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June 3, 2016

Via Hand Delivery
Mr. George Mehnert, Director
Arizona Navigable Stream Adjudication Commission
1700 W. Washington, Room B-54
Phoenix, Arizona 85007

Re: San Carlos Apache Tribe's Third Submission of Salt River Evidence
In re Determination of Navigability of the Upper Salt River
Case No. 04-005-NAV and 04-008-NAV Salt River (Consolidated)

Dear Mr. Mehnert,

Enclosed is the original and seven copies of the San Carlos Apache Tribe's Third Supplemental Submission of Evidence Regarding the Navigability of the Upper Salt River and Notice of Filing Supplemental Evidence, as well as a disc containing electronic copies of the Tribe's submission.

This Third Supplemental Submission includes the following documents:

1. Tellman, Barbara; Yarde, Richard; Wallace, Mary G. Arizona's Changing Rivers: How People Have Affected the Rivers. Tucson, Arizona: Water Research and Resource Center, University of Arizona, 1998.
(Excerpt pg. Cover-16; 39-42; 51-52; 59-66; 105-108).

Yours truly,

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Joe P. Sparks

Enclosures, as stated

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BEFORE THE ARIZONA NAVIGABLE STREAM ADJUDICATION COMMISSION

In re Determination of Navigability of the Upper Salt River from the Confluence of the Salt River from Granite Reef Dam to the Gila River Confluence, Maricopa County, Arizona	Nos. 03-005-NAV and 04-008-NAV (Consolidated) (Salt River) **San Carlos Apache Tribe's Third Supplemental Submission of Evidence Regarding the Navigability of the Upper Salt River and Notice of Filing Supplemental Evidence**

This is notice that the San Carlos Apache Tribe ("Tribe") submits the following attached evidence for consideration by the Commission and for the Record in this matter:

Exhibit 25: Tellman, Barbara; Yarde, Richard; Wallace, Mary G. Arizona's Changing Rivers: How People Have Affected the Rivers. Tucson, Arizona: Water Research and Resource Center, University of Arizona, 1998. (Excerpt pg. Cover-16; 39-42; 51-52; 59-66; 105-108).

A list of all evidence submitted by the Tribe in this matter to date is also attached to this filing.

Dated this 3rd day of June, 2016.

THE SPARKS LAW FIRM, P.C

By _____

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ORIGINAL AND SEVEN COPIES of the foregoing
to be hand delivered for filing on the 3rd day of June, 2016 to:

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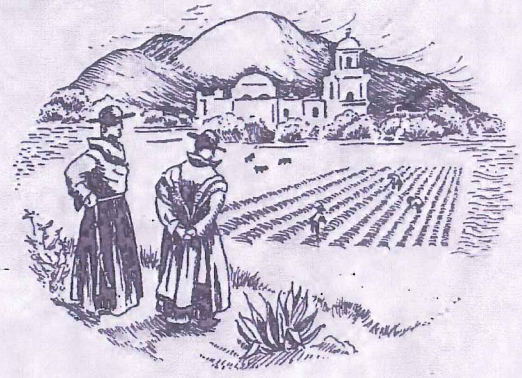
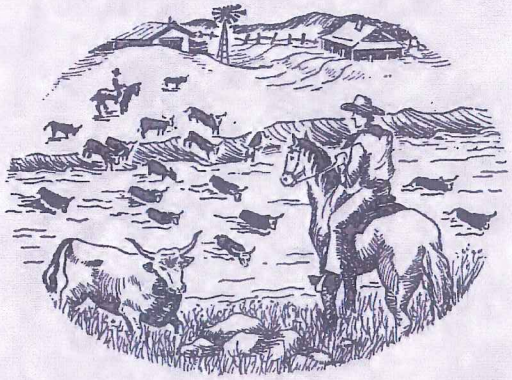
SCAT Submission Item 25

ARIZONA'S CHANGING RIVERS:

HOW PEOPLE HAVE AFFECTED THE RIVERS





Barbara Tellman
Richard Yarde
Mary G. Wallace

Water Resources Research Center
College of Agriculture
The University of Arizona
March 1997

ARIZONA'S CHANGING RIVERS:

HOW PEOPLE HAVE AFFECTED THE RIVERS

Barbara Tellman
Richard Yarde
Mary G. Wallace

Water Resources Research Center
College of Agriculture
The University of Arizona
Issue Paper # 19

ACKNOWLEDGEMENTS

This book is a synthesis of the works of hundreds of scholars who have studied Arizona history, archaeology, water law, hydrology, ecology and other topics. The most valuable sources are recognized in the "For Further Reading" section. This book is only a beginning. We welcome information from historians, from people who live along the rivers, people whose ancestors pioneered along rivers, and from experts in related fields.

Many thanks to the staff at the Arizona Historical Society and the University of Arizona Special Collections in Tucson, the Arizona Historical Foundation and Arizona Collection at Arizona State University in Tempe. We also thank Joe Gelt, Margaret A. Moote, Ana Rodriguez and Gary Woodard for helpful editorial reviews. Thanks to Patricia Oogjen, Tempe artist, for the cover drawings and other drawings throughout the book.

SPECIAL THANKS TO

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V. Ottozawa-Chatupron, P.E., Arizona State Land Department

Duncan Patten, Ecologist, Arizona State University

FOR THEIR CAREFUL REVIEW OF THE MANUSCRIPT

AND MANY HELPFUL SUGGESTIONS

TABLE OF CONTENTS

FEATURE SECTIONS, MAPS, GRAPHS & ILLUSTRATIONS

Feature Sections

Maps

Graphs

Illustrations

Some Suggestions for Reading this Book

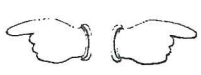
This book is organized unlike other books about rivers. Even the Table of Contents looks different. Rivers are interrelated into the lives of people and wildlife. Historical events are related to other events and many kinds of activities affected more than one river. For these reasons, the book is organized into history chapters alternating with chapters about specific rivers. The history chapters contain information needed to understand impacts on the rivers. They are not intended as a thorough history of the state. The river chapters contain information specific to each river, with frequent references to the history chapters for information common to several rivers. Short feature sections contain information on specific common topics. We have attempted to avoid technical terms, but those that are used are defined in the glossary. Similarly, we have used common names for plants and animals. Readers interested in the scientific names will find those in a special section of the glossary.

The chapters are designed so that readers can start almost anywhere in the book and read chapters without having to read what went before. As you read the chapters, you will find a pointing hand symbol at the bottom of the page pointing to related materials on other pages. You will also find a hand symbol with an M inside that indicates that a relevant map is located on the page indicated.

Some readers may prefer to read the chapters in a different order than we have presented them. People knowledgeable about Arizona history can start with the river chapters, while those with little historical background may wish to read all the history chapters before the river chapters. Readers primarily interested in a specific part of the state or a specific topic can start with those chapters.

While this format may appear confusing at first, we hope it will serve to make the reader aware of how, as the Navajos say, everything is related to something else— or as Norman Maclean said "All things flow into one and a river runs through it."

Related information symbols



Map symbol

CHANGING RIVERS

Rivers are Always Changing

Rivers are constantly changing. An ancient Greek philosopher pointed out that a person never steps in the same river twice. The water is always moving—moving itself, the soil and rocks. In years of high rainfall and snowmelt, the river may spread out over its normal banks, tearing out vegetation and rocks. In years of low rainfall and snowmelt, the banks of the river may move closer together. Vegetation and wildlife may suffer. In the long run, more typical years prevail.

Rivers change along with the seasons. During the late spring, full of snowmelt, they may rush forth, while in the summer and fall they may be shallow and slow. Many plants and animals take advantage of these natural cycles. Cottonwood trees produce seeds in spring when the high flows are receding. The seeds germinate in the moist soil, then flourish as the soil dries out in the summer, the roots still reaching water. Young fish may be born in the high waters of spring, then adapt to life in deep pools in summer.

Hayden's Ferry across the Salt River in the 1890s.

An informative description

"[The Rillito River] is insignificant at this point, but its bed enlarges as it descends to join the Santa Cruz, nine miles north of Tucson. Its waters cease to run above ground about a mile below the camp, and do not rise again until they join the Santa Cruz. The Rillito also receives an underground tributary near the post, its water coming from the cienega or swamp in the southeast portion of the mesa and about 23 miles distant from the camp. The cottonwood grows at intervals on the banks of the Rillito and Santa Cruz, and in some places attains considerable proportions. ...." U.S. Surgeon General, 1875.

People Change Rivers

Arizona's rivers tend to be fragile. In many rivers flash floods may occur—the river dry or nearly so one day and full of rushing water the next. The loss of stabilizing vegetation in the uplands and along the rivers can lead to downcutting, floods and formation of arroyos. Some human-caused changes to rivers are short-lived. A severe pollution incident may change a river radically killing fish. But if the incident is not repeated, the river may recover.

People, however, often change rivers in ways that make recovery difficult or even impossible. Once a river is dammed, for example, it becomes very different regardless whether rainfall is low or high. The new cycles of the river may be determined not by rainfall but by demand for electricity by distant cities. This often causes more water to be available at times when flows would naturally have been low, with less water available during natural high flow periods when the dams are filling to store water.

Groundwater pumping and surface water diversions remove water from rivers, completely changing them and their vegetation and affecting wildlife. Even human activities on nearby land may change rivers. Paved city streets, parking lots and roofs on homes can worsen downstream floods because of increased runoff. Great quantities of water rapidly enter a river, sometimes causing banks to give way. When banks are stabilized to protect buildings along the rivers edge, the force of the floods moves downstream creating further damage. Overgrazing may remove vegetative cover so that sudden, heavy rains tear away the unprotected soil, pouring soils into the river and spreading erosion.

Humans have been changing Arizona's rivers for centuries, but the changes that have occurred since the mid-19th century are more profound than most earlier changes. The great dams on the Colorado River are the most visible of those modern activities. Arizona's population explosion of the 20th century accelerated those changes, many of which are probably irreversible.

The history of Arizona and the history of Arizona's rivers are inextricably linked. All wildlife, plants, and humans need water to survive in an arid environment such as Arizona's. Within a desert, sources of water are oases of life; they are the centers of commerce, art, settlement, and recreation. From the first settlers thousands of years ago until the twentieth century, people have settled near sources of water. Farming was possible only near rivers. Miners needed a dependable water source and often transported water away from the streams.

Only in the twentieth century has technology allowed people to be independent of rivers, as groundwater pumping provided the means for cities and farms to develop by using water deposited underground thousands of years ago. Technology makes it possible to transport water hundreds of miles from its natural source to be consumed at a distant location. The Central Arizona Project is an example of such a technological feat.

An exaggerated claim

"'Where you can tickle the land with a hoe and make it smile with a harvest.' The soil in the Gila River Valley [north of Gila Bend] is equal in fertility to any found in the most famous garden spots of the world, not excepting the Valley of the Nile, the Polders of Holland or the Black Lands of Russia. ..." Gila Water Company, 1920.

A vague description

"The whole country traversed from the San Francisco mountains was barren and devoid of interest. It consists of a succession of mountain ranges and desert plains, the latter having an average height of about 5,000 feet above the level of the ocean. The larger growth, almost exclusively of cedar, was confined to the mountains; and the scanty vegetation of the plains, parched by a long drought, furnished few specimens for the botanist." Capt. L. Sitgreaves, 1853.

Interpreting Historical Sources

Trying to determine what rivers were like in the past is not easy. In some cases Indian oral tradition provides clues, as do histories of their way of life. We have other clues starting with the early Spanish travelers' accounts of the 16th century. Unfortunately, those accounts often do not give us much detail about the rivers. Father Kino, for example, often wrote about his welcome to a village and what the people wore, but seldom wrote about a river. Early 19th century Anglo beaver trappers experienced the rivers firsthand, but few of them kept journals. James Pattie's journal of travels in Arizona contains a great deal of detail, but is often obviously exaggerated, especially his encounters with wild animals. By the mid-19th century the U.S. government was sending out surveyors whose job was to describe the country. Many of these reports are very useful, but some are distressingly vague.

Some 19th century works are surely the writing of promoters—people trying to impress the folks back home or bring thousands of new people to Arizona. Other writers stressed the terrible hardships of the cross-country trip and compared the

An opinionated description

"There is a small creek that runs through the town. The water is alkaline and warm. The hogs wallow in the creek, the Mexicans water their asses and cattle and wash themselves and their clothes and drink out of the same creek. ... It never rains there, only in the rainy season and sometimes not then. There is very little air stirring, and if hell is any hotter than this, I don't want to go there." Phocian Way, 1857, describing the Santa Cruz River at Tucson.

desert rivers unfavorably with their green homeland. Many writers, however, wrote vivid and careful descriptions of what they found. Balduin Mollhausen, for example, wrote in detail of the castle-like beaver dams he found on the Bill Williams River.

From these descriptions and from other sources of information, historians have pieced together fairly detailed pictures of what places were like in the past. With knowledge about the many large old trees that were cut to provide fuel for the mines, for example, the historic forests can be envisioned. Bones of large edible fish in archaeological remains along rivers that are now dry tell of rivers that once flowed deeply. Tales of encounters with grizzlies and wolves, hunters' or fishermen's descriptions of their catches (even if exaggerated, in the way of hunters and fishermen) tell of animals that inhabited regions where they are not seen today.

We have barely discussed one important change —change in water quality. Except for a few major pollution incidents, water quality is scarcely mentioned. This is not because water pollution is unimportant but because little has been written on the subject. A separate study is planned for the future.

The Purpose of this Publication

Some people claim that 90 percent of Arizona's rivers have been altered by human activities. For example, a recent Forest Service visitor handout says, "It is estimated that 90 percent of the original riparian habitats of Arizona have been lost through diversion of the water and abuse of the lands." Some people say that 90 percent is excessive. Others believe this figure underestimates the damage and that, in fact, there are no unaltered rivers in the state. We do not believe a precise figure can be determined. And so instead of attempting to quantify river changes, our aim is to describe what changes have occurred and what caused those changes.

This is a series of sketches about Arizona's major rivers, written from a river's perspective. It asks how have human activities changed rivers? This is not a history which centers around the people, but a history of the major rivers as people affected them. Many histories of Arizona have been written over the past century, all of them focused foremost on the people. The reader is encouraged to supplement information presented here with a modern history such as Tom Sheridan's very readable *Arizona: a History*, published in 1995.

This publication does not bemoan losses of the past or pass judgment on the value of pristine rivers versus the forces of change. Rather, the purpose is to try to understand what caused the many changes that have occurred. In some cases, most people agree that mistakes were made that led both to changed rivers and to other problems for humans. In other cases, tradeoffs were made. A flowing river became a lake or a dry streambed in exchange for millions of dollars worth of crops or cities that house millions of people. Whether the tradeoffs were worth it is a value judgment.

Arizona's rivers were looked at to answer the questions: How much have our rivers changed over the past several hundred years? What are

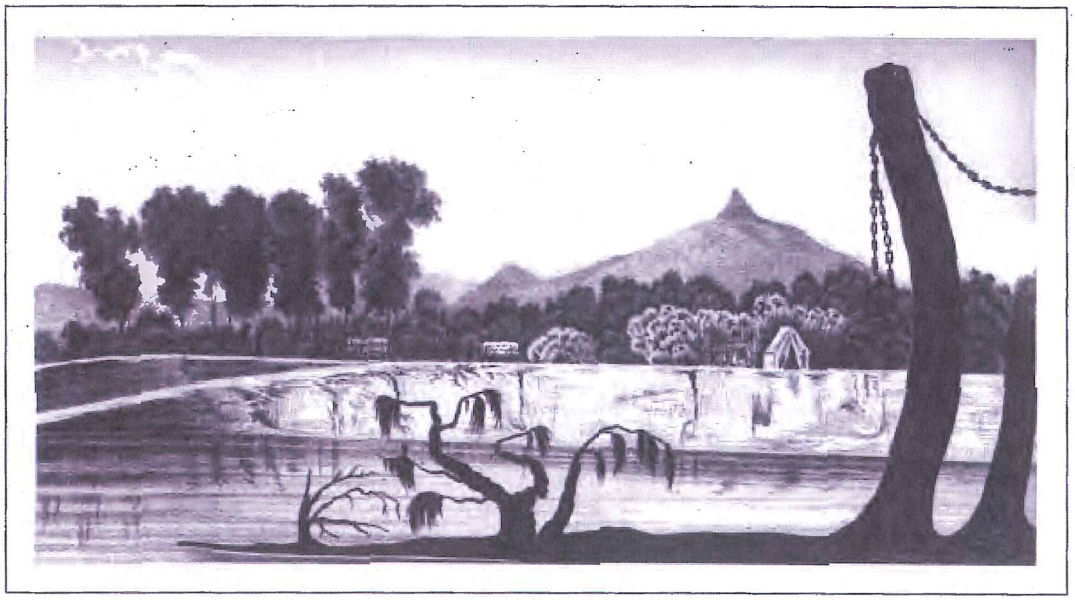
A fictional account

Steamships on the Santa Cruz River? Back at the end of the nineteenth century, an enterprising land speculator promoted sales of property at Calabasas (now Rio Rico, north of Nogales) with brochures showing ocean-going steamships moored at a busy Santa Cruz River wharf. The Tombstone Epitaph described the brochure which advertised a busy port, ideal for commercial ventures. The story persisted for years that steamships had plied the river. Anyone who came to see the busy wharf was destined to be disappointed in the shallow marshy creek, unable to support even small boats except in flood season.

the greatest changes? What brought about those changes?

How Have the Rivers Changed?

All of Arizona's major rivers and their major tributaries have changed to some degree. Even stretches of the Gila River with adequate water have changed because of the introduction of the exotic saltcedar tree. The Colorado River has changed from a highly variable flowing river to a series of dams and reservoirs, with progressive loss of water through municipal and agricultural diversions of water. The Gila River which used to flow most of the time all the way to the Colorado, now is generally dry below Ashhurst-Hayden Dam, except for effluent flow from the Phoenix area. The Santa Cruz once was a series of marshy areas alternating with flow for much of its length through the Tucson area. Groundwater pumping has mostly dewatered the stream north of the Mexican border, except for effluent flow from both Nogales and Tucson. The Salt River no longer flows through the Phoenix area, because of upstream dams and water diversion for agricultural and municipal use. The Verde River has been affected by water diversions, sand and gravel mining and dams. The Little Colorado River has lost most of its riparian character downstream of Lyman dam, because of water use and historic overgrazing which led to massive loss of soil. The San Pedro River upstream of St. David is recovering from historic changes, but faces a serious challenge from population growth in the Sierra Vista area. Aravaipa Creek has changed less than the other rivers—it has no dams or major water diversions. All of these rivers and others are discussed in the chapters that follow.



Fort Yuma and the Colorado River Crossing in the 1880s.

CHANGING RIVER NAMES

Rivers have changed over time and so have their names as new explorers and residents named them. These are some of the names that Arizona's rivers or sections of rivers have had over the years.

Bill Williams
- Hah-weal-ha-mook
- Hah-cu-che-pah
- Rio de San Andrés
- Bill Williams Fork
- Santa María
- Cottonwood Creek

Colorado
- Poketto
- Hakoti
- Pahaweep or Pah Gaiv
- Ahamcave
- Hahweal
- Hah withlcha cohut
- Javil
- Buqui Aquimuri
- Gritetho
- Firebrand River
- Tizón
- del Coral
- Río de la Conversión de San Pablo
- Río de los Martyrs
- Río de Buena Guia
- Río Grande de la Buena Esperanza
- Río Colorado del Norte
- Grand River
- Red River of the West
- Red River of California
- Red River

Gila
- Hahquah Saeel
- Jela, Jila
- Xela, Xila, Xelay
- Río de Nombre Jesus
- Río de Apóstoles
- Río Grande de Hila
- Spine Fluss
- Florida
- Poison River

Hassasyampa
- Aziamp, Assamp
- Haaviamp
- Ah-ha-seyampa
- Hesiampa

Little Colorado
- Tol Chaco
- Rio Bermejo
- Colorado Chiquito
- Río Jaquesila
- Río de la Alameda
- Río de San Pedro
- Río de Lino
- Colorado
- Flax River
- Salt River

Rio Puerco
- To Nizhoni

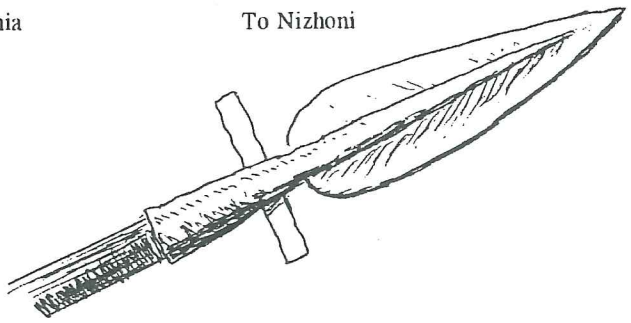
Salt River
- Río de las Balsas
- Río Azul
- Salinas
- St. John
- Salada
- Río de la Asunción
- Black River
- San Mateo

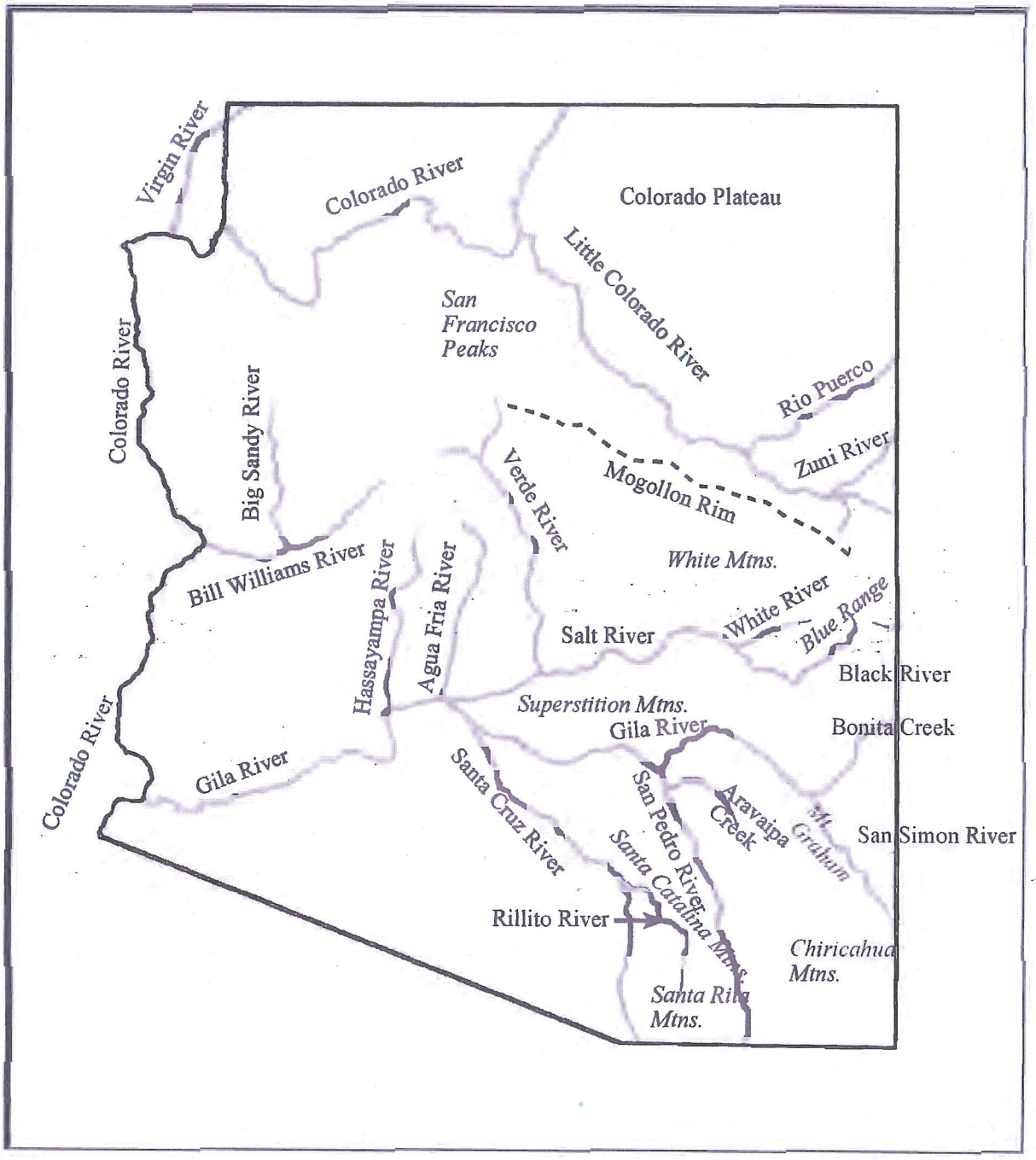
San Pedro
- Nexpa
- Sobahipuris
- Hiburi, Quibiri
- San Joseph de Terrenate
- José Pedro
- Santa Ana de Hiburi (Quibiri, Kiburi)
- San Juan
- Babocomari
- Beaver River
- Dirty River

San Simon
- Rop de Saiz
- La Ciénega Salada
- Valle de Sauz

Santa Cruz
- Río de Santa María del Pilar
- Río de Santa María de Suamca
- Río de Tubac
- San Lucas

Verde
- San Antonio





Arizona's major rivers and tributaries.

CHANGING LANDSCAPE AND PEOPLE

Dinosaurs and Ice Ages

Much of what is now Arizona once was under water. Fossils of sea creatures are found where deserts now prevail. About 150 million years ago dinosaurs such as the Diplodocus and Allosaurus roamed the area. The forests were dense, filled with evergreens, palms, ferns, rushes and mushroom-like fungus. Flowering plants and hardwood trees did not yet exist. Central Arizona along the present day Gila River was swamp land, with an ancient river running about two miles wide. A shallow sea lay to the west covering the area now known as California. The present location of the Colorado River was a seacoast.

About 100 million years ago, the land to the west and north of Arizona slowly rose above sea level forming a huge inland sea, stretching from Utah to Alberta, Canada. The lower shores of the sea flowed into the Gila watershed in central Arizona, creating a large tropical swamp.

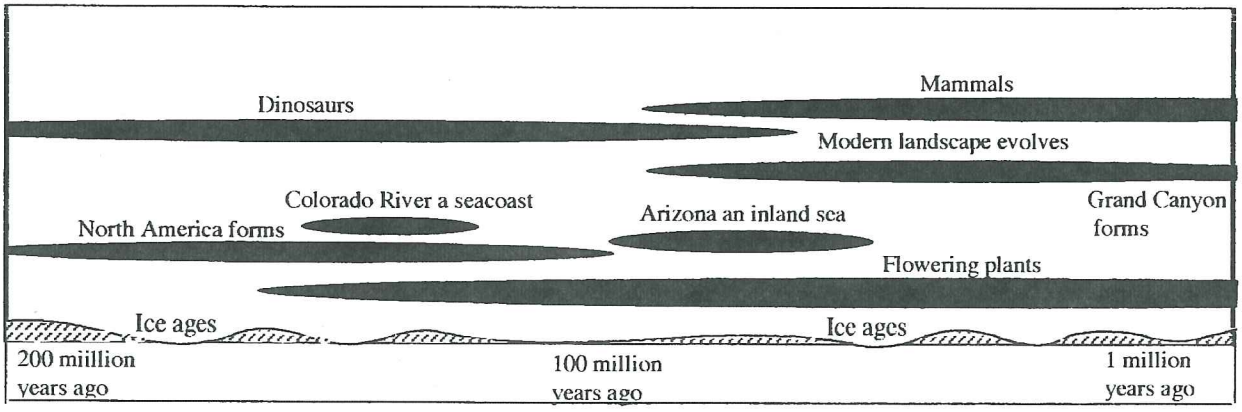
About 60 million years ago, the present landscape of Arizona began to take shape. The sea receded and the Rocky Mountains and Sierra Nevadas began to rise. What was once swamp land became an arid basin as the Sierra Nevadas rose and blocked most Pacific winds and rainstorms. Early in this period, mammals such as camels, peccaries, deer, mammoths, and Eocene horses replaced dinosaur-like reptiles.

For the next 50 million years, the landscape continued to evolve into the high mountains, low valleys, desert and range characteristic of Arizona today. Forces of erosion and uplift formed the Grand Canyon and the Mogollon Rim.

Modern humans appeared in the world one million years ago, but hundreds of thousands of years passed before they reached the Americas.

The area was much cooler and wetter in the distant past than it is today. Pinon, juniper and oak woodlands dotted the lower elevations. Desert grasslands, joshua trees, beargrass and yucca grew in the lower valleys. The mighty saguaro, a now-famous symbol of Arizona, grew only to the south in Mexico.

About 10,000 years ago, as the last Ice Age receded, the region became drier and hotter and the Sonoran Desert (with new plant and animal species) crept north. The climate grew warmer but wetter in the summer while winters became drier. Plants that needed more water were concentrated near rivers and springs.



Some plant and animal communities moved upwards in elevation, in some cases becoming stranded species on mountain "sky islands" such as Mount Graham in southeastern Arizona. New species moved in fairly gradually and co-evolved with other species. Natural predators tended to appear along with their prey species. By 2000 B.C., the landscape and climate essentially resembled modern conditions.

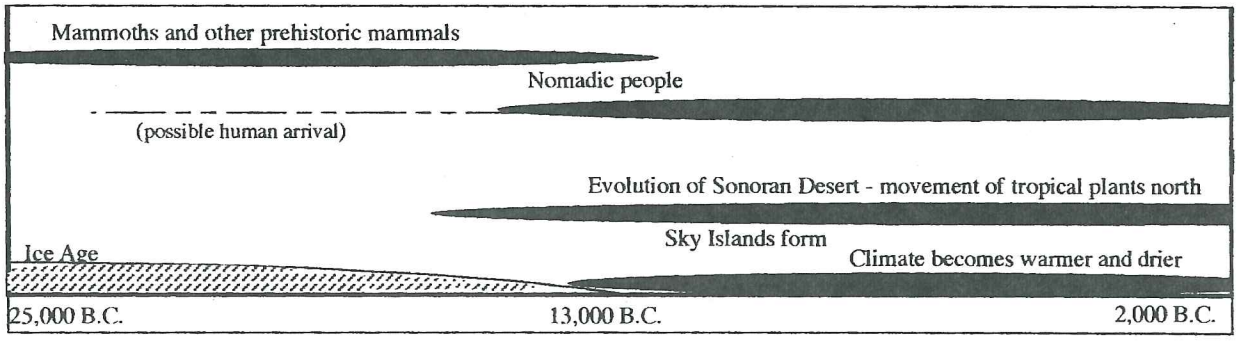
As the climate became hotter and drier, temperatures rose and patterns of precipitation changed. Many streams across the state began to dry up. More snow and rain occurred in the winter, but less in the summer. Animals, as well as humans, became dependent on the remaining free-flowing streams, springs, and seeps. Riparian areas, which became isolated environments in the desert, became important habitats, providing corridors and nesting areas for many kinds of wildlife, as well as places for the early residents of the area to hunt and settle. Today, less than four percent of Arizona's land surface is covered by rivers or lakes, but these areas are necessary to more than 75 percent of Arizona's wildlife species.

Early Inhabitants

Some 15,000 to 20,000 years ago, the first in a series of migrations brought people from the north to Arizona. The first people to discover Arizona will never be known, but it is known they were skilled hunters who could bring down the mighty mammoth with primitive weapons. Some of these people passed through Arizona to migrate farther south. Others remained, always moving to new locations in the area using temporary dwellings. These people were few in number and had little direct impact on the rivers. By about 8000 B.C. most of the large animals, such as mammoths, had died out. Some scientists believe over-hunting played a role in the demise of these animals as well as the animals that fed upon them. Others believe the climate changed at the end of the Ice Age and those animals could not adapt. If the hunting theory is correct, humans would have indirectly impacted the rivers by eliminating some important species from them.

At least three other major migrations brought people south to Arizona over the millennia. By about 1000 B.C. some of those people began to settle in permanent communities where they grew crops to augment their hunting. These communities were near dependable water sources. People used wood for cooking, heating, and building their homes—the first major way humans began to affect the rivers directly by altering the vegetation.

Four major civilizations dominated Arizona rivers at different times between 1000 B.C. and about 1450 A.D. The Anasazi used the Little Colorado and parts of the Colorado River basins, while the Mogollon occupied the high country in the upper watersheds of the Verde, Salt and Gila rivers. The Sinagua occupied the Verde Valley. The Hohokam used the Salt, Gila, San Pedro and Santa Cruz basins.



In the driest part of the state, the southwest corner away from the major rivers, people for millennia have lived using widely separated water sources, "tinajas." They were skilled in finding isolated water sources and using them to sustain life. All of these civilizations used their environment intensively for farming, hunting, food gathering, and woodcutting.

The Anasazi People

The Anasazi primarily occupied the Colorado Plateau. Until the middle of the sixth century they were primarily nomadic, living in the lowlands in the summer and moving upland in the fall. Climate change in the sixth century improved conditions, enabling them to settle in more permanent agricultural communities. They built diversion dams to control runoff for fields where they grew corn and other crops. The civilization reached its peak in the twelfth century, utilizing extensive water distribution systems with terraces, checkdams, irrigation ditches and masonry-lined reservoirs.

Chaco Canyon in northwest New Mexico was the leading trade center for a large area extending into central Mexico. Traces of trade routes extending for miles from Chaco still can be seen. Anasazi architecture required the use of thousands of wood beams. More than 200,000 beams were used in multi-storied pueblos in the canyon. Over the years people had to go farther and farther from home to find big enough trees. Chaco Canyon residents deforested the area for miles around, leading to erosion, more damaging floods, arroyo cutting, and loss of good farming soil. This probably contributed to the settlement being abandoned at the end of the 12th century. The Anasazi in other areas increased their use of check dams, reservoirs and irrigation and were temporarily able to feed and house a growing population in the face of disasters in Chaco and elsewhere and were able to prolong their way of life for another century or so.

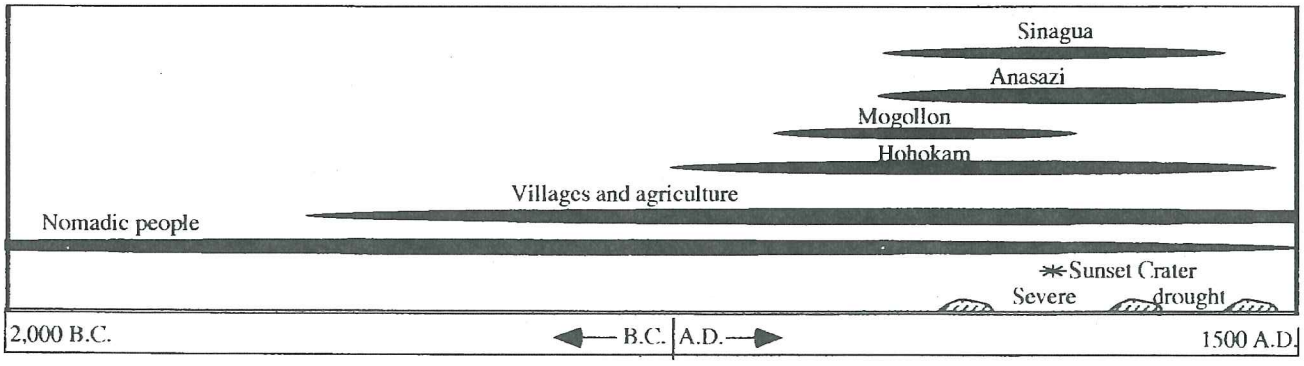
The Mogollon People

The Mogollon people also began as nomadic groups living in the highlands of the Arizona-New Mexico border. They eventually settled into communities and developed farming techniques suitable for their area. They are best known for their fine pottery which depicts with great artistry stylized bighorn sheep, bats, birds and human forms.

After 750 the role of the Great Kiva (a major religious structure) increased and by 1000 the society was at its height. This lasted only about 100 years, however, and the Mogollon pueblo society had nearly disappeared by 1150, for reasons not fully understood, but probably related to climate change.

The Sinagua People

The Sinagua settled around the Verde Valley and up into the San Francisco Peaks region. In the 8th century they, too, shifted to an agriculture-based economy, growing crops such as corn in the floodplains and agave in the uplands. These people traded extensively with the Anasazi and Hohokam, as far away as Chaco Canyon and with tribes as distant as the Pacific coast. Tuzigoot



Approximate territories of ancient cultures.

(now a National Monument), a hilltop structure near the Verde River, was built in the 14th century and is a prime example of how these people lived and farmed. Over the years they developed the Palatkwapi Trail, a 150-mile long major trade route to Hopi Villages.

People used irrigated crops such as corn, squash, cotton, and tepary beans. They grew agave on drier terraces. Something happened within a century of these achievements. By 1400 there was a high rate of infant mortality, and about 25 years later the Verde Valley was abandoned. The people moved to the northwest. Archaeologists do not agree on the reasons for this.

The Hohokam People

For about five hundred years from 900 to 1400 the Hohokam intensively farmed the Salt River Valley, the Santa Cruz River, the San Pedro River, and other river valleys in Arizona. They practiced irrigated agriculture in the Santa Cruz Valley as early as 500 B.C. They lived in small communities, and in many places built mounds whose purpose is still debated. They may have been food warehouses, living quarters, military structures, religious structures or administrative centers for running their complex agricultural systems. In the Salt River Valley mounds were at about three-mile intervals along the major canals. The Hohokam at times farmed most of the good land in the valley using well-engineered canal and reservoir systems as well as water harvesting systems in the smaller drainages.

The Hohokam served as middlemen between the Anasazi and civilizations farther south and traded all the way to the Pacific Ocean. They, too, used their environment intensively. The peak of Hohokam civilization lasted almost 400 years, until about 1450. When the first Spaniards arrived in the late 17th century, they found only ruins. Modern Tohono O'odham and Pimas consider themselves to be descendants of the Hohokam.

Why Did the Great Cultures Disappear?

No one theory can explain the failure of the ancient cultures—separated in time and space as they were. Archaeologists do not even fully agree on just when they failed or what happened to the survivors.

Climatic factors were undoubtedly important—major droughts affected all three cultures at different times. Concentration of large numbers of people in small areas, made possible by years of normal or above normal rain probably made it difficult to replace lost crops with gathered food supplies when the rains failed. The people may have over-exploited resources such as timber and soil, making their lands less fertile. In some areas, years of irrigation probably led to salting of the soil, making it difficult to grow crops. Occasional large floods temporarily damaged irrigation systems. Some archaeologists believe that when the Chaco civilization failed in the north, its trading partners (especially the Hohokam) also suffered, contributing to the decline of their way of life. Other archaeologists believe that the amount

of governmental control needed to maintain the complex irrigation systems of the Hohokam led to revolt of the "working classes." Some wonder if the spread of European diseases such as small pox reached Arizona even before the Spaniards themselves did, which caused people to die of new diseases to which they had no immunity. Even if this were true, the societies were already in decline. Some scholars, however, believe Hohokam civilization lasted into Spanish times.

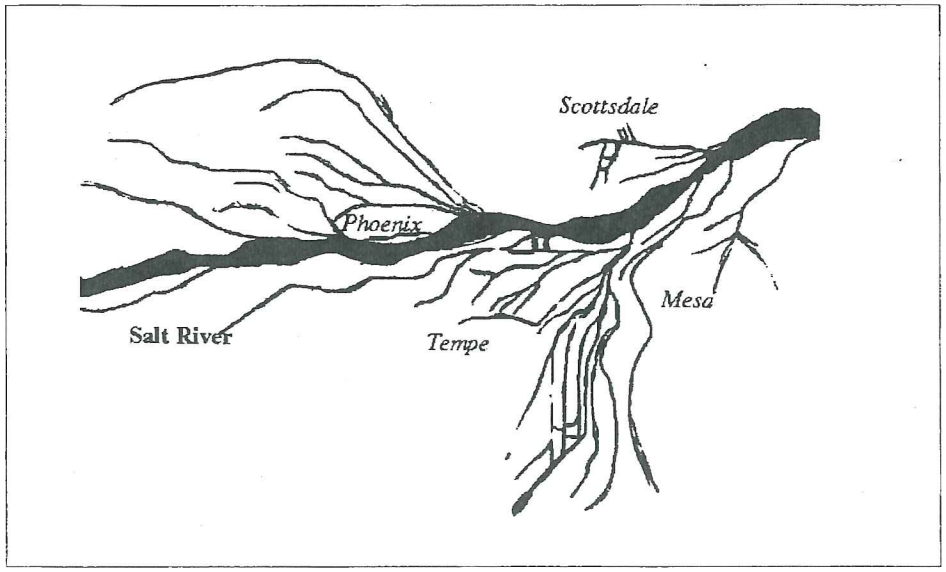
Hohokam Agriculture Along the Salt River

Of all the early civilizations, the Hohokam probably had the greatest impact on the rivers. Their irrigation system was the most extensive in North America. Their effect on rivers has not been thoroughly studied by archaeologists or hydrologists, but some generalizations can be made about one large urban center. Ways in which the Hohokam impacted their rivers were probably duplicated on a smaller scale by the other civilizations.

The Hohokam developed a complex and sophisticated irrigation system in the Salt River Valley. Much of that system has been recycled into modern canals or destroyed by modern agriculture and cities so that fully understanding many important details is difficult. We do not know how large the population was, what the maximum area under irrigation was or the exact impact this civilization may have had on the Salt River and other central Arizona rivers. It is certain they did impact some rivers to a relatively large extent, for at least a few hundred years.

In 1903 H.R. Patrick described what was known about the canal systems at that time. Many ruins had already been destroyed, but some were still standing in the Phoenix area. He determined that many of the modern canals followed the alignments of ancient canals. He believed that there were about 135 miles of canals, irrigating 120,000 - 130,000 acres and supporting as many as 200,000 people.

In 1929 Omar Turney published an exhaustive survey of the ancient canals and other structures, looking at ruins, reading old descriptions and talking with people who had themselves knocked down buildings or plowed over canal systems. His map had enough canals to account for 200,000 irrigated acres and up to 250,000 people. Later researchers put the acreage at up to 400,000 acres, not all of which would have been farmed at the same time. The most recent estimates are that between 100,000 and 200,000 acres were farmed through 185 miles of canals. The maximum population was between 50,000 and 200,000.



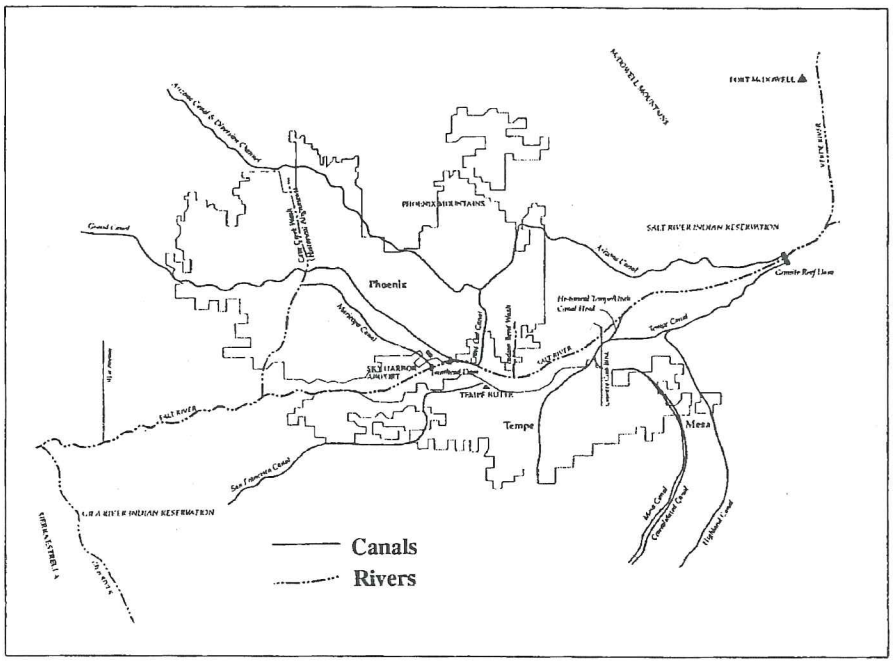
Ancient Hohokam canals in the Salt River Valley.

Two Agricultural Styles

What are the differences between the peak of Hohokam society and twentieth century agriculture in the Salt River Valley? In 1920 the population probably was roughly the same as the population in 1420 and the number of irrigated acres probably approximately the same. They both used canals to irrigate fields in about the same places. Use of river water was probably roughly comparable.

There were, however, major differences. In Hohokam times, beaver dams were common throughout the watershed as well as many smaller dams and water harvesting projects. In modern times almost all the beaver and small dams are gone. In their place are six large dams and some smaller dams. Beaver dams hold back water throughout the system, while modern dams create a few large lakes.

The Hohokam grew many spring-summer crops, but no winter crops until the Spanish introduced wheat. Thus, Hohokam land was left fallow in the winter while modern agriculture continues all year long. The Hohokam probably used all the summer flow for irrigation, and little water flowed downstream of the fields during the dry period. In the winter, however, the river flowed normally and was able to recharge the water table. This would have been adequate for most riparian vegetation. In modern times the river through Phoenix is dry all year long except for big flood years, because of dams and diversions.



Modern Salt River Valley canals.

Flooding would have been quite different in ancient times. While the Hohokam had buildings, ball courts and other structures, they had no paved streets or parking lots. Most of the rain would have soaked into the ground. In modern times, the high amount of paved surface sends more water into the streams when rainfall is heavy. This leads to occasional high run-off that lasts only a short time, but leads to erosion. Occasional huge floods devastated Hohokam canals and fields. These floods caused enormous damage that had to be repaired, but also brought silt and nutrients to the farmlands. More importantly, the floods also would have helped leach out salts in the soil. Modern farms are seldom flooded and canals seldom seriously damaged.

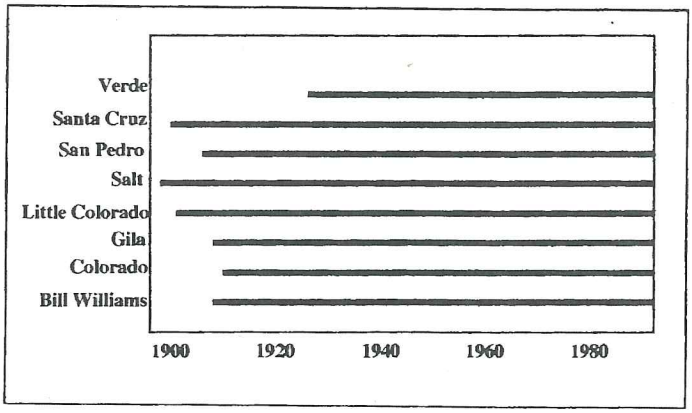
One of the biggest differences is the ability of modern people to pump water from deep underground and the ability to transport water great distances. Life in the Salt River Valley in 1920 depended both on the Salt River and groundwater. The Hohokam could dig shallow wells that basically used the same water that fed the river—river water in another form. Because modern farmers can use groundwater, their total water use was undoubtedly greater in 1920 than in 1420, and less water was wasted. The Hohokam had to depend on streamflow for all their water needs.

The Hohokam would have collected and cut wood for their fires and homes. In many cases they probably left vegetated strips between fields and harvested by cutting branches rather than taking whole trees. Before the introduction of electricity, the Anglos harvested wood extensively and cleared whole forests, leading to erosion and loss of soil which changed the rivers.

Climate and Geologic Change

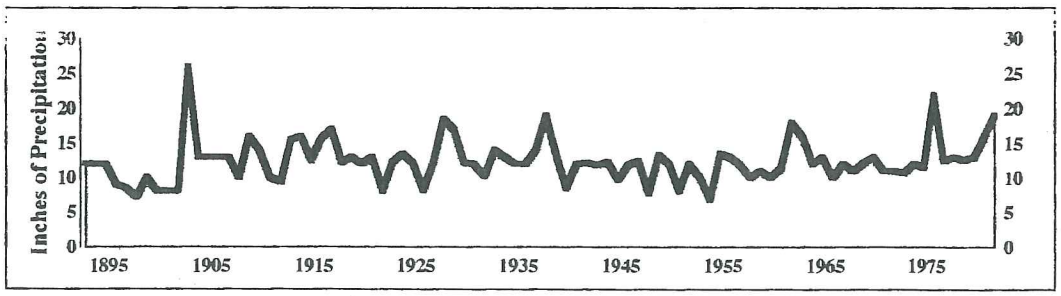
Climate

Arizona has a highly variable climate. Droughts and floods, scorching heat and freezing temperatures occur in the desert lowlands. Upper elevations also experience dramatic variations in temperature and rainfall. The state has a wide range of geological zones with very different climates. In general, however, Arizona is an arid state; about one-half of Arizona receives less than ten inches of rain a year. Parker gets an average of only 2.26 inches of rain a year, while Prescott gets more than 12 inches, and the mountainous areas may get more than 30 inches. High temperatures of 120 degrees occur in the summer along the Colorado River, while low temperatures of -23 degrees are reported in Flagstaff, with temperatures in mountainous areas falling even lower.



Extent of official streamflow records.

Learning about past climate is not easy. The first official weather stations in Arizona were at the army forts as early as 1879. The first continuous weather stations, operating to the present day, were established in 1892. Newspaper accounts of major weather events provide a limited record for the previous 50 or so years. To go farther back, scientists study tree rings to determine which years were drought years (when the rings were small) and which years had plenty of precipitation (when the rings were wide). Farther back than that, scientists look at evidence of past vegetation. Fossil pack-rat middens tell scientists what plants grew in the vicinity of the nest in the past. If there were plants requiring a cooler climate than today's, they infer that the climate then was cooler. Another method is to study pollen records in ancient lake sediments. Floods can also be inferred from geological records.



Arizona statewide mean annual precipitation.

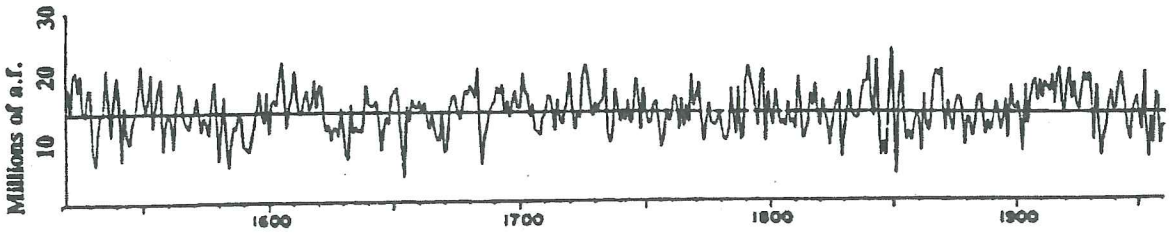
"The country through which we traveled for several days was not altogether new to me. I had passed through it before during a tour of exploration among the Southern Indians in 1860. But how different was it now. In former years the magnificent valleys, stretching all the way from Los Angeles to the borders of the Colorado Desert were clothed in the richest verdure. Vast herds of cattle roamed over them rampant with life. ... Now, after two years of drought, all was parched, grim and melancholy. ... For hundreds of miles the country was desolated for want of rain. ... Thousands of cattle lay dead around the black, muddy pools. ... No more pitiable sight ever disturbed the eye of a traveler in this lovely region than the dreary waste of dead and dying animals." J. Ross Browne, 1864, describing drought in southern California.

Drought

Among the most important climatic factors affecting Arizona's rivers is the variable pattern of rainfall. Much of the history of Arizona's rivers has been cycles of flooding and drought. These variable patterns of precipitation have affected human settlement from prehistoric times to the present. Different cultures at different times have been affected by sudden, changes in climate.

Precipitation varies greatly from season to season and year to year throughout the Colorado River Basin. The longest statewide drought of historical record lasted 76 months at the beginning of the twentieth century when annual rainfall was consistently at least two inches less than average. The longest drought period affecting Arizona rivers is found in tree-ring records and lasted from 1579-1600 when the annual flow of the Colorado River (throughout the basin) is estimated to have been less than 9 million acre-feet per year. But droughts affected Arizonans even earlier. Drought conditions affected prehistoric civilizations in the eighth century, the thirteenth century and the fifteenth century. A lack of water made it difficult to grow crops, and have adequate drinking water. It even affected the plants and animals that could be gathered to supplement meager food supplies. People who could not find adequate food or water supplies moved or did not survive.

The years after the early twentieth century drought were particularly wet ones, when Colorado River flows of more than 15 million acres-feet were common. Using those recent flow records, the water of the Colorado River was divided between the Upper Basin states (Colorado, Utah, New Mexico and Wyoming) and the Lower Basin states (California, Arizona and Nevada), with upper and lower basins each allocated 7.5 million acre-feet annually. If negotiators had the tree ring records when they calculated river flow in the late 1920s, they probably would have allocated far lesser amounts. A drought as long as the one in the sixteenth century probably will again affect the river.



Annual flow of the Colorado River at Lee's Ferry, reconstructed from tree-ring records.

17 55 94 109 139

"Tucson Gets an Earthquake.
Buildings Rock Like Ships at Sea.

... It was only a moment until the streets were filled with terror stricken people. ... The court house dome moved back and forth like a tall tree. ... great slices of the [Catalina] mountains gave way and went tumbling down into the canyons, huge clouds of dust or smoke ascended it to the blue sky, high above the crest of the queenly mountain. ... Great boulders or little mountains, wrested from their seats by the shock came thundering down into the valley. ... [May 4]

"... A peculiar feature of the earthquake ... in the Sulphur Springs Valley ... was the opening up of hundreds of water veins. ... the dry parched earth beneath our feet was opening up in every direction around us and water was spurting up in some places as high as 10 feet above the surface. ..." Arizona Daily Star, May 6-7, 1887.

Flooding

Flooding also is common in Arizona. Flooding, while inconvenient for modern desert dwellers, is a natural part of the hydrologic cycle and is an important part of a river regime. Cycles of plant and aquatic life are tied to annual floods. Less frequent large floods move soil and rock, create new beaches, fertilize floodplains, and clear out old vegetation to make way for new trees and shrubs. Major flood years often have followed drought periods, with extremes occurring within a few years of each other. In the twentieth century, floods have occurred on an average of about every ten years.

One way in which modern society has attempted to even out these extremes of flood and drought is to build dams to store water in times of plenty for release in times of drought so that people could occupy the floodplains. Occupation of the floodplain, however, has led to repeated flooding problems for people who build structures in places destined to flood or be eroded.

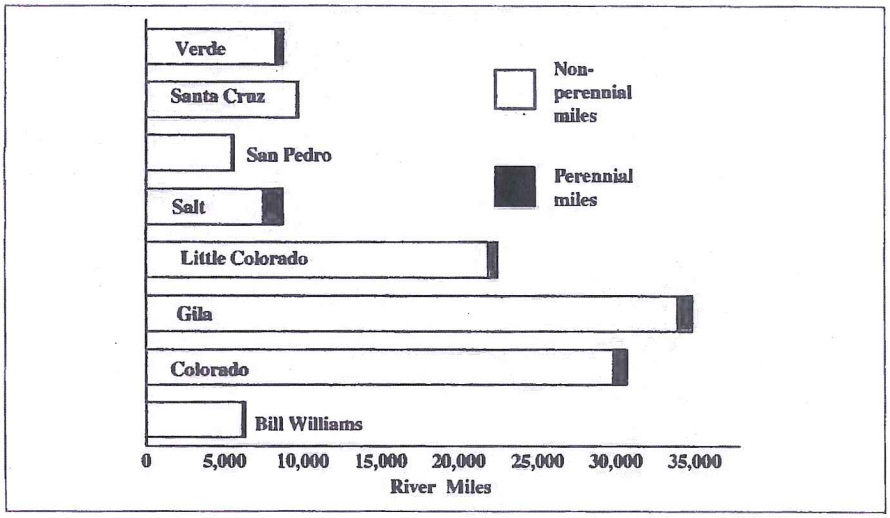
The seven-day release of water from Glen Canyon Dam in March 1996 was the first major dam release with the intent to mimic past flood conditions to help restore the downstream ecosystem. The release is expected to allow some restoration of the ecosystem by restoring beaches and scouring backwaters for habitat for young native fish. "Flood" levels were much lower, however, than in pre-dam times.

Geologic Changes

In relatively recent times, the state also has experienced natural geological events including an earthquake and a volcanic eruption. In 1066 AD, Sunset Crater, in northern Arizona, erupted. It caused short-term devastation, but also spread a layer of rich ash over the landscape which conserved soil moisture and increased the agricultural productivity in the area.

Another dramatic geologic event was the earthquake of May 3, 1887. Its epicenter was located just south of the border near San Bernardino Ranch in southeastern Arizona. It was about as powerful as the San Francisco Earthquake of 1906 . The quake damaged many of the buildings in St. David and elsewhere in the San Pedro Valley, including the remains of the abandoned town of Charleston. It also caused swamps and cienega areas in the St. David area to disappear. Many existing and newly-dug wells began to flow under artesian conditions. In fact, artesian wells in the area were first discovered in the 1890s when water flowed temporarily from a ground fissure opened up by the great earthquake.

Bavispe, Mexico was destroyed in the 1887 earthquake.

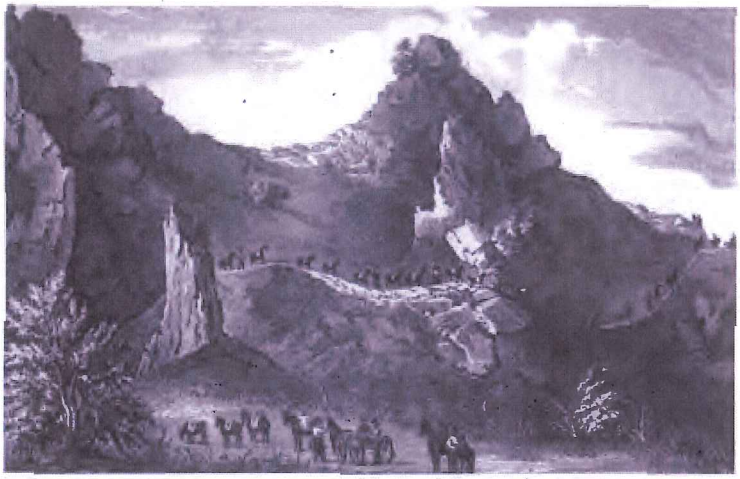


Perennial and non-perennial stream miles in river basins.

Of Arizona's 113,508 square miles of land surface, only 492 square miles are covered with water today. Lakes comprise the great majority of these "wet" areas, leaving less than .01 percent of the land area covered by streams. The vast majority of Arizona's streams are non-perennial, either flowing only after rains (ephemeral) or flowing in some sections and going underground in others (intermittent).

ANGLO-AMERICANS ARRIVE

The first Anglo-Americans to reach what eventually became Arizona were "mountain men" who came to trap beaver in the 1820s. James Ohio Pattie's company traveled down the Gila in 1824, collecting some 250 pelts. His journals provide much information about the period, although they contain obvious exaggerations. He returned in 1827, concentrating on the San Pedro and Colorado rivers, with a goal of "trapping the rivers clear," or getting all they could. Other trappers who explored Arizona's rivers at this time included Ewing Young in 1830, who sold 1,500 pelts in Santa Fe; Pauline Weaver, who returned as a guide in later years; William Wolfskill; and George Yount. Hat fashions changed from beaver to silk, and by the 1860s beaver populations had recovered on many of the rivers. Their numbers later were reduced again by other human activities, including overgrazing, urbanization and loss of water supplies in the rivers.



Surveyors' party exploring a tributary of the Gila River in 1848.

After most of present-day Arizona became part of the United States in 1848, more and more American travelers arrived. Many were just passing through on their way to the California gold fields. The U.S.-Mexico boundary had to be surveyed, and wagon and later railroad routes had to be mapped. Whereas the Spanish routes tended to be north-south from Mexico, the new American routes most often were east-west, from the East Coast to California.

"The [Colorado at Yuma] river here is 170 yards in breadth, with a current of about 3 ½ miles an hour. It is crossed by means of a rope suspended from either bank—a mode of travel very disagreeable and somewhat dangerous. Capt. Thorn endeavoring to pass here ... on two log canoes lashed together, was upset, and together with three others, swept down on the current and drowned." Lorenzo Aldrich, 1849.

Travel Routes

Travel routes from the earliest historic times to the present tended to follow a few major routes, avoiding the very great barriers of the White Mountains, the Chiricahua Mountains, the Canyonlands of southern Utah and northern Arizona, and the Apaches. The Colorado River could be crossed in only a few places. Water was necessary, so travelers stayed within one or two days distance of drinking water. In Arizona, rivers

were important travel corridors, providing water and food for people and livestock. People ventured into rivers only to cross them, not to travel on them. Instead, they traveled along the river banks.

The Colorado River formed a barrier to exploration for most of its length in Arizona. Travel through the Grand Canyon by foot or mule was very difficult (although Indians had traveled there for centuries), and boat travel was risky. There were only two good crossing spots to the north—Lee's Ferry and another near what is now the Page area. There were about a dozen ferries and crossing locations around and south of the present Lake Mead down to Yuma. The Colorado River is the only Arizona river on which boats regularly traveled—and such travel ceased by the end of the nineteenth century, except for recreational boating. Even though travelers no longer are dependent on rivers for drinking water, many of today's major transportation routes, such as I-10, still follow the historic trails and roads.

To cross the state from the east in the nineteenth century, most travelers either followed the Gila River, entering Arizona about where I-10 is today, or they traveled south of the Chiricahua Mountains, crossing the San Pedro River and then traveling up the Santa Cruz River. The southern route was longer than the northern route, but had the advantage of avoiding much of the Apache danger. A northern route left the New Mexico pueblos and met the Zuni and Little Colorado rivers, then headed west by either of several routes. Another route skirted Arizona, going through Utah and down along theVirgin and Colorado rivers.

"I with Samuel & James & My wife commenced to cork an old flat boat & by noon we were ready to cross [the Colorado River at Lees Ferry]. When we launched the Boat, My 2 sons hesitated to venture in such a craft. My wife ... Said that She would go over with Me & steer. Then we reached the opposite side, the [Navajos] Met us with open arms of Friendship. ... After Much difficulty we Succeeded in getting them & their luggage over safe. Next was their horses which we failed to swim over after 2 trials & nearly upsetting the Boat. ... Night fall closed the scene. For the last 3 hours I worked through fever and ague & when I reached the fire on shore I was so near exhausted that I Staggered. ..." [sic] John Lee, 1872.

The Great Surveys

Surveys to determine the boundary and to establish wagon roads and railroad routes produced a great deal of useful information about the territory and its vegetation and wildlife, as many of the survey teams included biologists. Captain Sitgreaves sought a road from Zuni to California in 1851. John Bartlett surveyed from southeastern Arizona to California in 1851 and 1852. Lt. Amiel Whipple surveyed for a transcontinental railroad in northern Arizona in 1853-54. At the same time Andrew Gray surveyed a railroad route along the Gila River.

In 1854-55 Lt. John Parke resurveyed the area along the eastern part of that route. When the U.S. became a territory Lt. Emory's survey in 1855 delineated the boundary. Joseph Ives, who had traveled earlier with Whipple, returned in 1858 to survey the lower Colorado River. In 1869, John Wesley Powell made the first of several investigations of the upper Colorado River. The most unusual survey was made by Edward Beale, who traversed northern Arizona in 1858 using a caravan of camels, to establish a wagon route.

Travelers adversely affected rivers on the more common trails. Wheeled vehicles rutted the roads, causing gullying and erosion. Firewood near the stopping places was gathered and trees were cut. Livestock trampled the shores at water holes and river crossings, especially when many animals traveled together. Livestock also ate whatever vegetation was available. This left the river vulnerable to erosion and more devastating floods.

In some areas so little vegetation was left near the trails that cattle starved. By the time travelers reached areas with vegetation, their livestock were ready to eat less palatable kinds of plants. When travelers were few and far between, or parties were small in number, the long-term impacts to rivers were small. On the more-traveled trails, however, the impacts could be significant, especially at major crossing points.

Stagecoach Routes

Stagecoach stops were located where there was adequate water and at comfortable distances for travelers and horses. All the stops across Ari-

"There was a big 7 steel-span bridge across the Gila River six miles up from San Carlos, but travelers from the East could not get up onto it and those from the West could not get off, because the Gila River's trenching had been to dig away the river bank on the east end of the bridge and to flow around it instead of under it." Apache Dancer, May 11, 1979.

zona on the Butterfield route were located by rivers, near springs or near lakes, except one where water had to be hauled in. The most famous stage station was at a spring at Apache Pass, a favorite watering source for Cochise as well as the travelers. The continual use of watercourses by livestock and people had an impact on those watercourses but after the stops were closed, the areas recovered and the long-term impacts were generally minor.

River Crossings

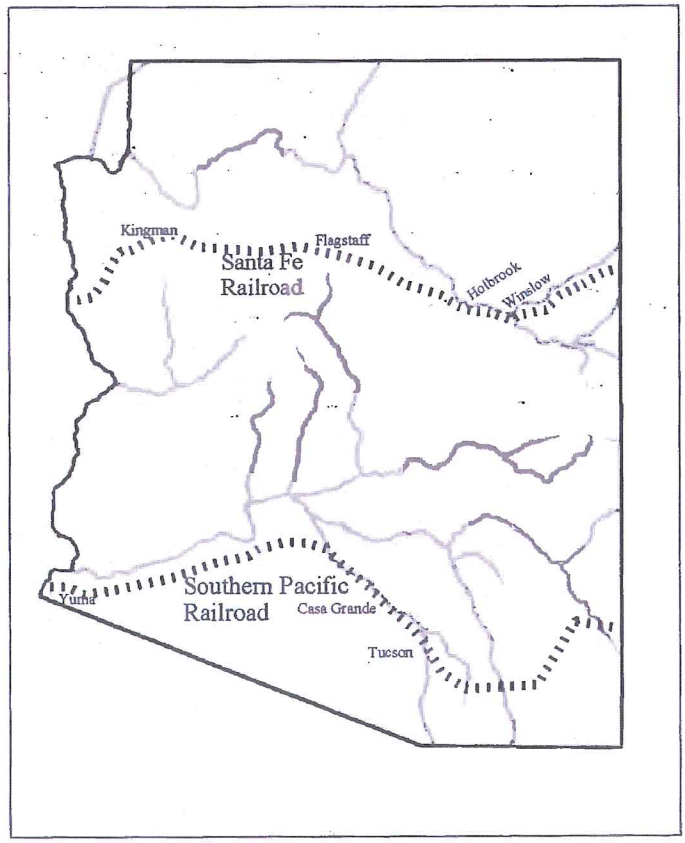
Most Arizona rivers were fordable during most of the year, but could become uncrossable raging torrents at other times. Only the Colorado River could seldom be forded and could be crossed at only a few spots. Enterprising pioneers set up ferry stations at the most desirable sites—Yuma, Lee's Ferry, and several others on the Colorado River, and Hayden's Ferry on the Salt River. Lee's Ferry in northern Arizona was the only feasible river crossing for hundreds of miles. The Yuma crossing was the most contested one, especially when travel to the California gold fields became popular. At least two pitched battles took place. Hayden's crossing over the Salt was principally needed only at flood time, but was essential then.

Railroads

Building of the railroads had a much greater impact on rivers than either trails or stagecoach routes. Lumber was needed for railroad ties and bridges. To provide an incentive for the investment needed, the federal government granted some major cross-country companies alternate sections of land for ten miles on both sides of the track. From these locations lumber and in the early days fuelwood could sometimes be gathered. Trains, however, soon converted to coal and later oil. Lumber for ties was usually brought in rather than harvested on site. Most railroad companies later sold their lands for ranching and other purposes.

In order to minimize costs of construction, bridges often were originally built as narrow as feasible, in some cases leaving the channel narrower than was necessary to carry flood flows. Washouts were a serious problem during infrequent floods. The Southern Pacific track along Cienega Creek, for example, had to be rebuilt several times, and finally was moved to higher ground.

The greatest impact of the railroads was in opening up lands that had formerly been inaccessible, such as areas on the Colorado Plateau. When the railroad reached towns such as Tucson or Phoenix, large numbers of people now were



Major cross-country railroads.

able to reach the area in relative comfort, and all kinds of materials could be imported and exported. Ranching was initially profitable largely because the beef could be sold in the East. Some communities, such as Casa Grande, developed originally as railroad towns.

Highways

Many modern highways approximately follow the old trails. I-10 follows the old trails (north of Apache Pass) along the Gila River west to Casa Grande, with a curve south to Tucson. I-8 resumes that trail all the way to Yuma. I-19 parallels old trails from Tucson to Nogales. In the north, I-40 follows the routes of travelers from Santa Fe west. The old trail around the Guadalupe Mountains east of Douglas has been abandoned, but parts of it have become highways 80 and 82. Old trails from Prescott west and south and through Wickenburg are now highways. Most of the roads going through Phoenix are recent since the city was not on most older routes. North-south travel from Flagstaff is also relatively recent, as is the Salt River route through Globe.

Impacts on the Rivers

The opening of the West through increasingly mechanized transportation had major impacts on Arizona's rivers. From the earliest times travelers and their animals left their marks on the rivers they crossed or traveled along. Beaver trapping radically affected the rivers by eliminating the many pools behind the dams. These pools created wildlife habitat and slowed river flow so that downstream floods were usually minimal. When the dams were eliminated, erosion damage to rivers increased and wildlife habitat was lost. Large numbers of livestock drastically reduced vegetation in some areas, leading to erosion and more devastating floods. Probably the greatest impact of improved transportation was to open up the West to large numbers of people who then impacted the rivers in many ways described throughout this book.

"After a wearisome ride I saw the wagons and the tall cottonwoods of the Gila, and when within half a mile of it, my tired mule smelt the running water. She pricked up her ears, gave one long bray, and made a beeline for the Gila directly through the thick chaparral. I hung on to her back like death to a deceased African and away we went like the wind to the banks of the Gila, into which she plunged her head and never raised it till her sides were distended like a hogshead. ... There was no checking their impetuosity; some of their riders were left hanging in the branches of the trees, some were thrown, and some were pitched headlong into the water. ..." John Durivage, 1849.

The Mormon Battalion

The first "official" American exploration of southern Arizona was led by Philip St. George Cooke, who took an ad hoc U.S. Army battalion of five companies of Mormon volunteers in 1846 from New Mexico to California to create a wagon trail to San Diego. They were also supposed to help consolidate U.S. victories over the Mexicans. Some of our best early descriptions of southeastern Arizona are from that trip. Traveling with the batallion were 36 wives and 54 children.

Cooke and his men made their way through the unknown terrain with the help of local Indians and experienced guides, including Pauline Weaver, who had trapped beaver in Arizona in the 1820s. They traveled the length of the San Pedro River from near the border with Mexico. It was not uncommon for soldiers, Mormons, and early explorers to battle wild cattle as well as Apaches in the San Pedro Valley. After a major battle with a herd of wild bulls (the only real battle of the journey) Cooke declared that he feared bulls more than Apaches.

The battalion went on to the Santa Cruz River to ensure that Mexican troops vacated the Presidio of Tucson. When they got there, the Mexicans had prudently left for San Xavier and the encounter was peaceful.

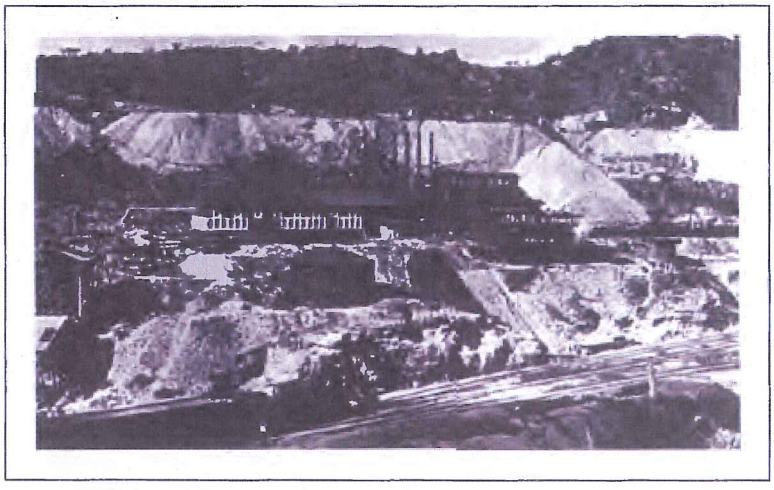
After many hardships and adventures, the battalion finally crossed the Colorado River at Yuma, having blazed an important route used by later travelers. Once they reached California the battalion dispersed and many of the soldiers joined the Gold Rush, while others settled in Arizona and elsewhere.

MINERS, FARMERS AND RANCHERS SETTLE ARIZONA

The three C's, cotton, copper and cattle, were considered the mainstay of Arizona's economy for more than 75 years. All three have long histories in Arizona, played a major role in settlement of the state, and have had important impacts on Arizona rivers. All three proved to be subject to booms and busts. In recent times, other sources of wealth have overcome the big three. By 1991, all agriculture and ranching made up only about one percent of Arizona personal income, and all mining another one percent.

In the nineteenth century, mining, farming and ranching developed simultaneously. Cattle drives across Arizona brought meat to the California gold fields. Ranching within Arizona provided meat for miners and farmers. Farmers sold crops to the miners. The three ways of life were closely related. And for some 20 years following the U.S. Civil War, the military, which protected the settlers, provided a steady market for their products.

Water was the key to success in mining, farming and ranching. Those who controlled the water supplies were the most likely to succeed. When the windmill became readily available in the late nineteenth century, many ranchers and farmers became less dependent on surface water. When pumping technology improved, people could take advantage of deeper water supplies. Some people thus were less dependent on streams and springs. Where groundwater was connected to surface water, however, streams were affected when pumping lowered water tables.



The Czar Mine in Cochise County about 1890.

Early Mining

Early inhabitants mined on a small scale for salt, coal, turquoise, pigments and other minerals. They did not, however, have the rich gold mines the Spaniards sought when they arrived seeking the fabled cities of gold. The Spaniards mined successfully for silver and gold in Mexico, and on a much lesser scale, primarily for silver, in southern Arizona. Espejo discovered a rich vein of silver south of the San Francisco Peaks of northern Arizona in 1582, but realized that mining would not be economically feasible in such a remote area.

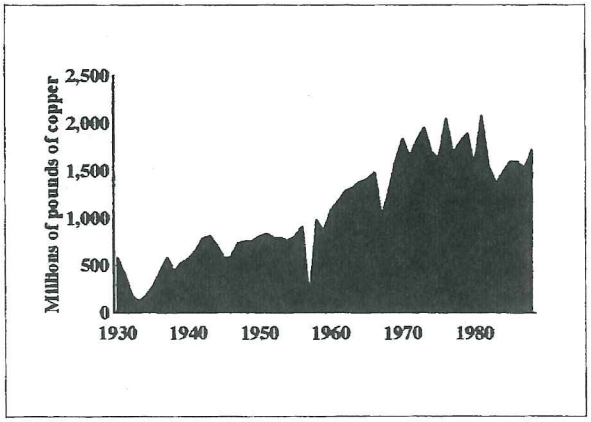
Gold and Silver Mining

It was not until after the California Gold Rush ended that the Anglo search for gold and silver in Arizona began in earnest. Reports went out that gold had been found

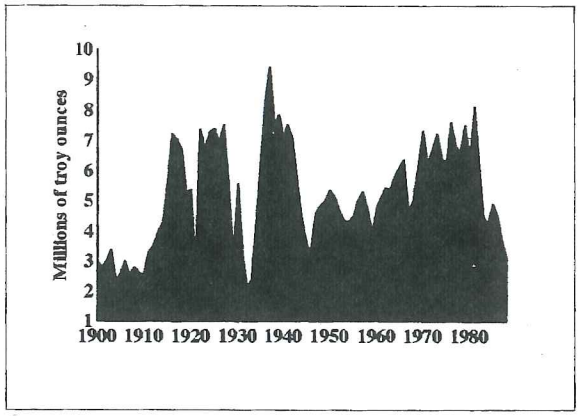
at spots along the Colorado River. Steamboats had reached the river about the same time, and boats transported prospectors up the river. More than 50 towns sprang up, but they usually disappeared after a few years. Only a few mines were successful. The difficulty of mining in a water-scarce region, coupled with problems of transporting supplies to the mines and moving the ore out to market defeated many. Most rich veins played out quickly, leaving the prospector not much wealthier than before. Often the people supplying the miners ended up richer than the miners.

In 1857, gold was discovered along the Gila River, 20 miles upstream from the Colorado River. Within a year more than 1,000 people were panning for gold, and the thriving town of Gila City sprang up. While a few got rich, most left with nothing. Even well-financed companies did not always make a profit. It was not until the railroad arrived, making transport easy, that mining really became profitable.

In 1856, enterprising businessman Charles Poston organized the Sonora Exploring and Mining Company and settled along the Santa Cruz River with about 80 mining claims. For a short time he was the "alcalde" (mayor) of Tubac. Gardeners soon produced all the vegetables and fruits the community could eat, using a canal from the Santa Cruz River to irrigate the crops. The high cost of transporting supplies in and ore out meant that only the richest veins were profitable, and soon these were exhausted. Poston went on to play a major role in the development of the Arizona territory and was known as "the Father of Arizona."



Copper production in Arizona.



Silver production in Arizona.

In 1862, gold was found along the Hassayampa River, with the Vulture Mine the most productive of the early gold mines. The gold rush that followed alarmed the Apaches who, fearing loss of their lands and hunting grounds, attacked pack trains and isolated miners.

Copper Mining

It was not until after the Civil War and military "pacification" of the Indians that mining proved profitable. The arrival of the cross-county railroads in the 1880s and many local lines also increased the profitability of mining.

The great silver boom along the San Pedro River in the late nineteenth century made Cochise County the leading county in production of gold and silver. In Cochise County and other areas, gold and silver were soon replaced by copper as the most profitable metal, although occasional rich gold or silver finds were still made in the twentieth century. Nearly all of Arizona's great copper mines—Clifton-Morenci, Globe, Ray, Bisbee, Ajo, Mammoth, and United Verde—were discovered in the late 1800s, and some continue to produce today.

Over the years, copper production has risen and fallen, depending on economic conditions. Since 1858, Arizona has led all other states in copper production, and Cochise County historically produced more copper than any other part of the state, but Pima County leads in copper production today. Development of new technology

SALT RIVER

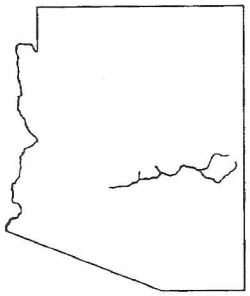
The Salt River is the major river in east-central Arizona, with tributaries throughout the White Mountains. The most sophisticated prehistoric irrigation system in North America was in the Salt River Valley. Its more modern history includes farming, ranching, a series of dams and the largest metropolitan area in the state.

The River

The Salt River begins high in the White Mountains where the Black and White rivers converge and meets the Gila River about 80 miles further downstream below the Phoenix area. The major tributaries are the Verde, White and Black rivers and Tonto Creek. The entire watershed (including the Verde) covers about 6,600 square miles. Steep canyons mark much of the upstream area, while the Salt River Valley below is a broad floodplain. There are 1,262 perennial stream miles, 7,469 nonperennial stream miles and 27,544 acres of manmade lakes in the watershed, including the Verde River.

The Early Residents

The Hohokam inhabited the Salt River Valley for more than 1,000 years using sophisticated irrigation systems.



The Salado people occupied the upper Salt River Valley at about the same time that the Hohokam lived downstream. They, too, lived in agricultural communities and farmed areas such as the confluence of the Salt River and Tonto Creek, an area now inundated by Roosevelt Lake. The Tonto National Monument and Besh-Ba-Gowah Pueblo in Globe are preserved examples of Salado dwellings. At its height in the 15th century, the population of the Tonto Basin was probably about 5,000. The Salado abandoned their homes and fields by 1450 for unknown reasons and moved north and east to join existing Hopi and Zuni pueblos. Hohokam civilization declined in the fifteenth century. Little use was made of the Salt River Valley for two hundred years after the disappearance of the Hohokam.

The Yavapai and Apache people moved in and were utilizing much of the upstream area by 1700 or earlier. While they were largely nomadic, agriculture was an important seasonal source of food for them. Using horses introduced by the Spaniards they were able to range over a large territory, including the Salt River watershed.

The Spanish Period

The Spaniards were barely aware of the Salt River, although Coronado probably crossed it in 1540. Even Father Kino on his travels did

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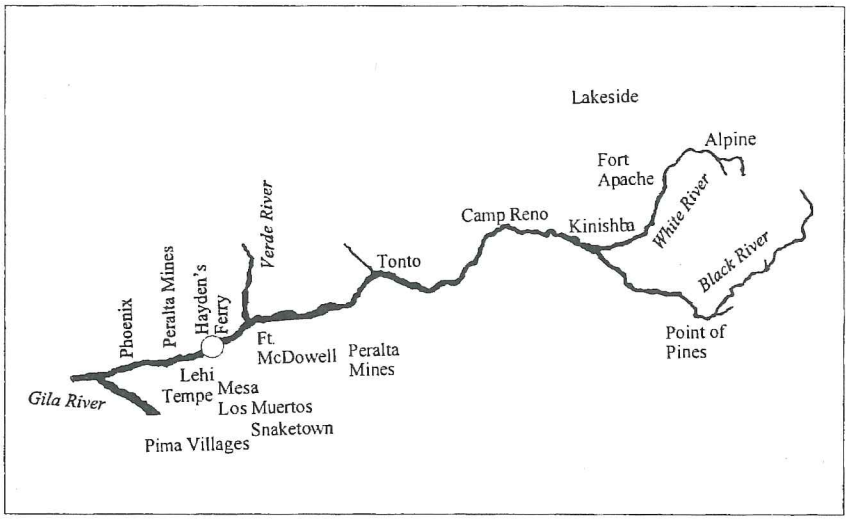
"We are now between the Salt and Gila Rivers, on a very extensive rich plain, covered with trees and small brush, watered in some places by means of canals from the two rivers named. The river dams and canals are very easy made, on account of the solid bottoms of the rivers and pure farming clay of the plain. In fact, the people who are now living here find it very easy to get good farms in one or two years without much hard labor. They unite as we do in making canals. The climate is one of the most delightful in the world and until a few years ago, one of the most healthy too, but lately the people have been troubled with fevers, which nobody seems to know the cause. The water is good and the sky is clear, there being no stagnant pools; the ground is dry and the winds blow freely in every direction." Deseret News, Jan. 1878.



Historic Sites Along the Salt River.

not go north of the Gila, although he did mention the confluence of the Gila and Salt rivers. The most lasting influence of the Spanish in this area was the introduction of horses.

Trappers and Anglo-American Explorers

James Pattie explored most of the Salt River in the 1820s. Young, Wolfskill, Yount and Weaver also explored the Salt to its confluence with the Verde River at that time. They trapped hundreds of beavers in the early 1820s.

The river was again mostly ignored by outsiders until after the Civil War when several forts and camps were established and were active for about twenty years. The largest were Fort McDowell at the confluence with the Verde River and Fort Apache far upstream on the White River. Indian occupation was severely reduced and ranching expanded into the upland areas from the Little Colorado River basin and from areas to the south.

The Walker Trail from the Pima Villages on the Gila River to Prescott was pioneered in 1864. It crossed the Salt River in the Phoenix area. This trail later became a stagecoach route.

Few Indians were living in the Salt River Valley when pioneer settlement began in the 1880s. Pioneers encouraged Pima Indians to move from the Gila River to an area north of the Salt River to help serve as a buffer against the Apaches. When the Gila River began to dry up because up-stream farmers were using so much water, other Pima Indians migrated to the Salt River Valley which still had water for farming. Later, when competition for farm land and water increased, settlers harassed the Pimas and tried to remove them from the area.

Anglo-American Settlement

In 1868 Prescott entrepreneur Jack Swilling saw great agricultural possibilities in the Salt River Valley and successfully reused an old Hohokam ditch. From then on, settlers built earthen dams and planted fruit trees, such as fig, plum, peach and citrus and were growing crops such as peanuts, alfalfa, tobacco, barley and corn. By 1889 more than 35,000 acres were under cultivation in the Valley. Ten years later almost four times this much land was cultivated. Settlers found that mesquite land supported more thriving crops than bursage land, but cutting down mesquite trees and preparing land for the plow cost them $3-$7 per acre, while bursage land clearing was only $1-$2 per acre. Ultimately, both mesquite and sage brush lands were converted to farming.

Mormon settlers who found the area appealing in the late 1800s, settled in the eastern part of the

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"Much difficulty has been experienced by the flood waters of our rivers going to waste at a time when they were not much needed, and when needed there was not enough to supply the demand. This difficulty will soon be overcome by impounding the flood waters by means of great dams and reservoirs. ... Happy homes will spring forth and millions of people will live and prosper where once there was nothing of value to mankind." Phoenix Chamber of Commerce, 1908.

Dam	River	Year	Lake
Granite Reef	Salt	1908	no lake
Roosevelt	Salt	1911	Roosevelt Lake
			1,381,600 a.f.
			23 river miles
Horse Mesa	Salt	1925	Apache Lake
			245,100 a.f.
			17 river miles
Mormon Flat	Salt	1925	Canyon Lake
			57,852 a.f.
			10 river miles
Stewart Mt.	Salt	1930	Saguaro Lake
			69,765 a.f.
			10 river miles
Bartlett	Verde	1939	Bartlett Lake
			178,477 a.f.
			12 river miles

Dams on the Salt River and its Tributaries.

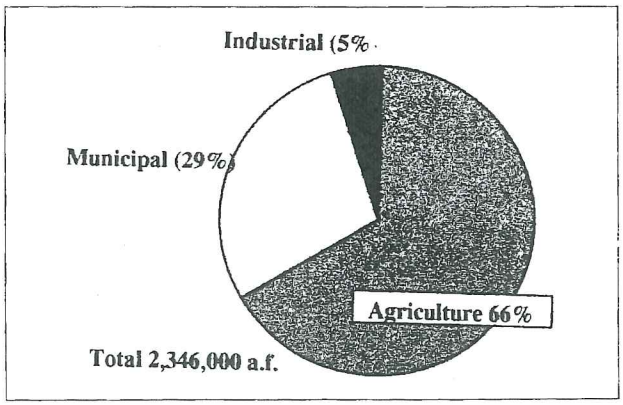
Valley, establishing Lehi, Mesa and Tempe on the south side of the river. Charles Trumbull Hayden was one of those who recognized the possibilities of the area on a trip to Whipple barracks. He arrived at flood time and had to wait two days to cross the Salt River. This gave him time to dream not only of finding ways to help people cross the river, but also of growing wheat. A year later he returned and established an important river crossing with a ferry—the only way to cross the river for miles in either direction when river flows were high. Hayden also built a store and water-powered flour mill at that location, which became Tempe. From 1887 to 1889 severe drought hit the valley, limiting the amount of land that could be irrigated. This was followed by extensive flooding.

In February 1891 rain began to fall and it continued to fall for days. By February 18th, most of the town of Lehi was under water. The Steele family on West Lehi Road saw their adobe house melt into a large pile of mud. At one point, the river measured eight miles wide near present-day 24th Street in Phoenix. Rain continued to fall even after the first crest of the river. A week later, 225 men were working to protect the Arizona Dam with gunny sacks and other supplies. The river was rising at a rate of one foot per hour. All of Lehi was flooded except for about two acres of rocky ground where large numbers of rabbits gathered with the people.

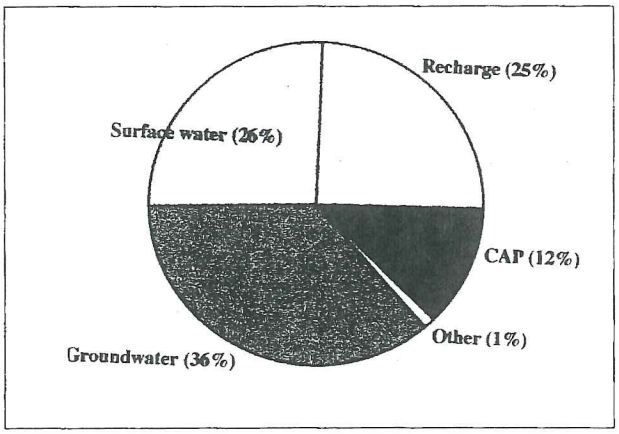
This time of flood was followed by a decade of severe drought. Only a trickle of water flowed in the canals, if it flowed at all. No water flowed in the river through Phoenix. In the year 1900, violence broke out over water when there was not enough for all who claimed water rights. The Mesa Free Pres reported "Lehi has had quite a good deal of trouble during the past week over the water question. A scrap occurred Wednesday evening in which guns, revolvers, and other weapons figured conspicuously. ... if it continues to get much worse, it has been suggested that the sheriff call out the National Guard. The shortage of water increased fire danger so much that on June 22 the Free Press expressed the hope that 'owing to the scarcity of water ... the small boy with firecrackers will be rigorously suppressed'." The long drought brought about a spirit of cooperation among water users who united to support building storage dams.

Dams

Historically, beaver dams throughout the river system held back water in pools, promoting water recharge. Although beavers were heavily trapped in the 1820s and 1830s, they had pretty much re-



Phoenix Area Water Uses in 1990.



Phoenix area water supplies.

covered by the time American settlers arrived. By the 1920s, however, settlers had eliminated beaver from all except the high elevation tributaries.

Diversion dams have been necessary for irrigated agriculture since Hohokam days. Before the twentieth century, dams were small, usually built of trees, brush and earth and were easily washed out by floods. The twentieth century brought a whole new type of dam—very large dams intended to last for many years. The purpose of the dams was to distribute water supplies throughout the year, through times of summer low flow and control floods.

Roosevelt Dam was the first dam ever built by the newly created U.S. Reclamation Service. It is located 80 miles from Phoenix, at the confluence of the Salt River and Tonto Creek. It took six years to build and was completed in 1911. The dam was modified and raised 77 feet in the 1990s, increasing the flood storage capacity. In the 1920s and 1930s three more large dams were built on the Salt River and two on the Verde River, largely to serve the Salt River Valley. A dam once planned on the Fort McDowell Indian Reservation was never built because of opposition from Indians and others. This dam would have flooded most of the useable land and damaged bald eagle nesting areas.

The cumulative effect of the dams has been to completely change the character of the river.

The Salt River Project

In 1889 the Maricopa County Board of Supervisors wanted to build a dam site 80 miles east of Phoenix on the Salt River. The expanding population of the Phoenix area, coupled with uncertain river flow, had prompted local irrigators to look for new ways to supply water. In territorial times there were federal restrictions that kept the territory, county, or individuals from proceeding with water reclamation projects, so, in 1903, the Salt River Valley Water User's Association was formed.

Under the National Irrigation Act of 1902, the federal government provided the funds for water reclamation projects. Using these funds, the association welcomed the start of construction, in 1903, of its first water storage facility—Roosevelt Dam. The Federal Reclamation Service controlled the operations of the dam and related irrigation system until 1917, when the Association took over control of all water and power activities. About a decade later it began drilling wells to pump groundwater.

In 1937 the Association created a new municipality, the Salt River Project Agricultural Improvement and Power District. This was a semi-public, tax-exempt organization responsible for power generation. The two organizations tried to operate distinctly, but in 1967 increasing overlap in their duties led to the combination of the Association (water) and the District (power) into the Salt River Project.

When the dual Salt River Project (SRP) was formed, it had six dams on the Salt and Verde rivers with a capacity of over 2 million acre feet. From the main distribution point, Granite Reef Dam, 131 miles of main canals delivered 1,050,000 acre feet of water to 238,252 acres of land. Hydroelectric generators and steam electric plants had a capacity of 598,162 kilowatts.

The SRP today has about as many storage facilities, miles of canals, and serves the same number of acres as it did in 1967. However, to serve the growing population, it has expanded by drilling wells. SRP serves over one million power and water customers in the Phoenix area, and has 250 wells. SRP has also initiated a groundwater recharge project to capture surplus water from years of high precipitation and store it underground.

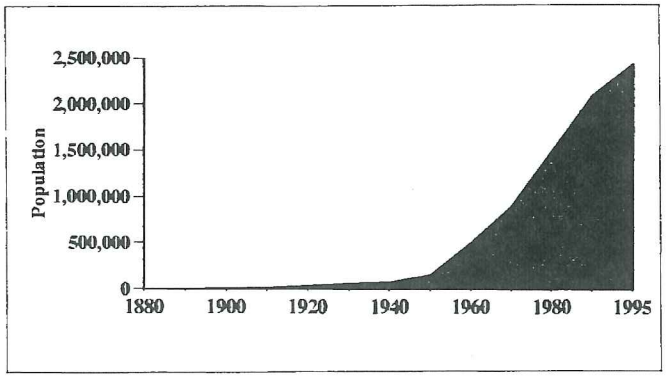
Before 1900, the river's flow was heaviest in the spring and early summer when snow melted in the mountains. Heavy summer storms also could bring about high water. Flows were generally low in fall and in drought years.

The dams transformed some 70 miles of flowing river into a chain of lakes and changed the way water flowed downstream. No longer did high spring flows ensure cottonwood regeneration. Instead, saltcedar (a non-native tree), which has much less demanding germination and growth requirements and disperses seed throughout the summer, took hold. Native fish were unsuited to lakes and could not compete with the sport fish introduced into those lakes.

Diversions from Granite Reef Dam, a dam which diverts most of the water in the Salt River to the Phoenix area, effectively dewatered the river, turning it into a sandy expanse experiencing high flows only during unusually rainy years when flood waters had to be released from the dams upstream.

Agriculture

Settlement in the valley depended on agriculture, and agriculture depended on a reliable water supply. When the dams were completed, agriculture began to expand and flourish. Dams not only provided water, but also power, allowing more groundwater pumping. Cotton and citrus became the most important crops. By 1930, about 375,000 acres were under cultivation, using over 2 million acre-feet of water. In recent times much of the former agricultural land has been converted to urban land, except on the Salt River Reservation and the west side of the valley.



Population in Maricopa County.

Urbanization

As more and more people moved into the Phoenix area, agriculture began to decline. Urbanization had new impacts on the river, which was already drastically changed from its pre-Arizona Territory status by dams and diversions. While total water use did not change much, land use did. Instead of porous soil surfaces where crops were grown, much of the area became either paved with streets and parking lots or covered with homes. During intense storms water now runs off quickly into the river and goes downstream, often as flood water. Local regulations have mitigated the problem somewhat by requiring that certain new construction include provisions for detention or recharge of flood water.

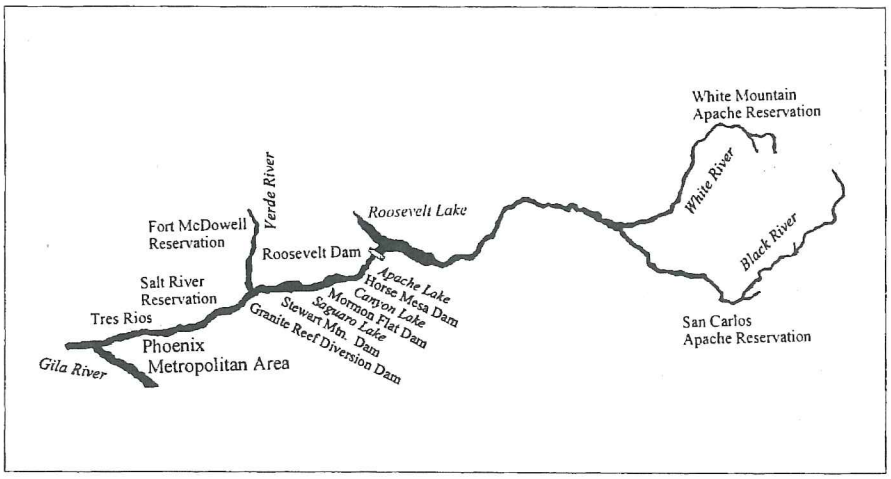
The dry floodplain attracted developers. Many commercial and residential buildings are located in the former floodplain of the river. This means that flood control projects are needed to protect those structures. The dry river bed is also an economical place to mine for sand and gravel for construction purposes.

The dry river bed also was a convenient place to dispose of trash, especially where holes were already dug to excavate sand and gravel. A large metropolitan landfill operated by the Salt River Indian Tribe on the north bank of the Salt River across from Mesa was damaged in the 1993 flood and large amounts of trash fell into the river. A volunteer effort was able to remove some of the larger materials after the flood had subsided, but some contamination occurred. Contamination from old landfills is a continuing problem during high flows.

Water Use

Water diversions have taken their toll on the amount of water in the Salt River. Below Granite Reef Dam, all its water is diverted. The river is normally dry and no longer supports riparian vegetation until it reaches the first wastewater plants downstream of the Phoenix area. Groundwater pumping has further depleted the amount of

water available to the river. Only on the west side of the valley are water tables still high, due to wastewater. In 1990 2,725,447 acre-feet of water were used in the Phoenix Active Management Area, while only 2,397,152 acre-feet of renewable supplies were available. Even with Central Arizona Project (CAP) water from the Colorado River, over 300,000 acre-feet of groundwater were used beyond the natural recharge level. C.A.P. is helping to eliminate the overdraft problem.



Twentieth Century Sites along the Salt River.

Much of the Phoenix metropolitan area is served by the Salt River Project (SRP). SRP delivers water from both surface water and groundwater sources and holds water rights for a large portion of the Salt and Verde rivers. These water rights, requiring that water be delivered downstream for use in the Phoenix area, have limited surface water use in the upper reaches of the river, keeping the river flowing to Granite Reef Dam.

Wastewater Flows

Treated wastewater enters the Salt River downstream of the metropolitan treatment plant at 91st Avenue west of Phoenix, creating a riparian area—dominated, however, by saltcedar—and wildlife habitat all the way to the Salt River's confluence with the Gila River. Even the endangered Yuma Clapper Rail has settled in this riparian area. Much of this water is used downstream by agriculture and the Palo Verde Power Plant. This effluent flow is gradually being replaced by recharge projects and a constructed wetland, the Tres Rios Project, near the confluence of the Agua Fria, Salt and Gila rivers.

"For the past five or six days about half our living has been fish. Our only trouble is that we have not got lines strong enough for the large fish which weigh from 10 lbs. to 40 lbs., neither can we catch many of them in our willow drag." F.A. Cook, 1864

Vegetation and Woodcutting

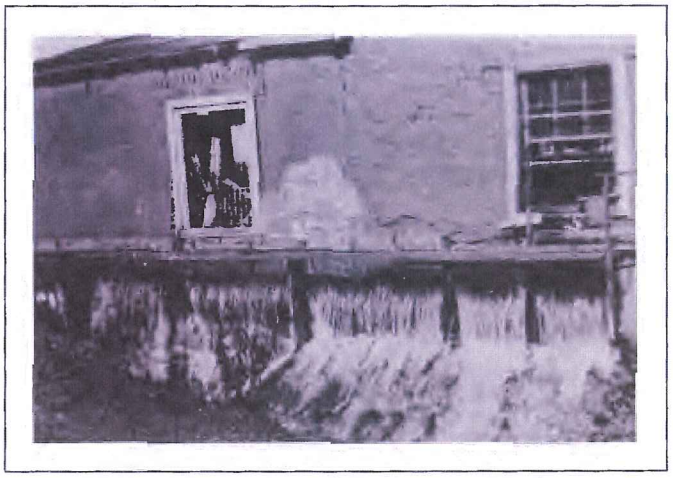
Cottonwood, willow and mesquite were once common in the Salt River Valley. As recently as 1921, a photo of the Central Avenue bridge in Phoenix revealed extensive cottonwood stands. From the days of earliest settlement, the demand for fuelwood was enormous. As in most other early communities, woodcutting had a major impact on the river and nearby lands. In towns, trees were planted for shade, but the surrounding areas were largely deforested to provide wood for heating, cooking, powering steam engines, and many other purposes. Once the local supply was exhausted, lumber was brought from as far away as Prescott and the White Mountains.

As competition for water increased, irrigation districts, businessmen and homeowners were determined to eradicate cottonwoods, which they considered water guzzlers. According to the newspaper editor, "They pollute the air and the ground about them with their masses of white, fluffy seeds, and they are subject to disease, and their brittle limbs, easily broken, constitute a hazard during our violent windstorms." Native trees were replaced with exotics such as umbrella, eucalyptus and citrus trees in yards. Today cottonwoods are rare along the Salt River. Only a few isolated stands are found in the urban area, though there are extensive stands at the Salt-

Verde confluence. Near the dams, saltcedar thickets predominate in many places.

Mining

Mining has greatly impacted tributaries in the Globe-Miami region, especially Pinto Creek. Some of the most dramatic changes in land use can be seen near Globe, Miami, and Superior where large open pit mines and tailings ponds dominate the landscape. Small watercourses have been filled in or diverted. Pumping and water diversions have taken water from the rivers. Water quality problems from metals, low pH and other contaminants are attributed to mining activity, especially occasional tailings ponds spills during flood times. Mitigation measures are underway to improve water quality.



Hayden's Flour Mill about 1895.

Fishing

Fishing was an important food source for the early inhabitants. Hohokam trash mounds contain bones of several kinds of large edible fish. Pima Indians ate bony-tail, sucker, humpbacked sucker, squawfish and several species of smaller chubs and dace.

In 1877 Lehi pioneers found edible fish abundant in the Salt River, which was an important food source for them, especially before they established successful farms. Dan Jones bragged that he had caught "a five-foot long salmon [squawfish] weighing 40 pounds." In 1888, a fishing party near the site of the present Granite Reef Dam reported catching 64 fish, with many of them being "that prince of Arizona waters, the Colorado salmon [squawfish]." In 1879, the Phoenix Herald called indiscriminate killing of large numbers of fish with gunpowder a serious problem.

Fishing is popular today in the upper stretches of the river although it no longer provides a major food source. Introduced fish have mostly replaced the native fish, except for a few native species in the mountain streams. Official warnings have been issued for fishing downstream of Phoenix, because of water pollution.

Farming in the Salt River Valley about 1885.

Recreation

The Salt River has many popular recreation areas. Rafting trips starting at the Highway 60 crossing are popular during the late spring and early summer. The Apaches limit the number of rafters and canoers on their section of the river to minimize negative impacts on the river. The four reservoirs provide manmade lakes that are popular boating, fishing and camping areas.

Restoration and Preservation

Where the Salt River flows through Tempe, a major restoration project is underway: the Rio Salado Project. In the planning stage for more than 20 years, the project is under construction.

Near the confluence of the Salt River with the Gila River and the Agua Fria a large constructed wetland, the Tres Rios Project, is being built using wastewater that has been flowing into the river from the wastewater treatment plant.

Apaches helping build Salt River Project canals, 1906.

Changes in the River

Far upstream, the Salt River continues to flow freely through National Forest and Indian Reservation lands. Here some remote creeks have changed little through history, except for several modern impacts. In some areas, however, changes have occurred. For example, beaver dams are few, and in some areas overgrazing has seriously impacted some of the tributaries. Logging in the White Mountains also has impacted the rivers. Downstream water rights serving Phoenix area water demands ensure that most of the water remains in the river until the big SRP diversions, thus protecting the upstream areas.

While Hohokam agriculture and settlement certainly had an impact on the river, the river by 1850 probably looked much like it did before Hohokam times. It flowed all the way to the Gila River except during drought. Cottonwood trees and other vegetation lined the banks. There had been virtually no direct impact during the Spanish period, except the introduction of horses and new crops and diseases.

Beaver trapping changed the river dramatically in the 1820s and 1830s. American settlement brought major changes to the Salt River Valley, by eliminating many small dams (beaver and man-made) that kept water in the upstream areas. At first the biggest changes resulted from woodcutting, water diversion and land clearing for agriculture. By the early 1900s alternate flood damage and water shortages led to construction of dams which completely changed the river. By the time the upstream dams were completed, water no longer flowed beyond Granite Reef Dam except at flood time. Lakes that replaced the flowing river support a quite different type of vegetation and wildlife.

Groundwater pumping lowered the water table in most parts of the Salt River Valley further depleting surface flow. The Salt River is a dry, sandy channel through the metropolitan area except when water is released from the dams. Downstream of the metropolitan area, wastewater supports a riparian forest, made up largely of saltcedar much of the way to the Gila River.

Urbanization has had other impacts on the river from increasing the intensity of flood flows from creation of impervious surfaces to creating an environment inhospitable to most kinds of wildlife.

Mining has impacted the tributaries of the river near Globe-Miami, where there are several huge copper mines. Upstream from Roosevelt Lake the river is less impacted by human activities. Most of the upstream portion within either National Forest or Indian lands is relatively unchanged by most human impacts, except grazing and some timber cutting in the higher elevations.

FARMS, CITIES AND INDUSTRY COMPETE FOR WATER

Competition for water has been an integral part of Arizona's development. Some of the early water battles were fought with guns, but the need for laws quickly became apparent. Arizona settlers sought reliable sources of water for their homes and enterprises. Miners needed water to process gold, copper and other metals. Where both ore and water were found in the same place, the success of a mine was more likely. Ingenious methods sometimes were used to bring the two together. In some places water was shot from large pressure guns across ravines to process ore. Fights over water in mining areas could be fierce and led to the first attempts at surface water laws in neighboring California at the time of the Gold Rush. Arizona's water law followed developments in California.

As agriculture and ranching grew, so did competition for water. Farmers needed to move water from rivers onto their fields. Irrigators often competed to build bigger canals to divert large amounts of streamflow. Ranchers and homesteaders located near dependable water supplies, but soon found themselves at odds with later settlers and Indians.

Water Law and the Rivers

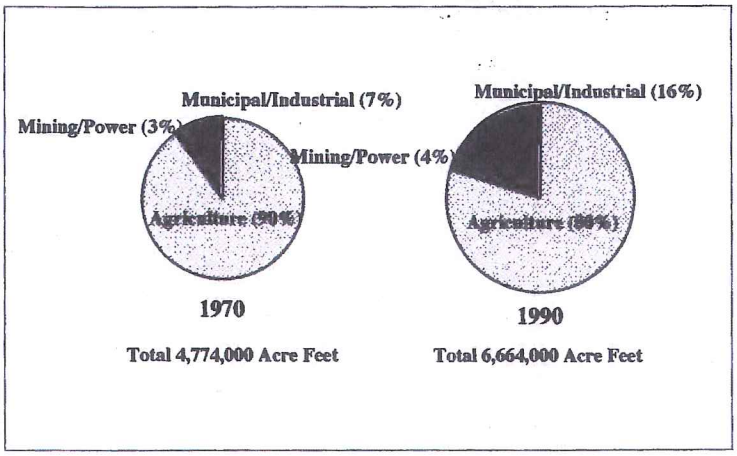
One of the most important but more obscure forces that has changed Arizona's rivers is Arizona's water law. From the beginning, the law developed to encourage water use and protect those who arrived first. Since rivers occupy only a small portion of the land, the settlement of the arid West was supported by a system that allows a user to remove water from a river, with this use protected from later users.

Surface Water Law

To settle conflicts and to avoid outright warfare, water law gradually developed that granted rights for water taken from a stream to be used elsewhere. This type of water law—the doctrine of prior appropriation—reflected the arid nature of the West. Water was not always available where it was needed, whether for agriculture, mining or urban uses. Prior appropriation allowed the diversion of water, with some certainty that its use would be protected from future diversions

In 1864, Arizona's first territorial legislature adopted an appropriation system for surface water rights. Since water use was minimal at the time, no method for filing or receiving water rights was established. However, by the late 1800s, development of irrigated agriculture along the Salt River and the onset of drought caused water shortages. In 1893, the territorial legislature required new appropriations be posted at the place of diversion and recorded at the county recorder's office. More than 15,000 water rights claims were filed before Arizona became a state in 1912.

With statehood, Arizona also adopted a state water code that essentially remains unchanged. Today's law requires that people file applications



Arizona water uses in 1970 and 1990.

with the Arizona Department of Water Resources (ADWR). If all requirements are met, a permit to use surface water is issued. The resulting law (which applies generally in all western states) is the appropriation doctrine. It has three important provisions:

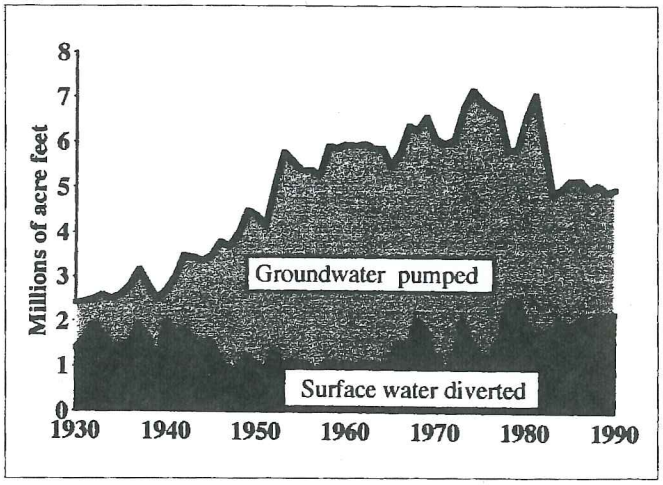
First in time - first in right. Users must apply for a permit to appropriate surface water. If there is enough water left after previous appropriations, a permit can be granted. Once the user has actually developed a way to use that water, a certificate is granted. If the water rights holder takes water out of the river downstream, other users may not use that water, unless it is used in the stream. This has, for example, benefited the Verde River. The Salt River Project holds major water rights on the Verde River, but pumps its water downstream near Phoenix. That SRP has these Verde River water rights means that the flow of the rivers is ensured until it reaches the Phoenix area.

Water must be used beneficially. The law sets out beneficial uses of water which (in order of priority) are domestic, municipal, irrigation, stock watering, power generation, recreation, wildlife (including fish), artificial recharge and mining. Most uses require the water to be removed from the stream. The priorities are in effect only if more than one applicant applies for the same water at the same time. Otherwise any user may get a permit for unappropriated water for any intended use

Use it or lose it. If a certificated user does not actually use the water beneficially at least once every five years, for the use specified in the certificate, other users can claim that water, although this provision is rarely used. In the case of Scottsdale and the Bill Williams River, for example, to maintain its water rights the city must pump water for agriculture at least once every five years, even if it would prefer not to. This issue is being resolved by the Department of Water Resources.

Instream Flow

Water may be appropriated for use **in the stream** for wildlife and recreation—"instream flow"—but all senior users, i.e., those with earlier water rights, have priority over later users, including those with water rights for instream flow uses. In only a few cases is unappropriated water available. To transform existing water rights to instream flow rights is not easy. Seventeen instream flow permits or certificates have been granted in Arizona.



Arizona water use.

Groundwater Law

Most surface water was fully allocated by the time advances in groundwater pumping technology appeared. Many believed the supply of groundwater was virtually endless. When pumping technology made it possible to extract large amounts of groundwater, users no longer depended on rivers and springs.

With the advent of high-power pumps and cheap electricity in the 1940s, groundwater withdrawals began in earnest. Arizona developed laws to control groundwater pumping in 1948, when conflicts arose between agricultural interests and newcomers. The first groundwater law protected prior pumpers in certain areas of intense farming and water use. No new wells could be drilled for agriculture, although wells could be drilled for other uses.

By 1980, it was clear that pumping had to be regulated, at least in certain areas, and the Arizona Groundwater Management Act (AGMA) was passed (largely to satisfy federal government requirements for building the Central Arizona

"To halt construction of Parker Dam in 1934, Arizona Governor Benjamin B. Moeur called out the Arizona National Guard. Governor Moeur, arguing the construction of the dam would be an infringement on Arizona's sovereignty, sent one major, a sergeant, a cook and three privates to the dam site. Traveling by ferry boat, horses, and cars, the Guard was sent to prevent construction of the dam. More than a hundred national guardsmen were also sent when construction on a trestle bridge began. The Governor issued a proclamation 'To Repel an Invasion' and declared martial law. Construction halted for more than a year on the dam." Philip Fradkin, 1968.

Project). The law declared certain areas Active Management Areas (AMAs) while others became Irrigation Nonexpansion Areas (INAs). AMAs had requirements and incentives for water conservation and limits on drilling of new wells. In INAs only new agricultural uses are controlled. In the rest of the state no control over well drilling and water use exists, except that the well be registered.

The AGMA only deals with groundwater. In Arizona law groundwater is considered to be separate from surface water. Water may be pumped from aquifers which contribute to streamflow, even if the river or individual surface water rights are adversely affected. The law has no incentive for conservation to protect rivers, except in the Santa Cruz AMA, which was created in part to conserve the Santa Cruz River.

Surface-Groundwater Conflicts

Conflicts over water are increasing as the connection between surface water and groundwater is realized. Although separate under Arizona water law, surface water and groundwater are hydrologically connected in most areas in the state. In some areas this connection has been severed by excessive pumping. In other areas the underlying geology separates groundwater and surface water. Groundwater pumping has affected rivers throughout the state, some more than others. The Santa Cruz River is Arizona's prime example of a situation in which groundwater pumping has dewatered a river. Both the San Pedro and Verde rivers face serious problems as groundwater pumping increases for a growing population.

In contrast, the federal government requires a contract with users to pump groundwater hydrologically connected to the Colorado River, an interstate river with federal jurisdiction. Flow of the river must not be diminished by pumping. On the Gila River, however, many farmers have drilled wells because of lack of surface water, diminishing the flow of the river. This problem is being litigated in federal court.

Indian and Federal Water Rights

Indians and the federal government hold another type of water right different from water rights established under state water law—federal reserved rights. In 1908, in *Winters v. United States,* the U.S. Supreme Court ruled that Indian tribes were entitled to enough water to fulfill the purposes for which reservation were established. Later, in another landmark decision, *Arizona v. California*, the U.S. Supreme Court set a standard to measure Indian water rights, based on irrigated agriculture.

State water law does not have precedence over Indian or federal claims. The reservation's priority date is based on the date it was established,

Irrigation pumps near the remains of Gillespie Dam on the Gila River, 1996.

and water rights cannot be lost through nonuse. Other reserved water rights for federal land such as military bases and national forests are recognized, but their scope is more restricted. The status of Indian water rights claims varies. Five tribes settled their water rights in *Arizona v. California.* The Tohono O'odham Nation, the Salt River Pima-Maricopa Community, and the Ak-Chin Indian Community chose to negotiate with non-Indian water users. Other tribes are pursuing options from filing water rights claims in court to negotiations.

Who Owns the Rivers?

In Canada and some U.S. states, rivers belong to the public. Most rivers in Arizona, however, are privately owned. When settlers first arrived, the rivers were the first areas to be claimed and became privately owned. When Arizona became a state, the federal government turned over the navigable rivers to the state as public land (Public Trust Doctrine) but rivers already privately owned remained private. The entire Colorado River is public, because it is navigable, but most other streams are not unless some public agency bought them. The U.S. Supreme Court ruled in the 1980s that any Arizona streams that were navigable at the time of statehood are in fact public and should not have been given away. A lengthy process is underway to determine which streams were in fact navigable and should be returned to public ownership or purchased at fair market value by individuals. The fact that many streams have been considered private property for years has profoundly affected them.

Settling Disputes

For the most part, disputes are settled in court. The burden of proof lies with those who believe their rights have been violated. They must gather the information and challenge the violator in court. ADWR does not enforce water rights claims. There is little in the law to protect users of groundwater from pumping by others. Nor does the law for the most part protect surface water rights holders from loss of their water due to groundwater pumping.

Surface water rights in the Little Colorado River and the entire Gila River system are being adjudicated in a lengthy court proceeding. The intent is to assign a water right and priority date for every water user in these areas, including Indian tribes and other federal lands.

The Arizona adjudications involve more than 27,000 people asserting over 77,000 water rights. Included are most of the large water users in the state, Indian tribes and independent landowners. Claims probably will not be settled until well into the next century. How the settlement acts are implemented, and how the remaining claims are settled will certainly impact Arizona rivers.

Impacts on the Rivers

Arizona encourages population growth, with its increased water use. At the same time the state has a legal system that favors prior rights holders over newcomers. In this inevitable competition for water, the rivers have often been the losers.

While Arizona's historic water laws served well to help settle the West, the result has been less and less water for riparian habitat, fish and recreation. The law has almost no incentive for water conservation to maintain river flow.

Groundwater Pumping Can Affect Rivers

Rivers can be affected by pumping of groundwater in three ways. If the water table is high and near a river, its water contributes to the flow of the stream. When the water level is lowered too far by pumping, it no longer contributes water to the stream. Pumping near a stream can also intercept water that would normally flow into the stream, thus depriving the stream of that water. Finally, when a lot of pumping occurs in an area, a "cone of depression" may form, so that the water level is lower near the pump than in surrounding areas. This can cause water to flow by gravity from the stream toward the cone of depression, further dewatering the stream.

San Carlos Apache Tribe's Supplemental Evidence Submissions Nos. 1-25

In re Determination of Navigability of the Upper Salt River from the Confluence of the Salt River from Granite Reef Dam to the Gila River Confluence, Maricopa County, Arizona

Nos. 03-005-NAV and 04-008-NAV (Consolidated) (Salt River)

ANSAC Upper Salt River Navigability Supplemental Evidence
Submitted by the San Carlos Apache Tribe
November 30, 2014

No.	Description
1	Report of The Governor of Arizona to the Secretary of the Interior (1878) John C. Fremont, Governor.
2	Report of The Governor of Arizona to the Secretary of the Interior (1879) John C. Fremont, Governor.
3	Report of The Acting Governor of Arizona to the Secretary of the Interior (1881) John J. Gosper, Acting Governor.
4	Report of The Governor of Arizona to the Secretary of the Interior (1883) F.A. Tritle, Governor.
5	Report of The Governor of Arizona to the Secretary of the Interior (1884) F.A. Tritle, Governor.
6	Report of The Governor of Arizona to the Secretary of the Interior (1885) F.A. Tritle, Governor.
7	Report of The Governor of Arizona to the Secretary of the Interior (1886) C. Meyer Zulick, Governor.
8	Report of The Acting Governor of Arizona to the Secretary of the Interior (1890) N.O. Murphy , Acting Governor.
9	Report of The Governor of Arizona to the Secretary of the Interior (1894) L.C. Hughes, Governor.
10	Report of The Governor of Arizona to the Secretary of the Interior (1895) L.C. Hughes, Governor.
11	Report of The Governor of Arizona to the Secretary of the Interior (1896) B.J. Franklin, Governor.
12	Report of The Governor of Arizona to the Secretary of the Interior (1899) N.O. Murphy, Governor. (pg. 11-13; 41-54; 75-85; 201-204; 229-231).

13	Report of The Governor of Arizona to the Secretary of the Interior (1900) N.O. Murphy, Governor.
14	Report of the Governor of Arizona to the Secretary of the Interior (1901) N.O. Murphy, Governor. (pg. 21-26; 38-39; 98-108; 139-141).
15	Report of the Governor of Arizona to the Secretary of the Interior (1902) Alexander O. Brodie. (pg. 30-54; 97-106).
16	Report of the Governor of Arizona to the Secretary of the Interior (1907) Joseph H. Kibbey, Governor.
17	Hinton, Richard J. The Hand-Book to Arizona: Its Resources, History, Towns, Mines, Ruins, and Scenery : Amply Illustrated : Accompanied With a New Map of the Territory. 1878. Reprint. San Francisco: Payot, Upham & Co., 1954. Print. Chapter XVI. "Miscellaneous."
18	Raymer, Robert. Early Copper Mining in Arizona. Pacific Historical Review, Vol. 4, No.2. (June, 1935). Print. (pg. 123-130).
19	Wilson, Eldred D. Early Mining in Arizona. Kiva. Vol. 11, No. 4, (May, 1946). Print. (pg. 39-47).
20	History of Arizona and New Mexico 1530-1888, Hubert A. Bancroft. Entered According to Act of Congress in the year 1888. (pg. 578-607).
21	Supplementary Volume Arizona by Irish. F.M. 1870-1941. Head of Department of Science, Tempe Normal School of Arizona Published in New York by the Macmillan Company in 1907.
22	Arizona Transportation History, Final Report 660, December 2011. Arizona Department of Transportation Research Center [Report # FHWA-AZ-11-660] Prepared in Cooperation with the United States Department of Transportation and the Federal Highway Administration.
23	Chapters 1 &2 of the Arizona State Rail Plan. Phoenix, Ariz.: Arizona Department of Transportation, 2011. Print.

ANSAC Upper Salt River Navigability Supplemental Evidence Submitted by the San Carlos Apache Tribe November 19, 2015	
No.	Description
24	White Mountain Apache Tribe's Upper Salt River Rafting Information on: Rafting Season, Mandatory Equipment, Permits and Regulations.

ANSAC Upper Salt River Navigability Supplemental Evidence Submitted by the San Carlos Apache Tribe April 27, 2016	
No.	Description
25	Tellman, Barbara; Yarde, Richard; Wallace, Mary G. Arizona's Changing Rivers: How People Have Affected the Rivers. Tucson, Arizona: Water Research and Resource Center, University of Arizona, 1998. (Excerpt pg. Cover-16; 39-42; 51-52; 59-66; 105-108)