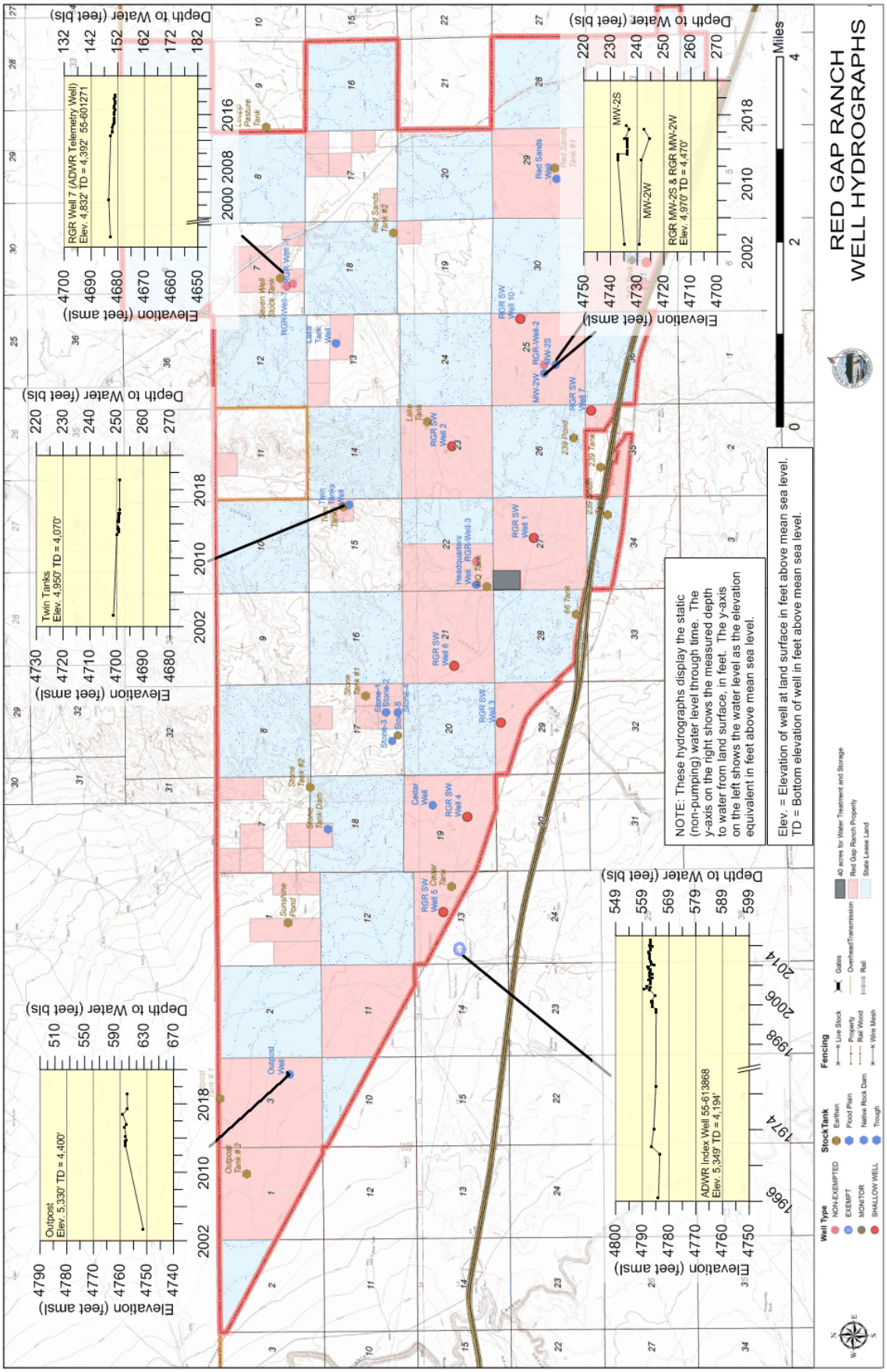
1. COF = City of Flagstaff; H.S.I=HydroSystems Inc
2. Pursuant to agreement with ADWR dated 2013, continuously monitoring water level
3. Red Gap Shallow Wells (SW)

*AMSL = Above mean sea level

16-3 Red Gap Ranch Well Locations and Hydrographs



16-3 Red Gap Ranch Well Locations and Hydrographs, continued



17 2019 MISCELLANEOUS INFORMATION

17-1 Statistics

psi	Pounds per square inch	2.304 feet of water head
Acre-foot	Gallons in 1 acre, 1 foot deep	325,851 gallons
Cubic foot	Gallons in 1 cubic foot	7.48 gallons
Cubic foot per second (cfs)		450 gallons per minute
Million gallons per day		694 gallons per minute
Break horse power		(total lift x gpm)/3960 0.67 kwh (kilowatt hours)
GPCD	Gallons per capita per day	
mg/L	milligram per liter or part per million	
TTHM	Total Trihalomethanes	

CITY PERMIT NUMBERS

WATER
Water System No. 403008
Recycled Water Type 3 – R511384

WASTEWATER
Wildcat Hill WRP — AZPDES AZ0020427
APP 100760
Rio de Flag WRP — APP 102421
AZPDES AZ0023639

AWWA Membership No. 00033465
ADWR Designation No. 41-900002.0002
ADWR Community Water System ID: 91-000086.0000

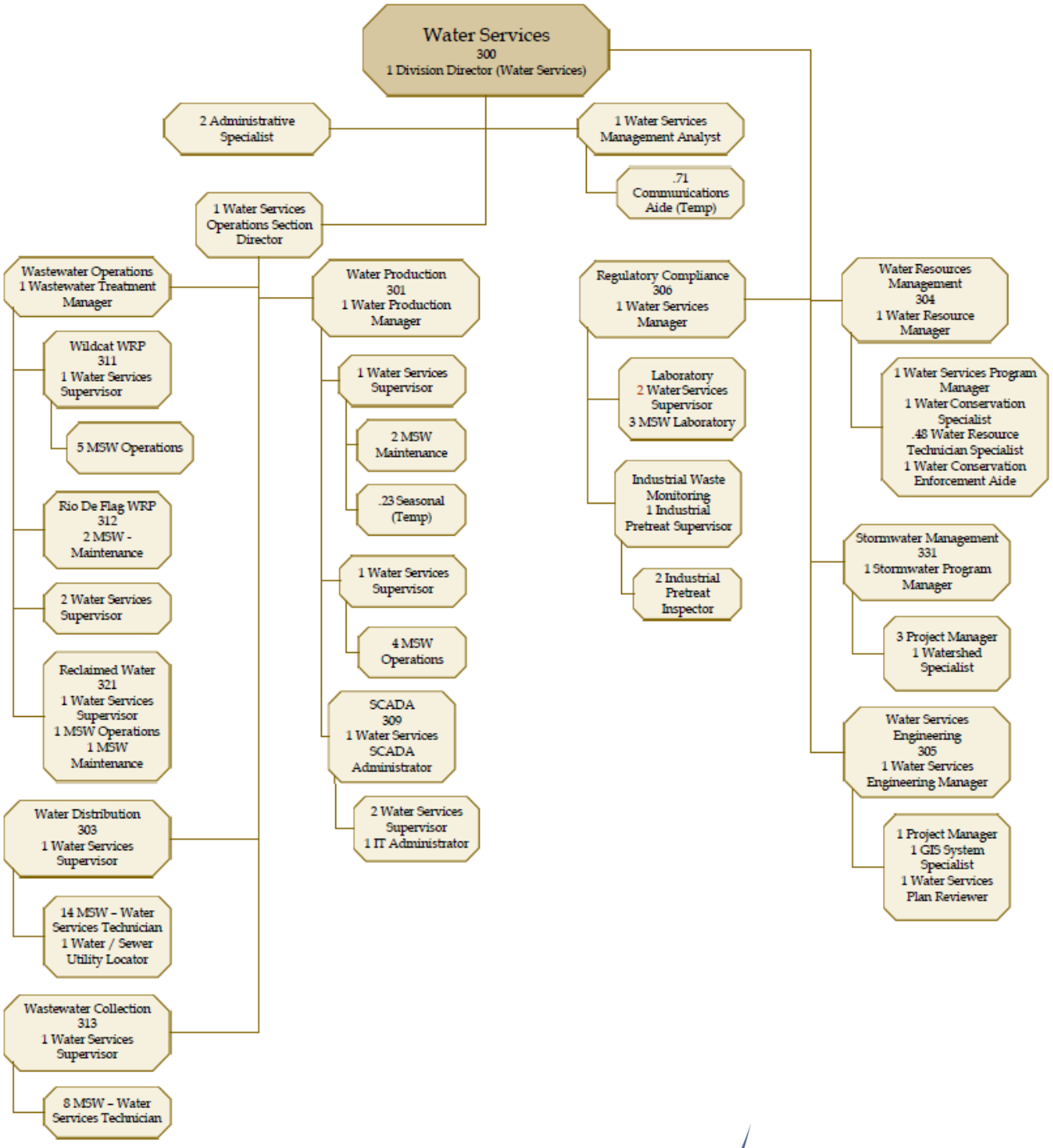
REVENUES (FY= July thru June) Water, Sewer & Reclaimed Water Revenues.
FY 18 & 19 include capacity fees and interest.

FY 2019 WATER	$ 20,274,806	FY 2018	$ 18,398,923
FY 2018 SEWER	$ 11,584,890	FY 2018	$ 11,785,764
FY 2018 RECLAIM	$ 818,176	FY 2018	$ 1,370,131

SYSTEM INFORMATION (2019)
Number of fire hydrants – 3,397
Number of reclaim hydrants - 14
Number of manholes – 7,734
Number of valves – Reclaim = 250, Water control valves = 471, Water system valves = 11,475
Number of wells – 26 active in 2019
Miles of sanitary sewer – 281.841 (gravity), 4.347 (pressurized)
Miles of water main – 438.43 (pressurized), 1.01 (gravity)
Miles of reclaim pipeline – 25.83 active
Miles of storm drain – 93.19
Average annual gallons per household in 2019 – 139 gallons per house per day
Average annual gallons per capita per day in 2019 – 48 gallons per person per day
Upper Lake Mary capacity – 16,300 acre feet (USGS OFR 2008-1098)
Year 2019, number of housing units – 18,696 (15,674 Single Family/3,022 Multi-Family)

KEY ELEVATIONS (Feet)
Pressure Zone A – 7,260
Presssure Zone B – 7,137
Pressure Zone A+ (RR Springs) – 7,320
Upper Lake Mary Spillway – 6,835.5 (USGS OFR 2008-1098)
Inner Basin cabin -9,415
Lake Mary WTP – 6,960
Wildcat WWTP – 6,760
Rio de Flag WRP – 6,860

17-2 Water Services Division Organizational Chart



17-3 City of Flagstaff Water Rates and Fees

CITY OF FLAGSTAFF WATER & SEWER RATES

Effective January 1, 2020 (Subject to Change**)**

MONTHLY FIXED CHARGE

Meter Size:	Customer Class	Inside City Rate	Outside City Rate
3/4"	All	$ 16.64	$ 18.30
1"	All	19.60	21.56
1 1/2"	All	26.98	29.68
2"	All	35.84	39.42
3"	All	56.52	62.17
4"	All	86.05	94.66
6"	All	159.88	175.87
8"	All	248.47	273.32
10"	All	351.83	387.01

WATER RATES

POTABLE WATER: (per 1,000 gallons)		Customer Class	Water Rate	Water Energy Rate	Total Inside City Rate	Outside City Rate
Single Family	Tier 1 (0 - 3,500 gallons)	R1 or R4	$ 3.44	$ 0.83	$ 4.27	$ 4.70
	Tier 2 (3,501 - 6,200 gallons)		4.45	0.83	5.28	5.81
	Tier 3 (6,201 - 11,500 gallons)		6.86	0.83	7.69	8.46
	Tier 4 (11,501+ gallons)		13.72	0.83	14.55	16.01
Multi-Family Units		R2 or R3	4.42	0.83	5.25	5.78
Commercial/Schools		C	4.69	0.83	5.52	6.07
Northern Arizona University		NA	4.30	0.83	5.13	N/A
Manufacturing		MN	4.63	0.83	5.46	6.01
Landscaping/Lawn Meters		LM	4.69	0.83	5.52	6.07
Hydrant Meter		HM	7.17	0.83	8.00	N/A
Standpipe*		SP	7.17	0.83	8.73	N/A

*Includes sales tax

RECLAIMED WATER: (per 1,000 gallons)		Customer Class	Inside City Rate	Outside City Rate
Private Residential	Tier 1 (0 - 3,500 gallons)	R1	$ 1.43	$ 1.57
	Tier 2 (3,501 - 6,200 gallons)		1.77	1.95
	Tier 3 (6,201 - 11,500 gallons)		2.56	2.82
	Tier 4 (11,501+ gallons)		4.80	5.28
Commercial (no main Ext):		C	1.95	2.15
Commercial (w/ main Ext):		C	4.14	4.55
Manufacturing (no main Ext):		MN	1.93	2.12
Manufacturing (w/ main Ext):		MN	4.10	4.51
NAU (No main extension):		NA	1.82	N/A
NAU (with main extension):		NA	3.85	N/A
City Departmental		MU	1.95	N/A
Hydrant Meter		WR	4.00	N/A
Standpipe**		RS	4.37	N/A
Off Peak/Golf Course:	Tier 1 (0 - 150,000,000 gallons)	WR	1.65	1.82
	Tier 2 (150,000,001+ gallons)	WR	1.65	1.82

**Includes sales tax

17-3 City of Flagstaff Water Rates and Fees, continued

SEWER RATES

SEWER: (per 1,000 gallons)	Customer Class	Inside City Rate	Outside City Rate
Residential			
Single- and Multi-Family	R1 - R4	$ 5.35	$ 5.89
Non-Residential			
Car Washes	CW	5.38	5.92
Laundromats	L	5.53	6.08
Commercial	C	5.68	6.25
Hotels & Motels	H	7.58	8.34
Restaurants	RF	9.09	10.00
Industrial Laundries	IL	8.36	9.20
Manufacturing	MN	6.09	6.70
Pet Food Manufacturers	PF	13.34	14.67
Soft Drink Bottling	SD	10.57	11.63
Ice Cream Cone Manufacturing	IC	16.48	18.13
NAU	NA	4.91	5.40

STORMWATER RATE

STORMWATER: (per ERU)	Customer Class	Inside City Rate	Outside City Rate
1 ERU (January 1, 2019 through June 30, 2019)	All	$ 2.26	$ 2.49
1 ERU (Effective July 1, 2019)	All	$ 3.74	$ 4.11

TRASH AND RECYCLING

EFFECTIVE JANUARY 3, 2020

RESIDENTIAL	Customer Class	Inside City Rate*	Outside City Rate*
One Trash and One Recycling Container (Each Container Serviced 1x per Week)	R1 - R4	$ 20.49	22.54
Each Additional Container		10.00	11.00

COMMERCIAL	Customer Class	Inside City Rate*	Outside City Rate*
Container Size and Scheduled Pickup May Vary	Please call (928) 213-2110		

PRIVATE FIRE PROTECTION

CONNECTION SIZE	Customer Class	Inside City Rate	Outside City Rate
4"	KS	$ 12.59	$ 13.85
6"		36.58	40.24
8"		77.96	85.76

17-3 City of Flagstaff Water Rates and Fees, continued

CITY OF FLAGSTAFF WATER & SEWER SYSTEM FEES

Effective July 1, 2019 except as otherwise noted (Subject to Change**)**

WATER AND SEWER FEES

All Single Family Subdivisions: Residential and Townhomes (1 Meter, 1 Unit) EXCEPT as listed in next section

Any Meter Larger than a 3/4" Must have documentation approved by Water Services 928-213-2400

Meter Size	Meter Fee	Water Capacity Fee	Sewer Capacity Fee	Service Fee	Taxes	Total Fees
3/4"	$ 340	$ 5,728	$ 3,723	$ 24	$ 33.42	$ 9,848.42
1"	$ 520	$ 9,566	$ 3,723	$ 24	$ 49.94	$ 13,882.94
1 1/2"	$ 920	$ 19,074	$ 3,723	$ 24	$ 86.67	$ 23,827.67
2" or larger Call	Call	Call	Call	Call	Call	Call

Exceptions Single Family Residential Subdivisions (1 Meter, 1 Unit)

Linwood Heights & Rock Ridge West (1" Meter Required)

1"	$ 520	$ 9,566	$ 3,723	$ 24	$ 49.94	$ 13,882.94

Pine Canyon (1 1/2" Meter Required)

1" *(See Comment Below)*	$ 520	$ 9,566	$ 3,723	$ 24	$ 49.94	$ 13,882.94
1 1/2"	$ 920	$ 19,074	$ 3,723	$ 24	$ 86.67	$ 23,827.67

** Meters <1 1/2" in Pine Canyon must be approved by the Fire Department as adequate to handle domestic & fire sprinkler system

Multi-Family Residential, Condos, Mobile Homes (Sewer Fees are Per Unit) ***Water Services Invoice Required 928-213-2400***

Meter Size	Meter Fee	Water Capacity Fee	Sewer Capacity Fee	Service Fee	Taxes	Total Fees
3/4"	$ 340	$ 5,728	$3,723 (Per Unit)	Based on # of Units		
1"	$ 520	$ 9,566	$3,723 (Per Unit)	Based on # of Units		
1 1/2"	$ 920	$ 19,074	$3,723 (Per Unit)	Based on # of Units		
2"	$ 1,070	$ 30,530	$3,723 (Per Unit)	Based on # of Units		
3"	$ 3,130	$ 57,279	$3,723 (Per Unit)	Based on # of Units		
4"	$ 4,130	$ 95,484	$3,723 (Per Unit)	Based on # of Units		
6" or Larger	Call					

Commercial/Non-Residential ***Water Services Invoice Required 928-213-2400***

Meter Size	Meter Fee	Water Capacity Fee	Sewer Capacity Fee	Service Fee	Taxes	Total Fees
3/4"	$ 340	$ 5,728	$ 3,723	$ 24	$ 33.42	$ 9,848.42
1"	$ 520	$ 9,566	$ 6,218	$ 24	$ 49.94	$ 16,377.94
1 1/2"	$ 920	$ 19,074	$ 12,399	$ 24	$ 86.67	$ 32,503.67
2"	$ 1,070	$ 30,530	$ 19,845	$ 24	$ 100.44	$ 51,569.44
3"	$ 3,130	$ 57,279	$ 37,233	$ 24	$ 289.57	$ 97,955.57
4"	$ 4,130	$ 95,484	$ 62,068	$ 24	$ 381.38	$ 162,087.38
6"	$ 6,130	$ 190,910	$ 124,099	$ 24	$ 565.00	$ 321,728.00
8"	$ 13,737	$ 305,468	$ 198,566	$ 24	$ 1,263.40	$ 519,058.40
10" Call	Call	$ 439,157	$ 285,468	$ 24	Call	Call

WATER AND SEWER SYSTEM CONNECTION FEES

WATER FEES	Tap Size	Tap Fees	Taxes	Total Fees
Water Service Line Connection to Main - Residential Only	Call the Water Services at 928-213-2400			
Fire and Wet Taps (Contractor excavates to water main)	**3/4" to 2"**	$ 190	$ 17.44	$ 207.44
	3" to 12"	$ 310	$ 28.46	$ 338.46
Additional tap, same time and parcel, any size	**3/4" to 12"**	$ 125	$ 11.48	$ 136.48
SEWER FEES	**Tap Size**	**Tap Fees**	**Taxes**	**Total Fees**
Sewer Taps (Contractor excavates to sewer main)	All Sizes	$ 275	$ 25.25	**$ 300.25**

To determine if service line connections or if water and sewer taps are required, please contact Water Services at: 928-213-2400

17-4 Water Services Personnel Contact Information

CONTACTS

CUSTOMER SERVICE
211 W. Aspen 213-2231
WATER DISTRIBUTION
5401 E. Commerce 213-2444
VEHICLE SHOP
3200 W. Route 66 213-2180
WASTE WATER COLLECTION
5401 E. Commerce 213-2445

WAREHOUSE
5447 E. Commerce 213-2279
COMM DEVELOPMENT
211 W. Aspen 213-2600
LAKE MARY PLANT
4500 S. Lake Mary 774-0262/556-1266
WILDCAT HILL PLANT
2800 N. El Paso 526-2520

ENGINEERING
211 W. Aspen 213-2602
WATER SERVICES ADMIN
2323 N. Walgreen St. 213-2400
METER ROOM
211 W. Aspen 213-2244
LANDFILL
N. Hwy 89 527-1927

PARKS/THORPE PARK BLDG
Thorpe Rd. 213-2161
STREETS YARD OFFICE
3200 W. Route 66 213-2165
SOLID WASTE
3200 W. Route 66 213-2110
PUBLIC WORKS ADMIN
3200 W. Route 66 213-2100

COF MAIN LINE 213-2000 **BS FAX 213-2409**

PHONE & RADIO CALL NUMBERS

WATER SERVICES ADMIN (213-2400)

ADMIN FAX	**213-2409**	
Bradley Hill	**X 2420**	**814-2596**
Mark Richardson	X 2443	**(928)**202-0666
Marion Lee	X 2406	
Debra Valencia	X 2407	
Lisa Deem	X 2471	

WATER SERVICES ENGINEERING

Ryan Roberts	**X 2410**	**606-3303**
Jim Davis	X 2411	
Justin Emerick	X 2437	607-2541
Vacant	X 2408	

LAKE MARY PLANT (774-0262/556-1266)
(FAX 556-1267) (Plant Cell 853-2183)
(853-1451 Maint.cell)

Brian Huntzinger	522-4407/213-2459
Taylor Prichard	213-2454
Lee Williams	213-2476
Ladd Steele	213-2477
Steven Morrison	
Danny Hickey	213-2453
Kristian Heckard	
Tim Hourihan	
James Holsten	
Vacant	213-2456

REGULATORY COMPLIANCE

Steve Camp		**213-2475**
Krista Snow		213-2458
Laney Stevens		213-2451
Lisa Adams		
Janice Hakala		
Joshua Brown		213-2428
Jolene Montoya	x2117	(607-6778)
Kurt Novy	x2118	(853-6031)
Glenn Kuyper	x2119	(853-5904)

WATER DISTRIBUTION (213-2444)
Patrick O'Connor (699-61740) /213-2444
Call Out Phone #1 853-6136
Tyler Boswell
Jason Hoyungowa
Richard Tsinnie
Adam Nelson
Jim Ellis
Matt Anaya
Jared Bohn
Randy Cody
Lucas Staires
Robert Cunning
Joseph Armijo
Chase Stoneberger
Jesse McKerracher
Juan Rubalcava
Greg Sidwell **699-3989 cell**

STORMWATER

Monica Rabb	X 2473
Jim Janecek	X 2472
Ed Schenk	X 2470
Chris Palmer	X 2474
Doug Slover	X 2478

CUST SERVICE (213-2231)

Rick Tadder	**X 2252**	
Jessica Huleatt	X 2267	
Krista	X 2246	
Kim Burns	X 2233	
Nanci Thomas	X 2236	
Danielle Tiedeman	X 2234	
Rachel	X 2233	
Sabrina James	X 2238	
Matt Scheide	X 2244	699-1489
Bill Katlin	X 2244	
Scott Klotz	X 2244	
Manny Sierra	X 2244	

WATER COLLECTIONS (213-2445)
Joe Almendarez 853-4876/213-2445 cell
Call Out Phone #2 607-8841
Lorne Sampson
William Atherton
Ralph Hernandez
Brian Smith
Jason Toback
Paul Wolf
Vacant
Vacant

RIO DE FLAG PLANT (X1110)
Address 600 Babbitt Dr. (556-1301/1303)
(Cell 853-4584) (Fax 556-1302)
Frederick Wright
Cory Mueller
Paul Adams
Shawn McKee

WILDCAT HILL PLANT (526-2520)
(FAX 526-3526) (Plant Cell 699-8659)
Jim Huchel (853-8715)
Troy Dagenhart
Bill Case
Scott Gede
Matthew Black
Kiley McCormack
Kyle Nelson
Septage Shack (527-1431)

WATER RESOURCES

Erin Young	**X 2405**	**(821-5952)**
Tamara Lawless	X 2404	(607-7674)
Kate Miele	X 2403	(890-7339)

SCADA/GIS
Timothy Harrington
Corryn Smith
William Liebe

We are Water