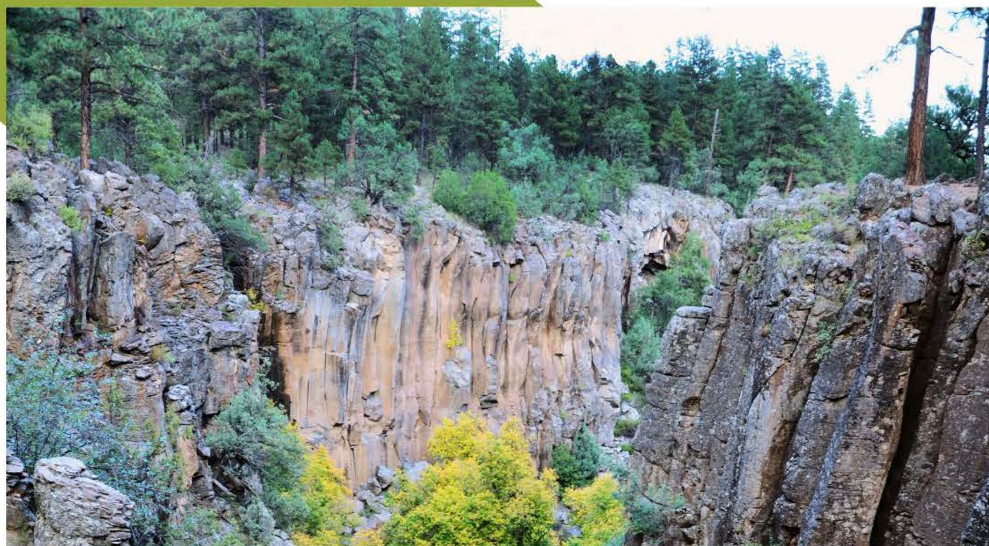


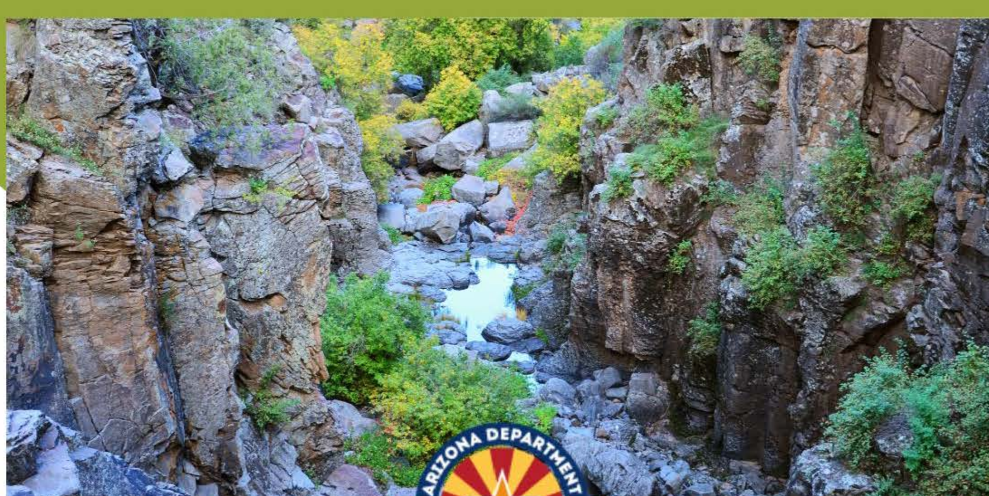
PRELIMINARY HYDROGRAPHIC SURVEY REPORT

FOR THE

SYCAMORE SUBWATERSHED

WITHIN THE VERDE RIVER WATERSHED

In re the General Adjudication of All Rights to Use Water in the Gila River System and Source



March 2026

Cover photo: From *Sycamore Falls Area in the Wilderness off of the Sycamore Rim Trail*, by Kaibab National Forest 2015 (https://flic.kr/p/zn7QVD). In the public domain.

Abstract

This Preliminary Hydrographic Survey Report ("Preliminary HSR") presents the Arizona Department of Water Resources' ("ADWR" or "Department") investigative work concerning historical and current water uses in the Sycamore Subwatershed within the Verde River Watershed. The Preliminary HSR provides a background on the study area, describes the investigative procedures, and includes 1,623 Watershed File Reports ("WFRs") describing water uses on a parcel-by-parcel basis. These investigative findings will assist the Adjudication Court in determining the nature, extent, and relative priority of water rights in the Sycamore Subwatershed. This is a preliminary report, as a Final HSR will be published at a later date following the close of the public comment period.

Keywords: Hydrographic Survey Report, Arizona General Stream Adjudication, Verde River Watershed, Sycamore Subwatershed

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Chapter 1: Legal Background

1.1 Introduction

This report, titled *Preliminary Hydrographic Survey Report for the Sycamore Subwatershed* ("Preliminary HSR"), was requested by the Court in the Gila River General Stream Adjudication[1] ("Gila Adjudication") (*In re Subflow Technical Report, Verde River Watershed*, Contested Case No. W1-00-000106, at 5 (Feb. 27, 2023)). The Arizona Department of Water Resources ("ADWR") prepared this Preliminary HSR to review water right claims and water uses in the Sycamore Subwatershed, including those actual uses for which no Statement of Claimant ("SOC") has been filed.[2] The Sycamore Subwatershed is subject to the Gila Adjudication, a judicial proceeding which will determine, based on state and federal law, the nature, extent and relative priority of over 80,000 water rights claimed by tens of thousands of water users (*See* the Arizona Revised Statutes ("A.R.S.") §§ 45-251 to 264).[3]

As governed by the A.R.S. §§ 45-252 and 256, ADWR provides technical support to the division of the Superior Court which has authority to determine the nature, extent and relative priority of the water rights of all water users in the river system and source, commonly referred to as the Adjudication Court. Under A.R.S. § 45-256, ADWR is required to prepare preliminary and final hydrographic survey reports ("HSRs") for watersheds and federal reservations when requested by the Adjudication Court. HSRs include detailed information, tables, and maps regarding water resources, water uses,

---

[1] Generally, an adjudication is the process of settling a legal case through the court. The Gila Adjudication is a judicial proceeding to determine the extent and priority of all water rights in the Gila River system.

[2] ADWR conducted investigations from October 2023 to September 2025. SOCs filed after September 6, 2025, were not reflected in this report.

[3] See also Overview of General Stream Adjudications.

hydrologic[4] analyses, and landownership for each water right or water use investigated. ADWR is also required to propose water right attributes,[5] when applicable, for individual water right claims or uses investigated in a particular HSR boundary or to identify water right claims or uses for which no water right is recommended (A.R.S. § 45-256(B)). This Preliminary HSR is intended to provide water users with an opportunity to inspect the information ADWR gathered pertaining to water right claims and uses in the Sycamore Subwatershed. Additionally, this version of the report is intended to give water users the opportunity to make a claim for a water right, or to update existing claims and filings. Water users who filed Statements of Claimant ("Claimants") may also provide comments on any portion of this Preliminary HSR, which ADWR will also consider when making revisions, if any, before publishing the final HSR (See **Section 1.3.4**).

The final version of this report will be published following the conclusion of the public comment period and will replace this preliminary version. At least one hundred twenty (120) days of notice will be given prior to its publication (A.R.S. § 45-256(H)). The Final HSR will assist the Adjudication Court in determining the nature, extent, and relative priority of all water rights in the Sycamore Subwatershed.

1.2 History of Proceedings

1.2.1 Water Appropriation

Generally, appropriating water means legally taking and using surface water for a specific beneficial use. In Arizona, different laws apply to a person's right to use surface water or underground water. The right to use surface water is subject to the doctrines of prior appropriation and beneficial use, while non-appropriable groundwater may be pumped by the overlying landowner subject to the reasonable use doctrine ("Gila River

[4] In science, anything *hydrologic (adj.)* involves water or the effects of water on the planet.

[5] Water right attributes are those reflected in a Watershed File Report that include the owner of the water right, landowner, SOC number, basis of right, beneficial use type, priority date, quantity, place of use, point of diversion, and source of water.

IV") (*In re the Gen. Adjudication of All Rts. to Use Water in the Gila River Sys. & Sourc*e, 198 Ariz. 330, 335-36 (Ariz. Sep. 21, 2000); A.R.S. §§ 45-141(A), 45-251(7)). Those who appropriate water first are referred to as "senior" surface water users. These senior surface water appropriators possess rights which are superior to rights acquired by later appropriators of surface water (*Slosser v. Salt River Valley Canal Co.*, 7 Ariz. 376, 388, (Ariz. Jun. 01, 1901)). This concept is commonly described as "first in time, first in right" and means, in times of scarcity, senior rights holders must receive their full allotment of water before junior rights holders receive any. Prior to 1919, surface water rights were established by putting water to beneficial use or posting notice of the intention to use surface water (*Phelps Dodge Corp. v. Arizona Department of Water Resources*, 211 Ariz. 146, 118 (Ct. App. 2005)). On June 12, 1919, the legislature enacted the Arizona Surface Water Code, also known as the Public Water Code.[6] This defined surface water[7] and established an administrative system for acquiring surface water rights in statute, which requires water users to file an application to appropriate water with the applicable state agency A.R.S. § 45-151 et seq.). Although the Arizona State Legislature amended the statutes containing the Public Water Code over time, the current version of the statute provides:

> Any person, including the United States, the state or a municipality, intending to acquire the right to the beneficial use of water, shall make an application to the director of water resources for a permit to make an appropriation of the water.
>
> A.R.S. § 45-152(A).

[6] See the ADWR website for more information on Surface Water.

[7] A.R.S. § 45-141 is the current citation for the definition of Surface Water, and was originally found in 1919 Ariz. Sess. Laws, Ch. 164, § 1.

Under state law, appropriable water includes surface water and certain underground water referred to as subflow ("Southwest Cotton") (*Maricopa County Municipal Water Conservation Dist. No. 1 v. Southwest Cotton Co.*, 39 Ariz. 65, 96-97 (Ariz. Oct. 22, 1931), modified and reh'g denied, 39 Ariz. 367, (Ariz. Jan. 12, 1932). Subflow is underground water hydraulically connected to a stream and is considered to be part of the surface stream itself ("Gila River II") (*In re the Gen. Adjudication of All Rts. to Use Water in the Gila River Sys. & Sourc*e, 175 Ariz. 382, 392, (Ariz. July 27, 1993)). Wells located inside the boundaries of the subflow zone of a stream are presumed to be pumping subflow, unless a well owner shows it is more probable than not that the well pumps groundwater (*In re the Subflow Technical Report, San Pedro River Watershed,* Contested Case No. W1-00-000103, at 3 (July 13, 2017)). Certain wells located outside the boundaries of the subflow zone may also be subject to the Adjudication Court's jurisdiction based on projected impacts of the well's pumping on the subflow zone (Gila River II, at 391, 857). Wells pumping subflow are subject to the same rules of appropriation as the surface stream itself (Southwest Cotton, at 97). ADWR published three technical reports proposing the subflow zone delineation for the entirety of the Verde River Watershed.[8] The Water Judge will ultimately issue a final report establishing the subflow zone.

[8]Access all three reports in the "Reports" section of ADWR's website at https://www.azwater.gov/adjudications.

1.2.2 General Stream Adjudication

By statute, any water user on a river system and source may file a petition for the court to determine the nature, extent, and relative priority of the water rights of all persons in the river system and source (A.R.S. § 45-252). On February 24, 1976, the Salt River Valley Water Users' Association (also known as "SRP") filed a petition to determine the water rights for the Verde River ("River") and its tributaries. In 1979, the Salt River, Verde River, and Gila River adjudications were transferred to the Maricopa County Superior Court. In 1981, the Arizona Supreme Court consolidated these adjudications into one proceeding assigned to the Maricopa County Superior Court under the caption *In re the General Adjudication of All Rights to Use Water in the Gila River System and Source*, Nos. W-1, W-2, W-3 & W-4 (Consolidated).[9]

Figure 1-1 shows the geographic extent of the Gila River Adjudication. Water users within this boundary were notified of the commencement of adjudication proceedings and were required to file an SOC if the person or entity claimed a water right within this area. ADWR continues to send notice of the adjudication proceedings on a bi-annual basis to any person who initiated a new water use within the areas subject to the adjudication.[10]

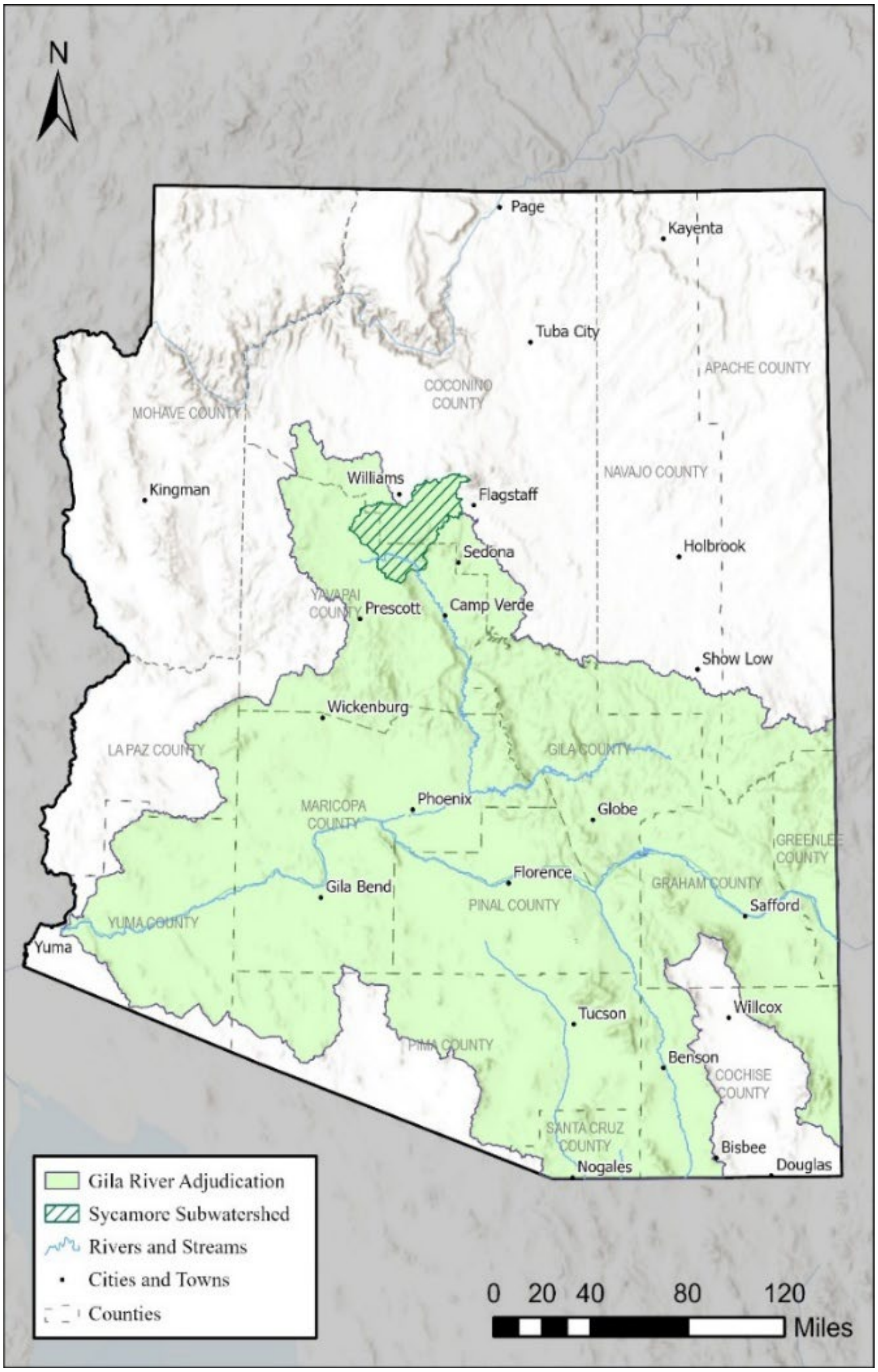
---

[9] In 2025, the Adjudication Court changed the numbering system due to its incorporation in the Superior Court's electronic case management system ("ICIS"). W-1, W-2, W-3 & W-4 Consolidated is now numbered as W1-00-001234.

[10] More information on the General Stream Adjudications is available on the Maricopa County Superior Court website at:

https://www.superiorcourt.maricopa.gov/SuperiorCourt/GeneralStreamAdjudication/faq.asp#8 .

Figure 1-1
Gila River Adjudication and Sycamore Subwatershed



1.2.3 Water Right Claims

For a water right to be adjudicated, an SOC must be filed with the Adjudication Court on a court-approved form (A.R.S. § 45-254). As required by statute, information must be provided on the form describing the attributes of the claimed water right, including, but not limited to, the water source,[11] the quantity of water claimed,[12] legal descriptions of the point(s) of diversion ("POD") and place(s) of use ("POU"),[13] the owner of the land at the place of use, the purpose and extent of the water use,[14] the time of the initiation of the water right and date when water was first put to beneficial use for that purpose,[15] and the legal basis of the claim.[16] ADWR investigated all claimed and unclaimed uses within the Sycamore Subwatershed from streams and other natural channels, lakes, ponds, springs, reservoirs, stockponds, and wells and presents this information in this Preliminary HSR.

Water users who filed SOCs within the Sycamore Subwatershed may file comments to this Preliminary HSR for ADWR's consideration (A.R.S. § 45-256(H); Pretrial Order No. 5 Re: Notice of Hydrographic Survey Reports, *In re the Gen. Adjudication of All Rts. to Use Water in the Gila River Sys. & Source*, W1-00-001234, at 4 (Mar. 29, 2000)). The comments must be received by ADWR no later than September 4, 2026 (See **Section 1.3.4**).

---

[11] A.R.S. § 45-252(C)(2)

[12] A.R.S. § 45-252(C)(3)

[13] The POU is the location of where the water is used, whereas the POD is the location of where the water is diverted from the source.

[14] A.R.S. § 45-252(C)(6).

[15] A.R.S. § 45-252(C)(8).

[16] A.R.S. § 45-252(C)(9); other required attributes which must be included on the Statement of Claimant for certain types of water uses are found in A.R.S. § 45-254.

1.3 Scope of the Preliminary HSR

The Adjudication Court requested ADWR issue this Preliminary HSR on March 6, 2026.[17] A.R.S. § 45-256(A) lists ADWR's responsibilities when creating an HSR, which are:

1. Identify the hydrological boundaries of the river system and source and the names and addresses of all reasonably identifiable potential claimants. In identifying potential claimants, the director, at a minimum, shall identify as far as reasonably possible the current record owners of all real property within the geographical scope of the adjudication.
2. Locate, procure, and make available all public and other records relevant to determination of any factual or legal issues.
3. Conduct a general investigation or examination of the river system and source.
4. Investigate or examine the facts pertaining to the claim or claims asserted by each claimant.
5. Make a map or plat on a scale not less than one inch to the mile adequate to show with substantial accuracy the course of the river system and source, the location of the ditch or canal diverting water from such river system and source, and the legal subdivisions of lands that have been irrigated or are susceptible to irrigation from the ditches and canals already constructed.
6. Take such other steps and gather such other information as may be necessary or desirable for a proper determination of the relative rights of the parties.

---

[17] (*No. W1-00-000106* at 5, Feb. 27, 2023)

The statute also requires ADWR's findings to be set forth on a claim-by-claim basis, listing all the information obtained by ADWR which reasonably relates to a particular water right claim or use investigated (A.R.S. § 45-256(B)).

1.3.1 De Minimis Water Uses

A *de minimis* water use is a use, "found to be sufficiently small so that the costs of a detailed adjudication of the use outweigh the benefits that would result" (Memorandum Decision, Findings of Fact, and Conclusions of Law for Group 1 Cases Involving Stockwatering, Stockponds, and Domestic Uses ("Memorandum Decision"), *In re Sands Investment Co.*, Contested Case No. W1-11-19, at 5 (Nov. 14, 1994)). A *de minimis* classification for small water uses is a case management decision made by the Adjudication Court, which simplifies the adjudication of those uses. Once designated as *de minimis*, certain attributes, or characteristics, of the water rights are determined uniformly, intended to result in a faster adjudication for these water rights (Memorandum Decision*,* 8-9, 1994). *De minimis* criteria may also resolve the objections to many small water uses and therefore remove those uses from active litigation. Although some attributes of *de minimis* uses may be determined uniformly,[18] future changes to those attributes, such as location or use type, will require approval from the Adjudication Court.[19]

At the request of the Adjudication Court, ADWR previously evaluated Domestic, Stockpond, and Stock and Wildlife Uses in the Verde River Watershed to assist the Court in determining whether any of those uses are eligible for the *de minimis* classification (ADWR, 2022). Subsequently, the Adjudication Court approved uniform quantities for summarily adjudicated rights for *de minimis* Stock Watering from a Stockpond, Stock and Wildlife Watering, and Domestic Uses within the entirety of the Verde River Watershed, inclusive of the Sycamore Subwatershed (De Minimis Order, at 14).

---

[18]Assigned reasonable, but non-exact, elements based on the beneficial use type.

[19] *See* ("De Minimis Order") *In re Subflow Technical Report, Verde River Watershed,* Contested Case No. W1-00-000106, Attachment I at 8-9 (Dec. 9, 2025).

See **Section 4.4** for more information on beneficial use types and the investigation procedures ADWR used when evaluating them. The approved quantities are as follows:

> Stock Watering from a Stockpond: Not to exceed (≤) 4 acre-feet in capacity with continuous fill.[20]
>
> Stock and Wildlife Watering: Reasonable use.[21]
>
> Domestic: The claimed quantity of use, not to exceed 1 acre-foot per annum ("AFA").[22]

In this Preliminary HSR all uses qualifying equal to or under the above-referenced quantities for *de minimis* uses are organized by name of the claimant or landowner. If ADWR recommended a water right pursuant to A.R.S. § 45-256(6)(B), then a proposed abstract was created and a Proposed Water Right ("PWR") number was assigned.

1.3.2 Wells within the Subflow Zone

As described above, wells located inside the lateral boundaries of the subflow zone of a river are presumed to be pumping appropriable subflow, and certain wells located outside the boundaries of the subflow zone may also be subject to the Adjudication Court's jurisdiction based on projected impacts of the well's pumping on the subflow zone.

---

[20] *See* De Minimis Order, Attachment I at 5-6, and *see* Final Report of the Special Master Concerning Summary Adjudication Proceedings in the Verde River Watershed, *In re Subflow Technical Report, Verde River Watershed,* Contested Case No. W1-00-000106, (Feb. 13, 2025), at 30.

[21] *See* De Minimis Order, Attachment I at 6.

[22] For this quantity, what is claimed will be abstracted for recommended rights, so long as it does not exceed 1 AFA. For any claimed domestic uses above 1 AFA, ADWR will abstract the quantity as 1 AFA. Any claimant claiming a domestic use greater than 1 AFA may file a comment during the public comment period, closing on September 4, 2026. *See* De Minimis Order, Attachment I at 5.

At the request of the Adjudication Court, ADWR previously provided a technical report and a series of maps outlining a proposed subflow zone for the Verde River Watershed, inclusive of the Sycamore Subwatershed.[23] As of the date of publication of this Preliminary HSR, the subflow zone for the Verde River Watershed ("Verde Subflow Zone") has not been finalized.

ADWR used the proposed subflow zone, as submitted to the Court by ADWR in December 2021, April 2023, and December 2025 to identify uses that may be subject to the jurisdiction of the Adjudication Court, should the proposed Verde Subflow Zone be adopted by the Water Judge.[24]

1.3.3 How to Read This Report

This Preliminary HSR defines the area of interest, identified as the Sycamore Subwatershed within the Verde River Watershed, and breaks down the types of beneficial uses of water which are occurring or historically occurred within it. ADWR describes the methods used to investigate each water use and/or claimed water use in Chapter 4 of this report. Chapter 5 of this report provides instructions on how to access the results of these investigations, as well as how to read a Watershed File Report ("WFR").

1.3.4 Publication and Comment

Under A.R.S. § 45-256(H), ADWR must provide notice to each claimant and provide an opportunity for comments on the report once the Preliminary HSR is issued. After ADWR receives comments, ADWR will revise the Preliminary HSR, where appropriate, and will file a final version of the HSR with the Adjudication Court.

---

[23] See ADWR's December 2021 *Subflow Zone Delineation Technical Report for Verde River Mainstem & Sycamore Canyon* ("Mainstem Report").

[24] An interactive map depicting the entirety of the proposed Verde Subflow Zone is available at:

https://azwater.maps.arcgis.com/apps/webappviewer/index.html?id=a4c748130c7b435ea72afebf90031f70

As required by Pretrial Order No. 5 in the Gila River Adjudication (dated March 29, 2000), the Department takes the following steps regarding the publication of this Preliminary HSR:

1. ADWR files a notice of publication of this Preliminary HSR with the clerk of the Superior Court for Maricopa County which specifies where this report is available for inspection or purchase, the deadline and procedure for submitting comments, and procedures for obtaining additional information.

2. A press release is issued which contains the information in the Notice of Publication. The press release is posted on the Department's website (azwater.gov) and is published in general circulation newspapers within the geographic boundaries of the Gila River Adjudication.

3. Copies of the Notice of Publication are sent by first-class mail to those persons included on the court-approved mailing list for Contested Case No. W1-00-000106, and all other claimants and landowners within the Sycamore Subwatershed boundaries, along with links to the portion(s) of the Preliminary HSR describing each specific water use or claim by that person.

Comments on the Preliminary HSR must be received by ADWR on or before September 4, 2026. ADWR is scheduled to issue the Final HSR on March 12, 2027.[25] Water users who filed an SOC in the Gila River Adjudication and who wish to file an

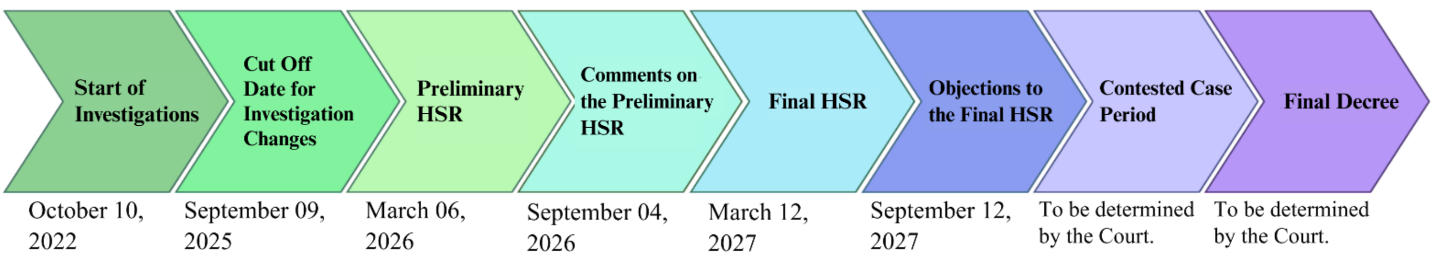
[25] ("March 25, 2024, Report") (*Report of the Special Master on Amendments to the Watershed Boundary Map and Sequencing for Future Hydrographic Survey Report Development*, *In re HSR Sequencing*, Contested Case Nos. W-1, W-2, W-3, and W-4 (Consolidated) and CV6417, adopted by the Court in *Decision Concerning the Special Master's March 25, 2024, Report*, *In re HSR Sequencing*, Contested Case Nos. W-1, W-2, W-3, and W-4 (Consolidated) and CV6417 at 12, February 18, 2025, (Ariz. Super. Ct. Maricopa and Apache Ctys. Mar. 25, 2024).

objection to the Final HSR, or any part thereof must do so by September 8, 2027, (A.R.S. § 45-256(B)). Following the objection period, the Adjudication Court reviews each PWR described in the Final HSR and any objections associated with them. Then, the Court initiates contested cases for the WFRs with objections, which are litigated separately. The Adjudication Court considers the information found in the SOC, information gathered by ADWR, and any evidence provided during the contested case proceedings to determine water rights. At the conclusion of all contested case proceedings, the Adjudication Court issues a final judgment, referred to as a decree, adjudicating the attributes of each water right in the Sycamore Subwatershed (A.R.S. §§ 45-256-257).

Figure 1-2 provides an estimated timeline for the Adjudication Court to issue a final decree for the Sycamore Subwatershed, as of the publishing of this report.

Figure 1-2

Timeline for the Adjudication Court to Issue a Final Decree for the Sycamore Subwatershed



Note. Dates subject to change if ordered by the Adjudication Court.

Chapter 2: Study Area

2.1 Verde River Watershed

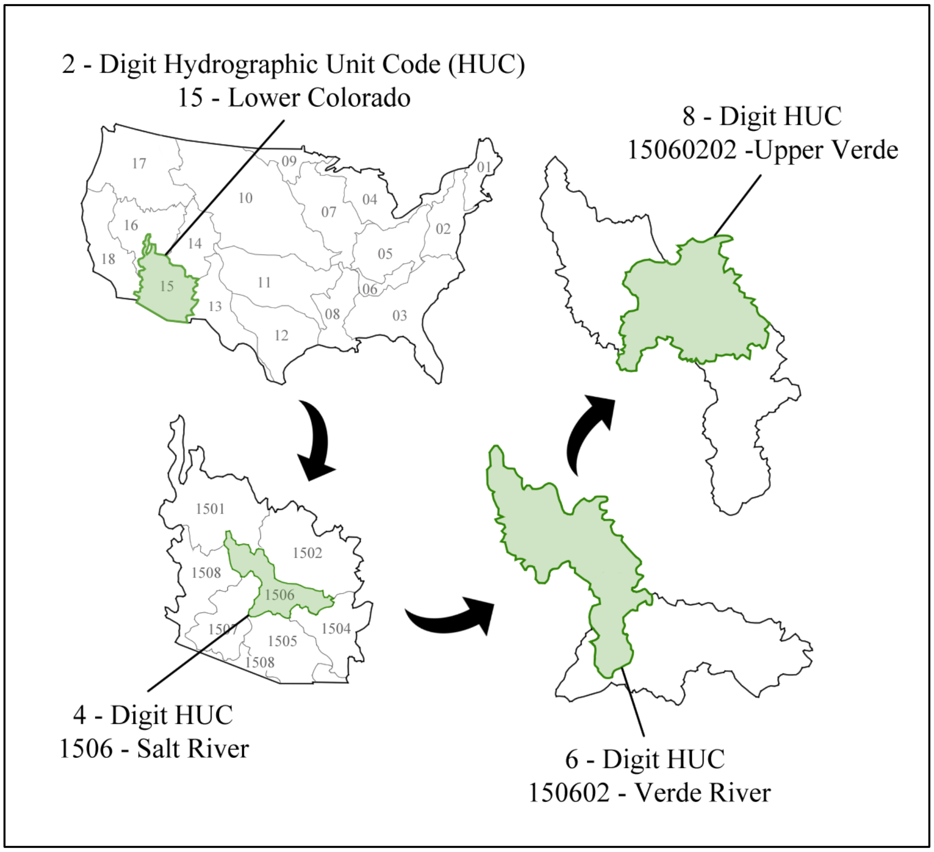
The Verde River Watershed is home to the Verde River. The River flows through changing landscapes, such as rocky canyons and wide floodplains, each with different vegetation and diverse wildlife species. Examining water rights within the Verde River Watershed requires background knowledge of the Verde River's hydrologic and geologic characteristics, the region's water resources, and the water's connection to the land.

The United States Geological Survey ("USGS") defines a *watershed* as an area of land where all the streams and precipitation (e.g., rain and snowmelt) drain to a common outlet such as a reservoir or a point along a stream channel. The USGS outlines *drainage areas* based on these features and assigns a hydrologic unit code ("HUC") to identify their boundaries (Water Science School, 2019a).

HUC boundaries follow a tiered numbering system to classify each drainage area. Each drainage area is assigned a 2-digit to 12-digit number which uniquely identifies each of the six levels of classification. Two digits are added to each level as the area goes down in size. Therefore, the smaller the HUC number, the bigger the drainage area. **Figure 2-1** illustrates nested 2-digit to 8-digit HUC boundaries.

Figure 2-1

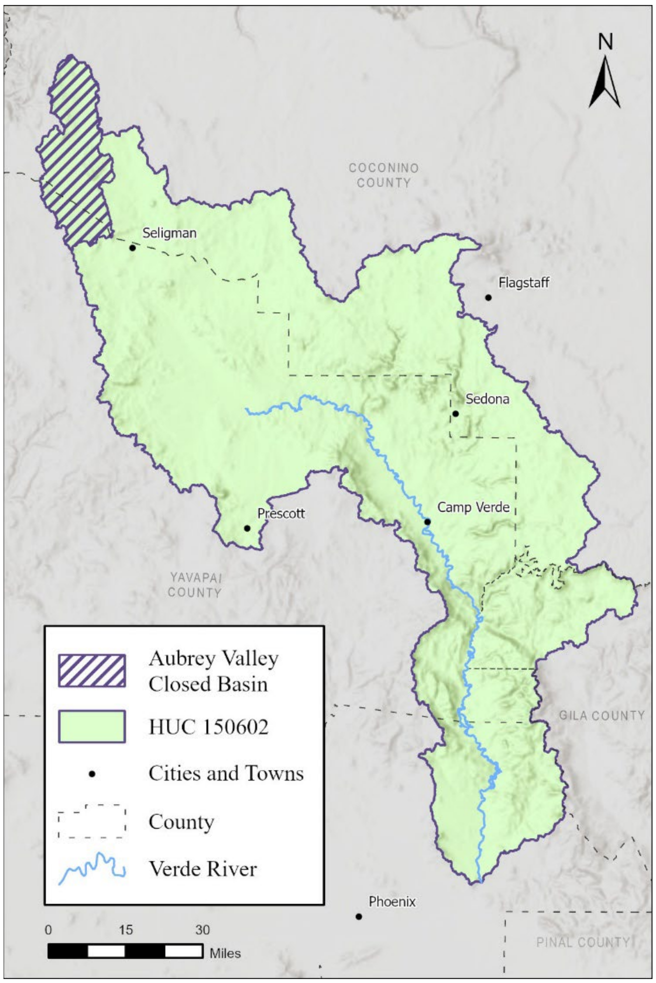
Hydrographic Unit Code Hierarchal Structure for Upper Verde



In the context of the Gila Adjudication, the Verde River Watershed is defined by the 6-unit HUC 150602 (*March 25, 2024, Report* at 17). A piece of the 6-unit HUC 150602, located northwest of Seligman, is known as Aubrey Valley (Billingsley et al., 2000). Aubrey Valley is not part of the Gila River Adjudication because it is a closed basin. In a closed basin, runoff does not contribute to the larger watershed (U.S. Geological Survey, 2026a) as it does not drain to a common outlet, such as the Verde River. **Figure 2-2** highlights the location of Aubrey Valley within the Verde River Watershed.

Figure 2-2

Aubrey Valley Closed Basin in the Verde River Watershed (HUC 150602)



The total area of the Verde River Watershed is 6,615 square miles (U.S. Geological Survey, 2026c). However, Aubrey Valley's area does not contribute to the total drainage area of the Verde River Watershed. Thus, the drainage area for the Verde River Watershed is approximately 94.5% of the 6-unit HUC boundary (6,250 square miles).

2.1.1 Geologic History

Regional Geology

The physical geography and geology of an area determine the behavior and course of the Verde River. An area with distinct geography and geology is called a *physiographic province*. The state of Arizona includes three major physiographic provinces: the Colorado Plateau, the Basin and Range, and the Transition Zone (Brand & Stump, 2005). All three of Arizona's physiographic provinces influence the hydrology and geography of the Verde River (KellerLynn, 2019; U.S. National Park Service, 2017b; Wagner & Blinn, 1987). **Figure 2-3** illustrates the three major provinces.

Figure 2-3
The Three Major Physiographic Provinces within Arizona

A physiographic province's distinct geology is influenced by its tectonic setting and *stratigraphy*.[26] The geology of the valley or basin where the stream is located plays a significant role in determining whether a connection between the streambed and underground water exists. Specifically, the stratigraphy (layers of rock) and the shape of the streambed (morphology) affect how water moves and is stored. For example, a streambed bound by a low-*porosity*[27] rock, such as granite, slows from seeping into the ground. In contrast, loose sands allow water to quickly seep into the ground, as well as saturate the areas adjacent to and below the streambed, due to its high *permeability*[28] (USGS, 2019).

Colorado Plateau

The Colorado Plateau covers northern Arizona, northwestern New Mexico, eastern Utah, and western Colorado. The plateau formed between 80 to 27 million years ago as part of a mountain-building event known as the Laramide Orogeny. During this time, the plateau uplifted several thousand feet, relative to the surrounding terrain (Ott et al., 2018). The increase in elevation led to rapid river incision of the surrounding rock, forming steep canyons. Most of the Colorado Plateau lying within Arizona drains into the Colorado River upstream of Lake Mead. However, runoff from areas southwest and west of the San Francisco Peaks flows into the Verde River. Similarly, most underground water beneath the Colorado Plateau flows to the north and northeast through regional *aquifers*,[29] with the remainder flowing to the south and southwest towards the Verde River.

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[26] The compositional and structural variations in the layers of rock deposited on Earth throughout Earth's history (Society for Sedimentary Geology, 2024).

[27] Porosity, or the space between the grains of rock, controls how much water, if any, a geological unit[27] holds.

[28] Permeability is how easily water flows through the rock, affecting data such as infiltration rate (The rate of infiltration is how fast the water seeps into the ground) and underground water velocity (the speed at which underground water moves through porous material).

[29] An aquifer is a body of rock and/or sediment which holds underground water.

The remaining water emerges from *springs*[30] along the Mogollon Rim and contributes to the *baseflow*[31] of the upper *reaches*[32] of the River (Bills et al., 2016; Blasch et al., 2006).

Transition Zone

Most of the Verde River Watershed lies within the Transition Zone physiographic province. The Transition Zone describes the area between the Colorado Plateau to the north and the Basin and Range Province to the south and west. Here, the Verde River travels through canyons mainly composed of Paleozoic-aged sedimentary rocks and Neogene-aged basalts, before flowing into the "Verde Valley" (Cook, Pearthree, Onken, Youberg, et al., 2010).[33] Within the Verde Valley, the River flows through the Miocene-Pliocene-aged Verde Formation. After the Verde Valley, heading south towards Horseshoe Reservoir, the River flows primarily through bedrock canyons cut into Miocene-aged basalt and Proterozoic-aged granodiorite. After Horseshoe Reservoir, the Verde River emerges into the Basin and Range physiographic province. Here, it flows through a sequence of conglomerates, basalt, consolidated crystalline bedrock, and Holocene-aged *alluvium*[34] until it joins the Salt River, near the city of Mesa (Arizona Geological Survey - University of Arizona, 2022; Cook, Pearthree, Onken, Youberg, et al., 2010) .

[30] A spring is a natural discharge point of underground water at the surface.

[31] Baseflow refers to the portion of water in a channel which consistently flows, independent of direct runoff.

[32] In hydrology, a reach refers to a *segment* of a stream or river, instead of its entire length.

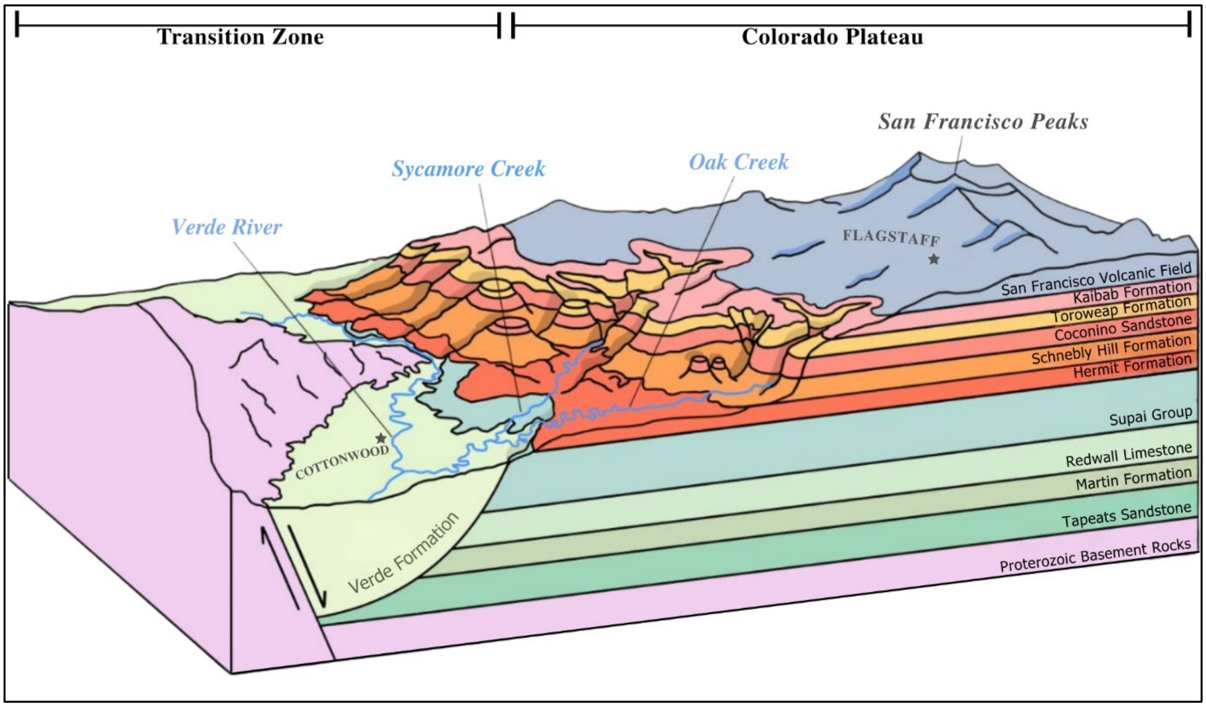
[33] The Verde Valley encompasses the towns and cities of Cottonwood, Clarkdale, Jerome, Camp Verde, Sedona, Cornville, the Village of Oak Creek, Lake Montezuma, and Rimrock.

[34] Alluvium is sediment primarily deposited by water. Deposits of alluvium are typically formed because of flooding or transportation in a stream or river.

Figure 2-4 illustrates the geology of the southern margin of the Colorado Plateau and Transition Zone containing the Verde Valley.

Figure 2-4

Simplified Geologic Block Diagram and Stratigraphic Column for the Colorado Plateau and Transition Zone Containing the Verde Valley



Note. View is looking northwest from Camp Verde. Adapted from (KellerLynn, 2019; U.S. National Park Service, 2024, 2025)

Basin and Range

The Basin and Range Province extends from northern Mexico, north and northwest, into Idaho and Oregon. Extensional *tectonic forces*[35] formed the Basin and Range Province on the southwestern edge of the North American plate (Brand & Stump, 2005). The widespread stretching, thinning, and fracturing of the Earth's crust created steep mountain ranges separated by flat basins characteristic of this province. The erosion-resistant

[35] Tectonic forces are the movements and energy which cause changes in the Earth's crust. Specifically, extensional forces are stress forces which act to pull apart or stretch the Earth's crust.

mountain ranges play a role in dictating the course of rivers (Ayers, 2010; KellerLynn, 2019; Wagner & Blinn, 1987).

Present-Day Verde River

Several million years ago, the Verde Valley contained a shallow lake. Upstream erosion eventually deposited enough sediment to cause the lake to overflow, causing the water to cut a channel through surrounding rock and sediment. This process drained the lake and shaped the current channel of the Verde River (Cook et al., 2010, Ott et al., 2018). The spillover process continued to additional downstream basins until the Verde River connected to the Salt River (Wittmann & Dorn, 2016).

The Verde River officially begins in the basalt canyon immediately downstream of Sullivan Dam (Cook, Pearthree, Onken, Youberg, et al., 2010). The total length of the modern Verde River is approximately 190 miles. ADWR estimates approximately 120 miles of the Verde River flows through bedrock canyons, and 70 miles flow through *alluvial basins*.[36] The Verde River's perennial flow begins at several springs (collectively known as Verde Springs) approximately one mile downstream of Sullivan Dam near its confluence with Granite Creek (Blasch et al., 2006). Many springs along the upper Verde River emerge from faults, typically through the Verde Formation (KellerLynn, 2019). Water discharged from these springs originates from the nearby alluvial and *basin-fill*[37] aquifers and from a Paleozoic-aged carbonate aquifer which underlies the western portion of the Coconino Plateau (Blasch et al., 2006; KellerLynn, 2019).

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[36] An alluvial basin is a flat or gently sloping land surface made up of loose clay, sand, or gravel deposited by rivers and floods.

[37] Basin-fill refers to the layers of sedimentary deposits which accumulate within a basin over time.

2.1.2 Surface Water Resources

Surface water characteristics, such as availability and variation in flow, are affected by various physical factors. Factors like topography, underground water conditions, and climate significantly influence these traits.

Baseflow & Runoff

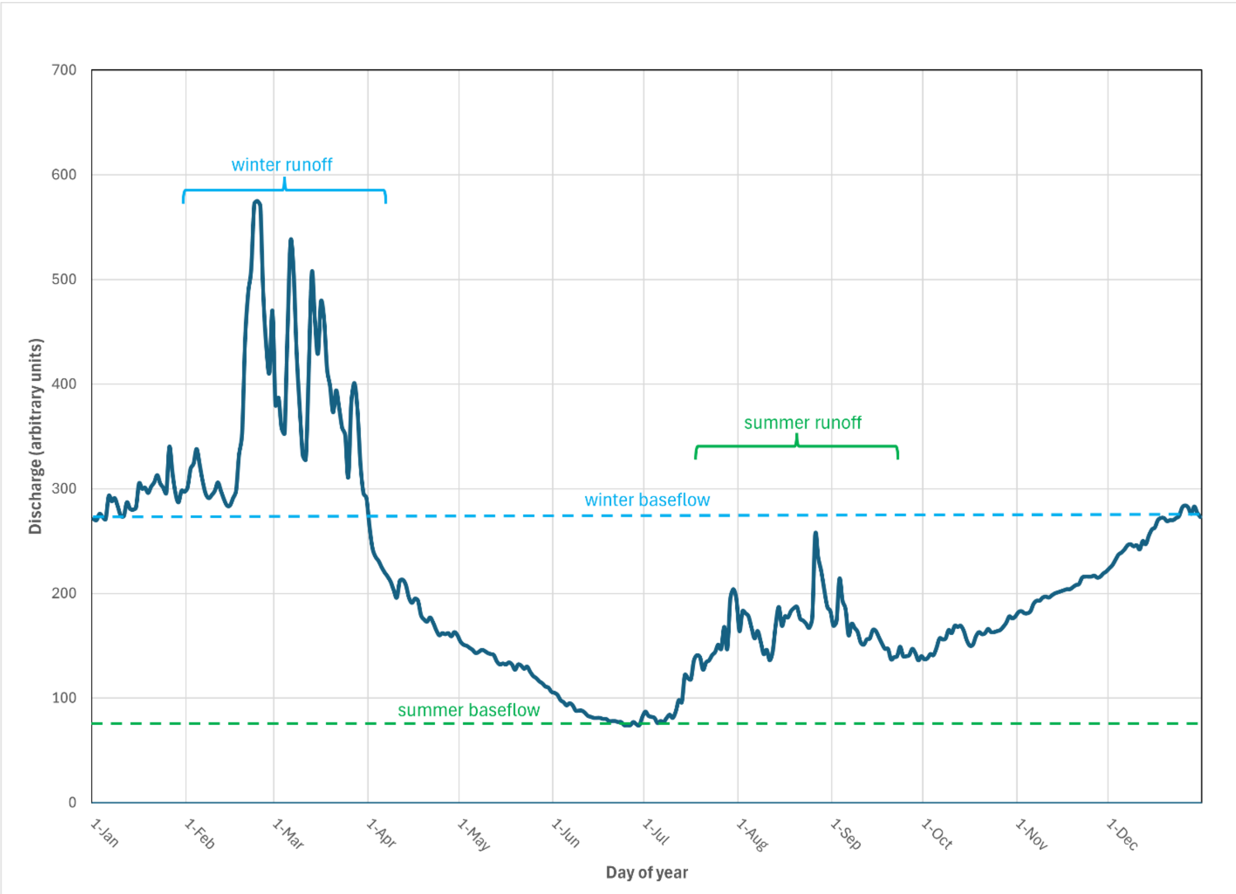
A river's output of water is typically characterized in terms of total *streamflow*,[38] which includes both baseflow and runoff. *Baseflow* refers to the portion of water in a channel which consistently flows, independent of direct runoff (see **Section 2.1.3**). *Runoff* is water which flows over the land during and after rain and snow (precipitation) events (Blasch et al., 2006). Perennial streams, such as the Verde River, are supported by the discharge of underground water and supplemented by precipitation. As a result of this, baseflow represents hydrologic conditions which change on a scale of seasons to years (Garner & Bills, 2012). Climate conditions, direct diversions, changes in vegetation, and pumping from wells may also be tied to fluctuations in the Verde River's baseflow (Blasch et al., 2006; Ellis et al., 2008; Serrat-Capdevila et al., 2012). Alternatively, runoff represents hydrologic conditions which change from hours to days, since precipitation events are short-term. These short-term flows depend on how much precipitation occurs in a geographic area and the physical characteristics of the watershed (Leopold, 2006).

Hydrographs display the volume of water moving past a specific point over time, also referred to as "stream discharge" (Blasch et al., 2006). Baseflow and runoff are illustrated on a hydrograph by the high and low points. **Figure 2-5** shows an example hydrograph for the Verde River.

[38] The amount of water which moves past a point in a stream over a set period of time.

Figure 2-5

Example Hydrograph for the Verde River Showing Winter and Summer Baseflow and Seasonal Runoff



Precipitation and Floods

Runoff varies throughout the year, and from year to year, because it is impacted by precipitation events, weather patterns, and climate changes (Haney et al., 2008, Chapter 3). The Verde River Watershed follows *orographic*[39] and seasonal precipitation patterns which are typical in the southwestern United States (Blasch et al., 2006; Fuller, 2003). The Watershed has two distinct wet seasons, one in the winter and one in the summer. Due to the seasonality and infrequency of precipitation events in the Watershed, the Verde River's

[39] Orographic precipitation is caused by hills or mountain ranges forcing the moisture-laden air masses upward, causing them to cool and drop their moisture as rain, hail, or snow.

perennial flows are entirely supported by underground water discharge during dry periods (Blasch et al., 2006; Garner & Bills, 2012).

Annual precipitation increases with elevation. Therefore, the edges of a watershed will experience a greater volume of precipitation compared to the lower-elevation valleys. As such, precipitation in the Verde River Watershed varies between 10-30 inches annually, with the valleys receiving 10-15 inches per year and the mountains receiving 15-30 inches per year (Blasch et al., 2006). The area with the highest precipitation is located along the Mogollon Rim in the northeast portion of the Verde River Watershed (Byrkit, 1992).

Arizona's *monsoon*[40] storms, which are typically localized and intense, bring precipitation from the south and southeast of the state from mid-summer to early fall. Additionally, frontal storms from the Pacific Ocean, which are widely distributed and less intense, bring precipitation from fall to early spring. The wettest month in the Verde River Watershed is typically August, with June as the driest month (Blasch et al., 2006). Precipitation that does not evaporate either collects in a natural channel, disperses as *sheet flow,*[41] seeps into the ground to recharge aquifers, or remains in the soil. Precipitation events do not impact the low flow of the Verde River as much as other rivers in Arizona because of its steady discharge from springs, which provide perennial baseflow. However, precipitation does influence the Verde River's average and high flow rates (Blasch et al., 2006; Fuller, 2003).

As a result of these precipitation events, the Verde River produces flood flows much greater than its baseflow (Busby, 1966; Leopold, 2006). For example, the Verde River's estimated highest recorded streamflow occurred on February 24, 1892, by USGS Streamgage No. 09508500 ("Tangle Creek Gage") (U.S. Geological Survey, 2026b). See

[40] The term "monsoon" refers to a seasonal time when thunderstorms are more likely to occur (Arizona State Climate Office, 2024).

[41] In general, the term "sheet flow" may refer to any form of unconfined runoff which occurs over a broad, expansive area. See *State Standard for Identification of and Development Within Sheet Flow Areas* (ADWR, 1995).

the section *Streamgages* for more information. The streamgage reported a discharge of 150,000 cubic feet per second (ft^3/s) ("CFS") (4247.53 m^3/s), which is at least 500 times greater than the median annual flow.[42] When comparing the available data between streamgages for the Verde River, the data illustrates the average annual streamflow is higher than the *median*[43] annual streamflow. This indicates infrequent flood flows are the biggest contributors to the amount of average annual discharge (See **Appendix B**).

Floods transport sediment downstream (Leopold, 2006). The removal or accumulation of sediment impacts a stream's characteristics including its course, floodplain, and flow (Fuller, 2003; Guan et al., 2016; KellerLynn, 2019; Leopold et al., 1964) . Floods occurring every few years are responsible for maintaining channel shape, aquatic and riparian habitat, and recharging local aquifers (Beyer, 2006). Regardless of the size, flood events are an important component of the Verde River Watershed, since the resulting recharged aquifers will increase streamflow in the weeks or months following a flood (Healy et al., 2007). See **Figure 2-6** for an example of floodplain changes caused by a flooding event.

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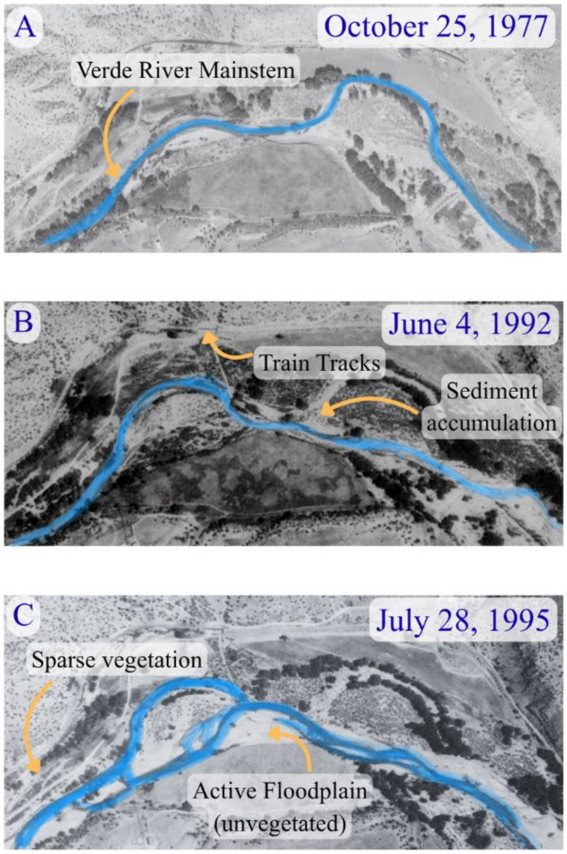
[42] The 2022 *De Minimis Domestic, Stockpond, and Stock and Wildlife Watering Uses in the Verde River Watershed* report calculated 281,336.14 acre-feet per annum ("AFA") (347,025,101.08 m^3) as the median annual flow for the Tangle Creek gage. The full report is available at https://infoshare.azwater.gov/docushare/dsweb/View/Collection-21608.

[43] The median is the middle value of a set of data when the data is arranged in order, either ascending or descending.

Figure 2-6

Example of a 1993 Flooding Event Changing the Course of the Verde River Near Perkinsville



Aerial imagery of Perkinsville illustrates changes to the Verde River's water course and appearance throughout time.

USGS gathered data on the February 20th, 1993 flood, registering 23,200 CFS upstream from Perkinsville at Paulden Gage.

Images (B) and (C) illustrate how a major flood event can alter sediment and vegetation.

Streamgages

A streamgage is a tool used to measure streamflow. Although other entities own and monitor streamgages, the USGS maintains and operates the most extensive network of streamgages. The USGS computes streamflow from measured water levels and discharges using a site-specific relation at each streamgage. The data is publicly available online.[44]

Seven active streamgages, operated by the USGS, measure streamflow along the Verde River, the uppermost at Streamgage No. 09503700 ("Paulden Gage") and the lowermost at Streamgage No. 09511300 ("Scottsdale Gage"), near the River's mouth (**Figure 2-7**, pg. 139). Sixteen other streamgages within the Verde River Watershed

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[44] USGS WaterWatch

measure discharge along *tributaries*[45] to the Verde River mainstem (U.S. Geological Survey, n.d.). Flow data from the streamgages located within the Verde River Watershed is listed in **Appendix B**. As mentioned in **Section 2.1.1**, flow data is analyzed using various methods, such as constructing a hydrograph to display streamflow over time. Measuring streamflow over time is critical for understanding the naturally occurring and human-caused changes to any water system (Eberts et al., 2019).

Streamflow Classification

For the purposes of the Adjudication, the following definitions are used to classify streams based on their flow characteristics (Goodfarb Order at 23-24[46]):

> Perennial streams discharge water continuously through the year. Their source of supply is normally comprised of both direct runoff from precipitation events or snow melt, and baseflow derived from the discharge of groundwater into the stream.
>
> Intermittent streams discharge water for long periods of time, but seasonally. For example, an intermittent stream may flow all winter, every winter, but never flow continuously during the summer. During seasons when baseflow is maintained, groundwater is contributing to the stream. During seasons of discontinuous streamflow, natural and cultural losses may be greater than the contribution from groundwater, resulting in a losing stream. Or, the amount of groundwater discharge itself may have decreased due to natural or cultural uses.
>
> Ephemeral streams discharge water only in response to precipitation events or snowmelt, and do not have a baseflow component at any time of the year; they flow out sporadically. The groundwater system and surface water system do not establish a hydraulic connection in these systems.

[45] A stream or river that flows into a larger stream (main stem or "parent"), river, or lake.

[46] "Goodfarb Order" refers to: Order, *In re the General Adjudication of All Rights to Use Water in the Gila River System and Source*, Contested Case No. W1-00-001234, June 30, 1994.

In the Verde River Watershed, perennial and intermittent stream reaches occur where the streambed connects to the *water table*[47], whereas ephemeral stream reaches do not (Bills et al., 2007). As described in **Section 2.1.1**, an area's geologic characteristics also determine the degree of connectivity between surface water and underground water systems.

ADWR identified tributaries with perennial or intermittent reaches within the Verde River Watershed for its 2021, 2023, and 2025 subflow zone delineation reports.[48] The tributaries contributing the majority of the Verde River's surface water inputs, and flowing directly into its mainstem, are Sycamore Creek, Oak Creek, Wet Beaver Creek, West Clear Creek, Fossil Creek, and the East Verde River (Cook, Pearthree, Onken, & Bigio, 2010; Cook, Pearthree, Onken, Youberg, et al., 2010; Gladwin, 1930).

Gaining and Losing Reaches

In addition to the previously mentioned stream classifications, sections of a stream are further described as a "gaining reach" or a "losing reach" depending on its connection to the water table. Perennial and intermittent streams connect to the water table; ephemeral streams do not. A stream with a *gaining reach* receives, or gains, water from the underground water system (see **Section 2.1.2**) (Barlow & Leake, 2012). In these reaches, the water table elevation is higher than the streambed. See **Figure 2-8** for an example of gaining and losing reaches. Conversely, along a *losing reach*, the water table slopes away from the streambed to a lower elevation, and the stream loses water to the underground water system. As a result, streamflow increases along a gaining reach and decreases along a losing reach. However, a gaining reach may transform into a losing reach over time, and

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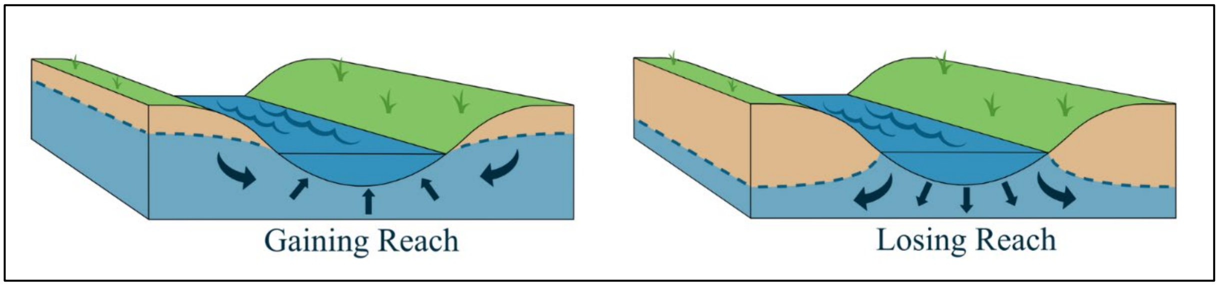
[47] The uppermost saturated area of an unconfined aquifer is known as the water table (Water Science School, 2019b)

[48] December 2021 Subflow Zone Delineation Technical Report for Verde River Mainstem & Sycamore Canyon ("Mainstem Report"), April 2023 Subflow Zone Delineation Technical Report for the Remainder of the Verde River Watershed ("Remainder Report"), and December 2025 Addendum to the Verde River Watershed Subflow Zone Delineation ("Addendum").

vice versa, in response to changes in the underground water levels (Garner & Bills, 2012; Newman et al., 2024).

Figure 2-8

Depiction of Gaining and Losing Reaches of a Stream



With the exception of a few reaches, the Verde River is classified as a gaining stream (Blasch et al., 2006; Fuller, 2003). Beginning at Verde Springs, the Verde River gains water from the underground water system until it reaches the Paulden Gage. From the Paulden Gage, the Verde River loses water to the underground water system until it reaches Clarkdale. From Streamgage No. 09504000 ("Clarkdale Gage") to the Tangle Creek Gage, the natural flow of the Verde River increases at each successive streamgage. After Streamgage No. 09510000 ("Bartlett Gage"), the Verde River becomes a losing reach until it joins the Salt River (Blasch et al., 2006).

Tributaries to the Verde River, however, do not continuously gain water as they flow downstream (Blasch et al., 2006). Most of these smaller, spring-fed tributaries lose streamflow to seepage and infiltration as they flow through basin-fill or alluvial deposits in their lower reaches (Blasch et al., 2006). Discharge from the tributaries' headwater springs may be small, and surface flow may be entirely consumed by *evapotranspiration*[49] before the tributary joins the Verde River (Blasch et al., 2006). The total discharge of a

[49]Evapotranspiration includes water evaporation into the atmosphere from the soil surface, evaporation from the capillary fringe of the groundwater table, and evaporation from water bodies on land. Evapotranspiration also includes transpiration, which is the water movement from the soil to the atmosphere via plants. Transpiration occurs when plants take up liquid water from the soil and release water vapor into the air from their leaves (Water Science School, 2018).

tributary may not make it to the mainstem if the water is entirely consumed (i.e., the water is hydraulically disconnected and would not contribute to baseflow) (Blasch et al., 2006). In this case, surface water consumption in the upper reaches of a tributary would not deplete the Verde River's baseflow. Non-consumed waters from these tributaries, however, recharge tributary aquifers, which ultimately contribute to the baseflow of the Verde River (Blasch et al., 2006).

Flow Alterations

Flow alterations are any changes to the natural streamflow of a river, which in turn impact streamflow measurements (U.S. Environmental Protection Agency, 2015). For example, two major dams on the Verde River, Horseshoe and Bartlett, impound water on the mainstem of the lower Verde River and thus alter the River's natural flow. Horseshoe and Bartlett Reservoirs store surplus water from wet periods to release downstream to water users during dry periods. Since the construction of these dams, the streamflow below the reservoirs is dependent on human-controlled dam releases. Furthermore, numerous diversions along the Verde River in the Verde Valley redirect water into irrigation ditches, complicating flow analyses in this area (ASLD, 1993; Blasch et al., 2006; Garner & Bills, 2012).

Other changes, such as urbanization, forest management practices, grazing, fluctuations in climate, and vegetation changes alter the volume of runoff and recharge, which further affects the Verde River's streamflow characteristics (Leopold, 2006). Although the River's streamflow is impacted by these changes, the Tangle Creek Gage gives an estimate of the Verde River's annual discharge because of its location near the end of the River and upstream from Horseshoe and Bartlett Reservoirs.

2.1.3 Underground Water Resources

Aquifers are underground layers of rock or sediment that store or allow water to flow through them (USGS, 2019). Aquifers are classified as unconfined, confined, or perched depending on their geologic structure and position within the geologic layers of an area. *Unconfined aquifers* connect directly to the surface and recharge primarily through rain and snowmelt. The uppermost saturated area of an unconfined aquifer is known as the water table (USGS, 2019b). *Confined aquifers*, in contrast, are separated from the surface by impermeable layers called confining units (USGS, 2019b). These aquifers recharge where the impermeable layers end or where fractures in the confining layer allow seepage. *Perched aquifers* are relatively small areas of saturation trapped above the regional water table by small, localized sections of impermeable rock layers (USGS, 2019b).

Surface water and underground water are closely linked, although in Arizona different laws apply to each. Although most precipitation remains on the surface or is lost through evapotranspiration, a small portion of precipitation will seep into the ground and recharge regional aquifers (Blasch et al., 2006). Once water enters the underground water system, it has the potential to return to the surface through springs.

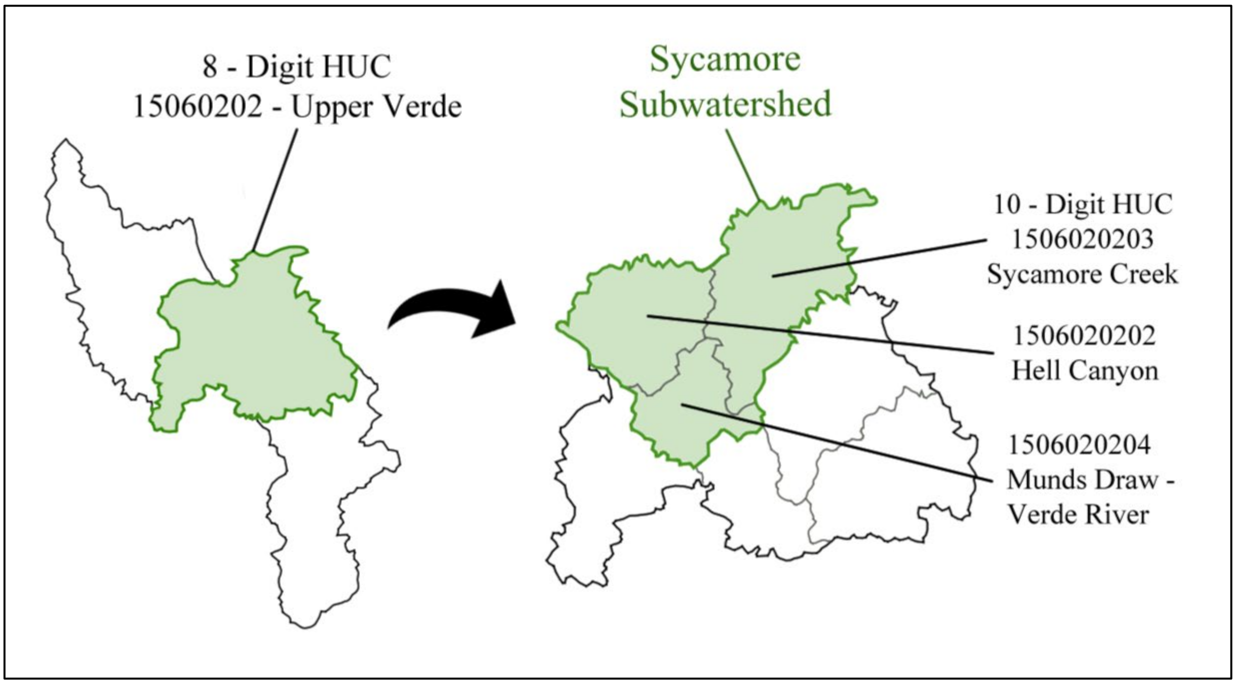
Springs are areas where underground water naturally emerges to the surface. Within the Verde River Watershed, approximately 982 identified springs exist (Springs Stewardship Institute, 2023). Most of these springs are located along the edges of the Verde Valley and discharge less than 0.2 ft^3/s (0.0057 m^3/s) each (Blasch et al., 2006). Humans modified some of the springs within the Watershed to allow consumptive use, while other springs remain in their natural state.

2.2 Sycamore Subwatershed

The Verde River Watershed is subdivided into five HSR investigation boundaries, referred to as subwatersheds, "for the purpose of delineating the boundaries covered by each HSR" (March 25, 2024, Report, at 11-12). The investigation boundary for this Preliminary HSR falls within the 8-digit HUC 15060202, which the USGS refers to as "Upper Verde." Three 10-digit HUC boundaries[50]—Sycamore Creek, Hell Canyon, and Munds Draw—form the study area referred to within the Adjudication Court proceedings as the "Sycamore Subwatershed." **Figure 2-9** illustrates the 10-digit HUC boundaries delineated within the Upper Verde 8-digit HUC.

Figure 2-9

The Three 10-digit HUC Boundaries Forming the Sycamore Subwatershed Study Area



[50] As previously stated, the HUC numbering system is hierarchical meaning the bigger the number the smaller the drainage area.

The Sycamore Subwatershed ("Subwatershed") begins at the summit of Humphreys Peak at the northeast corner of the boundary. The "Saddle Trail," along the easternmost part of the Subwatershed between Humphreys Peak and Agassiz Peak, includes the first and second highest points of the San Francisco Peaks.[51]

The Subwatershed is home to bedrock canyons, riparian corridors, productive springs, lush grasslands, and abundant game animals (Fuller, 2003; Westerlund, 2001). The study area provides differing topographic features, from the steep, rugged, and rocky canyons of Sycamore Creek and its tributaries, to the flat unaltered sedimentary rocks of the Colorado Plateau (Huff et al., 1966; Verde River Corridor Project Steering Committee, 1991). This transition between different topographic features is emphasized by the area's distinct ecosystems, ranging from Montane Conifer Forest and Chaparral at the northern high elevations to the Conifer Woodland and Semidesert Grassland southern low elevations (Arizona Game and Fish Department, 2022).

The northern half of the Subwatershed includes the Sitgreaves and Bill Williams Mountains, Big Black Mesa to the west, and Woodchute Mountain to the south. Elevation in the northern half of the study area ranges from approximately 4,200 feet (ft) to 12,633 ft at Humphreys Peak, the highest point in the state of Arizona. These higher elevations support juniper-pinyon woodlands, mixed conifers, and some spruce-firs (Fuller, 2003; Bowman, 2001). These areas experience large fluctuations between daytime and nighttime temperatures and typically receive snowfall in the winter. Summer temperatures typically do not exceed 85°F, and winter temperatures rarely drop below 10°F (Southwest Media Communications, 2024).

Conversely, most of the southern half of the Subwatershed with lower elevations nearing 3,200 ft experiences warmer weather conditions (Arizona Game and Fish Department, 2022). Summer temperatures range from 85°F to 95°F with maximum temperatures reaching 100°F. Winter temperatures for the area range from 30°F to 60°F

[51] In geography, a saddle is the lowest point between two peaks.

(AZ.Gov, 2024). Sycamore Canyon, after which the Subwatershed is named, resides along the southern boundary of the study area. Within the canyon, tall sycamore trees line the bed of Sycamore Creek, which carved a red rock canyon (Huff et al., 1966). As Sycamore Creek flows south out of the canyon, it meets the Verde River, which flows along the southern end of the Subwatershed's boundary. In lower-elevation areas adjacent to the Verde River, velvet mesquite, crucifixion thorn, and a variety of grasses are found (Bowman, 2001; Fuller, 2003).

Along the Verde River itself are *deciduous*[52] riparian woodlands and growing marshland communities (Fuller, 2003; Verde River Corridor Project Steering Committee, 1991). Vegetation in the Subwatershed provides riparian habitats for local and migrant animals, offering unique niches for over 60 percent of the vertebrates inhabiting the land surrounding this section of the River (Fuller, 2003; Verde River Corridor Project Steering Committee, 1991). These riparian areas are also home to approximately 30 threatened, endangered, or special interest wildlife species (Verde River Corridor Project Steering Committee, 1991). For example, at least 50 percent of the bird species which nest in the cottonwood trees depend exclusively on this riparian habitat (Verde River Corridor Project Steering Committee, 1991). In addition, three wildlife species listed under the Endangered Species Act of 1973 are found within the Subwatershed, including the bald eagle, peregrine falcon, and *spikedace*[53] (Verde River Corridor Project Steering Committee, 1991). Additionally, Arizona's state mammal, the ringtail, is known to inhabit portions of the study area. Much of the Subwatershed remains undeveloped and is labeled a "critical habitat" by the Arizona Game and Fish Department (Verde River Corridor Project Steering Committee, 1991).[54]

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[52] A type of tree species that sheds its leaves seasonally (Merriam-Webster.com, n.d.).

[53] A threatened native fish species that lives exclusively in the upper Verde River.

[54] See Arizona's Online Environmental Review Tool administered by Arizona Game and Fish Department at: https://ert.azgfd.gov/.

2.2.1 Geology

Geology plays an important role in determining the course of water in a given area. For example, geologic characteristics such as porosity and permeability determine how readily water flows through a rock or sediment layer (Gannett et al., 2010). The Sycamore Subwatershed lies within a complex geologic setting that encompasses parts of both the Colorado Plateau and the Verde Valley within the Transition Zone.

Volcanic Rocks of the San Francisco Volcanic Field

Volcanic rocks from the San Franciso Volcanic Field ("SFVF") blanket the northern two-thirds of the Sycamore Subwatershed. SFVF rocks are the youngest major geologic unit in the Subwatershed. The first eruptions in the SFVF occurred around six million years ago near present-day Williams, forming Bill Williams Mountain and dozens of cinder cones (Priest et al., 2001). Over time, the eruptions progressed to the east, with the most recent eruption occurring around 1085 C.E. at Sunset Crater, roughly twenty miles northeast of Flagstaff (USGS, 2023).

The San Francisco Peaks are the remains of a *composite*[55] volcano, and the most prominent volcanic feature in the Subwatershed. Several million years ago, the northeastern side of the volcano collapsed and formed the modern peaks and the central *caldera*,[56] now referred to as the Inner Basin.

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[55] A volcano made up of many layers of volcanic rock and ash.

[56] Calderas are collapse features that form during large-volume volcanic eruptions when the underlying magma chamber is partially emptied and the ground above it subsides into it. Calderas are both landforms that are parts of other volcanoes and a type of volcano in their own right (U.S. National Park Service, 2023).

Verde Formation

The Verde Formation is the youngest major sedimentary deposit in the Subwatershed. The formation was deposited in a lake that once covered much of the Verde Valley from the late Miocene through Pliocene ages. Two and a half million years ago, the Verde Lake and following basins spilled over, and the water cut through the Verde Formation, eventually draining the lake and creating the modern Verde River channel (Ott et al., 2018). The Verde Formation is white to light tan in color and is composed of limestone, sandstone, and mudstones (Blasch et al., 2006). It also contains a variety of fossils, from mollusks to mastodons (Twenter, 1962). In the Sycamore Subwatershed, the Verde Formation is found immediately downstream of the confluence, or meeting, of the Verde River and Sycamore Creek, where it overlies the much older Paleozoic-aged Redwall Limestone and units of the Supai Group (Cook, Pearthree, Onken, Youberg, et al., 2010).

Moenkopi Sandstone

The Moenkopi Sandstone was deposited in the early Triassic Period, shortly before the appearance of the first dinosaurs. Moenkopi Sandstone is composed of sandstones, siltstones, and mudstones. Hematite, the mineral form of rust, gives it a distinct red color. The Moenkopi Sandstone erodes easily and is present in the study area where the rock was covered and protected from weathering by SFVF lava rocks (Bills et al., 2000). Only a few small exposures of the Moenkopi Sandstone are present in the Subwatershed, near the upper reaches of Sycamore Canyon, east of Whitehorse Lake (Ulrich et al., 1984).

Kaibab Formation

The Kaibab Formation is one of the uppermost stratigraphic layers in the Subwatershed. While the formation is visible at the surface in parts of Subwatershed, the Kaibab is frequently covered by SFVF lava flows and, occasionally, by the Moenkopi Sandstone. The formation is composed of limestone and dolomite, along with minor siltstone and sandstone (Sorauf & Billingsley, 1991). Generally, the Kaibab Formation is white to light greyish-yellow in appearance within the Subwatershed. The Kaibab Formation was deposited roughly 270 million years ago, in the early to mid-Permian Period, when much of western Arizona was covered by a shallow sea that periodically rose over land as sea levels increased and decreased. The Kaibab Formation contains a variety of invertebrate and vertebrate marine fossils– from sponges and corals to nautilus shells and shark teeth (Hodnett & Elliott, 2013).

Toroweap Formation

The Toroweap Formation is Permian-Aged and underlies the Kaibab Formation. The Toroweap Formation is made of limestone, sandstone, and siltstone and is light reddish gray to grayish-yellow in color. In the Subwatershed, the Toroweap Formation is generally only visible where it forms steep cliffs along the upper section of the Mogollon Rim (Pfirman, 1968).

Coconino Sandstone

The Coconino Sandstone is a Permian-aged sedimentary rock layer and is one of the thickest in the region, ranging from 300 ft to 1100 ft (Bills et al., 2000).This unit is a fine-grained quartz sandstone and typically appears beige in color. The Coconino Sandstone was deposited in a coastal aeolian, or windblown, environment adjacent to the ancient sea that would later deposit the Toroweap and Kaibab Formations on top of it (Blakey, 1990). The Coconino Sandstone shows crossbedding, the remnants of ancient sand dunes. In certain areas, the overlying Toroweap Formation grades into the Coconino Sandstone, resulting in the two formations sometimes consolidating (Bills et al., 2000; Sorauf & Billingsley, 1991).

Schnebly Hill Formation

The Schnebly Hill Formation is Permian-Aged and made up of sandstones and mudstones (Bills et al., 2016). Hematite, a mineral, gives the Schnebly Hill a deep reddish-orange color, similar to the Moenkopi Formation. This unit was deposited in a near-coast environment and features sequences of both desert and shallow marine deposits. The Schnebly Hill, like the overlying Coconino Sandstone, is another one of the thickest geologic units in the Subwatershed, reaching over 1,000 ft thick along much of the Mogollon Rim (Blakey, 1990).

Hermit Formation

Below the Schnebly Hill Formation lies the Permian-Aged Hermit Formation. The Hermit Formation is made up of reddish-orange colored mudstones, siltstones, and sandstones (Blakey, 1990). The Hermit Formation is similar in appearance to the overlying Schnebly Hill Formation, although it erodes more readily, forming more gentle slopes as opposed to the steep cliffs of the Schnebly Hill Formation. The Hermit Formation outcrops along the lower reaches of Sycamore Creek and near the Creek's confluence with the Verde River (Cook, Pearthree, Onken, Youberg, et al., 2010).

Supai Group

The Supai Group are Pennsylvanian to Permian-aged deposits composed of sandstones, siltstones, mudstones, and other minor rock types (Cook, Pearthree, Onken, Youberg, et al., 2010; DeWitt et al., 2008). North of the study area, in the Grand Canyon, geologists distinguish the individual formations within the Supai Group. In the Subwatershed, the individual formations are difficult to tell apart and are referred to collectively as the Supai Group. The Supai Group stick out along the upper reaches of the Verde River and the lower reaches of Sycamore Creek (Cook, Pearthree, Onken, Youberg, et al., 2010).

Redwall Limestone

The Redwall is Mississippian-aged and composed primarily of limestone with minor dolomite, mudstone, and cherts. Despite its name, the Redwall Limestone is grey in color, but frequently stained red by hematite leeching from overlying units (Connors et al., 2020; Mckee & Gutschick, 1969). The Redwall is only exposed in the southern third of the Subwatershed, where it outcrops along the banks of the Verde River and at the mouth of Sycamore Creek (Cook, Pearthree, Onken, Youberg, et al., 2010).

Martin Formation

The Martin Formation is primarily composed of limestone and was deposited in a shallow ocean environment during the Devonian Period (DeWitt et al., 2008; Huddle & Dobrovolny, 1952). The Martin Formation is only visible as small outcrops in the southern part of the Sycamore Subwatershed, near the banks of the Verde River and the lower reaches of Sycamore Creek (Cook, Pearthree, Onken, Youberg, et al., 2010).

Tapeats Sandstone

The Tapeats Sandstone is the oldest sedimentary rock formation in the Sycamore Subwatershed. The Tapeats Sandstone formed around a half-billion years ago during the Cambrian Period. Like the Martin Formation above, the Tapeats Sandstone is only present in small outcrops near the banks of the Verde River in the southern part of the Subwatershed (Cook, Pearthree, Onken, Youberg, et al., 2010).

Proterozoic Basement Rocks

Beneath all the sedimentary and volcanic rocks of the Verde Valley and the Colorado Plateau lie Proterozoic granites and metamorphic rocks, referred to as basement rocks. These dense rocks have low porosity and permeability. Therefore, these rocks do not readily store or act as a conduit for underground water, unless extensively fractured or weathered (Blasch et al., 2006). The Black Hills range, which bounds the Verde Valley to the southwest of the Colorado Plateau and defines the southern edge of the Subwatershed, is primarily made up of these basement rocks (Blasch et al., 2006).

2.2.2 *Water Resources*

Surface Water Sources

All surface water in the Sycamore Subwatershed flows downstream through the Subwatershed's outlet, near the Clarkdale Gage, and into the Lower Verde Valley Subwatershed via the Verde River. Most surface water sources within the Subwatershed come from small springs (see **Figure 2-10**) and naturally ponded water resulting from snowmelt following wet winters (Blasch et al., 2006).

Figure 2-10

A Spring Developed by the J.D. Dam Camp in Kaibab National Forest in the Sycamore Subwatershed, June 1934.

Note. From *193406XX-FS-FLK-28985*, USDA Forest Service, 2023 (https://flickr.com/photos/usforestservice/53086580732/in/album-72177720310197774). Copyright 2023 by USDA Forest Service. In the public domain.

Rogers Lake is an example of naturally ponding water located southeast of Flagstaff. Rogers Lake is a high-elevation wetland which now serves as an important resource for nearby wildlife species. Similarly, although not naturally occurring, one of the larger man-made reservoirs within the Subwatershed is Scholz Lake. South of Parks, this reservoir is managed by the Arizona Game and Fish Department ("AZGF") as a bird refuge.

Volunteer Wash, a tributary to Sycamore Creek, is located in the northeast of the Sycamore Subwatershed and flows after heavy rainstorms or after snowmelt. Volunteer Canyon formed as a result of these flows (U.S. Army Corps of Engineers, 2015). Volunteer Wash is a tributary to Sycamore Creek.

In Sycamore Canyon, Geronimo Spring affords a perennial supply of good drinking water at creek level near the head of the canyon (Huff et al., 1966). Additionally, Parsons Spring, Summer Spring, and an unnamed spring aid in maintaining flow in the perennial reach of Sycamore Creek above the confluence with the Verde River (Blasch et al., 2005).

The Sycamore Subwatershed includes a small reach of the Verde River which flows between the Paulden and Clarkdale Gages. [57] Streamflow in the area is primarily measured by USGS streamgages. In 2021, the USGS began operating Streamgage No. 09503990 ("Sycamore Creek Gage") located immediately upstream from the confluence with the Verde River. Several other USGS streamgages provide streamflow data within the Subwatershed. The USGS recorded streamflow at Streamgage No. 09503740 ("Hell Canyon Gage"), south of Bill Williams Mountain, between 1969 and 1980. Furthermore, Streamgage No. 09503800 ("Volunteer Wash Gage") south of Bellemont collected streamflow data between 1965 and 1972 (U.S. Geological Survey, n.d.). Data summaries for these three streamgages are listed in **Appendix B**.

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[57] Of the Verde River's estimated 190 miles, approximately 34 miles flow through the Sycamore Subwatershed.

Underground Water Sources

All three types of aquifers exist beneath the Sycamore Subwatershed.[58] Its diverse hydrogeology is shaped by the wide arrangement of sedimentary rock formations and volcanic features of the San Francisco Volcanic Field. Two major aquifers underlie the region: the unconfined Coconino ("C") Aquifer and the confined Redwall-Muav ("R-M") Aquifer (Bills et al., 2000). The confining layers beneath the C-Aquifer prevent a hydrologic connection between it and the underlying units of the R-M Aquifer (Bills et al., 2000).

The Coconino Aquifer ("C-Aquifer") consists of multiple geologic units, including the Kaibab Formation, Toroweap Formation, Coconino Sandstone, Schnebly Hill Formation, Hermit Formation, and parts of the Supai Group. The Coconino Sandstone is the main water-bearing geologic unit of the C-Aquifer and the unit's namesake. The C-Aquifer primarily recharges through precipitation near Flagstaff and the San Francisco Peaks, with most of the underground water flowing north toward the Colorado and Little Colorado Rivers. However, some of water flows south and eventually surfaces at springs. These springs feed streams like Sycamore Creek and Oak Creek, as well as provide baseflow to the Verde River. The water table in the Sycamore Subwatershed is too low for most layers of the C-Aquifer to be saturated (Bills et al., 2000).

The Redwall-Muav Aquifer ("R-M Aquifer") lies beneath the C-Aquifer, separated by confining layers within the lower parts of the Supai Group. The R-M Aquifer recharges through fractures, faults, or slow seepage through the confining layer. The Redwall Limestone, its uppermost geologic unit, is partially saturated in the Sycamore Subwatershed and contributes significant baseflow to the Verde River (Bills et al., 2000; Blasch et al., 2006). Similarly, baseflow along the perennial reach of Sycamore Creek also originates from the regional R-M Aquifer (Blasch et al., 2006).

[58] See **Section 2.1.3** discussing unconfined, confined, and perched aquifers.

The perched aquifers beneath the Sycamore Subwatershed are relatively small compared to regional aquifers. The most notable perched aquifer is the Inner Basin Aquifer beneath the San Francisco Peaks, which supplies many of the springs on the western slope of the mountain in addition to hosting an important well field for neighboring Flagstaff (Bills et al., 2000, 2016; Montgomery & DeWitt, 1974; Priest et al., 2001). Other, smaller perched aquifers are found throughout the Subwatershed, typically within basalt flows, the Moenkopi Sandstone, or in dense sections of the Kaibab Formation (Bills et al., 2000, 2016).

Upstream of the Sycamore Subwatershed, aquifers like the Big Chino alluvial and basin-fill aquifers contribute flow to the Verde River, connecting the hydrology of neighboring regions to the Sycamore Subwatershed (Bills et al., 2007).

Chapter 3: Overview of Historical Water Uses

The Verde River Watershed's environment, as highlighted in Chapter 2, contains distinct physical attributes which affect the water use in the area. Chapter 3 details the history of some of the water uses in the Verde River Watershed and Sycamore Subwatershed, for context purposes only. Although the demographics of these areas changed over time, the environment consistently determined the types of water uses available to those living in the area. Water use played a defining role in shaping Arizona's landscape, connecting the needs of today's residents and descendants with those who lived here thousands of years ago.

3.1 Historical Overview of Water Users within the Verde River Watershed

3.1.1 Prehistory – 1850s

Archaeological evidence indicates human activity along the Verde River and its tributaries occurred as early as 10,000 years ago (Ogo & Lynch, 2014; U.S. National Park Service, 2025b). Although many groups inhabited the region for thousands of years, the earliest recorded evidence of permanent Sinagua settlements in the Watershed dates to around 1000 CE. The name Sinagua is derived from an early Spanish description of the San Francisco Peaks, "Sierra Sin Agua", or mountain without water (U.S. National Park Service, 2025a). Evidence shows the Sinagua settled between the Mogollon Rim and San Francisco Peaks (Kamp & Whittaker, 2009; Verde Valley Archaeology Center & Museum, 2025).

The Sinagua practiced both dry farming and irrigation relative to where they settled. They employed irrigation techniques and systems believed to be acquired from the Huhugam[59], who primarily inhabited Southern and Central Arizona (ACE Consultants, 2020; Gladwin, 1930; KellerLynn, 2019; Schroeder & Hastings, 1958; The University of

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[59] The term "Huhugam" refers to the ancestors of the O'Odham of central and southern Arizona. This term is often replaced by "Hohokam" in archeological research.

Arizona, 2026; Verde Valley Archaeology Center & Museum, 2025). At their peak, the Sinagua irrigated an estimated 60 acres of land along the Verde River (Schroeder & Hastings, 1958). However, between 1200 and 1400 CE, evidence suggests the Sinagua migrated and eventually integrated with other communities in the region (U.S. National Park Service, 2025a). Possible influences for this shift include climate-related challenges and a lack of water, volcanic activity of Sunset Crater, and conflicts among other groups (Benson & Berry, 2009; Berlin et al., 1990; U.S. Forest Service, 1985). Other semi-nomadic Indigenous peoples, such as the Yavapai, Western, and San Carlos Apache, remained in the Verde Valley and relied primarily on hunting and gathering (San Carlos Apache Tribe, n. d; Ogo & Lynch, 2014; U.S. National Park Service, 2020).

By the 1580s, Spanish expeditions led by the conquistadors Juan De Oñate and Antonio de Espejo progressed through the Verde Valley, the latter credited for writing the first account of the "Rio Verde" (Verde River) (Bartlett, 1942; Morgan, 1949; Pierson, 1957; Verde Valley Archaeology Center, n.d.-b; Yavapai-Apache Nation, 2024). Although these expeditions did not establish permanent settlements within the Verde Valley, they produced some of the first maps and written records of the region. The area was also introduced to cattle, horses, and sheep (Flint & Flint, 2003; Morrisey, 1957; U.S. National Park Service, 1992). As the Spanish moved through Arizona, so did their spread of disease. This contributed to substantial demographic decline among the populations of Indigenous peoples in the region and throughout the Southwest (Hämäläinen, 2010; Liebmann et al., 2015). Disease, forced labor, and frequent skirmishes with the Spanish left many Indigenous peoples increasingly vulnerable, enabling easier migration for early American Settlers by the mid-1800s. Waves of settlement initiated by the United States brought a significant change in the region's demographic, as well as an increase in natural resource use and land development (van Deusen, 2023).

3.1.2 Mid-1800s – Early-1900s

American settlers moved west for promised possibilities of independence, landownership, and economic opportunity, under the guise of *Manifest Destiny*[60] and the *Doctrine of Discovery*[61] (Bagley, 2012; Graebner, 1980). Federal legislation, such as the Preemption Act of 1841, the Graduation Law of 1854, and the Homestead Act of 1862, encouraged this migration by offering avenues to acquire land in the western United States, including along the Verde River and its tributaries (Pierson, 1957; Schroeder & Hastings, 1958). During this period, the United States Military conducted some of the first official surveys of the region to map the landscape and identify potential sites for settlements and railroad routes north of the Verde River (Ashworth, 1991; Fuller, 2003). Arizona officially became a US Territory in 1863, with Fort Whipple serving as the temporary territorial capital (Arizona State Library, 2025) Prescott became the official capital a year later because of its cooler year-round temperatures, the discovery of gold along Lynx and Hassayampa Creeks, and the need for a permanent civilian center separate from the fort (U.S. Forest Service, 1985).

Fort Whipple continued to serve as one of several military outposts established throughout the Territory. The increased military presence in the region led to more demand for agricultural products. The forts required a consistent supply of hay and other crops for their livestock and would either grow the resources themselves or purchase them from nearby settlers (Collins et al., 1993; Fuller, 2003). With the few troops stationed at Fort Whipple tasked with protecting settlers and wagon routes near Prescott and Chino Valley, the Army recognized a need to establish an additional outpost to the east to protect the

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[60] Manifest Destiny, coined sometime before 1820, is the idea that the United States is destined—by God, its advocates believed—to expand its dominion and spread democracy and capitalism across the entire North American continent. The philosophy drove 19th-century U.S. territorial expansion and was used to justify the forced removal of Native Americans and other groups from their homes. See https://www.history.com/articles/manifest-destiny for more information.

[61] See *Johnson & Graham's Lessee v. McIntosh*, 21 U.S. 543 (1823).

developing communities in the Verde Valley (Collins et al., 1993). By 1865, the Verde Valley's fertile soil and proximity to the main stem of the Verde River attracted numerous farmers, ranchers, and prospectors. Access to water was essential and resulted in the installation of new diversions, as well as continued operation of irrigation systems originally built by Indigenous groups (Pierson, 1957; Town of Camp Verde, 2024). Rising conflict between settlers and indigenous groups within the Verde River Watershed prompted the need to build Camp Verde (first named Camp Lincoln) in 1865 for additional protection in the region. The Camp was originally located 80 ft above the Verde River, but by 1870 was rebuilt and renamed Fort Verde (Arizona State Parks & Trails, 2026b; Pierson, 1957; U.S. Forest Service, 1985). **Figure 3-1** provides a photo of Fort Verde residents during this time.

Figure 3-1

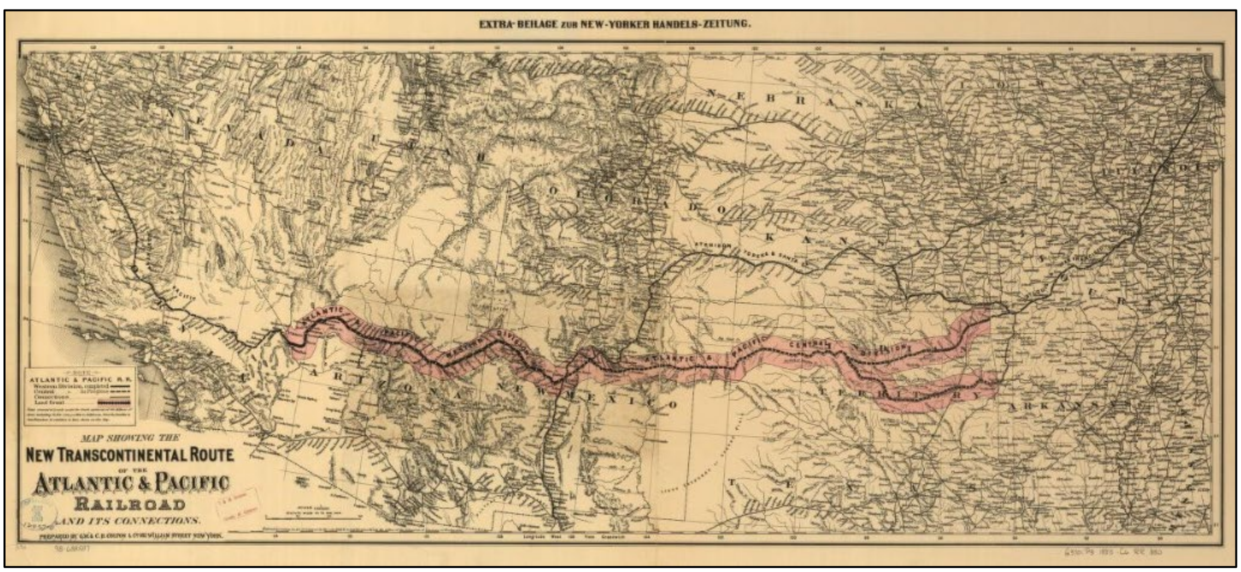
Officers and Families on Porch at Fort Verde

Note. From *Officers and Families on Porch at Fort Verde*, Sharlot Hall Museum Library & Archives, 2017 (https://archives.sharlothallmuseum.org/index.php/photos/product-details/11746).

A decade later, water access and demand increased for railroads thanks to the steam engine. In 1882, the Atlantic and Pacific Railroad Company established a railroad across the country, through Flagstaff, and across parts of the Verde River Watershed. **Figure 3-2** illustrates the railroad's route through Arizona.[62] The railroad ushered Northern Arizona into the national market as goods could be sold in all parts of the country (Collins et al., 1993; Fuller, 2003; Northern Arizona University, 2002; U.S. National Park Service, 1985, 1992, 2025a; Westerlund, 2001)Other railways encouraged further development in the Verde River Watershed by transporting goods and passengers. The increased economic growth and convenience provided by the railroad encouraged more settlements and thus increased water use. **Figure 3-3** provides an example of how development increased around railroad stops in northern Arizona, such as the town of Seligman.

Figure 3-2

Map Showing the New Transcontinental Route of the Atlantic & Pacific Railroad and its Connections



Note. From *Map Showing the New Transcontinental Route of the Atlantic & Pacific Railroad and its Connections*, by Atlantic & Pacific Railroad Co. Arizona Memory Project, accessed 27/01/2026 (https://azmemory.azlibrary.gov/nodes/view/22093). In the public domain.

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[62] The Atchison, Topeka and Santa Fe Railway and the Burlington Northern Railway merged to form the present-day Burlington Northern and Santa Fe Railway ("BNSF").

Figure 3-3

Seligman Railroad Hotel, Seligman, Arizona

Note. From *Seligman Railroad Hotel, Seligman, Arizona*, by Sharlot Hall Museum Library & Archives, 2017 (https://archives.sharlothallmuseum.org/index.php/photos/product-details/8437). Copyright 2017 by Sharlot Hall Museum. Reprinted with permission.

Railroads supported the mining industry by transporting people, supplies, and ore between the region's mining towns and beyond. In 1895, William A. Clark, owner of the United Verde Copper Company, extended the United Verde & Pacific Railway to Jerome to capitalize on the town's mining boom. In 1911, Clark financed construction of the Verde Valley Railway from Clarkdale (his namesake) to Drake to reduce freighting costs of the active mines nearby. By the early 20th century, the United Verde Mine was the largest copper producer in the Arizona Territory, although they also mined gold, silver, and zinc, as well. **Figure 3-4** shows a steam shovel operating at the United Verde Mine in 1919. Copper production in Jerome peaked in 1929, though the town's mining operations ended in 1953 (Arizona State Parks & Trails, 2026a; Town of Jerome, 2026).

Figure 3-4

Steam Shovel operating at the United Verde Copper Company, 1919

Note. From *United Verde Copper company (Steam Shovel)*, by Sharlot Hall Museum Library & Archives, 2017 (https://archives.sharlothallmuseum.org/index.php/photos/product-details/13703). Copyright 2017 by Sharlot Hall Museum. Reprinted with permission.

Dependable water supplies remained necessary for the growing populations within the Verde River Watershed. Dams were constructed in the early 1900s alongside extensive canal systems to serve as potable water sources, recreational sites, and irrigation systems. For example, a pipeline was constructed at Del Rio Springs to bring water to Prescott in the early 1900s.

Later, the railroad transported potable water from Del Rio Springs to other parts of the Verde River Watershed like Seligman, Ash Fork, and Williams. Watson Lake Dam and Willow Creek Dam were built for irrigation purposes by the Chino Valley Irrigation District. Meanwhile, the nearby Sullivan Lake Dam was initially built to provide recreational opportunities (Wirt, 2005). **Figure 3-5** provides a photo of the Willow Creek Dam during construction.

Figure 3-5

Willow Creek Dam During its Construction

Note. From *Willow Creek Dam*, by Sharlot Hall Museum Library & Archives, 2017 (https://archives.sharlothallmuseum.org/index.php/photos/product-details/7954). Copyright 2017 by Sharlot Hall Museum. Reprinted with permission.

In 1939, Bartlett Dam was finalized as the first dam on the Verde River mainstem and the largest multiple-arch-dam at the time (U.S. National Park Service, 2017a). The dam was constructed to provide flood control and irrigation water for downstream residents. In 1946, Horseshoe Dam was constructed upstream of Bartlett Dam to increase water supply for the Greater Phoenix Area (U.S. Bureau of Reclamation, n.d.). Both dams continue to store water during the wet season, providing steady supply year-round for nearby communities.

Congress, and the public, wanted to implement better sustainability legislation to ensure future resource use. The need for conservation influenced the United States government to create the Forest Reserves.[63] However, others worried the Forest Reserves would stifle economic growth and limit activities such as grazing and mineral extraction in the area (King, 2007). The government regulated use of the land by implementing acts such as the Forest Reserves Act, Multiple-Use Sustained-Yield Act, Organic Administration Act, Taylor Grazing Act, and Wild and Scenic Rivers Act to reflect the multi-use philosophy of conserving and regulating natural resources (Forest Reserves Act, 1891; Multiple-Use Sustained-Yield Act, 1960; Organic Administration Act, 1897; The Taylor Grazing Act, 1934; Wild and Scenic Rivers Act, 1968). In 1984, portions of the Verde River were federally designated as Wild and Scenic areas to protect its natural, cultural, and recreational values. The Verde River and its tributaries continue to be a critical source of water in Arizona as they serve nearby communities and color the semi-arid environment with lush greenery.

[63] Designated as "National Forests," today.

3.2 Historical Overview of Water Users within the Sycamore Subwatershed

As mentioned in Chapter 2, the rugged landscape and geology of the study area influence streamflow, making perennial water resources less reliable compared to the rest of the Verde River Watershed. Because of this, people historically relied heavily on seasonal precipitation. Major water users in the area included Indigenous communities, ranchers, logging operations, and railroad settlements. Some of the earliest trade centers in the region belonged to Southern Sinagua sites located within the Subwatershed (U.S. Forest Service, 1985). The Southern Sinagua likely cultivated corn, cotton, and other crops on the flats above or near Sycamore Creek—one of the few dependable water sources in the area (U.S. Forest Service, 1985). Elsewhere in the Subwatershed, water sources were less reliable. However, small precipitation-fed ponds supported local ranching efforts, which mainly involved raising cattle and sheep. Ranching in the southern part of the Subwatershed was more challenging due to the steep canyon landscape, as well as the overall semi-arid environment of the area. **Figure 3-6** provides an example of a basecamp, known as Taylor Cabin Line Camp, used by ranch hands to stay in the canyon to work their cattle during the winter months. The registered historical location, "attests to the adaptability of early ranchers in a harsh physical environment" (U.S. Forest Service, 1985). In contrast, the northern region—with its open grasslands and dense forests—offered more favorable conditions (Sowards, 1998; Westerlund, 2001).

Figure 3-6

Taylor Cabin Line Camp - Taylor Cabin

Note. From *Taylor Cabin Line Camp – Taylor Cabin*, by USDA Forest Service, 1985 (https://catalog.archives.gov/id/75609684). Copyright 1985 by USDA Forest Service. Reprinted with permission.

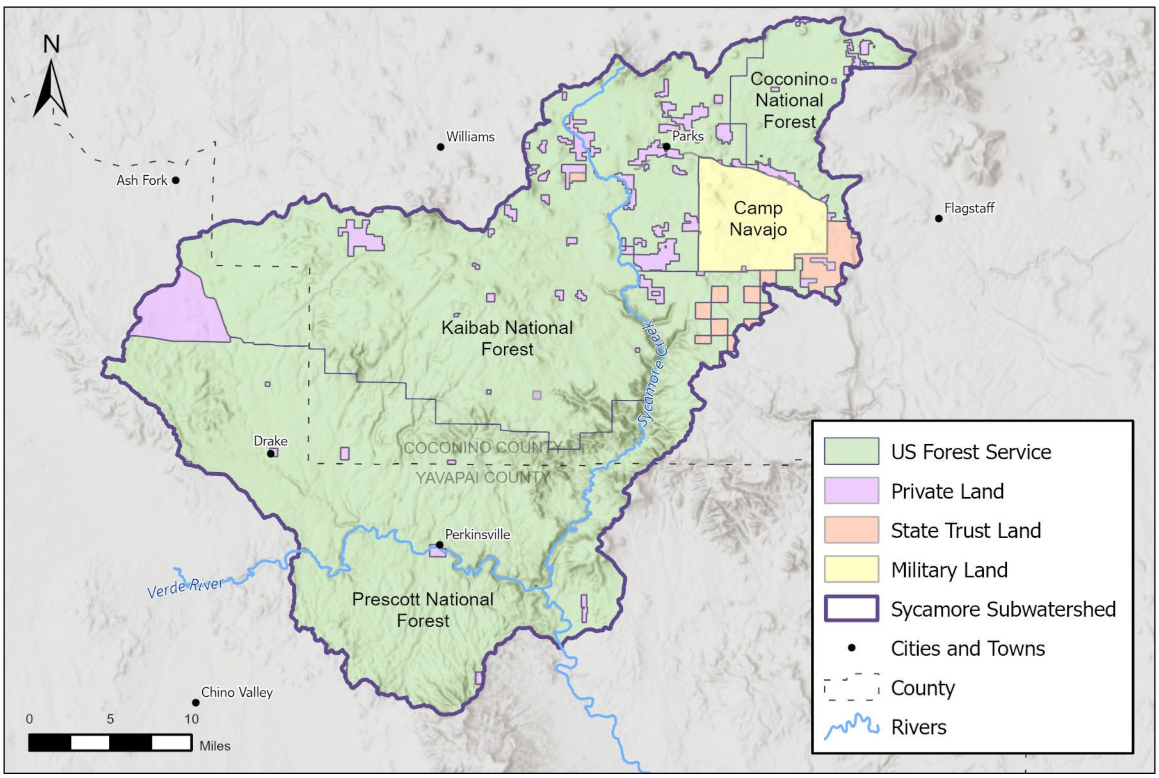
The northern portion of the Subwatershed contains the largest contiguous Ponderosa Pine forest in the world, which fueled development of the logging industry (Northern Arizona University et al., 2025). Edward E. Ayer, one of the most historically prominent lumber producers in the area, created the Ayer Lumber Company sawmill in 1882. In 1886, Denis M. Riordan bought the Ayer Lumber Co. and renamed it to Arizona Lumber & Timber Company ("AL&T") (Northern Arizona University et al., 2025). The timber industry partnered with the railroad to expand deeper into the Subwatershed, improving transportation and access to resources (Northern Arizona University et al., 2025).

Railroad expansion subsequently sparked development of "railroad stop communities" such as Bellemont and Williams (see **Figure 3-3**) (Fuller, 2003; Westerlund, 2001).

After the Organic Administration Act passed in 1897, the United States Forest Service ("USFS") took charge of the Forest Reserves to regulate sustainability practices. Over time, the USFS became the largest landowner and water user in the Sycamore Subwatershed. **Figure 3-7** illustrates the current landownership within the study area.

Figure 3-7

Current Landownership within the Sycamore Subwatershed



Today, the USFS land within the study area includes Prescott, Kaibab, and Coconino National Forests. USFS lands contain many headwater locations for important rivers as well as local and regional aquifer systems. Therefore, the National Forests regulate key sources of water in the Subwatershed. Currently, the USFS manages approximately 584,000 acres, or nearly 89% of the Subwatershed.

The military land, owned by the United States Department of Defense, spans approximately 28,000 acres, or just over 4% of the Subwatershed. 9,000 acres, or roughly 1.46% of the Subwatershed, is held in trust by the State of Arizona and managed by the Arizona State Land Department. The remaining land is under private ownership, comprising nearly 32,000 acres or 5% of the Subwatershed.

Water use in the Verde River Watershed extends beyond recorded history. The historical context outlined in this chapter explains how past decisions influenced current patterns of land use, resource management, and ownership in the Sycamore Subwatershed. Understanding the broad history of the study area provides important context when considering modern claims to water rights. **Figure 3-8** provides a photo of Sycamore Canyon captured in the 1920s.

Figure 3-8

Sycamore Canyon c. 1920

Note. From *Sycamore Canyon*, by Sharlot Hall Museum Library & Archives, 2017 (https://archives.sharlothallmuseum.org/index.php/photos/product-details/15279). Copyright 2017 by Sharlot Hall Museum. Reprinted with permission.

Chapter 4: Investigation Methodology

4.1 Investigation Overview

As mentioned in **Section 1.1**, the Adjudication Court requested ADWR to publish a Preliminary HSR that reviewed Sycamore Subwatershed's water right claims and water uses. In response to the Court, and pursuant to its duties as outlined in A.R.S. § 45-256, ADWR developed and applied a standardized investigation methodology. ADWR, as the technical advisor to the Adjudication Court, prepared a robust report of attributes associated with every water right claim and water use within the study area. The determined water right attributes include: source of water, the quantity of water, legal descriptions of the point(s) of diversion ("POD") and place(s) of use ("POU"), the landowner at the POU, the beneficial use, the priority date (i.e., the date when the water was first put to beneficial use), and the basis of right ("BOR") (i.e., the documentation establishing the claim to the water is legally valid). Additionally, ADWR recommended water right attributes for the Adjudication Court to consider based on the available evidence for each water use.[64] If ADWR recommended water right attributes, then those recommendations will appear on the *Proposed Abstract of Potential Water Right* page of a *WFR*.[65]

The procedures covered in this chapter detail how ADWR performed its investigations and reached its conclusions for this Preliminary HSR. The investigation's preliminary findings are summarized in each WFR. ADWR prepared a WFR for all landowners and entities with a water right claim or water use associated with their individual property in the study area. WFRs often contain multiple water uses and Proposed

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[64] A.R.S. § 45-256 outlines the ADWR's responsibilities as technical advisor to the Adjudication Court, which includes providing recommendations regarding the issuance of water rights.

[65] "Watershed File Report" or "WFR" means that portion of a Hydrographic Survey Report that sets forth ADWR's examination of water uses on an individual piece of property within a study area.

Water Rights ("PWR"). This Preliminary HSR compiled all WFRs within the Sycamore Subwatershed.

ADWR conducted investigations from October 2023 to September 2025. This report did not reflect changes to the reported information occurring after September 6, 2025.

4.2 Investigation Preparation

4.2.1 ArcGIS Pro and Data Storage

Each investigation was performed , at least in part, in ArcGIS Pro ("ArcPro"), the most recent generation of desktop geographic information system ("GIS") software from Environmental Systems Research Institute, Inc. ("ESRI"). ArcPro incorporates local network data including in-house data products such as "ADWR-made" features and tools. Cloud-based Portal information, mostly known as ArcGIS Online ("AGOL"), contains a vast library of publicly available data (e.g., topographic maps). ArcPro offers tools for straightforward data visualization and advanced analytic capabilities. Additionally, it allows multiple users to edit data layers simultaneously (ESRI, 2023).

ADWR used ArcPro to store investigation details in nonspatial and *geospatial format*.[66] *Features*[67] were created to illustrate water uses as polygons or points. Each feature had a record in its respective *attribute table*[68] where detailed investigation information pertaining to each water use was stored. ADWR used the information stored in the attribute tables in ArcPro to produce the WFRs included within this Preliminary

[66] Non-spatial data, also called attribute data, describes the characteristics of features without specifying their location. Geospatial represents any data about a specific location on the Earth's surface.

[67] Features are anything found on the Earth's surface represented on a map.

[68] Each feature typically has associated attributes that provide additional information. See https://support.esri.com/en-us/gis-dictionary/attribute-table for more detail. These are different from water right attributes as explained in **Section 1.1**.

HSR. WFRs include an Overview, Summary and Analysis pages, and, if the water right is recommended, a Proposed Abstract. See **Section 5.3** for more details on the WFRs.

Additionally, ADWR used an internal platform known as the Adjudications Investigation System ("AIS"). AIS utilizes data stored in an internal ESRI ArcSDE database as well as ADWR's databases. AIS stores additional data and allows for features created in ArcPro to be linked together to illustrate the connection between a POU and a POD in the WFRs.

4.2.2 Collection of Datasets

ADWR collected public resources and datasets before conducting investigations to make well-informed conclusions. Most resources were available online and downloadable; however, others only existed in physical formats and had to be digitized by ADWR personnel. **Appendix C** includes all resources and datasets examined by ADWR.

Digital Elevation Models

A digital elevation model ("DEM")[69] provides a digital representation of the Earth's surface by illustrating elevation changes in images called "rasters." USGS's 3D Elevation Program ("3DEP") provides publicly available, high-resolution DEM rasters with a spatial resolution of one square meter (m^2) or better. ADWR uploaded a polygon *shapefile*[70] of the Verde River Watershed boundary to *USGS EarthExplorer*[71] to locate all available DEMs for the study area. Once downloaded, ADWR combined the individual DEMs into a single *mosaic dataset*[72] and then merged the individual dataset items to create one

[69] Represented as a raster dataset (ESRI, n.d.).

[70] A vector data storage format for storing the location, shape, and attributes of geographic features. A shapefile is stored in a set of related files and contains one feature class. See https://support.esri.com/en-us/gis-dictionary/shapefile.

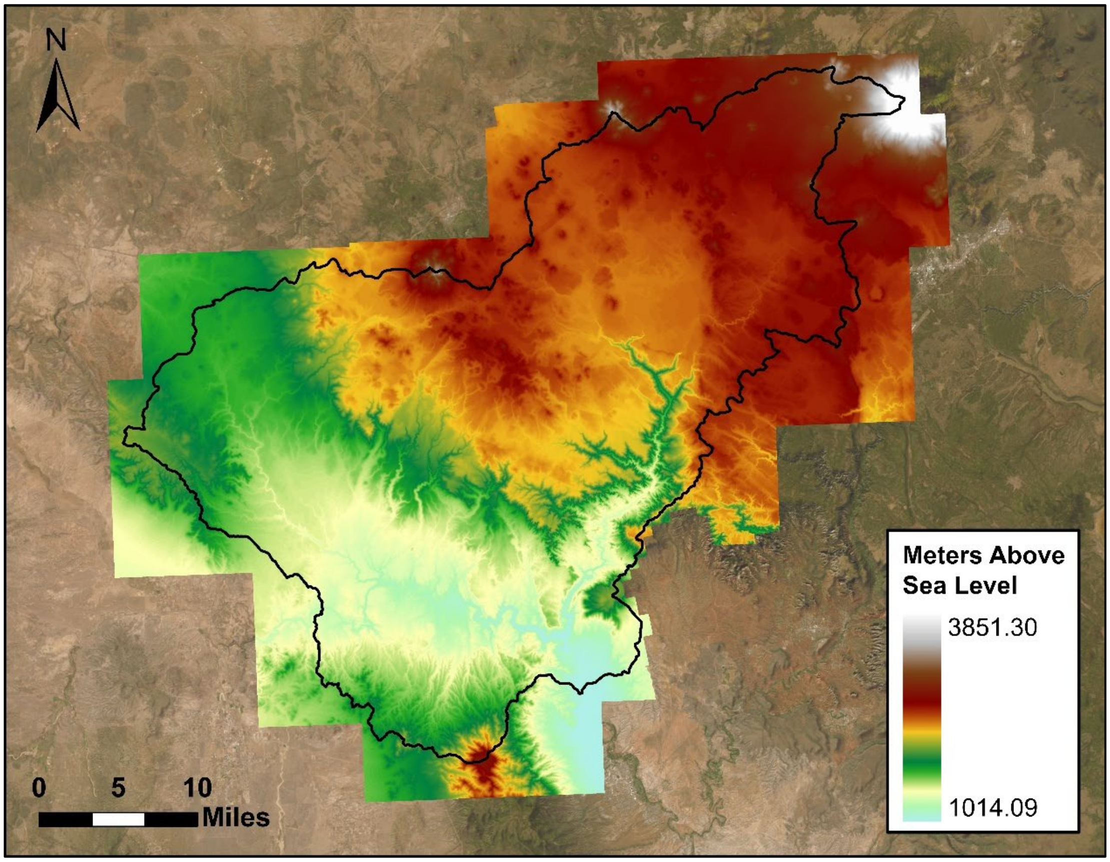
[71] An online tool developed by USGS for searching and obtaining aerial imagery and geospatial data.

[72] A collection of individual raster images managed as a single layer.

mosaic[73] of the Sycamore Subwatershed using the "Merge Mosaic Dataset Items" tool in ArcPro. The Combined DEM is shown in **Figure 4-1**. ADWR used the DEM mosaic to identify water uses, pinpoint stream channels, estimate depths of impoundments, and visualize berms.

Figure 4-1

Combined Digital Elevation Model for the Sycamore Subwatershed



[73] Combined images stitched together to make one continuous raster.

Notices of Appropriation ("NOA")

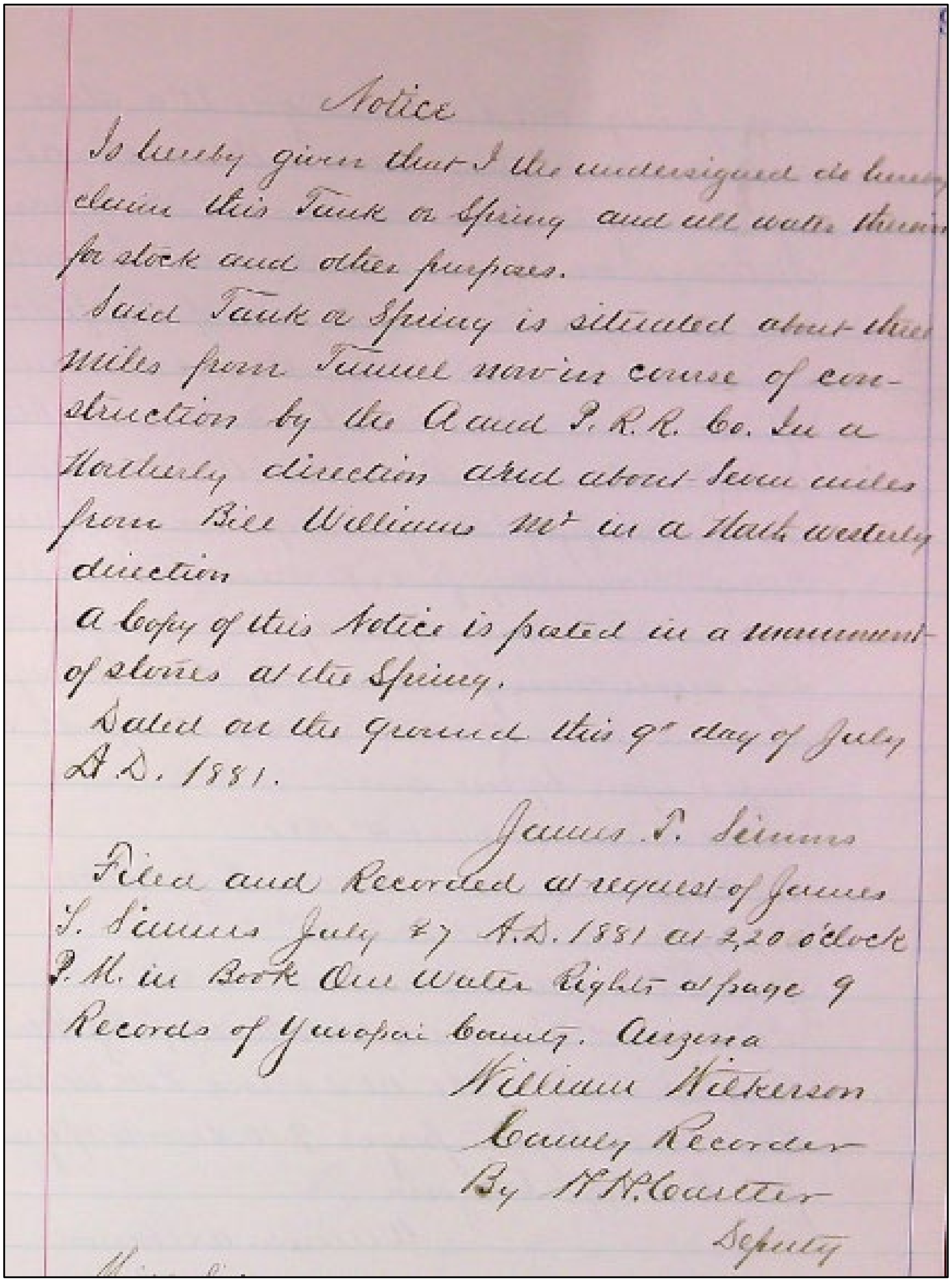
NOAs helped verify a pre-1919 water use when determining a water right recommendation. Before the *Arizona Surface Water Code* (i.e., "Public Water Code") took effect on June 12, 1919, water users could acquire a surface water right by (1) putting the water to beneficial use, (2) posting a Notice of Declaration of Intent to Appropriate or, after 1893, (3) filing the aforementioned Notice in the County Recorder's office for the county where the point of diversion was located. ADWR reviewed pre-1919 records from the Arizona State Library, Archives and Public Records, as well as Yavapai and Coconino County Recorder's Offices. ADWR used an IRIScan Desk Pro scanner to scan every page of the books containing pre-1919 records.[74] An example of an NOA filed with the Yavapai Recorder is shown in **Figure 4-2**. Once scanned, ADWR analyzed copies of the pre-1919 documents for potential NOAs. However, given the limitations of these searches, there may be other NOAs not reflected in this Preliminary HSR.

ADWR then recorded and cataloged the water use attributes associated with each NOA in an internal database. ADWR created a naming convention for the cataloged NOAs to begin with a prefix of "10" followed by numbers to represent the county, book, book type, and the sequence the NOA occurs on the page. Afterwards, a spatial layer was created in ArcPro to visualize an area of land with an associated NOA. However, in some cases, NOA's did not specify the legal descriptions of the POD(s) and/or POU(s), which made it difficult to associate an NOA with a certain property.

[74] The book titles considered for scanning include: Canals, Miscellaneous Records, Notices Affecting Real Estate, Notices of Water Locations, Promiscuous Records, Notices of Mill Sites and Water Rights, Miscellaneous Transcribed Records, Spanish Land Claims, Books for Pre-emptions, Water Locations and Miscellaneous Filings, Land Claims, Location Notices, Mill Sites, Mining Locations.

Figure 4-2

An Example of a Scanned Notice of Appropriation Filed with the Yavapai County Recorder in 1881



Notice

Is hereby given that I the undersigned do hereby claim this Tank or Spring and all water therein for stock and other purposes.

Said Tank or Spring is situated about three miles from Tunnel now in course of construction by the A and P. R.R. Co. In a Northerly direction and about seven miles from Bill Williams Mt in a North westerly direction

A Copy of this Notice is posted in a monument of stones at the Spring.

Dated on the ground this 9th day of July A.D. 1881.

James T. Simms

Filed and Recorded at request of James T. Simms July 27 A.D. 1881 at 2.20 o'clock P.M. in Book One Water Rights at page 9 Records of Yavapai County, Arizona

William Wilkerson
County Recorder
By W. H. Coulter
Deputy

Note. Scanned at the Yavapai County Recorder's Office.

Decreed Water Rights

A *decree* is a legally binding order issued by a court to resolve a legal dispute and determine the rights of the parties involved. A *decreed water right* is a court order establishing the right to use water. The court order details attributes of the water right allocated to a specific party or landowner. A.R.S. 45 §§ 257(B)(1) and 261(A) outline how the Adjudication Court and ADWR evaluate decrees when determining water right attributes. ADWR digitized and reviewed numerous decrees. However, a decree may exist that ADWR was not aware of at the time of the Preliminary HSR investigations. Additionally, in some cases, the legal descriptions of the POD(s) and/or POU(s) were not specified in the decrees, making it difficult to link them with a certain property.

ADWR cataloged the obtainable decrees to assist in investigations since a decreed water right may serve as a BOR for certain water uses. [75] The water use attributes associated with each decree were added to an internal database, and a *feature layer*[76] was created in ArcPro to visualize the decrees in their approximate geospatial locations.

Landownership Datasets

ADWR used landownership datasets to create WFR boundaries (see **Section 4.2.3**), track land exchanges, and understand how the land within the study area was used.

The Sycamore Subwatershed is within parts of both Yavapai and Coconino counties. ADWR used parcel data from the counties that contained ownership information for every parcel within the Subwatershed's boundary. The dataset also included shapefiles to spatially illustrate the parcel boundaries as polygons in ArcPro. ADWR filtered through the data and transitioned the formatting into a common schema, or data structure, to ensure the data was consistent for internal use.

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[75] *See* A.R.S. § 45-257(B)(1). *See also* De Minimis Order, Attachment I at 4-5.

[76] A layer that references a set of feature data. Feature data represents geographic entities as points, lines, and polygons.

Additionally, ADWR obtained United States Forest Service ("USFS") allotment datasets from the United States Department of Agriculture ("USDA"). The datasets included information such as allotment names and numbers, the managing forest and district, as well as shapefiles spatially-illustrating the boundaries of the allotments and pastures.[77] The shapefiles were used in ArcPro to show the allotment and pasture fence lines as they exist in-person. Along with allotment information, ADWR obtained datasets such as federally designated Wilderness Area and Motor Vehicle Use maps from the USDA. Each of these datasets were downloaded from the *Forest Service Geodata Clearinghouse*[78] and pulled into ArcPro for use in investigations. In addition to spatial data, ADWR collected *USFS Annual Operating Instructions*[79] which provided additional information on the number and types of animals grazing, the pastures grazed, and the time of year each pasture was used.

Similarly, the Arizona State Land Department ("ASLD") oversees grazing allotments on State Trust Land within the Subwatershed. ADWR obtained *feature classes*[80] of this data from the AZGeo Data Hub, a platform managed by the Arizona Geographic Information Council ("AGIC"). This hub provides access to a wide range of reliable geographic datasets across Arizona, including landownership details, allotment boundaries, and census-designated areas.

4.2.3 Watershed File Report Boundaries

The WFR summarizes the water uses investigated on an individual piece of property in the study area. ADWR created features in ArcPro to represent the boundaries of each

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[77] Allotment boundaries were separated by fence lines and were divided further into pastures.

[78] https://data.fs.usda.gov/geodata/edw/datasets.php

[79] Annual Operating Instructions are extensions of a grazing permit that include details on the maximum permissible number of livestock, grazing sequences, structural improvements, etc.

[80] Feature classes are homogeneous collections of common features, each having the same spatial representation (such as points, lines, or polygons) and a common set of attributes.

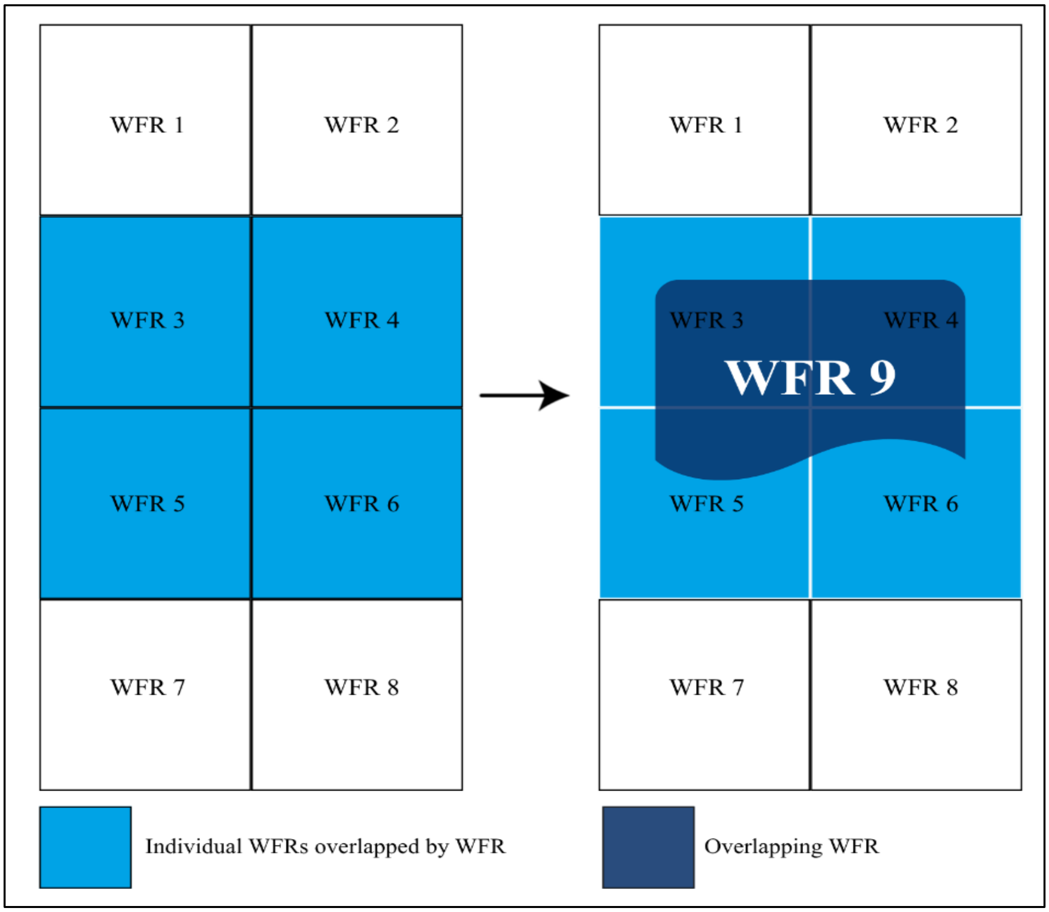
property throughout the Sycamore Subwatershed using the collected landownership data. These features represent each individual "WFR boundary."

First, using the "Select by Location" tool in ArcPro, the parcel boundaries were clipped to the Sycamore Subwatershed, so any portion of a parcel falling outside of the Subwatershed was not included. Then, ADWR created a new feature class in ArcPro based on the geometry of the parcel boundaries; meaning, the perimeters of each parcel were copied to create a corresponding WFR boundary. ADWR also created additional WFR boundaries by reviewing those set by agencies managing public land, such as land administered by USFS and ASLD. For example, ADWR created WFR boundaries based on the grazing-allotments data obtained from federal and state agencies.

However, unique circumstances where a WFR boundary overlapped other WFR boundaries occurred. In these instances, an overlapping WFR boundary feature was digitized based on the POU instead of landownership. This exception serves to effectively investigate the full extent of the POU. This exception intends to simplify the WFR and efficiently present the investigation findings for the full extent of the POU. Even then, if the individual parcels hold a claimed water use, the use will be investigated in its own separate WFR for that individual property. An example of this exception is illustrated in **Figure 4-3**.

Figure 4-3

Example of Overlapping Watershed File Report Boundaries for Cases Where Claimed Uses Span Multiple Landowners



ADWR created the WFR boundary features and recorded landownership information, such as landowner and Assessor's Parcel Number ("APN"), for each feature if information was available. Additionally, each WFR is assigned a unique identifier, referred to as a WFR number. The unique ID is made up of four parts, separated by hyphens, that represents location information. The first part of the unique ID starts with three digits; the first two digits identify the Watershed the property falls within, ("05" identifying the Verde River Watershed) and the third digit identifying the Subwatershed the property fell within ("3" represents the Sycamore Subwatershed). The second part represents the region[81] with a leading zero (e.g., "-07"). The third part is an alphabetical representation of the subregion[82] similar to cadastral quadrants[83] (e.g., "-ABCD" representing "NE NW SW SE," respectively). Finally, the last part is assigned a three-digit indicator for the WFR's sequence in the region (e.g., "-012"). The four parts combine to form the WFR number (e.g., "053-07-ABCD-012") used throughout the investigation to represent the investigated property. **Figure 4-4** of the regions into subregions, represented with the cadastral system.

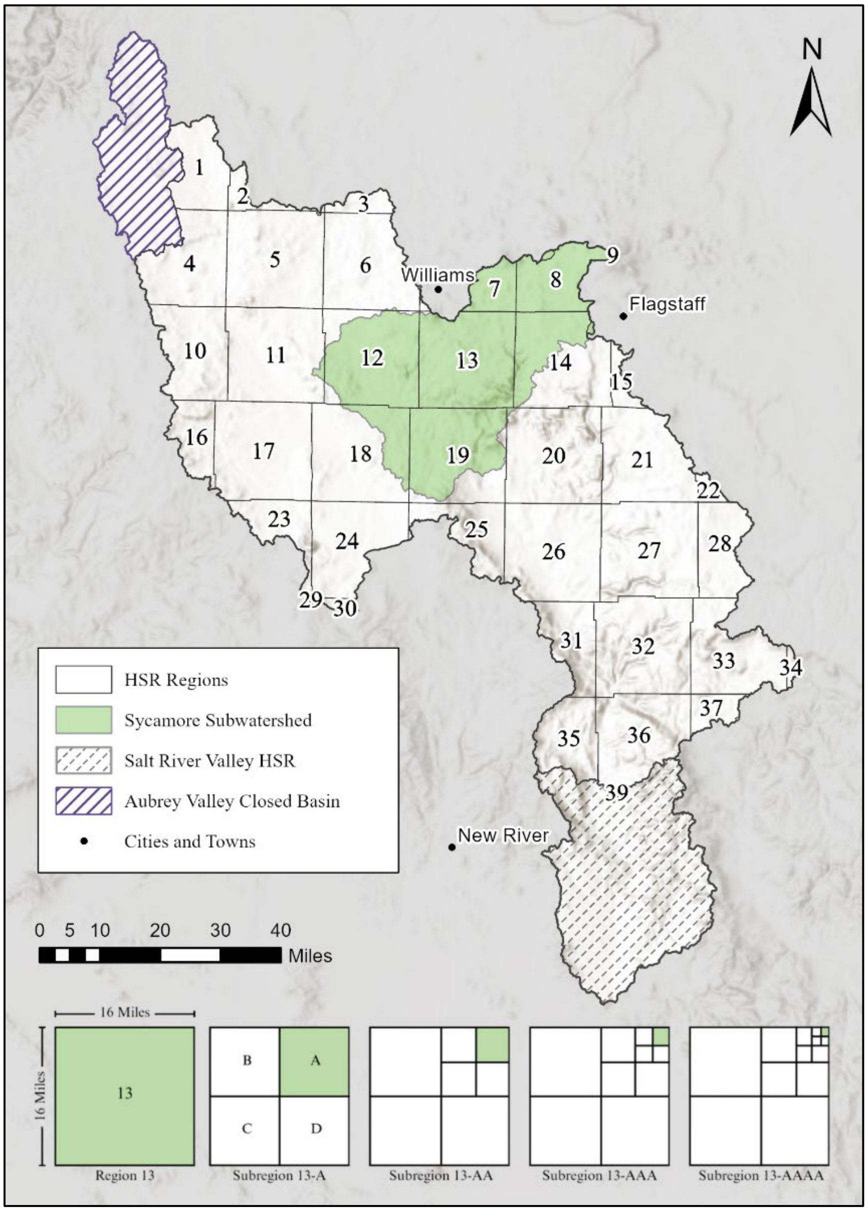
[81] ADWR divided the Verde River Watershed into regions by applying a grid with squares spanning 16 square miles in area.

[82] ADWR divided the regions further into subregions by applying a grid with squares spanning 1 square mile in area.

[83] The northeast quadrant is "A", the northwest "B", the southwest "C", and the southeast "D".

Figure 4-4

Verde River Watershed Regions and a Diagram Illustrating Subregion Division



Note. Region 38 was removed from the Verde River Watershed pursuant to the *March 25, 2024, Report*.

To report on the most up-to-date information, ADWR periodically compared parcel numbers and owner names, as well as allotment permittees, to maintain data integrity in its investigations. Real-time ownership records were available on the Yavapai and Coconino County Assessor's websites. Lessee and permittee records were reflected in the Annual Operating Instructions and associated lease documents. Landowner and permittee information was updated in ArcPro as ownership changes and lease transfers occurred. Additionally, ADWR adjusted the boundaries of WFRs in ArcPro when splits, mergers, or any other changes in landownership impacting the parcel occurred. ADWR used an internal tool built through Python Programming Language[84] to report weekly updates on the changes described. As mentioned in **Section 4.1**, the final date for incorporating boundary, landowner, or permittee changes into this Preliminary HSR was September 6, 2025. Any parcel, ownership, or lease changes after this date were not reflected in this Report. ADWR's final date for incorporating boundary, landowner, or permittee changes for the Final HSR will be six months before publication, currently set for September 12, 2026, since the Adjudication Court set the deadline of March 12, 2027, for the publication of the Final HSR.

4.2.4 ADWR Filings

ADWR reviewed every filing with an associated POU or POD within the Subwatershed to ensure every water right claim and water use was investigated. Preliminary HSR investigations considered the filings on record with the Department, which included, but were not limited to, SOCs, Surface Water Filings and Well Registration Filings.

[84] https://www.python.org/

Although some filings gave specific location information for the POU and/or POD, such as a parcel number, map, site plan, or GPS coordinates, many did not. The entity submitting the filing was responsible for supplying the information. A digital record of ADWR filings and their associated documentation are available online.[85]

SOC Filings

SOCs are filed with ADWR using a "39-" prefix. An SOC is not legal permission to use water. However, ADWR requires an SOC in order to recommend a water right.[86] An SOC is filed with the Adjudication Court, though ADWR accepts the filing on the Court's behalf. After filing, the person or entity claiming the right to use water becomes a claimant within either the Gila or Little Colorado River General Stream Adjudication. The information provided and submitted by the claimant consists of name, address, property records, and water use attributes. At the time of filing, ADWR does not determine the validity of SOCs, and claimants do not always provide all requested information on the SOC forms.

Surface Water Filings

Surface Water Filings primarily consist of:

1. Application for Permit to Appropriate Public Water or to Construct a Reservoir notate using a "33-", "4A-", or "3R-" prefix.
2. Application for Permit to Appropriate Public Water for Instream Flow Purposes notate using a "33-" prefix.
3. Claim of Water Right for a Stockpond and Application for Certification notate using a "38-" prefix.
4. Statement of Claim of Right notate using a "36-" prefix.

[85] ADWR Imaged Records

[86] *See* A.R.S. § 45-254. *See also* De Minimis Order, Attachment I at 2.

Permits, certificates, and claims for the use of surface water within Arizona are based on state law. For example, obtaining a Certificate of Water Right ("CWR") acquires permission to use surface water in accordance with state law. However, obtaining a CWR does not exempt the holder from participating in the General Stream Adjudication, where the priority and extent of all water rights are actually adjudicated and decreed. Surface Water Filings and CWRs may potentially serve as a BOR in the Gila and Little Colorado River Adjudication proceedings.[87]

Well Registration Filings

Well Registration numbers begin with a "55-" prefix.[88] Although all wells, new and existing, should be registered with ADWR,[89] many wells remain unregistered. Landowners choose which information to provide in Well Registration Filings.[90] These filings act only as a registry in ADWR's database (not as permission to use the water[91]).

[87] *See* A.R.S. § 45-261; *see also* De Minimis Order, Attachment I at 4-5.

[88] *See* ADWR Water Planning and Permitting Division Assignment of Well Index Numbers as of January 10, 2020 at https://infoshare.azwater.gov/docushare/dsweb/Get/Document-12526/37-50_Well_Index_Numbers.pdf for an explanation of how Well Registration numbers are assigned.

[89] *See* Article 10 of the Groundwater Code, A.R.S. §§ 45-591 et seq.

[90] "A Well Registration is not a valid basis of right. The list of acceptable legal bases of right is as follows: Prior judicial decrees, Water Rights Registration Act filings, Certificates of Water Right, Stockpond Registration Act Certificates." *See* De Minimis Order, Attachment I at 4-5. *See also* Report of the Special Master, *In re Town of Huachuca City*, Contested Case No. W1-11-000245 (Sep. 23, 2021).

[91] A Groundwater Withdrawal Permit is needed to withdraw groundwater in an Active Management Area ("AMA") for a specific use authorized under A.R.S. Title 45, Chapter 2, Article 7.

ADWR was only able to report on the information found within its Well Registry Database; however, ADWR requires minimal information to submit a registration. For example, a Well Registration Filing does not require the landowner to disclose which parcels use water from which wells. Additionally, although the well owner is responsible for submitting a pump report, the reports are not always submitted. The lack of updated reports leaves many wells marked as *capped*[92] even if they are no longer capped. Similarly, Well Registration Filings frequently describe the well as "dry" or in some way indicate the well is not producing water. ADWR generally did not review wells marked as "Cancelled" or "Monitoring" in the ADWR Well Registry Database.[93]

Ultimately, ADWR relied on the information in the Well Registration Filing during its investigation to determine if a well was used.

Digitizing Filings Spatially

Approximately 1,269 SOCs, 763 Surface Water Filings, and 684 Well Registration Filings were associated with the Sycamore Subwatershed at the time of this Preliminary HSR. The cadastral location or legal description listed in each filing was used to determine the associated WFR(s). The terms "cadastral location" and "legal description" both refer to a method of locating land according to the *Public Land Survey System* ("PLSS").[94]

For each filing type, a legal description was provided by the entity submitting the document. Typically, the legal description included at least the PLSS 160-acre and 40-acre subdivisions. In some instances, an Assessor's Parcel Number ("APN") was provided, but not always, as ADWR does not require it.

[92] Meaning the top of the well casing is sealed, after they are drilled, modified, etc.

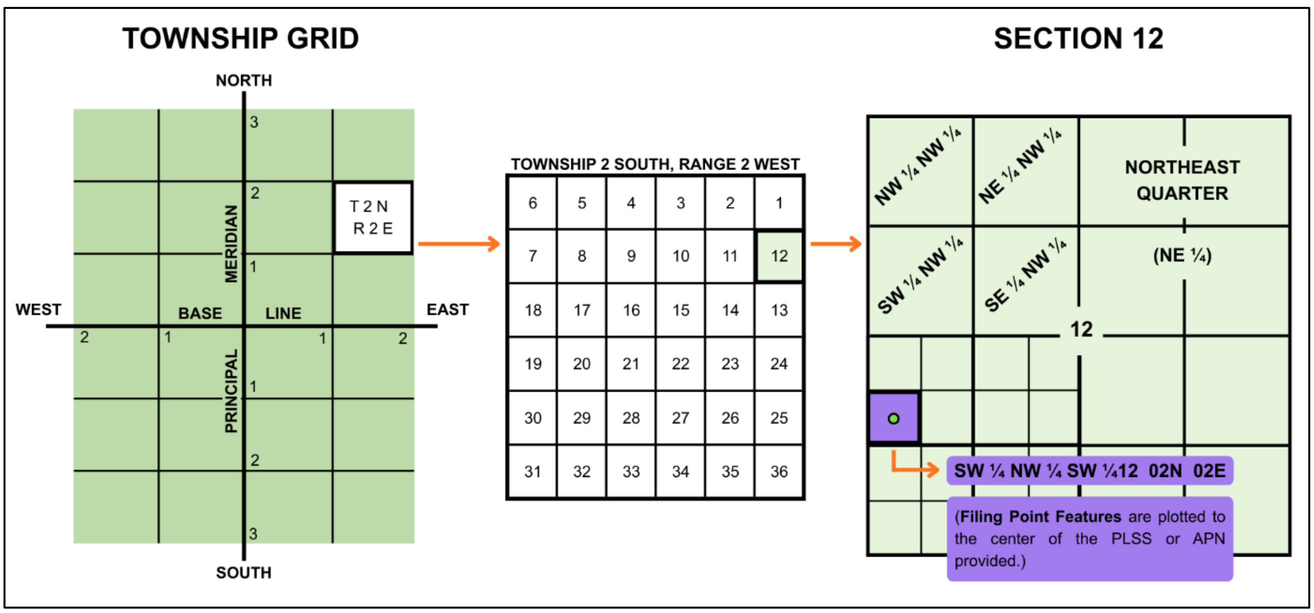
[93] Suggesting non-use or non-consumptive use.

[94] Additional PLSS information is available on the Bureau of Land Management website.

Initial digitizing used an automated tool to plot the filings spatially in ArcPro as a point feature by using the location information provided (see **Figure 4-5**). However, the point did not always plot to the exact location of the use. Therefore, ADWR reviewed each filing to confirm, to the extent possible, the exact location of the associated POU before investigations commenced. In addition to the information provided in the filing, ADWR used County Recorder landownership information, USGS topographic maps, aerial imagery, and any additional documentation associated with the filing to determine the location of the POU. Files without a legal description or enough information to determine the location of the POU were not associated with the water use investigated.

Figure 4-5

Example of How ArcPro Spatially Plots Legal Land Description from a Filing as a Point Feature



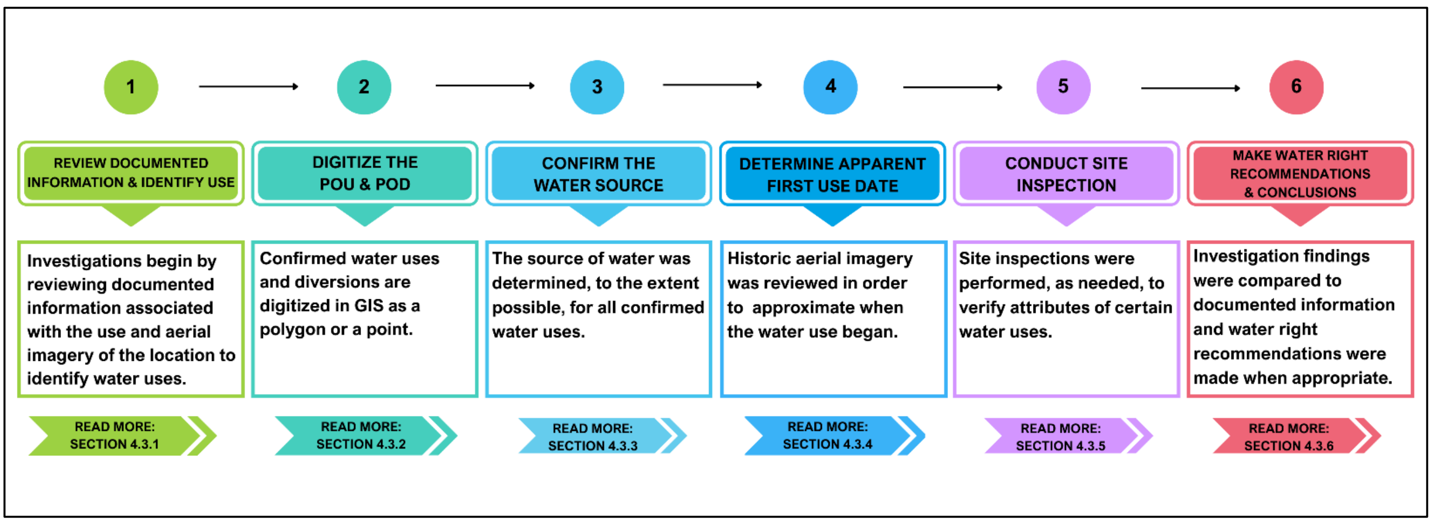
4.3 General Methodology

ADWR determined the type of beneficial use based on standardized definitions and proceeded with the necessary steps to complete each investigation (see **Sections 4.4.1 through 4.4.8**). The types of beneficial uses investigated in this Preliminary HSR, and detailed in this Chapter, are: Municipal, Irrigation, Stock Watering, Wildlife, Domestic, Recreation, Institutional, Commercial, and Water Storage.

The following use-types and variations were not found within the Sycamore Subwatershed: Mining, Power, Multiple Domestics, Small Facilities, Irrigation Districts, or Ditch Associations. Therefore, because these use-types did not occur within the Subwatershed, ADWR did not report on them in this Preliminary HSR. **Figure 4-6** summarizes the general methodology used for all water use investigations.

Figure 4-6

Flowchart of the General Methodology for a Water Use Investigation



4.3.1 Review Documented Information & Identify Use

To begin a water use investigation within a WFR, ADWR reviewed any documented information associated with the property to confirm the type of beneficial use. Documents, such as SOCs, NOAs, Well Registrations, and/or Surface Water Filings provided significant information for the parcel of land and its related water use(s). Information may include the when the water use started, where the water use occurred, or the quantity of water used. ADWR used the most current, available aerial imagery in ArcPro to confirm and/or identify a water use within a given WFR. Documented information also helped confirm the presence and type of use seen in aerial imagery. When filings did not exist for a use found in aerial imagery, ADWR used methods defined in the use-specific methodology of this chapter to determine the type of use (see **Section 4.4**). If the investigation determined a filing's claimed water use did not exist, then ADWR noted the discrepancy and categorized the related filings as "Unknown Uses" in the WFR. If ADWR found a WFR missing any related filings or uses, then the WFR was not published as part of this Preliminary HSR.

4.3.2 Digitize POU and POD

After a water use was identified, a POU was digitized as either a polygon or point feature. ArcPro auto-populated the legal description(s) of the POU in the POU's associated attribute table. Other fields, such as the landowner at the POU, the quantity of water (if applicable), and the water source, were logged using information verified during the investigation.

The location of the POD was digitized where the water was diverted from based on aerial imagery and documented information. The POD was digitized in ArcPro as a point feature, a legal description was generated, and a "Diversion Type" was assigned. Diversion Types included Impoundment, Streamside, Spring, Well, Instream Pump, and Diversion. "Impoundment" was used for water uses with a berm, dam, or barrier creating an impoundment of water. "Streamside" was used when water was consumed directly from a stream or naturally occurring body of water. "Spring" was used when water was directly taken from a developed or undeveloped spring. "Well," was used when water was initially taken from a well. "Instream Pump" was used when a pump was installed directly into a surface water source and was typically integrated into pipelines. If any POD did not fit those Diversion Types, then the POD was labeled as "Diversion" to accommodate all investigation circumstances. If the water was not diverted (i.e., the use occurred directly at the source), the POD was placed at the source of water. If ADWR was unable to confirm the POD's location or Diversion Type, then a POD was not digitized in the WFR and/or proposed abstract.

4.3.3 Determine Water Source

The source of water was determined through several means, depending on the water use and the available documented information. Surface water sources were verified using a USGS topo map, hosted by ESRI as a basemap, in ArcPro. However, if more information was needed, then additional online resources such as USGS topoView,[95] USGS EarthExplorer,[96] and the Springs Stewardship Institute ("SSI")[97] were reviewed. In situations where the surface water source was unnamed, ADWR recorded the water source as "Unnamed [Wash, Draw, Tributary, etc.]."

However, if the POD was identified as a well within the Verde Subflow Zone, then ADWR presumed the water source was appropriable subflow[98] and listed the source as "Well: Inside the Proposed Subflow Zone of [the surface water source]."

In situations where not enough information was available for ADWR to determine the water source, ADWR noted the source as "Unknown" in the WFR and/or proposed abstract.

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[95] USGS topoView: https://ngmdb.usgs.gov/topoview/

[96] USGS EarthExplorer: https://earthexplorer.usgs.gov/

[97] Springs Stewardship Institute: https://springstewardshipinstitute.org/

[98] *See* Goodfarb Order

4.3.4 Aerial Imagery Review & Apparent First Use

Available historical aerial imagery was reviewed to determine the apparent first use date of a water use, identify periods of possible non-use, and/or document possible changes to the use. To determine these attributes, ADWR navigated through aerial images of the POU taken throughout time.

ADWR has a library of Cooper Aerial Imagery, originally flown between the 1930s through the 1990s by Cooper Aerial Surveys Co., which were scanned and *georeferenced*.[99] Additional aerial imagery was downloaded from USGS Earth Explorer. If the downloaded aerial imagery was not georeferenced, then ADWR georeferenced it in ArcPro. All images were compiled into a mosaic dataset for the entire Verde River Watershed. The mosaic dataset allowed ADWR to select individual historical aerial images for a specific location and review them in chronological order to determine the presence of, and any changes to, a water use over time. In addition to the mosaic dataset, ADWR used the National Agriculture Imagery Program ("NAIP") aerial imagery, Google Earth Pro aerial imagery, and the current ESRI basemap, *World Imagery*. To the extent possible, all available aerial imagery was reviewed; however, some locations, years, or seasons lacked available aerial imagery. **Appendix D** details the historical aerial imagery sources obtained for review.

During an aerial imagery review, ADWR identified any changes in a water use and years of non-use. A change in a water use could indicate an increase or decrease in the quantity of water used. If evidence of non-use was present, then forfeiture or abandonment could occur. For example, when the owner of a right to the water use failed to use the water for five successive years, the right to the water use, "shall cease, and the water shall revert to the public and shall again be subject to appropriation" (A.R.S. § 45-141(C)). Investigations noted and referred to the apparent first use date and any changes to it over time to help draw conclusions. In some instances, a use was not obvious in aerial imagery (i.e., a use occurring from an undeveloped stream or spring). In these instances, other

[99] Georeferencing is the process of placing an image in the appropriate geographical location in GIS.

resources such as CWRs, historical topographic maps, affidavits, NOAs, etc. were used as supplemental evidence to help determine the apparent first use date. If the apparent first use date was still undetermined, then ADWR did not list this attribute in the WFR and/or proposed abstract.

When reporting the aerial imagery source for the apparent first use date, ADWR recorded the aerial imagery source by listing the agency responsible for capturing or managing image(s). For example, if the aerial imagery used to determine the apparent first use date came from Google Earth Pro, then the source listed was *Google Earth Aerial Imagery*. If the aerial imagery was downloaded from EarthExplorer, but the organization responsible for the photos was the Army Map Service ("AMS"), then the source listed was *AMS Aerial Imagery*. For non-aerial imagery sources, the apparent first use date source document was listed. See **Table 5-1** (pg. 137) for more information on all possible documents used to determine apparent first use date. ADWR noted any changes or periods of possible non-use in the WFR and/or proposed abstract during this review.

4.3.5 Conduct Site Inspections

When water use attributes were not evident through aerial imagery, or other in-house tools, ADWR personnel performed site inspections as needed to verify them. Typically, site inspections occurred for uses that had an associated Statement of Claim of Right (i.e., a filing with a "36-" prefix) as the claimed BOR because other Surface Water Filing types usually require a site inspection as part of the permitting process. ADWR prioritized site inspections for uses with obvious location or quantity discrepancies. Site inspections for uses connected to springs or wells were potentially conducted to verify the location by gathering coordinates and photos of the POD. Site inspections for uses associated with impoundments[103] or reservoirs were potentially conducted to verify how much water was impounded which required a small unmanned aerial system ("sUAS") or drone. Due to access restrictions and/or time constraints, ADWR did not conduct site inspects for every single use with these discrepancies. See **Section 4.4.3** for more information on site inspections for impoundments.

4.3.6 Water Right Recommendations and Conclusions

The attributes identified during the investigation were compared to those outlined in the water use's associated, documented information. If additional information was necessary to make a conclusion regarding the investigation, then ADWR contacted the claimants (see **Appendix G**).

Each water right claim or water use investigated may result in water right attributes recommended pursuant to A.R.S. § 45-256(6)(B). Generally, for a water use to be considered for recommendation, the use needs to include both an SOC[100] and a BOR.[101] Each recommended water use included a proposed abstract and an assigned PWR number. Water uses without recommendation also appear in the WFR. The water right attributes listed in the proposed abstracts include: the source of water, quantity of water, flow rate, POU, POD, landowner at the POU, lessee or permittee at the POU, owner of right, beneficial use, facility name, priority date, SOC, and BOR.

The Preliminary HSR results do not reflect final water right determinations. For more information on how to interpret these results and the next steps, see **Chapter 5**.

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[100] "A potential water right must be matched to an SOC…" *See* De Minimis Order, Attachment I at 4. *See also* A.R.S. § 45-254.

[101] "The list of acceptable legal bases of right is as follows: Prior judicial decrees, Water Rights Registration Act filings, Certificates of Water Right, Stockpond Registration Act Certificates." *See* De Minimis Order, Attachment I at 4-5.

Source of Water

See **Section 4.3** for information on how ADWR determined the source of water. The source of water was recommended based on the investigation findings and compared to the BOR.

In instances where the source of water differed from what was listed on the SOC and/or BOR, ADWR made note of the discrepancies on the associated WFR and/or proposed abstract.

Quantity of Water

The Adjudication Court requires ADWR to report the quantity of water for a recommended water right. ADWR first compared the quantity of water listed in the SOC and BOR to the investigation findings. If discrepancies between the quantity listed in the associated filings and the quantity estimated by ADWR existed, then the discrepancies were explained in the proposed abstract and/or WFR. The amount recommended to the Adjudication Court was whichever quantity of water was the lowest. If evidence of non-use of the full amount of water the right holder was entitled to use was found, then forfeiture or abandonment (partial or full) could occur.[102]

A flow rate, or how quickly the water was used or delivered, was also recommended where applicable (i.e., off-channel uses). ADWR noted flow rate as "N/A," or "Non-Applicable" in the proposed abstract if a flow rate could not be calculated.

If the recommended use was determined to be *de minimis*, ADWR recommended a specific quantity of water assigned to the use by the Adjudication Court.[103] See **Section 4.4.9** for more information on *de minimis* uses.

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[102] *See* A.R.S. § 45-141 for a list of exceptions to abandonment or forfeiture ADWR took into consideration during the investigation period.

[103] *See* De Minimis Order, Attachment I at 5-6.

Legal Descriptions of the POU and POD

The location of the POU(s) and POD(s) were described in the proposed abstract. All legal land descriptions within this Preliminary HSR were derived from the Gila and Salt River Baseline and Meridian.

ADWR only reported on water uses with a POD located within the Sycamore Subwatershed in this Preliminary HSR. If any POUs within the Subwatershed had a POD located outside of the Subwatershed, then ADWR provided information on the use to the Adjudication Court. However, any recommendations for the use would be described in the corresponding Preliminary HSR of the POD's location. For example, if a water use occurred in Sycamore Subwatershed, but its diversion (POD) was located in Big Chino Subwatershed, then any recommendations for the use would be reported in the Preliminary HSR for Big Chino.

ADWR verified the actual locations for the POU and POD. If the actual legal location of either the POU or POD differed from what was listed in the SOC and/or BOR, then ADWR made note in the associated WFR and/or proposed abstract. The legal location on the WFR and/or proposed abstract reflects the actual location determined by ADWR.

Landowner at the Place of Use

The Adjudication Court directed any person who filed an SOC to notify ADWR when a transfer of landownership associated with a water right happens. Generally, a water right or claim to a water right is held by the owner of the land at the POU. Therefore, any person or entity who purchased property associated with a water right, a claim to a water right, or water use, is responsible for updating the associated records maintained by ADWR.

For a use receiving a water right recommendation, ADWR recommended an *owner of right*.[104] ADWR only recommended an owner of right when the current landowner of the land at the POU matched the name listed on the SOC and BOR (*See* De Minimis Order, Attachment I at 2). ADWR identified discrepancies in landownership information by comparing the information contained in each SOC and/or BOR to the County Assessor Office or USDA records. As described in **Section 4.2.3**, landownership information was obtained from the Yavapai and Coconino County Assessor Offices, and lease information was obtained from the USDA and ASLD. In instances where the landowner or lessee's name differed from the SOC and/or BOR entry, then ADWR noted the discrepancies in the WFR and/or proposed abstract and did not list an owner of right.

As mentioned in **Section 4.1**, the cutoff date for updated information to be incorporated into the investigation findings was on September 6, 2025. Therefore, this report did not reflect recent landownership or lessee transfers after that date. Additionally, this report did not reflect any requested ownership changes submitted to, but not yet approved by, ADWR before this date. See **Section 4.2.4** for more information on keeping ADWR records up-to-date.

Beneficial Use

The purpose of the water's use, also known as the *beneficial use*, is the basis, measure, and limit to the use (A.R.S. § 45-141(B)). The beneficial use types included in this Preliminary HSR were Municipal ("MU," "WP"), Irrigation ("IR"), Stock Watering ("SW," "SP," "SS"), Wildlife ("WL"), Domestic ("DM"), Recreation ("RE"), Institutional ("IN"), Industrial ("ID"), Commercial ("CM"), and Water Storage ("WS").

[104] The person or entity legally entitled to use the water and hold the water right.

ADWR reported on the confirmed type of beneficial use based on the definitions described in **Sections 4.4.1** through **4.4.8**. For example, an SOC which claimed a Domestic Use was investigated as an Institutional Use if ADWR determined the use was associated with a church. In those instances, ADWR noted the beneficial use listed on the SOC and/or BOR and which use-type was investigated in the WFR and/or proposed abstract.

Priority Date

Arizona adopted the *Doctrine of Prior Appropriation* to govern the use of surface water; meaning, the person who first put the water to a beneficial use acquired a senior right to the use, compared to later (junior) appropriators of the use. The date the water was first put to beneficial use, along with any documented information, was reviewed to recommend a priority date for the water use.

ADWR verified the date water was first put to beneficial use by using aerial imagery, along with available documentation associated with the use's BOR (see **Section 4.3.4** for more information). The date was documented as the apparent first use.

If the apparent first use date was earlier than the date claimed in the SOC or listed on the BOR, then ADWR recommended the latest claimed or listed date as the priority date to the Adjudication Court. If the apparent first use date was after the date claimed in the SOC or listed on the BOR, then ADWR noted the discrepancy in the WFR and/or proposed abstract but did not recommend a priority date to the Adjudication Court. If the use was determined to be forfeited or abandoned, then ADWR noted the possible non-use in the WFR and did not recommend a water right.

Basis of Right

Prior to June 12, 1919, a person or entity could acquire a water right simply by applying the water to a beneficial use and posting an NOA at the POD, and/or filing the document with the County Recorder (see **Section 4.2.2** for more information on NOAs). After June 12, 1919, the *Public Water Code* required a person or entity to apply for and obtain a permit and certificate to use appropriable water. The Adjudication Court requires proof a water right was acquired legally through either of these two means. Common examples of a basis of right ("BOR") include prior judicial decrees, NOAs, and CWRs issued under the *Public Water Code*.[105]

The claimant listed a basis of claim ("BOC") on their SOC, and ADWR determined if the BOC would be recommended to the Adjudication Court as a BOR. If not enough information supported the basis of claim provided, then ADWR did not recommend a basis of right. Similarly, if not enough information provided for ADWR to connect a legal basis with a water use occurred, then a basis of right was not recommended. For example, if multiple impoundments existed in the same 10-acre tract, and the associated basis of right did not supply a map or other specifications indicating which impoundment was which, then ADWR could not make a conclusion. Therefore, ADWR noted uses without a basis of right, and uses without enough information to support their BOC, in the WFR and/or proposed abstract.

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[105] *See* De Minimis Order, Attachment I at 4-5.

4.4 Water Right Claim and Water Use Investigations

ADWR developed beneficial use definitions based on statutory definitions in A.R.S. §§ 45-151, 45-157, 45-181, 45-251, and 45-2201.

4.4.1 Municipal Uses and Small Water Providers

Overview

For the purposes of this Preliminary HSR, all non-agricultural uses of water supplied by a city, town, private water company or irrigation district were classified as Municipal Uses. Additionally, any entity delivering less than 250 acre-feet (308,372.31 m^3) of water per year was classified as a Small Water Provider. In this section, any reference to a methodology applied towards a Municipal Use also encompassed Small Water Providers.

Methodology

Municipal Uses were investigated using the general methodology described in **Section 4.3** in addition to the following municipal-specific variations.

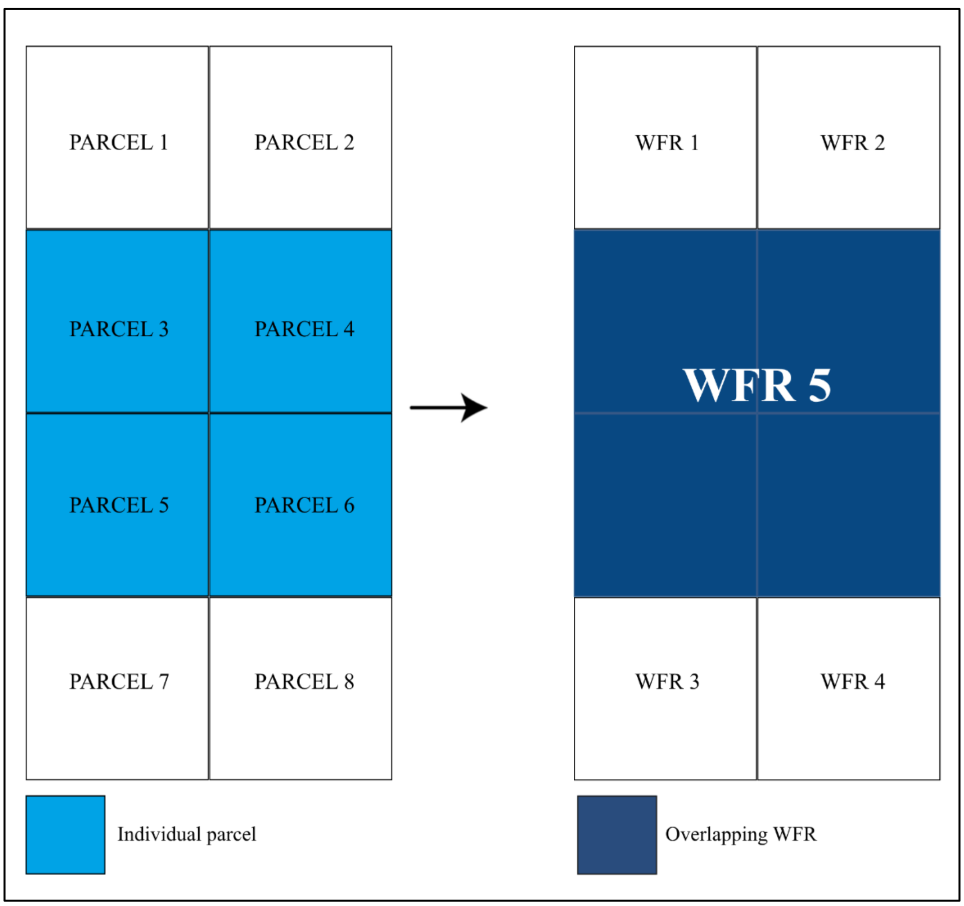
ADWR confirmed the municipality's boundary and service area to accurately digitize the POU in ArcPro. This involved reviewing the documented information associated with the Municipal Use or claimed use, available community water system (CWS) boundaries, and information on record with other agencies, such as the Arizona Corporation Commission ("ACC") and the Arizona Department of Environmental Quality ("ADEQ"). The ACC maintains regulatory authority over private water companies and private wastewater companies throughout the state. ADEQ also keeps records of public water systems data, and in some cases, detailed system information available online.

Once a Municipal Use was identified, the POU and POD were digitized as features in ArcPro. The POU of a Municipal Use was digitized as a polygon feature around the municipality's service area boundary. Generally, parcels within a municipality's service area did not receive an individual WFR, unless an individual parcel had separate filings. Instead, a WFR boundary was created to encompass the entire service area because ADWR assumed if a parcel fell within the service area, then the municipality served water there. See **Figure 4-7** for an example of a WFR boundary created for a Municipal Use. The boundary encompassed the entire service area served by the water supply system. A POD was digitized in ArcPro as a point feature using provided information, such as available filings, CWS reports and/or ADEQ reports. A POD was only digitized for a source actively providing municipal water.

Historical aerial imagery was reviewed to determine the apparent first use date of the Municipal Use. Changes to a Municipal Use may include, but are not limited to, the expansion or reduction of the service area boundary and the addition or removal of storage facilities. Any changes to a Municipal Use were noted in the WFR and/or proposed abstract.

Figure 4-7

Example of Overlapping Watershed File Report Boundaries for Municipal



4.4.2 *Irrigation Uses*

Overview

For purposes of this Preliminary HSR, an Irrigation Use was defined as using water to grow plants and includes outside water use associated with a domestic claim where there is more than 0.5 acres of land irrigated per residence.

Methodology

Irrigation Uses were investigated using the general methodology described in **Section 4.3** in addition to the following irrigation-specific variations.

Additional documented information ADWR reviewed for Irrigation Uses included historical land surveys to confirm the presence of the use. To digitize the POU, the polygon was drawn to contain the entire irrigated field. The area of the field was estimated in ArcPro based on the polygon feature. For the POD, the point was placed at the location where water was diverted from (i.e., well, surface water source, spring, etc.). When reviewing historical aerial imagery, ADWR identified Irrigation Uses by a field's distinct geometric shape, noticeable irrigation systems, uniform vegetation, or vibrant green color, see **Figure 4-8** for examples. Cemeteries, football fields, golf courses, and vineyards were considered as other possible Irrigation Uses.

Figure 4-8

Examples of Geometric Shape and Uniform Vegetation Indicating Irrigated Fields in Maricopa County Captured by 2025 Google Earth Aerial Imagery

When reviewing aerial imagery to identify the apparent first use date ADWR confirmed the presence or lack of an irrigated field. In addition, ADWR noted any obvious changes to the use over time, such as changes in the irrigation system, as well as land expansion or reduction. [106]

ADWR also determined the current acreage for each Irrigation Use, as well as an estimated quantity of water for any field irrigated by a surface water source. ADWR confirmed the acreage of the irrigated area and used to estimate the quantity of water used. Depending on the field size, the quantity of water was estimated by using either remotely-sensed evapotranspiration ("ET") provided by the program *OpenET*[107] or by applying a

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[106] If changes to the use occurred as land reduction and expansion, then ADWR determined if a Notice of Substitution of Flood Damaged Irrigation Acres was filed for the use, pursuant to A.R.S. § 45-172.01.

[107] OpenET is a non-profit entity developed in collaboration with the National Aeronautics and Space Administration ("NASA"), Desert Research Institute, and Environmental

"water use constant." For fields larger than both 0.5 acres and 30 x 30 meters, OpenET was used. ADWR used the water use constant provided by the *Phoenix Lawn Watering Guide*[108] to approximate annual water use only for fields less than 0.5 acres or 30 x 30 meters. Additionally, *irrigation application efficiencies*[109], used in the calculations of annual water use (used in both procedures), were derived using the methods outlined from The University of Arizona's *Determining the Amount of Irrigation Water Applied to a Field* (Martin, 2011).

<u>Estimating Volume for Fields Larger Than 0.5 Acres and 30x30 Meters</u>

OpenET provides remotely-sensed ET using *multi-model values*.[110] Using multi-model values is a common practice in the climate sciences and has shown to yield estimates, on average, equally or more accurate than any individual model (OpenET, 2025). These ET measurements come from a variety of satellites and, primarily, the *Landsat*[111] program.

Defense Fund with support from Google Earth Engine, USDA, USGS, and universities nationwide (see https://etdata.org/).

[108] "The average 15'x15' [1.39 m^2] bermudagrass lawn uses over 5,000 gallons [18.93 m^3] of water per year" (City of Phoenix, n.d.).

[109] Irrigation application efficiencies refer to the overall irrigation system's ability to apply an equal amount of water to a field. No irrigation system (e.g. drip, sprinkler, central pivot, etc.) is 100% efficient.

[110] Five models create the sixth ensemble model which provides an average of those models after outliers are removed (OpenET, 2025).

[111] Landsat is a satellite mission program run by the USGS most commonly to capture multi-spectral imagery including visible light imagery and thermal imagery. ADWR used Landsat 8 and 9 because they use the thermal band for OpenET (Earth Resources Observation and Science Center, 2020).

OpenET provides data at a spatial scale of 30 meters by 30 meters (0.22 acres), as well as data from a variety of temporal scales including daily, monthly, and yearly *timesteps*.[112] To calculate the volume of water for the Irrigation Use, the following data is required to run the tool: the field's acreage, the growing season, ET, local precipitation data, and the type of irrigation application system used.

1. The polygon created in ArcPro provided a number of acres for the field of interest. The geometry was then uploaded to OpenET to acquire monthly ET rates on a field-by-field basis.
2. The growing season was estimated and rounded to the nearest month for each irrigated field.[113]
3. ADWR downloaded and converted ET rates, using the previously determined growing season, to inches per month.
4. Precipitation data, obtained from GridMET, was summed to a monthly timescale and converted to inches (Abatzoglou, 2013, 2024). Effective precipitation was calculated following the USDA methods outlined in the 1970 *National Engineering Handbook* (U.S. Department of Agriculture, 1993).
5. Net irrigation requirement ("NIR") and estimates annual water use for fields greater than 0.5 acres *and* 30x30 meters were calculated following the methodology outlined by the Food and Agriculture Organization ("FAO") (Brouwer & Heibloem, 1986).

   Irrigation application efficiencies used in the calculations of annual water use were drawn using the methods outlined by The University of

[112] A timestep is an equally spaced unit of time used for collecting and analyzing time series data.

[113] Using information obtained from the *Western Regional Climate Center* (Western Regional Climate Center, 2006)

Arizona's *Determining the Amount of Irrigation Water Applied to a Field* (Martin, 2011). ADWR determined the irrigation application system using aerial imagery, DEMs, and associated filings.

The final quantity of use was calculated as a range of values in acre-feet per annum, due to the variability in application efficiencies. If a field's application system changed within the past five years of the time of investigation, quantification calculations were performed for all application types for a comprehensive understanding of water usage throughout time. However, the final calculated quantity was based on the current application system(s).

Estimating Volume for Fields Less Than 0.5 Acres or 30 x 30 Meters

If a field was under 0.5 acres, ADWR observed the data from OpenET would provide skewed data due to the limited spatial resolution. OpenET would compensate by pulling data from the surrounding area, thus resulting in an inaccurate estimate. Therefore, as a conservative measure, ADWR used the formula from the *National Engineering Handbook's Irrigation Guide* to estimate the annual water use for any field less than or equal to 0.5 acres *OR* any field with a length or width less than 30 meters (U.S. Department of Agriculture, 1997, p. 225). The water use constant provided by the *Phoenix Lawn Watering Guide* was used as a substitute for NIR to quantify small scale (<0.5 acres) irrigation uses (City of Phoenix, n.d.).

$$Volume\ of\ Water = \frac{Acres * Water\ Use\ Constant}{Efficiency}$$

Due to the limited size of the field, NIR was substituted with the water use constant, then multiplied by the field's acres. The efficiencies used in the formula were sourced from Table 2 in The University of Arizona's *Determining the Amount of Irrigation Water Applied to a Field* (Martin, 2011).

Irrigation Use Recommendation

Recommendations were made based on comparing the claimed quantity of water to the calculated quantity. ADWR reviewed the quantities for a specific Irrigation Use for the five years prior to the start of the investigation (e.g., if an investigation of an Irrigation Use started in 2025, water quantities were reviewed from 2020 to 2025). If the claimed quantity was within or less than the calculated range, then the claimed quantity was recommended. If the claimed quantity was greater than the calculated range, then the maximum value within the calculated range was recommended. Flow rate was calculated from the recommended quantity by converting the recommended quantity to CFS if the flow rate was greater than or equal to 1.0 CFS (0.028 m^3/s), or gallons per minute ("GPM") (Liter/min) if the flow rate was less than 1.0 CFS (0.028 m^3/s). Flow rates were only calculated for uses with a recommended quantity of water and were noted in the WFR and/or proposed abstract.

4.4.3 Stock Watering Uses

Overview

For purposes of this Preliminary HSR, a Stock Watering Use was defined as a water use for the purpose of watering livestock and wildlife.

ADWR separated Stock Watering Use investigations into three categories: Stock Watering Use (other than from a stockpond or streamside), Stock Watering Streamside Use, and Stock Watering from a Stockpond Use. These Stock Watering Uses were investigated using the general methodology described in **Section 4.3** in addition to the following stock watering-specific variations.

Stock Watering Use (other than from a stockpond or streamside) Methodology

A Stock Watering Use (other than from a stockpond or streamside) is the watering of livestock or wildlife occurring from a developed facility such as a drinker, trough, pipeline, or spring box.

ADWR reviewed documented information, such as Annual Operating Instructions, to confirm the presence of stock animals. When reviewing historical aerial imagery, ADWR identified Stock Watering Uses by the presence of drinkers, troughs, pipelines, corrals, stables, or spring boxes. To digitize the POU, ADWR created an in-house ArcPro tool to create a square polygon around the location of a small feature like a spring or a well. The square was centered around the small feature and extended 20 meters in each direction, to ensure consistency in digitizing these features. However, if the POU spanned a large area, like a piece of land with multiple movable drinkers, then the polygon was drawn to encompass the entire area. A POD was digitized in ArcPro as a point feature and placed at the location where water was diverted from (i.e., well, surface water source, spring, etc.). ADWR did not assume a Stock Watering Use occurred directly from an undeveloped spring or a well unless the filings for the use indicated it. Additionally, ADWR reviewed topographic maps or the SSI to locate named springs or wells.

If the Stock Watering Use was determined to be *de minimis*, ADWR recommended the specific quantity of water to assign to the use, as ordered by the Adjudication Court. See **Section 4.4.9** for more information on *de minimis* uses.

Stock Watering Streamside Methodology

A Stock Watering Streamside Use is the watering of livestock and wildlife from a naturally occurring (undeveloped) water course.

Stock Watering Streamside Uses were difficult to identify without reviewing any associated documents due to the lack of undeveloped features. ADWR reviewed additional information, including the USFS Annual Operating and/or grazing leases, to confirm the presence of livestock. Also, aerial imagery sometimes shows evidence of livestock animals, such as corrals or troughs.

To digitize the POU, the polygon was drawn to encompass the entire watercourse within the claimed legal location. For the POD, the point was placed at the most upstream point of the water course within the WFR (*See* Order to Map Stock Watering Uses, *In re SLD – Magoffin I*, Contested Case No. W1-11-003338 , at 3 (Jul. 24, 2020)). The Diversion Type used for this type of use was Streamside. Although the water was not necessarily diverted, the POD was assumed to be where the appropriable water for a Stock Watering Streamside use began. Due to the difficulty in identifying Stock Watering Streamside Uses from aerial imagery, the apparent first use date was usually determined from available documented information, such as the grazing leases. If no documented information was provided, and ADWR could not determine the apparent first use date, then ADWR did not list one in the WFR and/or proposed abstract.

If the Stock Watering Streamside Use was determined to be *de minimis*, ADWR recommended the specific quantity of water to assign to the use, as ordered by the Adjudication Court. See **Section 4.4.9** for more information on *de minimis* uses.

Stock Watering from a Stockpond Methodology

A Stock Watering from a Stockpond Use is the watering of livestock and/or wildlife from a constructed pond (impoundment) with a dam of some kind. A Stockwatering from a Stockpond Use is only designated for impoundments used solely to water livestock and wildlife.

A stockpond is commonly distinguished by an *earthen berm*[114] damming water from a drainage channel, and usually constructed without outlet controls, except for a spillway. ADWR used aerial imagery and topographic maps to identify these impoundments. Additionally, the DEM was used in ArcPro to help identify berms or other features linked

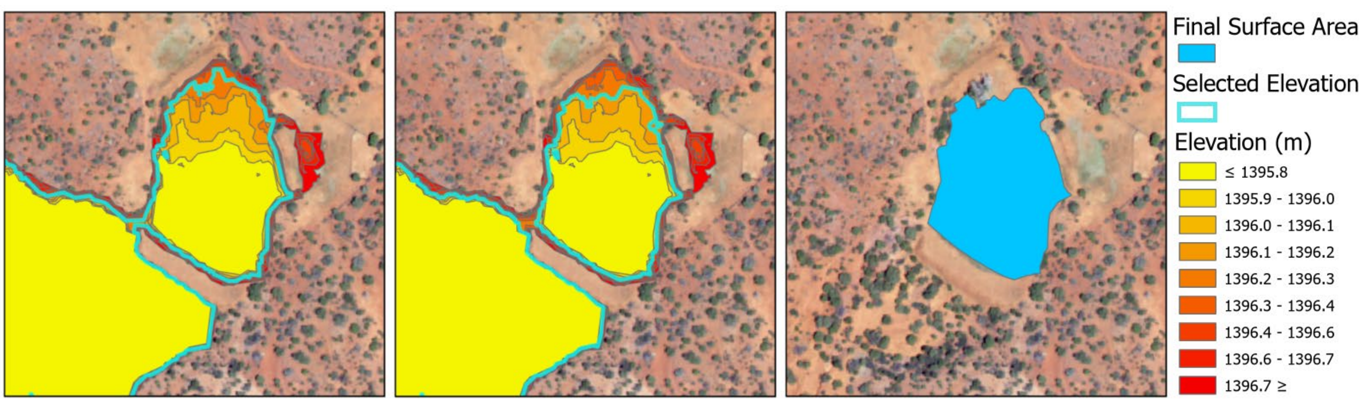
[114] An earthen berm is a raised mound of earth used to impound water.

with potential stockponds (e.g., inlet, spillway, etc.). Evidence of livestock animals, such as corrals or troughs, seen in aerial imagery, helped identify a Stock Watering from a Stockpond Use.

ADWR created an in-house ArcPro tool to create a polygon to represent the maximum capacity for each impoundment. First, to run the tool, ADWR identified the center of the impoundment, and then determined the *spillway elevation*[115] of the impoundment using the Digital Elevation Model. Then, from the tool's output, ADWR identified the impoundment's surface area at the maximum elevation of the impoundment down to one-tenth (0.1) of a meter. The resulting surface area was used to digitize the POU for the impoundment (see **Figure 4-9**). However, if the impoundment's POU was split between WFR boundaries, then the POU was drawn as two separate polygons along that boundary and recorded in both WFRs. A POD was digitized in ArcPro as a point feature and placed at the center of the berm. The Diversion Type for this type of use was typically "Impoundment."

Figure 4-9

Digitizing an Impoundment at Maximum Capacity in ArcPro



[115] The estimated spillway elevation was used to re-classify the raster along 0.1-meter increments +/- 0.5 meter (m) from the estimated spillway elevation. The resulting reclassified raster is converted to a shapefile and merged to provide a series of water level elevations from 0.1-meter increments at +/- 0.5 of a meter (m) from the estimated spillway elevation.

When reviewing historical aerial imagery, ADWR made note of any indication of a change to the Stock Watering from a Stockpond Use (e.g., breaches, expansion, reduction, etc.) over time in the WFR and/or proposed abstract.

If the Stock Watering from a Stockpond Use was determined to be *de minimis*, ADWR recommended the specific quantity of water to assign to the use, as ordered by the Adjudication Court. See **Section 4.4.9** for more information on *de minimis* uses.

Impoundment Site Inspection Using Drone Technology

A field inspection could help determine whether the claimed quantity of water put to beneficial use was consistent with the current capacity of the impoundment. A field inspection for impoundments typically occurred for a Stock Watering from a Stockpond Use or a Water Storage Use (see **Section 4.4.8**). Inspections occurred if the impoundment changed shape or size (i.e., breached, enlarged, etc.) since the issuance of its CWR, or if the impoundment had an associated Statement of Claim of Right ("36-") with a pre-1919 claimed priority date.[116]

ADWR used drone technology and its associated tools, such as *ground control points* ("GCPs")[117], sonar bobbers, photogrammetry software, and ArcPro, to determine the maximum capacity for impoundments. A flight plan for the drone was created after determining the surface area (see **Figure 4-9**). To prepare for the site visit, ADWR used professional judgement to draw the flight path for the drone in the drone's flight software,[118] using the impoundment's surface area as reference. The drawn flight path included the impoundment in its entirety to ensure a complete 3D model. The drones were typically programmed to fly between 150 ft and 200 ft above the ground and took pictures in a crosshatch pattern with an overlap of 70%. Thus, each consecutive picture contained

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[116] Generally, site inspections were not conducted for uses determined to be *de minimis*.

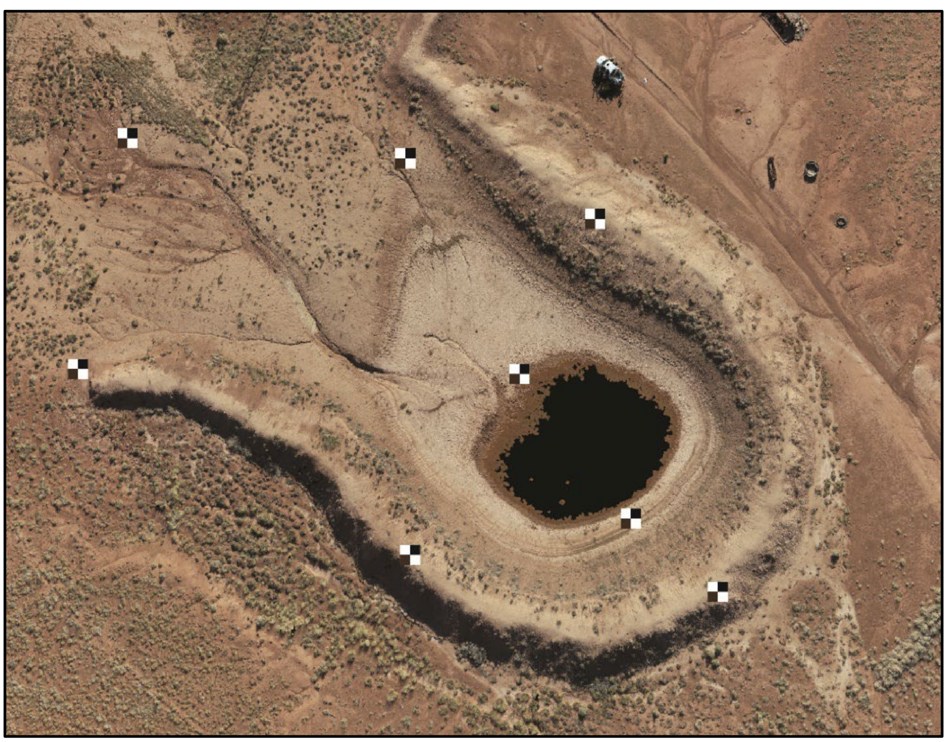
[117] GCPs are reference points with a known geographic location.

[118] Autel Explorer, DJI GS Pro, or Drone Deploy depending on the type of drone used for the inspection

70% of the area from the previous picture. The drone completed the flights autonomously using the previously mentioned pre-flight specifications. The drone pilot and at least one visual observer always monitored the flight.

At the site, GCPs were placed. The post-processing of the drone's aerial imagery with the GCPs created an accurate 3D-model of the impoundment. GCPs were spread out across the impoundment at points of interest and varying elevations (example shown in **Figure 4-10**), such as the highest point on the berm, the edge of the water, the spillway, the inlet, and other notable features like breaches. After the GCPs were placed, the coordinates and elevation of each point were recorded using a Trimble R10 RTK unit (see **Figure 4-11**).[119] The horizontal and vertical measurements were within 15 millimeters (mm), according to the Trimble R10 performance specifications.

Figure 4-10
Example of Ground Control Point ("GCP") Placement at Points of Interest for an Impoundment



[119] Trimble R10 MODEL 2 GNSS SYSTEM Product Description

Figure 4-11

ADWR Personnel Placing and Logging Ground Control Points During a Field Investigation

The drone captures images from *above* the water's surface, so if an impoundment was holding water at the time of inspection, the depth was calculated separately. A Deeper Sonar Pro or Deeper Chirp sonar bobber was used to calculate the depth from the water surface to the bottom of the impoundment. The Deeper Sonar Pro reaches a minimum depth reading of 2.0 ft (0.6096 m) and the Deeper Chirp reaches a minimum depth reading of 6.0 inches (in) (15.24 cm), making the Deeper Chirp ideal to measure shallow water. A sonar bobber was attached to a fishing rod and slowly reeled back to land to calculate multiple depth measurements (see **Figure 4-12**). Repeating this process at multiple points along the pond allowed for a complete and accurate representation of the impoundment below the water surface.

Figure 4-12
ADWR Personnel Casting a Fishing Rod with an Attached Sonar Bobber During a Field Inspection

ADWR used photogrammetry software, known as Pix4D, to stitch the images captured by the drone together and create a 3D model (see **Figure 4-13**). To ensure the 3D model was as accurate as possible, the GPS points measured by the Trimble R10 unit were matched to each GCP. ADWR calculated the volume of the impoundment above the water's surface using tools within Pix4D. The volume below the water's surface was calculated using the "Create TIN" and "Polygon Volume" tools in ArcPro. After calculating the volume below the water surface, the result was added to the volume from Pix4D to determine the impoundment's total volume or maximum capacity (see **Figure 4-14**). The result was recorded and used to assist in the investigation process.

Figure 4-13

Example Pix4D Rendering of an Impoundment Captured by a Drone

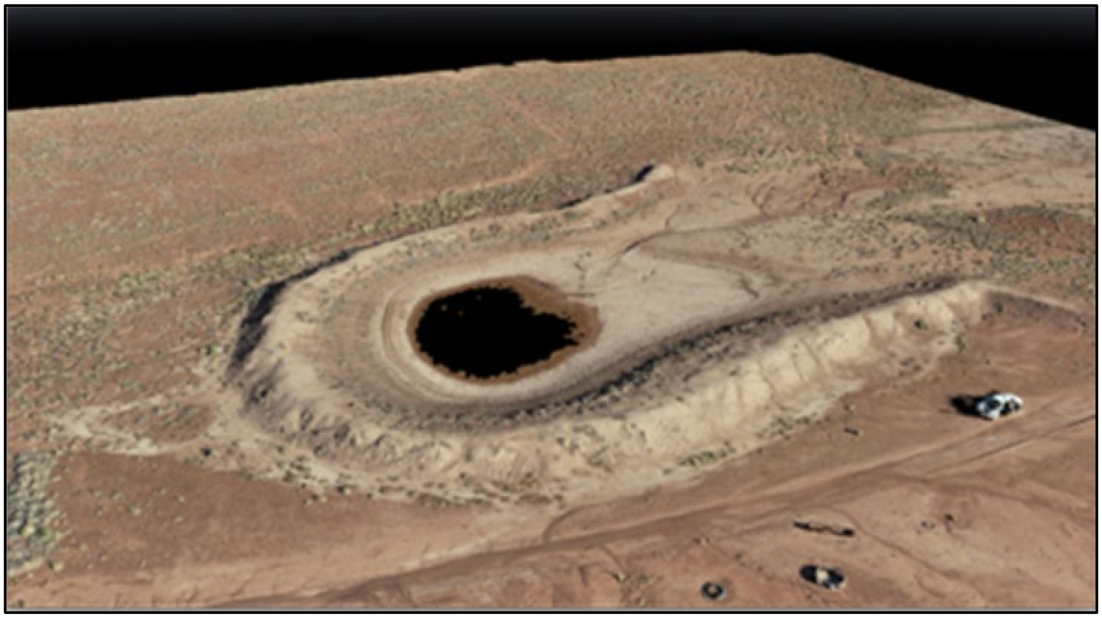
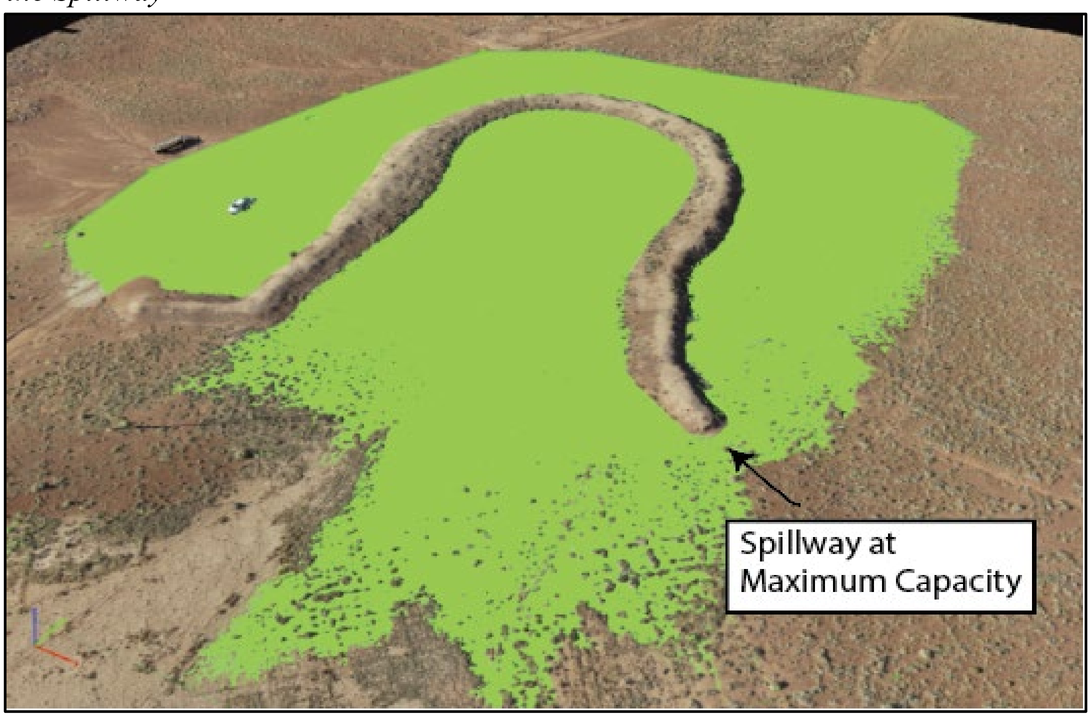


Figure 4-14

Example Pix4D Output Used to Determine the Maximum Fill of an Impoundment at the Spillway



4.4.4 Wildlife Uses

Overview

For purposes of this Preliminary HSR, a Wildlife Use is defined as the use of water for wildlife or fish. This is typically, but not always, an incidental use.

Methodology

Wildlife Uses were investigated using the general methodology described in **Section 4.3** in addition to the following wildlife-specific variations.

To begin a Wildlife Use investigation within a WFR, ADWR reviewed any documented information with the claimed POU. Generally, Wildlife Uses are not identified without filings since any source of water consumed by wildlife is incidental.

Once a Wildlife Use was identified, the POU and POD were digitized. In ArcPro, a Wildlife POU was digitized as a polygon feature. ADWR changed the type of polygon feature and/or the method for creation based on whether the claimed Wildlife Use occurred from a developed facility (e.g. drinker, trough, etc.), a naturally occurring water course, or an impoundment. ADWR digitizes these features using the same methodology for Stock Watering Uses (**Section 4.4.3)**. Based on the type of POU feature determined the POD's digitized placement.

Typically, historical aerial imagery was used to determine the apparent first use date for Wildlife Uses associated with developed facilities (i.e., wells, movable drinkers, etc.) However, means other than aerial imagery, such as the *Annual Operating Instructions* and CWRs, were used to verify the apparent first use date for Wildlife Uses occurring from naturally occurring water course. ADWR also reviewed topographic maps to locate named springs, impoundments, or wells.

If the Wildlife Use also met the *de minimis* requirements, ADWR recommended the specific quantity of water to assign to the use, as ordered by the Adjudication Court. See **Section 4.4.9** for more information on *de minimis* uses.

4.4.5 Domestic Uses

For the purposes of this Preliminary HSR, a Domestic Use is defined as, "a single appropriative water right serving a residence, or multiple residences up to a maximum of three residential connections" (A.R.S. § 45-251). ADWR interpreted the number of connections to mean the number of dwellings. Domestic Uses also include irrigation of up to 0.5 acres of land, including lawns, gardens, or landscaping, and watering of pets and farmyard animals. If more than 0.5 acres of associated irrigation was determined, the use was reported as an Irrigation Use (see **Section 4.4.2**).

Methodology

Domestic Uses were investigated using the general methodology described in **Section 4.3** in addition to the following domestic-specific variations.

Potential Domestic Uses were identified and confirmed via aerial imagery. Additional documented information ADWR reviewed included county zoning regulations, information from the County Assessor, and CWS boundaries. County zoning regulations helped determine if local regulations allowed for multiple dwellings. Information obtained from the County Assessor confirmed the existence of a dwelling by providing property information, documentation on improvements made, and legal classification[120] based on the current use of the property. The County Assessor also provided information regarding current ownership or deed transfer history. Finally, before digitizing the Domestic Use, ADWR used a CWS boundary layer in ArcPro to confirm whether the dwelling was within a CWS Service Area. A dwelling within a CWS boundary may be investigated as a Municipal Use (**see Section 4.4.1**), whereas a dwelling outside of the boundary is likely self-supplied and investigated as a Domestic Use.

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[120] https://azdor.gov/sites/default/files/2023-03/PROPERTY_PropertyClassification.pdf

Once a Domestic Use was identified, the POU and POD were digitized. In ArcPro, the POU point feature was placed in the center of the confirmed dwelling. If more than one dwelling (up to 3) was associated with the Domestic Use, then the POU point feature was placed in the center of the WFR boundary. A POD point feature was digitized if documented information specified the location and existence of a POD. The most common POD for a Domestic Use is a well. Certain wells exhibited associated structures, such as windmills or pump houses, detectable in aerial imagery.

ADWR reviewed historical aerial imagery to determine the apparent first use date of a Domestic Use. Factors, such as the presence of an air conditioning box, the shape of the property, distinctive driveways, developed roadways, vegetation, animals, and/or presence of vehicles usually indicated a structure was a dwelling. Google Earth Street View and real estate websites provided helpful viewpoints of the property to identify structures, as well as find information the County Assessor lacked, such as the year the dwelling was built. ADWR assumed the date the dwelling was constructed was the date water was first put to beneficial use. However, if the Well Registration Filing states a well was installed after the dwelling's construction date, then the well's completion date was recorded as the apparent first use date.

ADWR reviewed aerial imagery to determine if an Irrigation Use was associated with the confirmed dwelling. ADWR used the "Measure Area" tool in ArcPro to determine the size of the irrigated area from a drawn polygon. If the polygon's surface area was larger than 0.5 acres, then the irrigated area was investigated as an Irrigation Use separate from the Domestic Use (see **Section 4.4.2**).

If the Domestic Use also met the *de minimis* requirements, ADWR recommended the specific quantity of water to assign to the use, as ordered by the Adjudication Court. See **Section 4.4.9** for more information on *de minimis* uses.

4.4.6 Recreation Uses

Overview

For purposes of this Preliminary HSR, a Recreation Use is defined as the use of water for recreation activities such as using a lake for swimming, fishing, or boating activities.

Methodology

Recreation Uses were investigated using the general methodology described in **Section 4.3.** in addition to the following recreation-specific variations.

To begin a Recreation Use investigation, ADWR reviewed documented information of the property. Generally, Recreation Uses are not identified without filings or documented information claiming the use since any source of water used for recreation is incidental.

Once a Recreation Use was identified, the POU and POD were digitized. In ArcPro, a Recreation POU was digitized as a polygon feature. The type of polygon feature created, and the method used, depended on if the Recreation Use occurred at a developed facility, a naturally occurring water course, or an impoundment. These differences also determined how the POD was digitized. ADWR digitizes these features using the same methodology for Stock Watering Uses (**Section 4.4.3)**.

Historical aerial imagery was reviewed to determine the apparent first use date of a Recreation Use. Some Recreation Uses were difficult to identify in aerial imagery; however, public parks, docks, etc. were possible indicators used to determine the apparent first use date.

4.4.7 Institutional, Industrial, Commercial Uses

Overview

For the purposes of this Preliminary HSR, an Institutional Use includes uses by schools, churches, governments, and hospitals. An Industrial Use includes manufacturing uses. A Commercial Use includes gas stations, restaurants, RV parks, and private campgrounds.

Methodology

The above-referenced use types, although different, were investigated using the general methodology described in **Section 4.3** in addition to the following specific variations.

Property details obtained from the County Assessor on taxable and nontaxable information, ownership, as well as legal classification for all properties based on current use of the property were used to identify the above-referenced uses. If landowner name indicated a specific use type (i.e., if the landowner's name included terms like "Church," or "University," etc.), then ADWR classified the use as such.

Once identified, the POU and POD were digitized. In ArcPro, the POU was digitized as a polygon feature. The polygon encompassed the entire use. A POD was digitized in ArcPro as a point feature if documented information specified the location and existence of a POD. However, if the Department was unable to determine the location of the POD, the POD was either digitized within the center of the parcel or not digitized at all. If a POD was not digitized, then the water source was listed as "Unknown" in the WFR and/or proposed abstract.

4.4.8 Water Storage Use

Overview

For the purposes of this Preliminary HSR, a Water Storage Use is defined to include water stored both above ground (in a lake) or injected underground as recoverable or non-recoverable recharge. Typically, another primary use is associated with the Water Storage Use, unless the use is only for recharge (e.g., Water Storage and Recreation Uses or Water Storage and Municipal Uses).

Methodology

Water Storage Uses were investigated using the general methodology described in **Section 4.3.** in addition to the following water storage-specific variations.

ADWR used aerial imagery and topographic maps to identify the Water Storage Uses. Additionally, the DEM was used in ArcPro to identify berms or other features associated with potential Water Storage Uses (e.g., spillway, inlet, etc.). Once ADWR identified a Water Storage Use, the POU and POD were digitized. In ArcPro, a Water Storage POU was digitized as a polygon feature. The type of polygon feature created, and the method used, depended on if the Water Storage Use occurred from a developed facility or an impoundment. ADWR digitizes these features using the same methodology for Stock Watering Uses **(Section 4.4.3)**. A POD was digitized in ArcPro as a point feature, but the Diversion Type varied depending on the water source.

When reviewing historical aerial imagery, ADWR made note of any indication of a change to the Water Storage Use (e.g., breaches, expansion, reduction, etc.) over time in the WFR and/or proposed abstract.

4.4.9 De Minimis Uses

Water claims made under state law for domestic, stockpond, and stock and wildlife watering use within the Verde River Watershed may constitute *de minimis* water uses and may be *summarily adjudicated*[121] (De Minimis Order, at 14.). Summary adjudication procedures are based on factual findings and legal conclusions for the above-referenced use types within the Watershed. The Adjudication Court found that if these beneficial use

[121] Summary adjudication aims to expedite the legal process by resolving specific, undisputed issues before trial, potentially narrowing the scope of the trial or even leading to a complete resolution of the case. "Summary adjudication" means those procedures used by the court to adjudicate de minimis water uses in a simplified and expedited manner while safeguarding the statutory and due process rights of the litigants involved (*In re the Gen. Adjudication of all Rights to Use Water in the Gila River Sys. & Source, In re Sands Group of Cases and Other Related Cases* (consolidated) No. W1-11-19, at 11 (Ariz. Super. Ct. Maricopa Cty. Nov. 14, 1994)).

types used small amounts of water, then the benefits of summarily resolving the claims outweighed the costs of losing specificity in determining the exact attributes of the associated water rights. This process is meant to limit disputes and expedite the adjudication of water rights. Claimants may opt out of these non-mandatory procedures. On proposed abstracts for uses classified as *de minimis,* the following will appear under the recommended quantity:

> Stock Watering from a Stockpond: "Not to exceed (≤) 4 acre-feet in capacity with continuous fill."[122]
>
> Stock and Wildlife Watering: "Reasonable use."[123]
>
> Domestic: "The claimed quantity, not to exceed (≤) 1 acre-foot per year."[124]

ADWR identified existing *de minimis* water uses based on the documented information. If any filings associated with the uses suggested the amount of water used was above the *de minimis* threshold, or if the use was in any other way not aligned with the *de minimis* classifications, then the use was not classified as *de minimis*. If the information suggested the water use was eligible for *de minimis* classification, ADWR classified the use as *de minimis* and created a proposed abstract.

See **Appendix E** for the searchable index notating all uses recommended for *de minimis* classification, in addition to all the potential *de minimis* uses lacking necessary information. The deadline to provide additional or updated information for a de minimis use to be eligible for prioritized review is 60 days prior to the publication of the Final HSR, currently set for September 12, 2026.

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[122] De Minimis Order, Attachment I at 5-6.

[123] De Minimis Order, Attachment I at 6.

[124] De Minimis Order, Attachment I at 5.

4.4.10 Federal Reserved Water Right Claims

The *Federal Reserved Water Rights Doctrine* states that when the federal government sets aside lands for a particular purpose, it also reserves enough water to support that particular purpose. This includes land set aside for federally recognized Tribal Reservations, National Parks, and other public land. A federal reserved water right cannot be made for more water than the amount available at the time the land was set aside.[125] Such water rights only extend to the minimal amount necessary to accomplish the purpose for which the land was set aside. Furthermore, a federal reserved water right receives a priority date based on the date the land was reserved. Federal reserved water right claims are only investigated if an associated SOC detailing the federal reserved water right claim was submitted. Furthermore, the claimant is responsible for providing evidence to demonstrate the claimed quantity is reasonable. Evidence should supply the calculations used to determine the minimum quantity of water necessary to support the claim, as well as the federal documentation to support the reserve's establishment.

In instances where the federal reserved water right claim lacked supporting information, ADWR noted the discrepancies on the associated WFR and/or proposed abstract.

[125] *See Winters v. United States*, 207 U.S. 564 (1908); *Arizona v. California*, 373 U.S. 546 (1963); *Cappaert v. US*, 426 U.S. 128 (1976); *United States v. New Mexico*, 438 U.S. 696 (1978).

Chapter 5: Investigation Results

5.1 Summary of Findings

ADWR identified approximately 1,418 Domestic Uses, 717 Stock Watering from a Stockpond Uses, 122 Stock Watering Uses (other than from a stockpond or streamside), 17 Stock Watering Streamside Uses, 49 Wildlife Uses, 11 Irrigation Uses, 2 Municipal Uses, 8 Industrial Uses, 1 Recreation Use, 1 Small Water Provider Use, 27 Commercial Uses, 5 Water Storage Uses, and 12 Institutional Uses within the Sycamore Subwatershed during the investigation period.[126] Of the total number of water uses identified, approximately 618 were recommended for summary adjudication (*de minimis*). In total, ADWR proposed approximately 297 water rights.

Any person or entity who uses water or made a claim to use water on a property within the Sycamore Subwatershed may review all documents related to their WFR of interest. A WFR may be designated for determination in a contested case, in which the Adjudication Court will schedule conferences and/or hearings to occur.

5.2 How to View Watershed File Reports

ADWR developed an interactive map for the public to locate the WFRs and documented information contained within them. The online interactive map illustrates ADWR's preliminary findings associated with this Preliminary HSR which intends to assist the public as well as the Adjudication Court. The online application titled *Sycamore Subwatershed Preliminary HSR Interactive Map* is located under the "Find Your WFR" section of the Preliminary HSR webpage on ADWR's website at www.azwater.gov/adjudications/sycamorehsr.

[126] ADWR conducted investigations from October 2023 to September 2025. Changes to the reported information occurring after September 6, 2025, were not reflected in this report.

5.3 How to Understand Watershed File Reports

WFRs contain the detailed investigation results of individual water uses and claims within each WFR boundary. The information is intended to help the Adjudication Court determine the extent and priority of water rights.

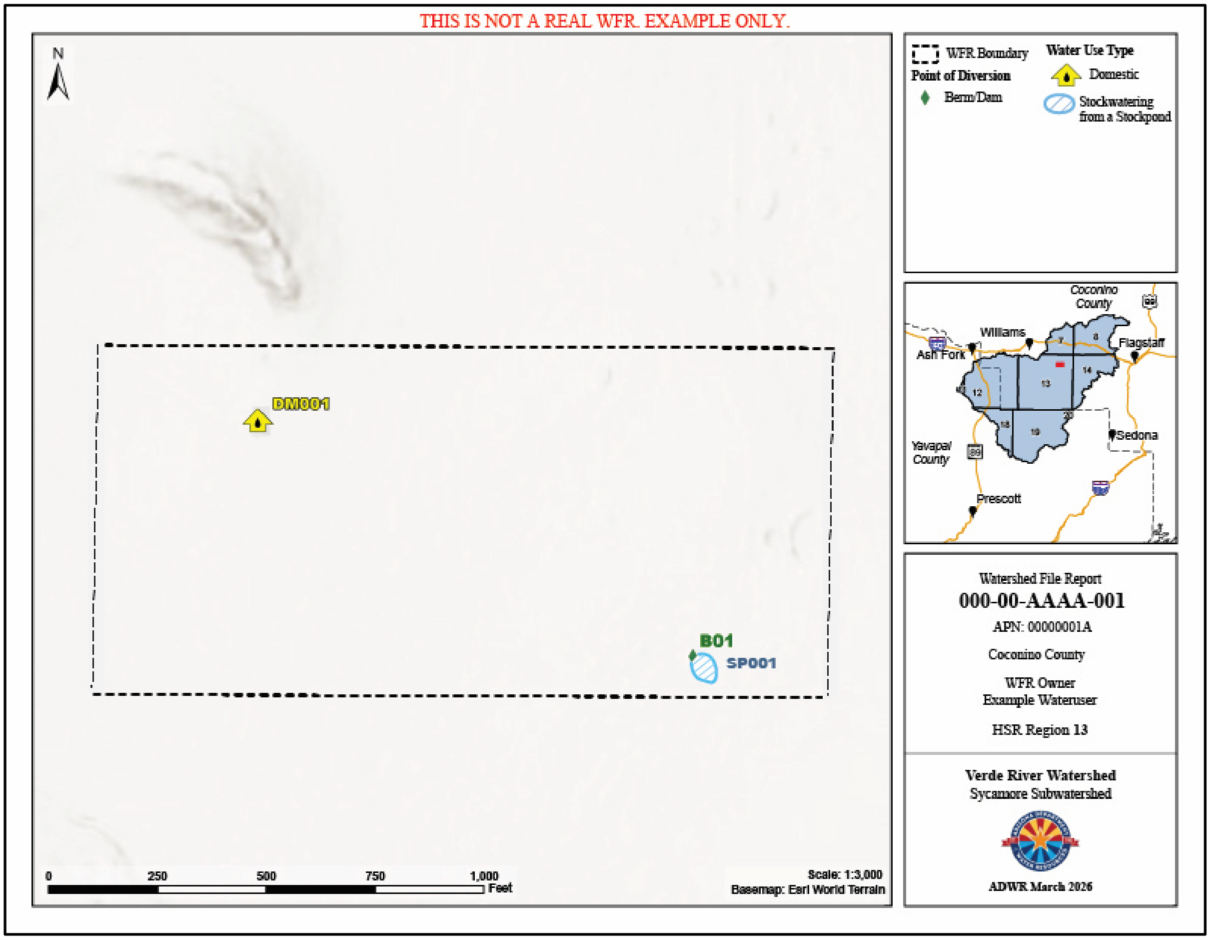
The WFR will always include the following pages: *WFR Overview*, *Summary of the Analysis of Claims and Uses Related to this Property*, and *Summary and Analysis of Filing(s)*. WFRs with recommended water right attributes will also contain a *Proposed Abstract of Potential Water Right* page. The WFR is organized into two sections: *Uses With Recommended Rights* and *Uses Without Recommended Rights*.

5.3.1 The WFR Overview Page

The *WFR Overview* page consists of a detailed map showing the specific WFR boundary and its investigated water use(s), symbology to describe the use(s), an inset map to show where in the Sycamore Subwatershed the WFR is located, as well as identifying information unique to the WFR. An example of the *WFR Overview* page is provided in **Figure 5-1**.

Figure 5-1

Example of a WFR Overview page



The water use and the Diversion Type (see **Section 4.3.2**) are illustrated on the overview map at the POU and POD, respectively, where applicable (see Appendix F for use type symbology).

Information unique to the WFR includes the WFR number, APN (when applicable), the county, WFR Owner, and HSR Region. 127 As mentioned in **Section 4.2.3**, the WFR number is the unique identifier for each property investigated in the Subwatershed. The APN is the unique identifier for the property assigned by the County Assessor.

[127] The Verde River Watershed is split up into HSR regions, and each region is assigned a number (**see Section 4.2.3**).

5.3.2 *The Summary of the Analysis of Claims and Uses Related to this Property Page*

The *Summary of the Analysis of Claims and Uses Related to this Property* page consists of a table summarizing all findings related to the property. An example of the *Summary of the Analysis of Claims and Uses Related to this Property* page is provided in **Figure 5-2**.

Figure 5-2

Example of a Summary of the Analysis of Claims and Uses Related to this Property Page

THIS IS NOT A REAL WFR. EXAMPLE ONLY.

WFR NUMBER:000-00-AAAA-001 WFR OWNER: Example Wateruser

SUMMARY OF THE ANALYSIS OF CLAIMS AND USES RELATED TO THIS PROPERTY

USE ID	RECOMMENDED WATER RIGHT	ALL ADWR FILINGS	USES DETERMINED BY ADWR	WATER SOURCE DETERMINED BY ADWR	POU LOCATION DETERMINED BY ADWR (LEGAL DESCRIPTION)	POD LOCATION DETERMINED BY ADWR (LEGAL DESCRIPTION)	FACILITY OR RESERVOIR NAME	APPARENT FIRST USE DATE DETERMINED BY ADWR (WITH SOURCE)
DM001	NO		DOMESTIC		NENENE00 00N 00E			06/27/1972 NASA AERIAL IMAGERY
SP001	YES	39-00000 33-00000	STOCK WATERING FROM A STOCKPOND	UNNAMED WASH	SESENW00 00N 00E	B01-SESENW00 00N 00E	EXAMPLE TANK	03/07/1954 CWR No. 33-00000
UNK-IR001	NO	39-99999						

Place of Use and Point of Diversion locations are derived from the Gila and Salt River Baseline and Meridian

The following elements appear on the *Summary of the Analysis of Claims and Uses Related to this Property* page:

1. **Use ID**: A unique identifier assigned once a POU is created.

2. **Recommended Water Right**: Specifying if ADWR recommended a water right.

3. **Filings**: All filing numbers associated with investigated uses. If no filings associated with the use existed, then the cell was left blank.

4. **Use Occurring**: The apparent water use that occurred in the five years preceding the close of the investigation period for this Preliminary HSR. If no apparent water use was evident, then the cell was left blank.

5. **Use Types Investigated in this Preliminary HSR**: Municipal, Irrigation, Stock Watering, Wildlife, Domestic, Recreation, Institutional, Commercial, and Water Storage.

6. **Water Source**: ADWR determined the source of water where possible. When not enough information was provided to determine the water source, then the cell was entered as "Unknown."

7. **POU**: Legal cadastral location of where the water was used. If associated filings exist, but no apparent uses for them do, then this cell was left blank.

8. **POD**: Legal cadastral location where the water was diverted from the water source. If a POD could not be determined, then this cell was left blank.

9. **Facility or Reservoir Name**: Used to differentiate facilities or reservoirs from one another. Names are often assigned to these types of features to provide clear identification on maps and property records. If a facility or reservoir name was not listed on the summary page, then either no information was provided to ADWR specifying the feature's name, or the water use was not associated with a facility or reservoir.

10. **Apparent First Use Date and Source**: As mentioned in *Aerial Imagery Review* (**Section 4.3.4**) of this report, the apparent first use date is determined by ADWR using available aerial imagery and documentation associated with each use. If a use's apparent first use date could not be determined, then this cell was left blank. See **Table 5-1** (pg. 137) for a list of abbreviations used in the WFRs for the apparent first use date sources. See **Appendix D** for a complete list of the aerial imagery used for this Preliminary HSR.

5.3.3 The Summary and Analysis of Filing(s) Page

The information on this page solely represents the information provided to ADWR from each filing since the information received was entered "as is" into its respective database.[128] In most instances, ADWR was not required to verify the information provided in each filing upon receipt.[129] ADWR manually entered the information into the internal databases managed by different Sections within the Department with individual data entry processes. Additionally, as with any manual data entry, there may be data entry errors, such

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[128] On the left-hand side, certain categories specify the attribute is "claimed." Claimed means the person or entity asserted it and has not been confirmed by ADWR or the Court.

[129] The findings within this Preliminary HSR (see the *WFR Overview*, *Summary of the Analysis of Claims and Uses*, and *Proposed Abstract of Potential Water Right* pages) represent the investigated results and findings verified by ADWR. Certain filings (e.g., *Application for Permit to Appropriate Public Water*, etc.) require a substantive review upon receipt in which ADWR verified the information provided before either granting or denying the application.

as formatting inaccuracies or calculation discrepancies. An example of the *Summary and Analysis of Filing(s)* page is provided in **Figure 5-3**.

Figure 5-3

Example of a Summary and Analysis of Filing(s) Page

THIS IS NOT A REAL WFR. EXAMPLE ONLY.

WFR NUMBER:000-00-AAAA-001 WFR OWNER:Example Wateruser

SUMMARY AND ANALYSIS OF FILING(S) FOR: STOCKWATERING FROM A STOCKPOND USE (SP001)

	FILING/USE 1	FILING/USE 2	FILING/USE 3	FILING/USE 4
FILING NUMBER(S)	39-00000	33-00000	33-00000	33-00000
PERSON OR ENTITY	EXAMPLE WATERUSER	EXAMPLE WATERUSER	EXAMPLE WATERUSER	EXAMPLE WATERUSER
CLAIMED BASIS OF RIGHT	33-00000			
CLAIMED BENEFICIAL USE(S)	STOCKPOND	ANNUAL USE	WILDLIFE	STOCK
CLAIMED QUANTITY		264960 GALLONS PER ANNUM		
CLAIMED PLACE(S) OF USE	SESENW00 00E 00E	SENW00 00N 00E	SENW00 00N 00E	SENW00 00N 00E
CLAIMED POINT(S) OF DIVERSION		SENW00 00N 00E	SENW00 00N 00E	SENW00 00N 00E
CLAIMED WATER SOURCE(S)	UNNAMED WASH	UNNAMED WASH	UNNAMED WASH	UNNAMED WASH
CLAIMED PRIORITY DATE	1977	10/25/1985	10/25/1985	10/25/1985
NAME OF FACILITY	EXAMPLE TANK	EXAMPLE TANK	EXAMPLE TANK	EXAMPLE TANK
RESERVOIR CAPACITY (ACRE-FEET)	0.30934	0.32	0.32	0.32

Place of Use and Point of Diversion locations are derived from the Gila and Salt River Baseline and Meridian

The same filing number may appear multiple times in the "Filing Number(s)" row. Each column is separated by the type of beneficial use when more than one use is listed on a single filing. Generally, a column with "Annual Use" shows the total quantity of water submitted in the filing. Any additional use types may contain their individual quantity of water listed. However, what appears in these fields depends on what was entered into the internal database (see **Section 4.2.4**).

If this page is entirely blank, then ADWR could not locate any filings associated with the water use. If associated filings do exist, but some of the rows are blank, then the information was either not entered in the respective database, the information was not provided in the initial filing, or the information was not applicable to the filing and/or use investigated.

The following elements appear on the *Summary and Analysis of Filing(s)* page:

1. **Filing Number(s)**: Any filings on record with ADWR determined to be associated with the water use.

2. **Person or Entity**: The current holder of the filing on record with ADWR.

3. **Claimed Basis of Right**: The document supporting the right to appropriate surface water, asserted by the person or entity.

4. **Claimed Beneficial Use(s)**: The purpose for which the water was used, asserted by the person or entity.

5. **Claimed Quantity**: The amount of water used for the beneficial use type, asserted by the person or entity.

6. **Claimed Place(s) of Use**: Legal cadastral location of where the water was used, asserted by the person or entity.

7. **Claimed Point(s) of Diversion**: Legal cadastral location where the water was diverted from the source, asserted by the person or entity.

8. **Claimed Water Source(s)**: The source of water supplying the water use, asserted by the person or entity.

9. **Name of Facility**: The name, if applicable, to aid in identifying the water use.

10. **Claimed Priority Date**: The date when a water right was established, typically when water was first put to beneficial use or the date the application was submitted, asserted by the person or entity.[130]

The second page of the *Summary and Analysis of Filing(s)* contains any notes made by ADWR summarizing the investigation results and/or noting discrepancies between the filings. The following elements appear on the second page of the *Summary and Analysis of Filing(s)*:

1. **Code**: The water right attribute with a discrepancy or note. The codes may include the following categories: Beneficial Use, POU/POD, Water Source, Priority Date, Quantity, Claimant/Landowner, Basis of Right, or Other.[131]

2. **Explanation**: Provides a brief explanation of the reasoning behind the water right recommendations made, or discrepancies identified during the investigation.

5.3.4 The Proposed Abstract of Potential Water Right Page

ADWR only drafted a *Proposed Abstract of Potential Water Right* page when ADWR recommended any attributes of the water right (A.R.S. § 45-256(B)). Any water right attributes left blank on the proposed abstract will include a corresponding explanation in the *Additional Information* section of this page. An example of the *Proposed Abstract of Potential Water Right* page is provided in **Figure 5-4**

Uses recommended for summary adjudication (*de minimis*) will include the verbiage requested by the Adjudication Court and will be distinguished with an asterisk (*) next to the applicable *de minimis* attributes.

[130] Not provided for Well Registration Filings.

[131] "Other" indicates a discrepancy with the Statement of Claimant.

Figure 5-4

Example of a Proposed Abstract of Potential Water Right Page

THIS IS NOT A REAL WFR. EXAMPLE ONLY.

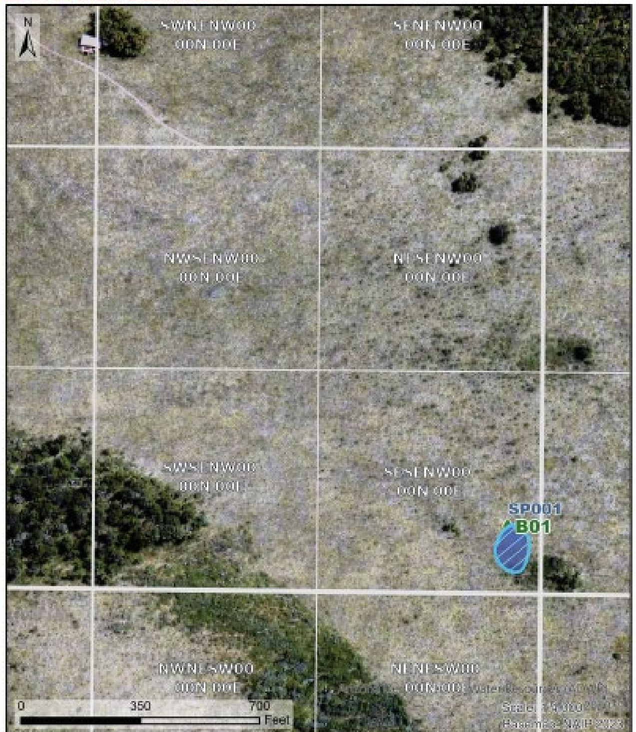
PROPOSED ABSTRACT OF POTENTIAL WATER RIGHT

1. Proposed Water Right	000-00-AAAA-001-SP001
2. Owner of Right	
3. Landowner	Example Wateruser
4. Statement of Claimant	39-00000
5. Lessee or Permittee	
6. Basis of Right	33-00000
7. Beneficial Use	Stock and Wildlife Watering From a Stockpond
8. Priority Date	*10/25/1985
9. Quantity	*Not to exceed (≤) 4 Acre-Feet in Capacity with Continuous Fill.
10. Flow Rate	N/A
11. Place of Use	SESENW Section 00 Township 00 North, Range 00 East; of the Gila and Salt River Baseline and Meridian, Coconino County, Arizona
12. Point of Diversion	B01-(-100.0000, 30.0000 WGS84) SESENW Section 00 Township 00 North, Range 00 East of the Gila and Salt River Baseline and Meridian, Coconino County, Arizona
13. Source of Water	Unnamed Wash
14. Facility Name	Example Tank

Additional Information:

* De Minimis Use:
De minimis water rights are approved in summary fashion and with less initial scrutiny than larger water rights due to their minimal impact on downstream uses. De minimis water rights will be subject to enforcement by owners of senior water rights in the same manner as all other water rights. If the owner of a de minimis right seeks to change the purpose for which the water is used or to change the place of use or point of diversion, the owner of the water right must first request the Adjudication Court to adjudicate the actual quantity and priority date of the right prior to filing an application for such change(s) with ADWR.

1) The claimant name listed in Filing No. 39-00000 is not consistent with the landowner name on record with the Coconino County Assessor's Office for this property. Ther...continued on next page



Beneficial Use
Stock Watering From a Stockpond
Point of Diversion
Berm/Dam

000-00-AAAA-000-SP001
Verde River Watershed
Sycamore Subwatershed
ADWR March 2026

The following elements appear on the *Proposed Abstract of Potential Water Right* page:

1. **Abstract Map**: A map illustrating each use.
2. **PWR Number**: A Proposed Water Right ("PWR") number is a unique identifier assigned to each water use receiving a proposed abstract.
3. **Owner of Right**: The person or entity legally entitled to use the water and hold the water right.
4. **Landowner**: The name of the most current owner of the land as of September 6, 2025.

5. **Statement of Claimant ("SOC")**: An Adjudication Court filing describing a claimed water use which enters the filer as a claimant in the General Stream Adjudication. Each SOC is assigned a number beginning with "39-" prefix, listed in this field.
6. **Lessee or Permittee**: The name of the most current holder of a lease or permit, as of September 6, 2025.
7. **Basis of Right**: The documentation establishing that the claim to the water is legally valid.
8. **Beneficial Use**: The Arizona Revised Statutes state a beneficial use shall be the basis, measure, and limit to the use of water within the state, A.R.S. § 45-141(B). The determined beneficial use type will be listed in this field.
9. **Priority Date**: The date when a water right was established, typically when water was first put to beneficial use or the date the application was filed with ADWR (A.R.S. § 45-162(B)).
10. **Quantity**: The amount of water allocated for consumption for the beneficial use type.
11. **Flow Rate**: The quantity of water delivered over a set period of time, when applicable.
12. **Place of Use**: Legal cadastral location of where the water was used.
13. **Point of Diversion**: Legal cadastral location where the water was diverted from the source. Coordinates are provided using the WGS 84 datum.[132]
14. **Source of Water**: The source of water supplying the use.

[132] A datum is a reference system that acts as a starting point for measurements like latitude and longitude.

15. **Facility Name**: The name, if applicable, to aid in identifying the water use.

16. **Additional Information**: A brief explanation of the reasoning behind water right recommendations made or discrepancies identified during the investigation. *De minimis* verbiage will show in this box, when applicable.

5.4 How to Use Watershed File Reports

The WFRs within this Preliminary HSR require careful review. ADWR staff are available to help the water users involved understand the contents of the WFRs. However, ADWR cannot provide legal advice. WFRs should be reviewed thoroughly before updating information or submitting new paperwork. ADWR cannot guarantee a water right will be decreed to any water user, even if ADWR recommended the water right. The Maricopa County Superior Court website provides updates for ongoing proceedings.[133]

Comments on this Preliminary HSR must be received by ADWR on, or before, September 4, 2026. Claimants who wish to provide additional information (i.e., identifying a use or filing associated with the property not included in the WFR, updating current address, providing records for uses lacking supporting documentation, etc.) pursuant to A.R.S. § 45-256(B) must do so six months before the issuance of the Final HSR on March 12, 2027.

[133] See the Maricopa County Superior Court website for more information.

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Full Page Tables

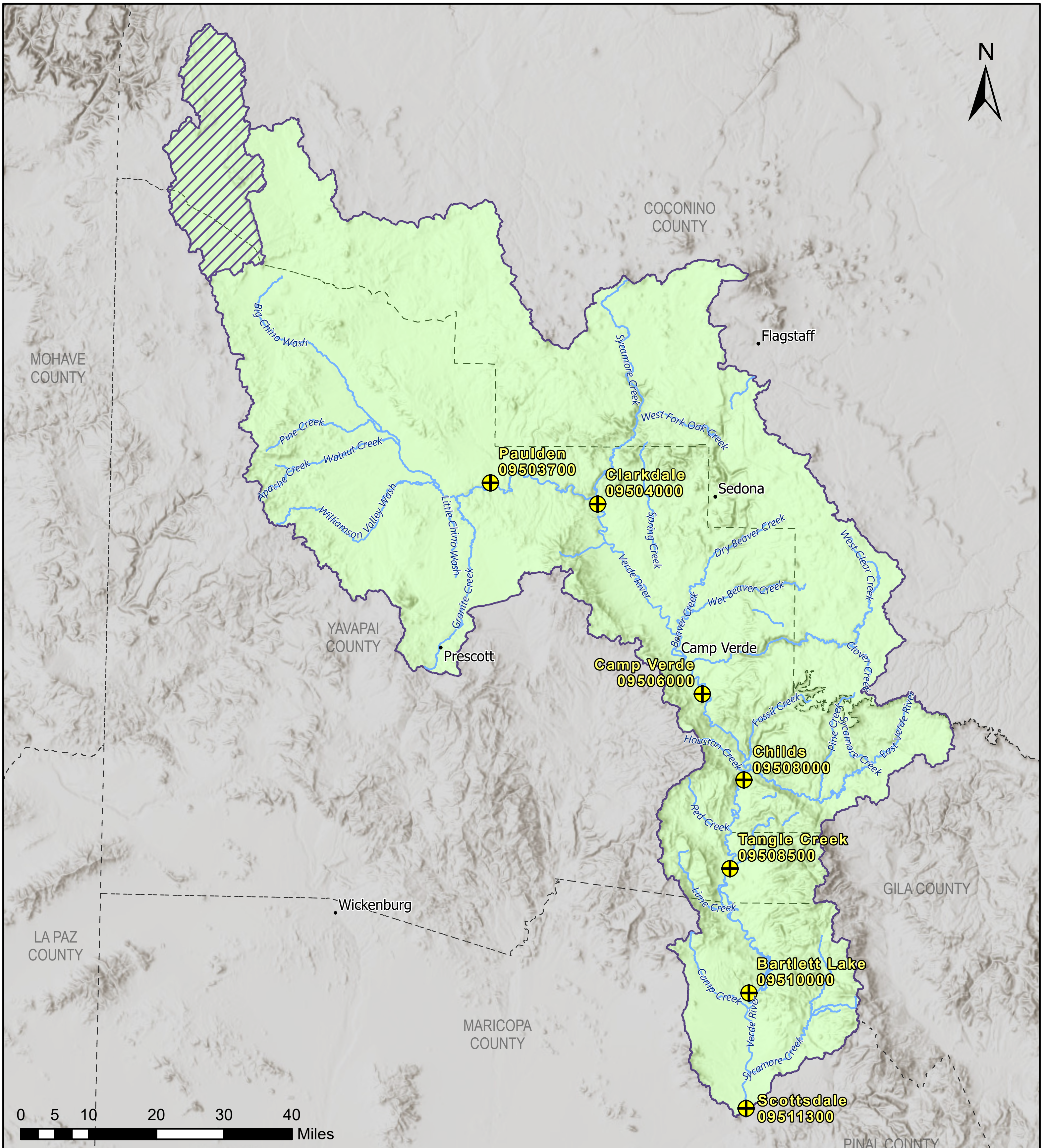
Table 5-1

Sources for Apparent First Use Date with Corresponding Abbreviations Used in Watershed File Reports ("WFRs").

Apparent First Use Date Source	WFR Abbreviation
Google Earth Pro	Google Earth Aerial Imagery
Army Service Map Service	AMS Aerial Imagery
Digital Orthophoto Quadrangle	USGS Aerial Imagery
United States Geological Survey	
National High-Altitude Photography	
High Resolution Orthophotography	
National Aerial Photography Program	
National Agricultural Imagery Program (before 2015)	
National Aeronautics and Space Administration	NASA Aerial Imagery
Soil Conservation Service	SCS Aerial Imagery
Arizona Department of Water Resources	ADWR Aerial Imagery
Certificate of Water Right	CWR No. XX-XXXXX
Notice of Appropriation	NOA No. XX-XXXX-XXXX
Well Registration	Well No. 55-XXXXXX
Homestead Patent	Homestead Patent No. XXXX
United States Forest Service	USDA Aerial Imagery
National Agricultural Imagery Program (2015 and later)	
United States Air Force	USAF Aerial Imagery
County Assessor	[County Name] County Assessor
Historical Map	[Year Published] [Map Title]
Historical News Source	[Year Published] [Document Title]

Note. An "X" serves as a placeholder for a number. The brackets ([ ]) contain temporary substitute terms that will be replaced with actual information depending on the source (e.g., [County Name] may be replaced with Coconino and "Coconino County Assessor" would appear on the WFR).

Full Page Figures



Streamgage

Verde River Watershed

Aubrey Valley Closed Basin

Rivers and Streams

Cities and Towns

Counties

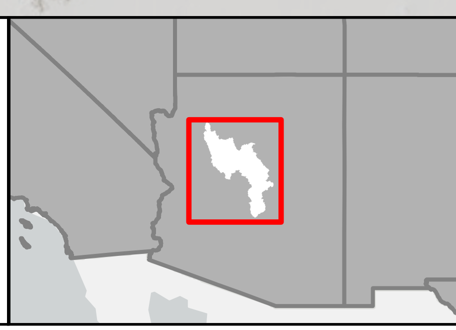


Figure 2-7

Streamgage Locations of the Verde River Mainstem

Preliminary Hydrographic Survey Report for the Sycamore Subwatershed within the Verde River Watershed

ADWR March 2026