Aquatic Resources Delineation Report

Grand Canyon National Park

Trans-canyon Water Distribution Pipeline Replacement

National Park Service

Coconino County, Arizona

July 1, 2021

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Acronyms and Abbreviations

ADEQ	Arizona Department of Environmental Quality
AgACIS	Agricultural Applied Climate Information System
AJD	Approved Jurisdictional Determination
AMSL	Above Mean Sea Level
CFR	Code of Federal Regulations
cfs	cubic feet per second
CWA	Clean Water Act
F	Fahrenheit
EPA	Environmental Protection Agency
FAC	Facultative
FACU	Facultative Upland
FACW	Facultative Wetland
FEMA	Federal Emergency Management Agency
FGDC	Federal Geographic Data Committee
GNSS	Global Navigation Satellite System
HDR	HDR Engineering, Inc.
HUC	Hydrologic Unit Code
LEDPA	Least Environmentally Damaging Practicable Alternative
NEPA	National Environmental Policy Act
NHD	National Hydrography Dataset
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NWI	National Wetlands Inventory
OBL	Obligate
OHWM	Ordinary High Water Mark
Park	Grand Canyon National Park
Project	Trans-Canyon Water Distribution Pipeline Replacement Project
PWS	Professional Wetland Scientist
REM	Registered Environmental Manager
RTX	Real Time eXtended
SBAS	Satellite-Based Augmentation Systems
SSURGO	Soil Survey Geographic Database
TCWL	Trans-Canyon Water Distribution Pipeline
TNW	Traditional Navigable Water
UPL	Upland
USC	United States Code
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WETS	Climate Analysis for Wetlands
WOTUS	Waters of the United States
WQC	Water Quality Certification

Executive Summary

This report summarizes the methodology and results of a desktop assessment and field investigation conducted to determine the extent of the U.S. Army Corps of Engineers (USACE) regulatory jurisdiction under Section 404 of the Clean Water Act (CWA) (33 United States Code [USC] § 1344) or Section 10 of the Rivers and Harbors Appropriation Act of 1899 (33 USC § 403) within the Trans-Canyon Water Distribution Pipeline Replacement Project (Project) for the purposes of obtaining any required CWA permits. The aquatic resources delineation was conducted in accordance with the *Wetlands Delineation Manual* (Environmental Laboratory 1987) and the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region Version 2.0* (USACE 2008a), and *A Field Guide to the Identification of the Ordinary High Water Mark (OHWM) in the Arid West Region of the Western United States* (USACE 2008b).

The 138.5-acre study area is in Grand Canyon National Park (Park) in Coconino County, Arizona and is comprised of eight separate segments: three within the inner-canyon (Indian Garden, Phantom Ranch, and Cottonwood), three in uplands along Bright Angel Trail, and two in upland forested areas within the South Rim region of the Park. Within the study area, the Colorado River and Bright Angel, Garden, and Pipe creeks provide perennial flows that support unique riparian ecosystems and wetlands in a region typified by little rainfall and ephemeral and intermittent drainages.

All aquatic features within the study area receive flows from tributaries of the Colorado River or convey flows into the Colorado River. The Colorado River in Arizona has undergone numerous navigation study determinations and was determined a Traditional Navigable Water (TNW) in all evaluations, including through the Grand Canyon and the study area. Since the Colorado River is a TNW and is therefore a water of the United States, features within the study area that are (1) a perennial or intermittent tributary of the Colorado River, or (2) adjacent wetlands, would be subject to USACE jurisdiction under Section 404 of the CWA.

Within the study area, four perennial streams, one intermittent stream, 13 ephemeral features, and twenty-four palustrine wetlands were mapped, totaling approximately 3.018 acres (7467.9 linear feet), 0.003 acre (74.4 linear feet), 0.588 acre (1821.0 linear feet), and 2.592 acres, respectively.

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1 Introduction and Background

The National Park Service (NPS) (Applicant) is proposing a major water system infrastructure replacement project that would relocate the water supply for the Trans-canyon Water Distribution Pipeline (TCWL)—Grand Canyon National Park's (Park) primary source of drinking water—from its current source at Roaring Springs (5,270 feet above mean sea level) approximately 3,000 feet below the North Rim at the convergence of Roaring Springs and Bright Angel canyons, to a new location near Bright Angel Creek in the Phantom Ranch developed area, and would replace portions of the TCWL between Phantom Ranch and the South Rim (Figure 1). In addition to replacing the portion of TCWL between Phantom Ranch and Indian Garden, new water treatment facilities would be constructed at Phantom Ranch and the South Rim.

The TCWL was constructed from 1965–1970 and spans extremely rugged terrain from the current water intake at Roaring Springs in Bright Angel Canyon to its terminus at Indian Garden. The water supply for Roaring Springs is from a large cave system supplied by snowmelt and precipitation (Jones et al. 2018) from the Kaibab Plateau. Preliminary data suggest changes in snowpack may affect flow at Roaring Springs (Klos et al. 2014; Schwinning et al. 2008; Seager et al. 2007). The TCWL currently has the capacity to convey about 1 million gallons per day (MGD) from Roaring Springs to the Indian Garden Pump Station. Current average day water usage in the Inner Canyon Corridor and on the South Rim ranges from approximately 300,000 to 850,000 gallons per day where peak day usage exceeds 1 MGD. On average, about 5 percent of the flow of Roaring Springs is captured by the TCWL.

The TCWL is a critical component of the Park's water distribution system and supplies water to the South Rim and facilities within the inner canyon, including the Cross-Canyon Corridor, which includes the three Corridor Trails: South Kaibab, Bright Angel, and North Kaibab. At over 50 years old, the TCWL has exceeded its projected 30-year design life. In its current design, gravity plays a major role in the functioning of the waterline, creating sufficient pressure to convey water from Roaring Springs down through Phantom Ranch and back up to Indian Garden. From an elevation 5,200 feet above mean seal level (AMSL), water travels down through the TCWL along North Kaibab Trail to Phantom Ranch. The pipeline then crosses the Colorado River suspended from the Silver Bridge and reaches its lowest elevation—2,430 feet AMSL—before it ascends the canyon and enters the Indian Garden pump house at 3,700 feet AMSL. From Indian Garden, water is pumped uphill to the South Rim through the borehole section of the waterline.

Breaks in the TCWL and distribution system have become a frequent occurrence. Over the past several years, the Park has, on average, responded to waterline breaks at least once a month. These failures are caused by a variety of factors including pipe weld failures at joints, internal pipe corrosion, freezing, flooding, and falling rocks. The TCWL is also susceptible to damage during major flood events that occur periodically in Bright Angel Canyon. Interruptions of the water supply at Phantom Ranch occur periodically due to breaks and leaks in the TCWL.

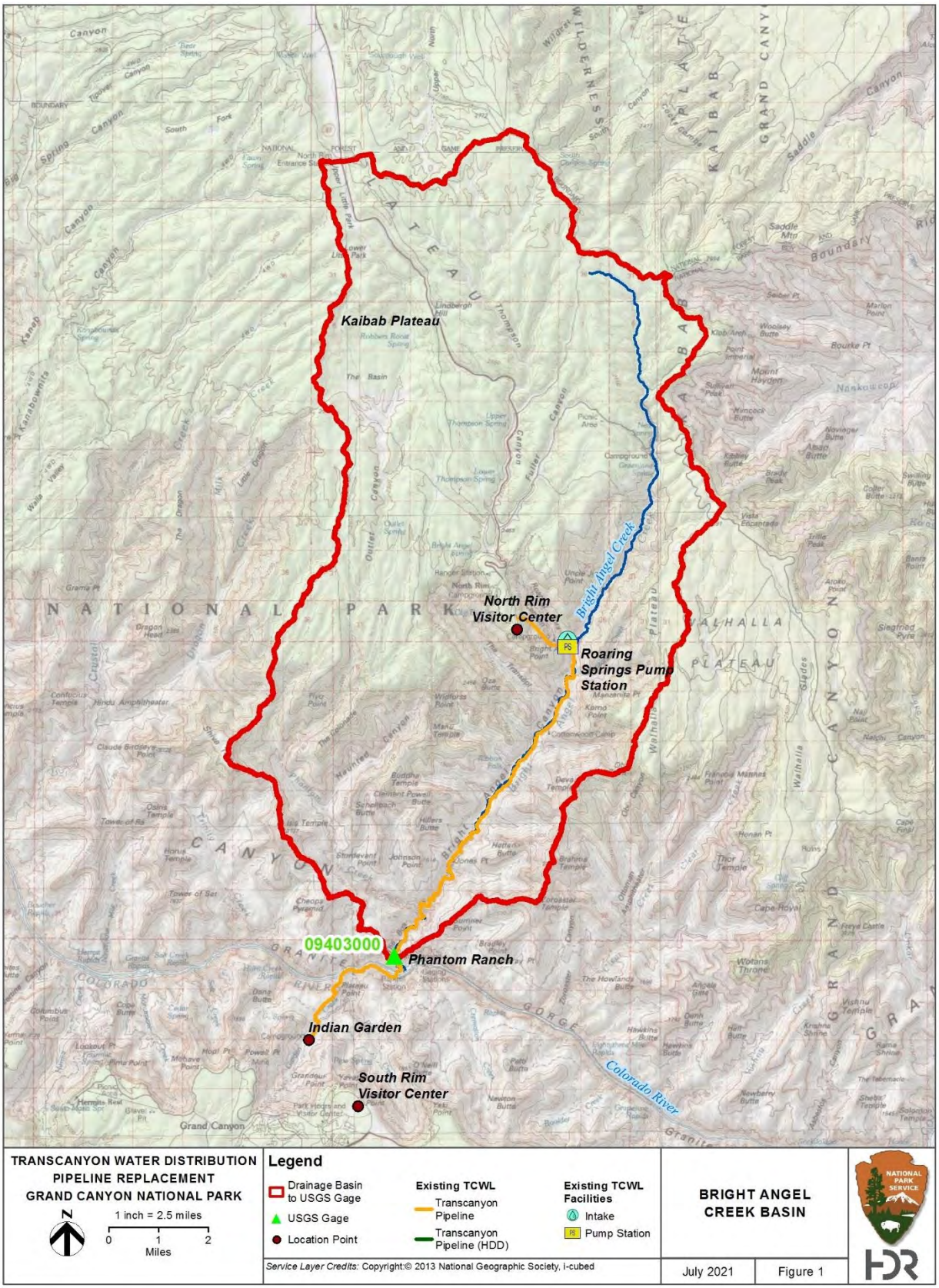
On average, the Park experiences 25 breaks per year along the TCWL. Repairs are costly, with each averaging approximately $25,000. A typical break interrupts the flow of water

through the inner canyon to the South Rim for three to five days and requires visitors, residents, and commercial operators to implement increasing levels of water conservation measures. Phantom Ranch, Indian Garden, and the South Rim have become dependent on water storage, with 15,000 gallons at Phantom Ranch and 14 million gallons of water storage on the South Rim (equivalent to about two weeks of use).

Extended repairs and consecutive waterline breaks have impacts on National Park Service (NPS) and concession operations. In 1995, a flood damaged the TCWL and the pipeline remained offline for 28 days while it was repaired, requiring the park to implement emergency measures to truck in water from outside sources to the South Rim which resulted in $5M of additional cost to the NPS. In the event of a complete failure of the TCWL, the South Rim and inner canyon facilities could run out of water for visitor and resident use and fire suppression. Pipeline failures are increasing in both frequency and severity each year. In March and April 2018, four consecutive waterline breaks accompanied by pump breakdowns mandated severe water restrictions for nearly four weeks during the busy Spring Break period. Over 17,000 visitors a day were impacted by the restrictions. Repairs exceeded $200,000 for the waterline, pump, and associated helicopter support.

Replacement of the TCWL will reduce the vulnerability of the water supply system, provide significantly higher system reliability, and provide consistent-quality drinking water. The new pipeline will stretch nearly three miles from Phantom Ranch to Indian Garden and will continue to serve the Park's millions of visitors and thousands of residents. Abandonment of 7 miles of pipeline along Bright Angel Creek will result in reduced impacts along this portion of the alignment.

Figure 1. Location of Existing TCWL Pipeline and Facilities



1.1 Contact Information

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Authorized Agent: Tracy L. Hamilton
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Phoenix, Arizona 85012
Ph: 602.522.4331
Email: tracy.hamilton@hdrinc.com

Driving directions to the Study Area from Phoenix are provided for the U.S. Army Corps of Engineers (USACE) to use in conducting field visits:

- Head north on Interstate 17 N for approximately 130 miles (mileage will vary based on starting location in Phoenix)
- Use the middle lane to continue on AZ-89A for 0.3 mile
- Take exit 340B to merge onto Interstate 40 W toward Los Angeles
- In approximately 25 miles, take exit 165 for AZ-64/Interstate 40 toward Williams/Grand Canyon
- Turn right onto AZ-64 N and continue straight for 50 miles
- At the traffic circle, take the 1st exit and stay on AZ-64 N
- At the traffic circle, take the 2nd exit and stay on AZ-64 N
- In approximately 1.6 miles, enter through the Park's South Entrance Station

2 Purpose

The NPS contracted HDR Engineering, Inc. (HDR) to provide design services and supporting studies for the TCWL replacement, and to perform an aquatic resources delineation of an approximately 138.5-acre study area to assist with the evaluation of

potential impacts on aquatic resources from construction of the proposed project. The study area was determined based on the level of potential construction impacts and a preliminary desktop review of aquatic resources within the construction footprint. Areas that are within the overall construction footprint but would not result in ground disturbance (e.g., portions of the TCWL that are abandoned in place) were omitted from the delineation and were not included in the study area.

This report summarizes the methodologies and results of a preliminary desktop assessment and subsequent field investigation of the study area to determine the extent of wetlands, as defined by NPS *Director's Order #77-1: Wetland Protection* and *Procedural Manual #77-1: Wetland Protection* for the purpose of implementing Executive Order No. 11990: "Protection of Wetlands", within the TCWL Project (Project) area. In addition, this report describes the aquatic resources delineated during the onsite field investigation that may be subject to USACE regulatory jurisdiction under Section 404 of the Clean Water Act (CWA) (33 United States Code [USC] § 1344) or Section 10 of the Rivers and Harbors Appropriation Act of 1899 (33 USC § 403).

3 Environmental Setting

3.1 Project Location

The study area is located within Grand Canyon National Park, approximately 6.5 miles north of the Town of Tusayan in Coconino County, Arizona, and approximately 60 miles north of the City of Williams, Arizona (Figure 2 and Figure 3). The study area is comprised of eight separate segments: three within the inner-canyon (Indian Garden, Phantom Ranch, and Cottonwood), three in uplands along Bright Angel Trail, and two in upland forested areas within the South Rim region of the Park.

The three survey segments in the inner-canyon span portions of the Corridor Trails between the North and South rims. Indian Garden supports a campground, NPS staff housing, and a potable water pump station, and is developed along Bright Angel Trail and Garden Creek approximately 4.8 miles below the South Rim; Phantom Ranch is approximately 0.5 mile north of the Colorado River along Bright Angel Creek at the bottom of the canyon, approximately 10 miles from the South Rim and 14 miles from the North Rim; and Cottonwood is located approximately 6.8 miles below the North Rim on the North Kaibab Trail. These areas are only accessible by foot, mule, or helicopter.

The study area occurs on the Bright Angel Point (2018), Phantom Ranch (2018), and Grand Canyon (2018) USGS 7.5-minute topographic quadrangles (Appendix A, Figures 4-1 to 4-7) and the cadastral locations are:

- Township 32 North, Range 3 East, Sections 2 and 11
- Township 31 North, Range 3 East, Sections 5, 6, 7, and 19
- Township 31 North, Range 2 East, Sections 12, 13, 23, 25, and 36

The approximate center coordinates of the eight segments within the study area are: 36.06060793, -112.1387047; 36.06580426, -112.1356147; 36.06740505, -112.1340765; 36.08389682, -112.1238489; 36.1007246, -112.1002688; 36.18131335, -112.035931; 36.03365597, -112.1282824; 36.05572559, -112.1125555 (decimal degrees, NAD 83).

Figure 2. State Vicinity Map

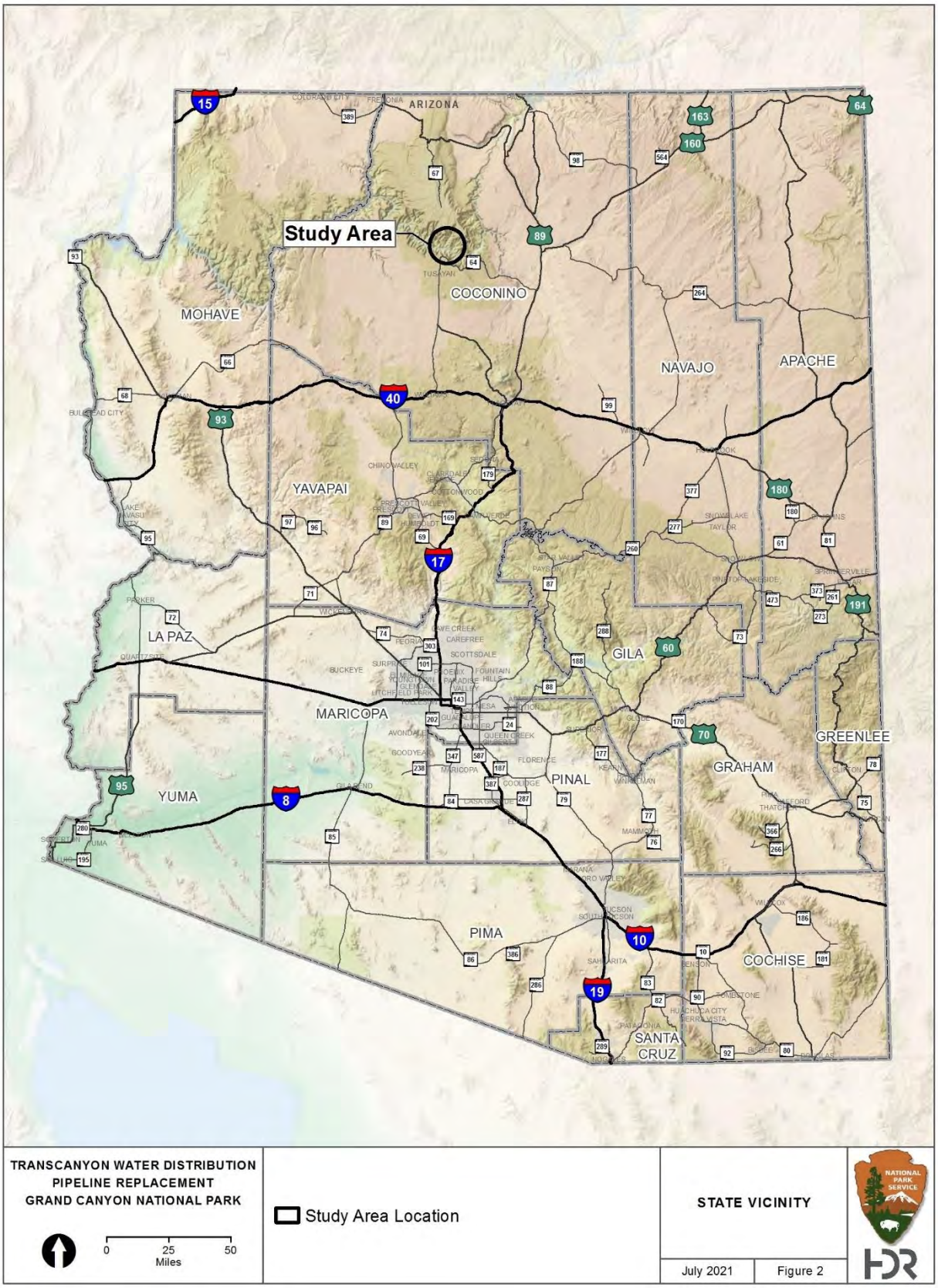
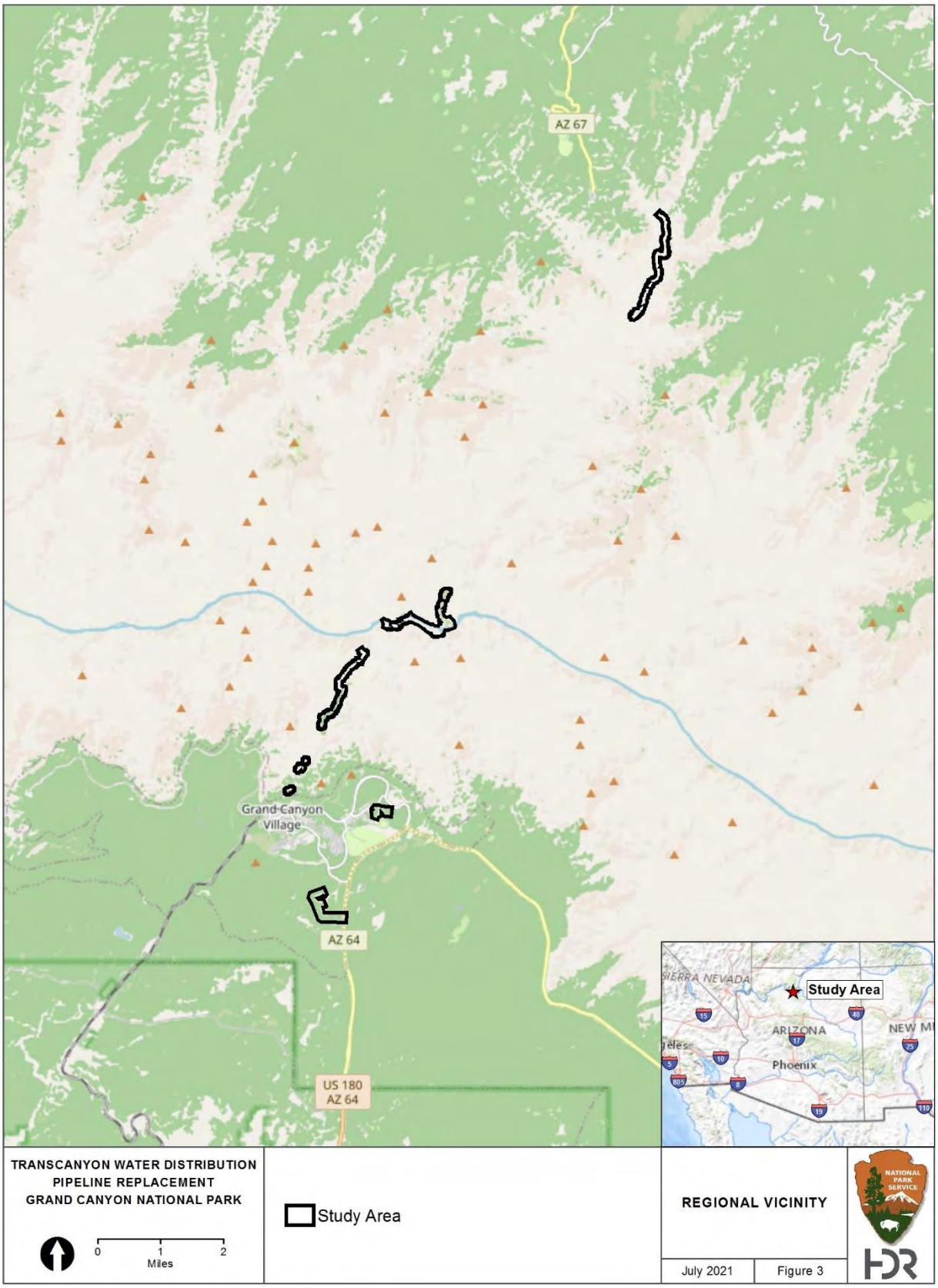


Figure 3. Regional Vicinity Map



3.2 Topography

The study area is within the Colorado Plateau Physiographic Province and is largely characterized by extreme vertical escarpments and strong aspect differences over short distances (USDA-NRCS 2021a). The lowest point in the study area is at the confluence of Bright Angel Creek and the Colorado River at approximately 2,430 feet AMSL. The highest point in the study area is approximately 7,050 AMSL in forested uplands southwest of the South Rim Visitor Center.

3.3 Climate and Precipitation

Climate within the study area varies due to significant fluctuations in elevation and topography. Rough terrain and deep canyons strongly influence solar heating and air circulation; consequently, numerous microclimates are found throughout the Park. For example, despite being less than eight miles apart, the weather station at the North Rim is the coolest and wettest in the region and Phantom Ranch is one of the hottest and driest.

At lower elevations within the inner canyon, the climate generally is arid to semiarid with warm summers and cool winters. Mean annual precipitation ranges from 6–10 inches but varies substantially from year to year. Most of the annual precipitation occurs as a gentle rain in the fall and winter months. Snowfall is uncommon and rarely lasts more than one to two days. Other precipitation occurs in the summer months of July through September as isolated thunderstorms originating in the Gulf of Mexico and the Pacific Ocean as moisture flows into the area on the north end of the Mexican monsoon. Late May through late June is generally a dry period.

Agricultural Applied Climate Information System (AgACIS) data for Phantom Ranch, AZ from 1991–2021 indicate the average daily maximum temperature for the area is 82.0 degrees Fahrenheit (F), the average daily minimum temperature is 55.6 degrees F, and average annual precipitation is 9.66 inches (AgACIS 2021a). The average freeze-free period is 220 days. In the summer, temperatures commonly surpass 100 degrees F.

At higher elevations on the South Rim, winter precipitation typically occurs as snowfall. On average, the South Rim receives 58 inches of snowfall a year. AgACIS data from 2011–2021 for station Grand Canyon Visitor Center indicate the annual mean maximum temperature is 62.3 degrees F, the annual mean minimum temperature is 8.0 degrees F, annual mean precipitation is 17.50 inches, and average annual snowfall is 49.0 inches (AgACIS 2021b).

3.4 Vegetation

The study area is in the U.S. Department of Agriculture's Major Land Resource Area 45 – Colorado Plateau, which is part of Land Resource Region D – Western Range and Irrigated Region (U.S. Department of Agriculture 2006). The major landform consists of a series of plateaus and mesas dissected by the Colorado River valley and smaller, widely spaced stream valleys surrounded by highlands.

The study area spans the Mohave Desertscrub, Great Basin Desertscrub, Great Basin Conifer Woodland, and Petran Montane Conifer Forest biotic communities (Brown 1994) at elevations ranging from approximately 2,500 to 7,000 feet AMSL. Vegetation in the

study area included species within five primary vegetation communities: ponderosa pine forest, pinyon-juniper woodland, riparian, desert scrub, and palustrine wetlands. Dominant species of each of the biotic communities in the study area are provided in Table 1.

Table 1. Dominant Plant Species of Biotic Communities in the Study Area

Common Name	Scientific Name
Ponderosa Pine Forest	
Curl-leaf mountain mahogany	*Cercocarpus ledifolius*
Oneseed juniper	*Juniperus monosperma*
Ponderosa pine	*Pinus ponderosa*
Pinyon-Juniper Woodland	
Alligator juniper	*Juniperus deppeana*
California redbud	*Cercis orbiculata*
Indian ricegrass	*Achnatherum hymenoides*
Narrowleaf yucca	*Yucca angustissima*
Netleaf hackberry	*Celtis reticulata*
Oneseed juniper	*Juniperus monosperma*
Pinyon pine	*Pinus edulis*
Red barberry	*Berberis* (*Mahonia*) *haematocarpa*
Spiny greasebush	*Glossopetalon spinescens*
Utah century plant	*Agave utahensis*
Utah juniper	*Juniperus osteosperma*
Winterfat	*Krascheninnikovia lanata*
Riparian[a]	
Arizona grape	*Vitis arizonica*
Arrowweed	*Pluchea sericea*
Five-stamen tamarisk	*Tamarix chinensis*
Fremont cottonwood	*Populus fremontii*
Mule-fat	*Baccharis salicifolia*
Narrowleaf willow	*Salix exigua*
Salt cedar	*Tamarix ramosissima*
Saltgrass	*Distichlis spicata*

Velvet ash	*Fraxinus velutina*
Western honey mesquite	*Prosopis glandulosa* var. *torreyana*
Desert Scrub	
Blackbrush	*Coleogyne ramosissima*
Brittlebush	*Encelia farinosa*
Catclaw acacia	*Senegalia greggii*
Cottontop cactus	*Echinocactus polycephalus*
Desert biscuitroot	*Lomatium foeniculaceum*
Desert trumpet	*Eriogonum inflatum*
Dollarjoint pricklypear	*Opuntia chlorotica*
Flatcrown buckwheat	*Eriogonum deflexum*
Graham's nipple cactus	*Mammillaria grahamii*
Grand Canyon century plant	*Agave phillipsiana*
Low woollygrass	*Dasyochloa pulchella*
Mormon tea	*Ephedra viridis*
Plains pricklypear	*Opuntia polyacantha*
Rough jointfir	*Ephedra aspera*
San Felipe dogweed	*Adenophyllum porophylloides*
Scarlet globemallow	*Sphaeralcea coccinea*
Scarlet hedgehog cactus	*Echinocereus coccineus*
Spinystar	*Escobaria vivipara*
Sticky brittlebush	*Encelia resinifera*
Tulip pricklypear	*Opuntia phaeacantha*
Turpentine broom	*Thamnosma montana*
Utah century plant	*Agave utahensis*
Wetland[a]	
Boxelder	*Acer negundo*
Cattail	*Typha* sp.
Chairmaker's bulrush	*Schoenoplectus americanus*
Common reed	*Phragmites australis*

Ferriss' horsetail	*Equisetum × ferrissii*
Goodding's willow	*Salix gooddingii*
Narrowleaf willow	*Salix exigua*
Rough horsetail	*Equisetum hymale*
Scarlet monkeyflower	*Mimulus cardinalis*
Scratchgrass	*Muhlenbergia asperifolia*
Watercress	*Nasturtium officinale*
Water sedge	*Carex aquatilis*
Willow baccharis	*Baccharis salicina*

[a] Wetland indicator status ratings are provided on the wetland data sheets in Appendix C

3.5 Geology

The following is an excerpt from the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) (USDA-NRCS 2011):

This area is part of an area that has been structurally uplifted and is known as the Colorado Plateau. Rivers flowing across the area cut down into the bedrock as it was being uplifted, resulting in spectacular geologic scenery. Areas of shale, sandstone, limestone, dolomite, and volcanic rock outcrop are extensive. Rocks representing nearly the entire geologic timespan are exposed from the bottom of the Grand Canyon up to the present-day surface. Quaternary and Tertiary lava flows occur on the surface in the southwest part of this area. Older flows cap plateaus and mesas, and isolated volcanic cones and eroded volcanic necks occur throughout the area.

3.6 Soils

Soils within the study area were mapped using the USDA-NRCS Soil Survey Geographic Database (USDA-NRCS 2021b). No hydric soils are mapped within the study area; however, 3.3 acres of the 138.5-acre study area are mapped as water. The study area includes the following mapped soils (Figures 5-1 to 5-7):

- **Chilton-Teesto-Puertecito families complex** – the map unit composition of these three soil families are 40, 30, and 25 percent for the Chilton, Teesto, and Puertecito families, respectively. All three soil families are well drained and occur exclusively on plateaus with slopes ranging from 15 to 55 percent. Mean annual precipitation ranges from 10 to 14 inches and mean annual air temperature is approximately 52 to 55 degrees F. Chilton soils are formed from parent material of alluvium and/or colluvium derived from limestone and sandstone. The parent material of Teesto soils is colluvium derived from sandstone and limestone. Puertecito soils consist of residuum weathered from arkose. These three soil families are not hydric.
- **Cliffdown, moderately steep-Cliffdown families complex** – these well-drained soil families occur on plateaus with slopes from 15 to 50 percent for the Cliffdown family, moderately steep, and 15 to 30 percent for the Cliffdown family. Mean annual

precipitation ranges from 6 to 10 inches and the mean annual air temperature is 56 degrees F. Cliffdown family, moderately steep soils consist of colluvium derived from limestone, sandstone, and shale. Cliffdown family soils are comprised of alluvium from mixed sources. Cliffdown families are not rated as hydric.

- **Cliffdown-Izo families complex** – this complex is comprised of 50 percent Cliffdown family and similar soils, 35 percent Izo family and similar soils, and 15 percent minor components, and is found on slopes ranging from 2 to 8 percent. Mean annual precipitation ranges from 6 to 10 inches and the mean annual air temperature is 56 degrees F. This family complex occurs on plateaus and is formed from alluvium derived from mixed sources; however, the Izo family occurs exclusively on floodplains. The Cliffdown-Izo families complex is classified as well drained to excessively drained and is not rated as hydric.
- **Curob-Whirlo families complex** – this complex is comprised of 50 percent Curob family and similar soils, 40 percent Whirlo family and similar soils, and 10 percent minor components, and is found on slopes ranging from 15 to 30 percent. Mean annual precipitation ranges from 6 to 10 inches and the mean annual air temperature is 56 degrees F. The Curob family is formed from alluvium derived from limestone and sandstone and/or colluvium derived from limestone and sandstone. The Whirlo family is formed from alluvium derived from calcareous sandstone and/or residuum weathered from calcareous sandstone. The Curob-Whirlo families complex is classified as well drained and is not rated as hydric.
- **Dera family** – the Dera family occurs on plateaus with 15 to 55 percent slopes. Mean annual precipitation ranges from 6 to 10 inches and the mean annual air temperature is 56 degrees F. Dera family soils are well drained, formed from alluvium and/or colluvium derived from limestone and sandstone, and are not rated as hydric.
- **Fluvaquents-Psamments complex** – this complex consists of 80 percent Fluvaquents and similar soils and 20 percent Psamments and similar soils and is found on slopes ranging from 2 to 6 percent. Mean annual precipitation ranges from 10 to 14 inches and mean annual air temperature is approximately 52 to 55 degrees F. Both soils are non-hydric, found on plateaus, and comprised of parent material of alluvium derived from mixed sources; Fluvaquents occur on floodplains and Psamments occur on bars.
- **Garr-Zibate families complex** – this complex occurs on plateaus with slopes ranging from 2 to 15 percent and is comprised of 50 percent Garr family and similar soils, 35 percent Zibate family and similar soils, and 15 percent minor components. Mean annual precipitation ranges from 6 to 10 inches and mean annual air temperature ranges from 57 to 63 degrees F. Garr family soils are formed from residuum weathered from shale. Zibate family soils are derived from residuum weathered from calcareous sandstone. The Garr-Zaibate families complex is well-drained and non-hydric.
- **Orthents-Rock Outcrop complex** – this complex occurs at elevations from 4,990 to 7,500 feet and is comprised of 80 percent Orthents and 20 percent rock outcrop. Mean annual precipitation ranges from 10 to 14 inches and mean annual air temperature is approximately 52 to 55 degrees F. Orthents are formed from alluvium derived from mixed sources and occur on plateaus with slopes from 2 to 6 percent. This complex is non-hydric.

- **Pocomate-Pinntank-Toqui complex** – this complex occurs on plateaus with slopes from 15 to 25 percent at elevations from 6,420 to 7,430 feet, and is comprised of 40 percent Pocomate, 35 percent Pinntank, 15 percent Toqui, and 10 percent minor components. Mean annual precipitation ranges from 13 to 25 inches and mean annual air temperature is approximately 45 to 52 degrees F. Pocomate soils consist of residuum weathered from cherty limestone, are well drained, and are non-hydric. Pinntank soils are comprised of residuum weathered from calcareous sandstone, are well drained, and non-hydric. Toqui soils consist of residuum weathered from cherty limestone, are well drained, and are non-hydric.
- **Pocomate-Pinntank-Ustifluvents complex** – this complex occurs on plateaus with slopes from 2 to 30 percent at elevations from 6,600 to 7,400 feet, and is comprised of 45 percent Pocomate, 35 percent Pinntank, 15 percent Ustifluvents, and 5 percent minor components. Mean annual precipitation ranges from 17 to 25 inches and mean annual air temperature is approximately 45 to 48 degrees F. Pocomate soils consist of residuum weathered from cherty limestone, are well drained, and are non-hydric. Pinntank soils are comprised of residuum weathered from calcareous sandstone, are well drained, and non-hydric. Ustifluvents are formed from alluvium derived from mixed sources, are well drained, and are non-hydric.
- **Tovar-Toqui-Yumtheska complex** – this complex occurs on plateaus with slopes from 2 to 8 percent at elevations from 5,000 to 7,000 feet and is comprised of 40 percent Tovar, 30 percent Toqui, 15 percent Yumtheska, and 15 percent minor components. Mean annual precipitation ranges from 14 to 18 inches and mean annual air temperature is approximately 50 to 52 degrees F. Tovar soils are comprised of residuum weathered from calcareous sandstone, are well drained, and non-hydric. Toqui soils consist of residuum weathered from cherty limestone, are well drained, and are non-hydric. Yumtheska soils consist of residuum weathered from limestone and sandstone, are well drained, and non-hydric.
- **Rock Outcrop-Akela family complex** – this complex occurs on slopes from 15 to 60 percent at an elevation of 1,600 to 2,000 feet and is comprised of 45 percent rock outcrop, 40 percent Akela family and similar soils, and 15 percent minor components. Mean annual precipitation ranges from 6 to 10 inches and mean annual air temperature is approximately 57 to 63 degrees F. The Akela family of soils is well drained and formed from colluvium derived from schist and/or granite, and/or eolian deposits derived from limestone and sandstone. The Rock Outcrop-Akela family complex is non-hydric.
- **Rock Outcrop-Lithic Torriorthents complex, Vishnu schist formation** – occurs on slopes from 15 to 60 percent at elevations from 1,600 to 2,000 feet and is comprised of 60 percent rock outcrop and 40 percent Lithic Torriorthents. Mean annual precipitation ranges from 6 to 10 inches and mean annual air temperature is approximately 57 to 63 degrees F. Lithic Torriorthents occur on plateaus and are comprised of colluvium derived from mica schist and/or eolian sands. This complex is not rated as hydric.
- **Rock Outcrop-Skos-Seis families complex** – this complex occurs on plateaus with 30 to 60 percent slopes and is comprised of 40 percent rock outcrop, 35 percent Skos family and similar soils, 20 percent Seis family and similar soils, and 5 percent minor

components. Mean annual precipitation ranges from 10 to 14 inches and mean annual air temperature is approximately 52 to 55 degrees F. Skos family soils consist of colluvium derived from limestone and sandstone, are well drained, and are non-hydric. Seis family soils are comprised of residuum weathered from argillaceous limestone, are well drained, and non-hydric.

- **Skos family-Rock Outcrop complex** – this complex occurs on plateaus with 15 to 55 percent slopes and is comprised of 55 percent Skos family and similar soils, 30 percent rock outcrop, and 15 percent minor components. Mean annual precipitation ranges from 14 to 18 inches and mean annual air temperature is approximately 48 to 52 degrees F. Skos family soils consist of colluvium derived from limestone and sandstone, are well drained, and are non-hydric.
- **Typic Torrifluvents-Typic Torripsaments complex, cool** – this complex occurs on stream terraces and is comprised of 70 percent Typic Torrifluvents and 30 percent Typic Torripsaments. Mean annual precipitation ranges from 6 to 10 inches and mean annual temperature ranges from 57 to 63 degrees F. Typic Torrifluvents occur on slopes of 0 to 2 percent and consist of alluvium derived from mixed sources. Typic Torripsaments occur on slopes ranging from 2 to 6 percent and consist are formed from sandy eolian deposits. Both soils in this complex are non-hydric.
- **Yumtheska-Toqui-Rock Outcrop complex** – this complex occurs on plateaus with slopes from 2 to 8 percent at elevations from 5,000 to 6,600 feet and is comprised of 40 percent Yumtheska, 30 percent Toqui, 15 percent rock outcrop, and 15 percent minor components. Mean annual precipitation ranges from 14 to 18 inches and mean annual air temperature is approximately 52 to 54 degrees F. Yumtheska soils consist of residuum weathered from limestone and sandstone, are well drained, and non-hydric. Toqui soils consist of residuum weathered from cherty limestone, are well drained, and are non-hydric.
- **Zibate family** – this family occurs on plateaus with 2 to 8 percent slopes. Mean annual precipitation ranges from 6 to 10 inches and the mean annual air temperature ranges from 57 to 63 degrees F. Zibate family soils are well drained, formed of residuum weathered from arkose, and are not rated as hydric.

3.7 Hydrology

The study area is within the Lower Colorado-Marble Canyon (HUC 8: 15010001) and Grand Canyon (HUC 8: 15010002) subbasins and the Bright Angel Creek-Colorado River (HUC 10: 1501000106) and Shinumo Creek-Colorado River (HUC 10: 1501000201) watersheds. The Grand Canyon subbasin is defined by the Colorado River drainage area, which begins at Lake Powell in Arizona and courses through the Park, eventually terminating at Hoover Dam at Lake Mead on the Arizona-Nevada border. Most of that subbasin is between 5,000–7,000 feet AMSL and is typified by high desert flora and fauna, including cold water aquatic communities in areas with perennial waters. Within the study area, the Colorado River and Bright Angel, Garden, and Pipe creeks provide rare perennial flows that support unique riparian ecosystems and wetlands in a region typified by little rainfall and ephemeral and intermittent drainages.

Although the Colorado River's flow has shaped the Grand Canyon, the river's headwaters originate in distant mountain streams in Rocky Mountain National Park in Colorado. Precipitation falling on the Coconino and Kaibab plateaus provides Grand Canyon's only native waters as they percolate through porous, faulted, and fractured rock units to discharge later as springs and seeps in the inner canyon. Aquifers are created when porous rock strata are bounded by aquitards that deter further seepage. When water reaches relatively impermeable layers such as the Hermit and Bright Angel shales, the water moves laterally along the surfaces of the shales until being discharged from canyon walls as a seep or spring (NPS 2015a).

Grand Canyon springs and seeps emerge from canyon walls usually at the contact between an aquifer and an aquitard, and sometimes from ancient cave systems, such as the system at Roaring Springs, or joints in the rock that have been enhanced by dissolution from the movement of water. In canyon bottoms, spring water often disappears into streambed gravel and reappears downstream in a canyon floor spring. If the spring emerges on a cliff face, it can form hanging gardens; or, if its source has been buried by falling rock, the spring emerges from rock debris on the talus slope below (NPS 2015a).

Garden Creek

Garden Creek is a first order perennial stream and a tributary of Pipe Creek, a tributary of the Colorado River (Figures 6-3 to 6-5). The creek originates from numerous springs surrounding Indian Gardens below the South Rim in the Park. Garden Creek was the source of water for the first pipeline to the South Rim (Anderson 2000).

Natural flows in Garden Creek are supplemented by a continuous discharge of overflow water and pump seal water from the Indian Garden Potable Water Pump Station that provides drinking water from the TCWL to the Grand Canyon South Rim Village and Grand Canyon Desert View settlement (Arizona Department of Environmental Quality 2020). This overflow is estimated to increase flows in Garden Creek by 50 percent (Rihs 2008).

Pipe Creek

Pipe Creek is a second order spring-fed perennial stream and a direct tributary of the Colorado River (Figures 6-3 and 6-4). This stream is not significantly influenced by anthropogenic alternations.

Bright Angel Creek

The spring-fed headwaters of Bright Angel Creek begin on the Kaibab Plateau above the North Rim of the Grand Canyon in the Park. In the study area, the creek is a fourth order perennial stream and direct tributary of the Colorado River (Figures 6-1 through 6-3). Bright Angel Creek has undergone several anthropogenic alterations, including diversion of a portion of its historic flow from Roaring Springs for the TCWL, partial channelization of the creek to accommodate the TCWL and North Kaibab Trail, and diversion for irrigation at Phantom Ranch. In addition, the banks of the creek have been partially stabilized with gabion to protect the Phantom Ranch and Bright Angel Campground developed areas from flooding.

Unlike most streams in the Arid West that are intermittent or ephemeral and dry for many months, Bright Angel Creek maintains a base flow of 10 to 20 cubic feet per second (cfs)

throughout the summer (HDR 2016). During the 50 years that the United States Geological Survey (USGS) maintained a daily streamgage at Bright Angel Creek, the daily mean discharge was never below 10 cfs, and the daily mean discharge was 35 cfs (USGS 1974).

Colorado River

The Colorado River is one of the principal rivers in the southwestern United States and northern Mexico. Prior to the construction of Glen Canyon Dam in 1963, the Colorado River experienced seasonable variable flow rates ranging from a few thousand cfs to springtime flood events of 100,000 cfs or more. Those flood events scoured the river bottom and enhanced natural processes essential to the river's ecosystem. Since construction of Glen Canyon Dam, natural springtime floods have been extremely rare and of low magnitude, and the morphology and ecology of the Colorado River have been permanently altered (Kaplinski et al. 2014).

Changes in the river's fluvial processes have had a dramatic impact on the geomorphology of the Colorado River corridor through Grand Canyon due to decreased peak flows downstream, sediment transport capacity, and sediment-to-water ratio. Beaches previously formed during spring floods have been lost to erosion, while rocks and boulders from side canyons have washed into the mainstream are not redistributed during periods of high water. The ecological characteristics of the river corridor have also been altered. Without the seasonal variations in river flow and temperature, native fish are not stimulated to spawn (NPS 2015b). The turbidity lost to clear water favors non-native fish species, including predators that prey on native fishes.

4 Regulatory Setting

4.1 Clean Water Act

The CWA is the primary federal statute governing discharge of pollutants into waters of the United States (WOTUS), which, in Arizona, include traditional navigable watercourses (TNW), their perennial and intermittent tributaries, and adjacent wetlands. The CWA's principal goal is to establish water quality standards to restore and maintain the chemical, physical, and biological integrity of WOTUS by preventing point (concentrated output) and nonpoint (widely scattered output) pollution sources.

Pursuant to Section 404 of the CWA, USACE regulates the discharge (temporary or permanent) of dredged or fill material into WOTUS, including wetlands. A discharge of dredged or fill material includes, but is not limited to, grading, placing riprap for erosion control, pouring concrete, and stockpiling excavated material into WOTUS. The limits of WOTUS are defined through a preliminary jurisdictional determination or an approved jurisdictional determination accepted by USACE. A preliminary jurisdictional determination is a written indication by USACE that assumes all aquatic resources identified in a specified area that are (1) territorial seas or traditional navigable waters, (2) intermittent or perennial tributaries of traditional navigable waters, and/or (3) wetlands adjacent to traditional navigable waters or tributaries and possess the required physical characteristics are subject to USACE jurisdiction. An approved jurisdictional determination is an official determination issued by USACE that identifies the presence or absence of WOTUS in a

defined area. For areas that include ephemeral features that were regulated under previous definitions of WOTUS but are omitted from the current definition, an approved jurisdictional determination is advisable to ensure accurate jurisdictional status and unnecessary permitting.

Common types of Section 404 permits for projects in Arizona are (1) Nationwide Permits to authorize activities that will result in no more than minimal individual and cumulative adverse environmental effects, and (2) individual permits, which are required for projects that are likely to have more than a minimal individual or cumulative impact on aquatic resources or involve impacts on adjacent wetlands. Mitigation may be required to minimize or offset the impacts on WOTUS with no net loss of functions and values of the water resource. Note that compensatory mitigation for losses of aquatic resources is guided under the regulations set forth at 33 C.F.R. Part 332. In Arizona, mitigation usually occurs through the purchase of credits by the permittee from an in-lieu fee program that serves the project's watershed or ecoregion.

According to 40 C.F.R. § 230.10(a), "… no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences." This regulation mandates that the least environmentally damaging practicable alternative (LEDPA) is identified as part of the alternatives analysis if an individual permit is required.

4.1.1 Waters of the United States

Types of WOTUS that are regulated in Arizona include traditional navigable waters and their intermittent and perennial tributaries; lakes and ponds, and impoundments of jurisdictional waters; and wetlands adjacent to those waters. The types of activities and impacts on affected Waters are fundamental to the associated permitting requirements and level of appropriate mitigation measures.

The CWA, however, does not define WOTUS. Since the 1970s, the Environmental Protection Agency (EPA) and the Department of the Army have defined WOTUS by regulation. WOTUS are defined under 33 CFR § 328.3; this section defines the term "waters of the United States" as it applies to the scope of federal regulatory authority under the CWA. In addition, it prescribes the policy, practice, and procedures to be used in determining the extent of federal regulatory authority concerning "waters of the United States."

The Navigable Waters Protection Rule: Definition of "Waters of the United States" became effective on June 22, 2020, following its publication in the *Federal Register* (U.S. Department of Defense and EPA 2020). The Navigable Waters Protection Rule redefines the scope of WOTUS federally regulated under the CWA and explicitly directs EPA and USACE to protect "navigable waters" and their core tributaries with perennial or intermittent flow (EPA 2020).

In June 2021, the EPA and the Department of the Army announced their intent to initiate a new rulemaking process to replace the Navigable Waters Protection Rule and restore the protections in place prior to the 2015 WOTUS implementation.

The current definition of WOTUS under the Navigable Waters Protection Rule includes four categories of jurisdictional waters and outlines exclusions for many aquatic features. These four categories are defined as:

- territorial seas and traditional navigable waters – (a)(1)
- tributaries – (a)(2)
- lakes and ponds, and impoundments of jurisdictional waters – (a)(3)
- adjacent wetlands – (a)(4)

Territorial seas and traditional navigable waters. The territorial seas, and waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including waters which are subject to the ebb and flow of the tide.

Tributaries. A naturally occurring surface water channel that contributes surface water flow to a paragraph (a)(1) water in a typical year either directly or through one or more paragraph (a)(2)–(4) waters. A tributary must be perennial or intermittent in a typical year.

Lakes and ponds, and impoundments of jurisdictional waters. Standing bodies of open water that contribute surface water flow to a paragraph (a)(1) water in a typical year.

Adjacent wetlands. “Adjacent” means wetlands that:

- abut, meaning to touch at least at one point or side of, a paragraph (a)(1)–(3) water;
- are inundated by flooding from a paragraph (a)(1)–(3) water in a typical year;
- are physically separated from a paragraph (a)(1)–(3) water only by a natural berm, bank, dune, or similar natural feature; or
- are physically separated from a paragraph (a)(1)–(3) water only by an artificial dike, barrier, or similar artificial structure so long as that structure allows for a direct hydrologic surface connection in a typical year through a culvert, flood or tide gate, pump, or similar artificial feature.

Streams

In general, the jurisdictional extent of streams is defined by the ordinary high water mark (OHWM). As defined under 33 CFR § 328.3(c)(7), “the term ordinary high water mark means that line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas.”

Wetlands

The definition of wetlands varies by individual and/or government agency; however, three factors of commonality generally occur across these definitions, including the presence of hydrophytic (water-loving) vegetation, hydric soils, and hydrology.

Wetland delineations are based on the presence of three parameters: (1) indicators of wetland hydrology, (2) predominance of hydrophytic vegetation, and (3) presence of hydric

soils. “Atypical” or “problem areas” may be missing one or more of the three parameters and still be classified as wetlands but require justification using USACE criteria.

Adjacent wetlands regulated as WOTUS are defined by 33 CFR § 328.3 (c)(16) as “areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.”

An adjacent wetland is jurisdictional in its entirety when a road or similar artificial structure divides the wetland if the structure allows for a direct hydrologic surface connection through or over that structure in a typical year.

Typical Year

The term typical year means: “when precipitation and other climatic variables are within the normal periodic range (e.g., seasonally, annually) for the geographic area of the applicable aquatic resource based on a rolling thirty-year period.”

“Typical year” is a key concept for establishing jurisdiction based on surface water flow between a relatively permanent body of water (i.e., a perennial or intermittent surface water channel, a standing body of open water) and traditional navigable waters/territorial seas, and between wetlands and other jurisdictional waters.

Application of the typical year concept ensures that the hydrologic flows and surface water connections necessary to establish jurisdiction are characterized based on normal climatic conditions (i.e., neither too wet nor too dry).

When determining whether climatic conditions are typical, the period of time examined may be a year, or a shorter or longer time period, depending on factors relevant to the water resource of interest.

4.1.2 Arizona Department of Environmental Quality

Section 404 permits require water quality certification as set forth in Section 401 of the CWA prior to discharging fill material into WOTUS. Under Section 401 of the CWA, a federal agency cannot issue a permit or license until or unless the appropriate certifying authority has certified, conditionally certified, or waived the 401 Water Quality Certification (WQC). A certifying authority’s issuance of a WQC ensures that the project will not violate surface water quality standards or adversely affect impaired waters (waters that do not meet water quality standards), and that the project complies with applicable water quality improvement plans (total maximum daily loads). The WQC becomes a part of the federal permit or license and is valid for the same period as the permit or license, often issued for 5-year terms.

On non-tribal lands in Arizona, Arizona Department of Environmental Quality (ADEQ) administers the WQC program. If a project meets criteria for conditional Section 401 certification, notification to ADEQ typically is not required. However, if a project does not meet criteria for conditional certification, such as projects requiring an individual permit or those occurring within 0.25 mile of unique or impaired waters, an individual Section 401 certification application to ADEQ is required. The CWA Section 303(d) list identifies those waters that are impaired and indicates the pollutant(s) causing impairment.

Effective September 11, 2020, the CWA Section 401 Certification Rule (85 *Federal Register* 42210) was implemented nationwide. The rule, promulgated by EPA, establishes procedures promoting consistent implementation of CWA Section 401 and regulatory certainty in the federal permitting process (USACE 2020). Under this rule, project proponents with projects under jurisdiction of the USACE Los Angeles Regulatory Division must request a pre-filing meeting with the certifying authority at least 30 days prior to submitting the WQC request. In addition, applicants are required to submit their requests for WQC to the certifying authority and to the USACE Los Angeles District Regulatory Division concurrently. Applicants are encouraged to copy the USACE Los Angeles District Regulatory Division on WQC requests submitted to a certifying authority for a project within the USACE Los Angeles District Regulatory Division geographic area of responsibility.

4.2 National Park Service Wetland Protection

NPS activities that could have adverse impacts on wetlands are subject to the provisions of Executive Order 11990 and implemented through *Director's Order #77-1: Wetland Protection* and the procedures outlined in *Procedural Manual #77-1: Wetland Protection* (NPS 2016). Executive Order 11990 was issued "in furtherance of the National Environmental Policy Act of 1969 (NEPA), as amended (42 U.S.C. 4321 *et seq*.), in order to avoid to the extent possible the long and short term adverse impacts associated with the destruction or modification of wetlands." The NPS wetland protection process differs in scope from the USACE's Section 404 permit process in that actions that could have adverse impacts on wetlands such as groundwater withdrawals, water diversions, nutrient enrichment, etc. must also be thoroughly evaluated and mitigated. In addition, the NPS wetland definition covers a broader range of shallow aquatic habitat types.

NPS uses the Federal Geographic Data Committee (FGDC) Wetlands Classification Standard (Federal Geographic Data Committee 2013), and any wetland that is classified in accordance with the FGDC standard is subject to *Director's Order #77-1: Wetland Protection* and the procedures outlined in *Procedural Manual #77-1: Wetland Protection* (NPS 2016). The FGDC-endorsed standard was developed in 2013 with the U.S. Fish and Wildlife Service (USFWS) and revised the previous USFWS publication *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al. 1979), commonly referred to as the Cowardin classification system, to determine if areas are wetlands.

Under the FGDC Wetlands Classification Standard, a wetland must have one or more of the following three attributes:

1. at least periodically, the land supports predominantly hydrophytes (wetland vegetation)
2. the substrate is predominantly undrained hydric soil
3. the substrate is non-soil and is saturated with water or covered by shallow water during the growing season of each year

However, according to Cowardin, confirmation of any one of the three attributes does not automatically qualify a site as a wetland. The Cowardin definition of wetlands was intended to also include wetland types that lack vegetation or soil due to physical or chemical factors such as wave action or high salinity but are still saturated or shallow inundated environments that support aquatic life. Accordingly, all attributes present at a particular site must be used to identify wetlands, as follows:

- If plants and soil are present (e.g., swamps, marshes, or wet meadows), all three attributes (wetland hydrology, hydrophytic vegetation and hydric soil) are required for positive wetland identification.
- If plants are present but soil is absent (e.g., vegetated rock substrates), a predominance of hydrophytic vegetation and presence of wetland hydrology are required for positive wetland identification.
- If plants are absent but soil is present (e.g., playas or mudflats), then a predominance of undrained hydric soil and wetland hydrology are required for positive wetland identification.
- If neither plants nor soil are present (e.g., rocky shorelines or unvegetated shallow stream bottoms), then wetland identification must be made solely on the basis of hydrology.

4.3 Section 10 of the Rivers and Harbors Appropriation Act of 1899

Any work and/or structures in or affecting, including above, over, or under, a navigable WOTUS (e.g., the Colorado River and its impoundments, sloughs, backwaters, old channels, oxbows, etc.), requires a Department of the Army permit under Section 10 of the Rivers and Harbors Appropriation Act of 1899 (33 USC § 403).

4.4 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (as amended, 16 USC §§ 661–666c) requires federal agencies, including the NPS, to consult with USFWS and state agencies for activities that affect, control, or modify waters of any stream or body of water so that adverse effects on fish and wildlife can be minimized. It requires that fish and wildlife resources receive equal consideration to other project features.

5 Methodology

5.1 Literature Review

The following literature and materials were reviewed both prior to conducting delineation fieldwork and in the process of evaluating jurisdiction and classification of features identified in the field:

- NPS *Procedural Manual #77-1: Wetland Protection* (NPS 2016)
- Google Earth aerial imagery of the study area to determine the potential locations of WOTUS and other wetland areas
- USDA-NRCS Soil Survey Geographic Database (USDA-NRCS 2021b)
- USGS 7.5-minute topographic quadrangles
- U.S. Environmental Protection Agency WATERS GeoViewer (EPA 2021)

- USFWS National Wetlands Inventory (NWI) data to identify areas mapped as wetland features (U.S. Fish and Wildlife Service 2021)
- Navigable Waters Protection Rule: Definition of "Waters of the United States" (33 Code of Federal Regulations [CFR] Part 328) and Definition of Navigable Waters of the United States (33 CFR Part 329)
- *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987)
- *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region (Version 2.0)* (USACE 2008a)
- *A Field Guide to the Identification of the Ordinary High Water Mark (OHWM) in the Arid West Region of the Western United States* (USACE 2008b)
- USACE Regulatory Guidance Letter No. 16-01 for Jurisdictional Determinations, dated October 2016 (USACE 2016)

5.2 Desktop Assessment

A preliminary desktop delineation was conducted using the best available high-resolution aerial imagery from 2002 through 2017 with 1-foot elevation contours overlaid viewed at a scale of 1-inch = 200-feet. Indicators of fluvial transport observed and used for mapping the limits of aquatic resources, including wetlands, on aerial imagery included saturation, bed and bank, sediment deposition, change in soil character (based on texture and color), destruction of terrestrial vegetation, and change in vegetation type, density, or maturity. The following datasets were also reviewed to help identify and classify wetlands and other potential WOTUS in the study area (Table 2).

Table 2. Desktop Evaluation Datasets

Dataset	Description
U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) mapping	The USFWS NWI indicates the presence of Bright Angel Creek, the Colorado River, Pipe Creek, Garden Creek, and freshwater forested/shrub wetlands.
US Geological Survey (USGS) National Hydrography Dataset (NHD)	The USGS NHD identified the same potential WOTUS as the NWI mapping in addition to a spring near garden creek
USGS 7.5' Quadrangles (1988, 2018): Bright Angel Point, AZ, Phantom Ranch, AZ, and Grand Canyon, AZ	The USGS quadrangles were reviewed to identify and help verify aquatic resources, including WOTUS
Federal Emergency Management Agency (FEMA) floodplain mapping	In the Grand Canyon, Colorado River flows are governed by upstream releases from Glen Canyon Dam; therefore, the area is not mapped by FEMA (Appendix A, Figures 7-1 to 7-7)
USGS Hydrologic Unit Code (HUC) Watershed Boundary Dataset	The USGS HUC Watershed Boundary Dataset identifies the study area as occurring within the Bright Angel Creek-Colorado River (1501000106) and Shinumo Creek-Colorado River (1501000201) 10-digit watersheds
Soil Survey Geographic Database	The Soil Survey Geographic Database (SSURGO) mapped the presence of 18 different soil map units within the study area, none of which are classified as hydric (USDA-NRCS 2021b)

5.3 Analysis of Rainfall Normality

Precipitation recorded at Phantom Ranch during the 6 months prior to the field investigation is shown in Table 3. Observed precipitation data in the 6 months prior to the field investigation were analyzed using the Direct Antecedent Rainfall Evaluation Method (USDA-NRCS 2015) and data from the nearest Climate Analysis for Wetlands (WETS) station at Phantom Ranch (elevation: 2,530 feet; latitude: 36.1066° N; longitude: -112.0947° W; Station IDs: 026471 AND 024335 [Coop], USC00026471 and USC00024335 [GHCN], PHRA3 [NWS LI]).

- March 22–29, 2021 site visit: During the 6 months preceding field investigations (September 1, 2020 through February 28, 2021), the Phantom Ranch weather station recorded 1.18 inches of rainfall, with the majority—0.77 inch—falling during the month of January. Based on these recorded data, all 6 months were significantly drier than normal. For the 6 months prior to the site visit, based on NRCS methodology, this represents below-normal rainfall.

Overall, conditions at the time of the field investigations were dry and primary hydrologic indicators may not have been present at the site. As a result, other factors such as secondary hydrological indicators, topographic changes, and presence of hydric soils were used to determine wetland boundaries in some areas.

Table 3. Precipitation in the Study Area from September 2020 through February 2021

Timeframe	Recorded Precipitation (inches)	Monthly Precipitation Average (inches)	Percent of Average Recorded	30% Chance Less Than or More Than Ranges for Normal Precipitation (inches)
September 2020	0.04	1.00	4.0	<0.45 >1.16
October 2020	T[1]	0.99	–[3]	<0.42 >1.00
November 2020	0.29	0.76	38.0	<0.23 >0.76
December 2020	0.08	0.83	9.6	<0.31 >0.87
January 2021	0.77	0.94	81.9	<0.38 >1.26
February 2021	M[2]	0.98	–[3]	<0.50 >1.18

[1] T indicates trace precipitation
[2] M indicates data missing for a month
[3] – indicates data missing for all days in a month or year

5.4 Field Investigation

This report documents the aquatic resources delineated during an on-site routine wetland determination conducted by HDR environmental scientists Ryan Hammons, Professional Wetland Scientist (PWS); Sirena Brownlee; Tara Kent; and Tracy Hamilton, Registered Environmental Manager (REM) from March 22 through March 29, 2021, to determine the presence of wetlands and other aquatic resources within the study area. As described above and depicted in the percent of average recorded in Table 3, review of the WETS Tabl

e from 1981 to 2021 yielded drier-than-normal conditions for the study area (AgACIS 2021a).

5.4.1 Mapping Accuracy

Aquatic resources identified during the literature review and review of aerial imagery and topographic maps were investigated in the field to determine whether indicators of fluvial transport observed were present in the study area. During the field investigation, data plot locations and wetland boundaries were recorded in ESRI ArcCollector using Trimble R1 Global Navigation Satellite System (GNSS) and EOS Arrow 100 submeter GNSS receivers paired to Apple iPads. Mapping accuracies of the units are submeter using Trimble Real Time eXtended (RTX) and/or SBAS (Satellite-Based Augmentation Systems) and SBAS differential data correction for the Trimble R1 and EOS Arrow 100, respectively. Spatial data recorded in the field were incorporated into ArcGIS Collector along with basemap data. The geographic information system data were then used in ArcGIS 10.7.1 to quantify the extent of aquatic resources within the study area.

5.4.2 Wetlands

Soil conditions, hydrology, and plant communities were evaluated using methods described in the USACE *Wetlands Delineation Manual* (Environmental Laboratory 1987) and the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region Version 2.0* (USACE 2008a). Data plots were selected by initial observation of topographic depressions, wetland vegetation, visual evidence of hydrology, and examination of soil samples. At locations exhibiting positive indicators of wetland characteristics, soil pits were excavated in conjunction with identification of vegetative and hydrologic indicators to aid in the determination of wetland boundaries. Once a plot site was selected, a soil pit was excavated; soils, hydrology, and vegetation were investigated; and results were recorded on wetland determination data forms. In addition, photographs were also recorded throughout the study area. Methods used to determine the presence of hydric soil, hydrology, and hydrophytic vegetation are discussed below. Variations to the standard methodology, if necessary, are indicated on the data forms.

Wetland habitats in the study area were also classified according to the system outlined by USFWS in *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al. 1979; FGDC 2013). The Cowardin system classifies wetlands based on their dominant vegetation structure and water regime.

Vegetation

At each data plot, the percent cover for each plant species was visually estimated and recorded. In accordance with USACE methodology, greater than 50 percent of the dominant plant species must be classified as hydrophytic (water loving), or the plot must have a prevalence index of less than 3.00 for a site to display a positive wetland vegetation indicator. The dominant plant species were identified using standard taxonomic references. The wetland indicator status for each species was determined in accordance with the National Wetland Plant List version 3.4 (USACE 2018). Vegetation was recorded as obligate (OBL), facultative-wetland (FACW), facultative (FAC), facultative-upland (FACU), or upland (UPL) (Table 4). Hydrophytic vegetation includes plants that have adapted to growing in anaerobic conditions associated with prolonged saturation of soils.

Thro

ugh their adaptations, hydrophytes have adapted to life in anaerobic conditions by evolving alternative methods of collecting oxygen.

Table 4. Plant Indicator Status Categories

Indicator Category	Symbol	Definition
Obligate wetland plants	OBL	Almost always occur in wetlands (>99 percent); may rarely (<1 percent) occur in non-wetlands
Facultative wetland plants	FACW	Usually occur in wetlands (67 to 99 percent); may sometimes (1 to 33 percent) occur in non-wetlands
Facultative plants	FAC	Occur in both wetlands and non-wetlands
Facultative upland plants	FACU	Usually occur in non-wetlands (67 to 99 percent); may sometimes occur in wetlands (1 to 33 percent)
Upland plants	UPL	Almost never (<1 percent) occur in wetlands

Source: (Lichvar et al. 2012)

Soils

Soils at each representative wetland and upland sample plot were inspected to a depth of 20 inches (where possible) to determine the presence or absence of hydric soil indicators outlined in Field Indicators of Hydric Soils in the United States (NRCS 2018). Hydric soils are defined as soils that are flooded, ponded, or saturated long enough during the growing season to develop anaerobic conditions in the upper part of the soil profile. The determination of a hydric soil generally is based on the presence of indicators of an aquic moisture regime and hydric conditions. Aquic moisture regimes occur under anaerobic conditions and could develop from continuous saturation for at least 5 percent of the growing season. At least one positive hydric soil indicator at each site is required to classify the soil as hydric. For example, soils in prolonged anaerobic conditions undergo chemical reduction of iron and manganese, thereby producing low-chroma soil colors. Additionally, if reduced iron and manganese in inundated or saturated soil is exposed to oxygen in other areas of the soil ped (for example, root pores and ped faces), areas of concentrated high-chroma mottles develop that are referred to as redoximorphic features. During the field survey, colors of the soil profile matrix and mottles were identified using Munsell® soil color charts (Munsell Color 2009).

Where necessary, soil samples were moistened to aid in the determination of the hue, value, and chroma of the soil matrix and redoximorphic features, if present (Munsell Color 2009). Soil texture was evaluated using field methods described by USACE and NRCS. In addition to the formal data plots that were recorded, various auger samples were taken throughout the wetlands and along the wetland boundaries to provide an accurate delineation. Although the results of these auger samples were not formally documented, they were used as a supplemental method of boundary verification.

Hydrology

To evaluate wetland hydrology characteristics, primary and secondary indicators were investigated at each of the data plots. The determination of wetland hydrology is based on the presence of at least one primary or two secondary indicators of a prolonged period of inundation or saturation as outlined in the *Regional Supplement to the Corps of Engineers*

Wetland Delineation Manual: Arid West Region Version 2.0 (USACE 2008a). Some of the primary indicators observed during the field survey included surface water, high water table, saturation, iron deposits, and/or aquatic invertebrates, among others. Secondary indicators included drainage patterns, saturation visible on aerial imagery, and/or FAC-Neutral Test.

5.4.3 Other Aquatic Resources

The ordinary high water mark (OHWM) of non-wetland waters in the study area was determined in the field using the methodology outlined in *A Field Guide to the Identification of the Ordinary High Water Mark (OHWM) in the Arid West Region of the Western United States* (USACE 2008b). The physical characteristics most commonly used to indicate the OHWM include changes in sediment texture, shelving or recent bank erosion, and changes in vegetation communities between adjacent areas. These indicators were observed in the field and used to determine the location of the OHWM. Mapped waterbodies were assigned NWI mapping codes based on *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al. 1979).

Distinctions between the low flow channels, terraces within the active floodplain, and low terraces were determined in the field. Low flow channels were identified by the complete absence of shrub vegetation, presence of sand or coarse sand substrates, and clear shelving. Low terraces within the active floodplain were identified based on the reduction of shrub vegetation, presence of very coarse sand or pebble substrates, and faint shelving. The boundary between the active floodplain and adjacent upland was determined based on presence of cobble or boulder substrates, dense shrub layer, and a break in channel slope.

6 Results

All aquatic features within the study area receive flows from tributaries of the Colorado River or convey flows into the Colorado River. The Colorado River in Arizona has undergone numerous navigation study determinations and was determined a Traditional Navigable Water (TNW) in all evaluations, including through the Grand Canyon and the study area. Since the Colorado River is a TNW and is therefore a WOTUS, features within the study area that are (1) a perennial or intermittent tributary of the Colorado River, or (2) adjacent wetlands, would be subject to USACE jurisdiction under Section 404 of the CWA.

Aquatic resources delineated within the study area are described below. Delineation maps for aquatic resources within the study area are provided in Appendix A, representative site photographs are provided in Appendix B, and wetland determination data forms in Appendix C. Table 5 provides the total acreages of all aquatic resources delineated in the study area.

Table 5. Aquatic Resources Mapped Within the Study Area

Aquatic Resources		
Resource Type	**Classification**	**Total Acreage in Study Area**
Wetlands	Vegetated Wetland	2.592

Perennial Streams	Open Water[1]	3.018
Intermittent Streams	Open Water[2]	0.003
Ephemeral Streams	Open Water[3]	0.588
Total Aquatic Resources Mapped Within the Study Area: 6.201 acres		

[1] Section 404 jurisdictional classification: TNW; (a)(2) waters
[2] Section 404 jurisdictional classification: (a)(2) water
[3] non-WOTUS

6.1 Wetlands

Twenty-four palustrine wetlands were delineated in the study area. Table 6 describes the wetlands mapped in the study area, including their proximity to an (a)(1)–(3) water (adjacent to, abutting, or flooded by in a typical year). Wetlands in the study area are primarily associated with perennial streams as fringe wetlands, springs, and effluent discharge, and headwater streams draining through canyons within the Park. These wetlands are associated with Garden, Pipe, and Bright Angel creeks and the Colorado River.

The wetlands within the study area are classified as palustrine—this classification includes all nontidal wetlands dominated by trees, shrubs, persistent and nonpersistent herbaceous plants, emergent mosses, or lichens (Cowardin et al. 1979). Palustrine wetlands also include aquatic habitats that are less than 20 acres in size, lack active wave-formed or bedrock shoreline features, have less than 6 feet of water at the deepest part, and have salinity due to ocean-derived salts below 0.5 percent. Characteristics of the palustrine wetland systems present within the study area are provided below.

Table 6. Wetlands in the Study Area

Feature ID	NWI Code[1]	Classification[2]	Extent within Study Area
W-1	PEM1K	Adjacent	0.009 acre
W-2	PSS1B	Adjacent	0.015 acre
W-3	PSS1B	Adjacent	0.085 acre
W-4	PSS1B	Adjacent	0.031 acre
W-5	PSS1B	Adjacent	0.033 acre
W-6	PSS1B	Adjacent	0.008 acre
W-7	PSS1B	Adjacent	0.023 acre
W-8	PSS1B	Isolated	0.179 acre
W-9	PFO1B	Isolated	0.102 acre

[1] according to Cowardin et al. (1979):
PEM1B: Palustrine Emergent Persistent Seasonally Saturated
PEM1K: Palustrine Emergent Persistent Artificially Flooded
PFO1B: Palustrine Forested Broad-Leaved Deciduous Seasonally Saturated
PFO1K: Palustrine Forested Broad-Leaved Deciduous Artificially Flooded
PSS1B: Palustrine Scrub-Shrub Broad-Leaved Deciduous Seasonally Saturated
PSS1E: Palustrine Scrub-Shrub Broad-Leaved Deciduous Seasonally Flooded/Saturated
PSS1K: Palustrine Scrub-Shrub Broad-Leaved Deciduous Artificially Flooded

[2] adjacent to, abutting, or flooded in a typical year by an (a)(1)–(3) water; isolated

W-10	PSS1B	Adjacent	0.032 acre
W-11	PEM1B	Adjacent	0.061 acre
W-12	PSS1B	Adjacent	0.014 acre
W-13	PSS1B	Adjacent	0.092 acre
W-14	PSS1K	Isolated	0.120 acre
W-15	PSS1B	Adjacent	0.068 acre
W-16	PSS1B	Adjacent	0.015 acre
W-17	PSS1B	Adjacent	0.035 acre
W-18	PSS1K	Adjacent	0.099 acre
W-19	PSS1E	Adjacent	0.082 acre
W-20	PSS1E	Adjacent	0.022 acre
W-21	PSS1E	Adjacent	0.409 acre
W-22	PFO1B	Adjacent	0.408 acre
W-23	PEM1E	Adjacent	0.581 acre
W-24	PEM1B	Adjacent	0.065 acre
Total wetlands mapped within the study area:			**2.6 acres**

Palustrine emergent wetland W-1 abuts Bright Angel Creek and is associated with overflow discharge from a pumping station draining through a pipe into Bright Angel Creek. Soils could not be evaluated due to the wetland's location on a rocky slope and are assumed hydric based on vegetation (passed FAC Neutral Test 1:0) and hydrologic indicators. Rough horsetail (*Equisetum hymale*) is the dominant plant species in this wetland. Within the study area, W-1 measures 0.009 acre. Refer to the Wetland Determination Data Form for Sampling Point DP-1 for additional information on vegetation, soil, and hydrology.

Palustrine scrub-shrub wetland W-2 is a fringe wetland that occurs in a low and relatively flat area that abuts Bright Angel Creek. Standing water was present in one portion of the wetland. Soils were saturated and assumed hydric although redoximorphic features were not visible likely due to saturation. The dominant plant species in this wetland included boxelder (*Acer negundo*), mule-fat (*Baccharis salicifolia*), narrowleaf willow (*Baccharis salicina*), water sedge (*Carex aquatilis*), rough horsetail, and brome (*Bromus* sp.). Within the study area, W-2 measures 0.015 acre. Refer to the Wetland Determination Data Form for Sampling Point DP-2 for additional information on vegetation, soil, and hydrology.

Palustrine scrub-shrub wetland W-3 is a fringe wetland that occurs in a low and relatively flat area that abuts Bright Angel Creek. Standing water was present in one portion of the wetland. Soils were saturated and assumed hydric although redoximorphic features were not visible likely due to saturation. The dominant plant species in this wetland included boxelder, mule-fat, narrowleaf willow, water sedge, rough horsetail, and brome. Within the study area, W-3 measures 0.085 acre. Refer to the Wetland Determination Data Form for Sampling Point DP-2 for additional information on vegetation, soil, and hydrology.

Palustrine scrub-shrub wetland W-4 is a fringe wetland that occurs in a low and relatively flat area that abuts Bright Angel Creek. Standing water was present in one portion of the wetland. Soils were saturated and assumed hydric although redoximorphic features were not visible likely due to saturation. The dominant plant species in this wetland included

boxelder, mule-fat, narrowleaf willow, water sedge, rough horsetail, and brome. Within the study area, W-4 measures 0.031 acre. Refer to the Wetland Determination Data Form for Sampling Point DP-2 for additional information on vegetation, soil, and hydrology.

Palustrine scrub-shrub wetland W-5 is a fringe wetland that occurs in a low and relatively flat area that abuts Bright Angel Creek. Standing water was present in one portion of the wetland. Soils were saturated and assumed hydric although redoximorphic features were not visible likely due to saturation. The dominant plant species in this wetland included boxelder, mule-fat, narrowleaf willow, water sedge, rough horsetail, and brome. Within the study area, W-5 measures 0.033 acre. Refer to the Wetland Determination Data Form for Sampling Point DP-2 for additional information on vegetation, soil, and hydrology.

Palustrine scrub-shrub wetland W-6 is a fringe wetland that occurs in a possible excavated second channel within the floodplain of Bright Angel Creek. Surface water was present in the wetland. Soils were problematic due to red parent material but exhibited redoximorphic features. The dominant plant species in this wetland included willow baccharis, narrowleaf willow, and water sedge. Within the study area, W-6 measures 0.008 acre. Refer to the Wetland Determination Data Form for Sampling Point DP-6 for additional information on vegetation, soil, and hydrology.

Palustrine scrub-shrub wetland W-7 is a fringe wetland that occurs in a possible excavated second channel within the floodplain of Bright Angel Creek. Hydrology, soils, and vegetation were the same as W-6. Within the study area, W-7 measures 0.023 acre. Refer to the Wetland Determination Data Form for Sampling Point DP-6 for additional information on vegetation, soil, and hydrology.

Palustrine scrub-shrub wetland W-8 is an artificially irrigated, isolated wetland occurring in ditches constructed to irrigate landscaping at Phantom Ranch. Surface water and hydrophytic vegetation, including rough horsetail, were present in the wetland; however, soils could not be evaluated and were assumed hydric based on the presence of vegetation and hydrology. Within the study area, W-8 measures 0.179 acre.

Palustrine forested wetland W-9 is an isolated wetland in a sloping depression between two trails and a mule corral. Saturation and high water table were both present. Soils were problematic due to red parent material, alkalinity, and saturation, and soil pit was restricted by rocky substrate at 6 inches. Dominant plant species in this wetland included Fremont cottonwood (*Populus fremontii*), Goodding's willow (*Salix gooddingii*), mule-fat, and saltgrass (*Distichlis spicata*). Within the study area, W-9 measures 0.102 acre. Refer to the Wetland Determination Data Form for Sampling Point DP-8 for additional information on vegetation, soil, and hydrology.

Palustrine scrub-shrub wetland W-10 is a fringe wetland that occurs approximately four feet from the OHWM and within the floodplain of Bright Angel Creek. Water stained leaves and oxidized rhizospheres along living roots were present. Soils were problematic due to red parent material but exhibited redoximorphic features. The dominant plant species in this wetland included mule-fat, willow baccharis, California satintail (*Imperata brevifolia*), and saltgrass. Within the study area, W-10 measures 0.032 acre. Refer to the Wetland Determination Data Form for Sampling Point DP-11 for additional information on vegetation, soil, and hydrology.

Palustrine emergent wetland W-11 is a fringe wetland that occurs within the floodplain of Bright Angel Creek. Oxidized rhizospheres along living roots were present. Soils were

problematic due to red parent material but exhibited redoximorphic features. The dominant plant species in this wetland was saltgrass. Within the study area, W-11 measures 0.061 acre. Refer to the Wetland Determination Data Form for Sampling Point DP-14 for additional information on vegetation, soil, and hydrology.

Palustrine scrub-shrub wetland W-12 is a fringe wetland that occurs within the floodplain of Bright Angel Creek. Oxidized rhizospheres along living roots were present. Soils were problematic due to red parent material but exhibited redoximorphic features. The dominant plant species in this wetland were Fremont cottonwood, mule-fat, willow baccharis, and saltgrass. Within the study area, W-12 measures 0.014 acre. Refer to the Wetland Determination Data Form for Sampling Point DP-15 for additional information on vegetation, soil, and hydrology.

Palustrine scrub-shrub wetland W-13 is a fringe wetland that occurs within the floodplain of Bright Angel Creek. Oxidized rhizospheres along living roots were present. Soils were problematic due to red parent material but exhibited redoximorphic features. The dominant plant species in this wetland were Fremont cottonwood, mule-fat, willow baccharis, and saltgrass. Within the study area, W-13 measures 0.092 acre. Refer to the Wetland Determination Data Form for Sampling Point DP-15 for additional information on vegetation, soil, and hydrology.

Palustrine scrub-shrub wetland W-14 is an artificially irrigated wetland occurring in ditches constructed to irrigate privacy landscaping at Bright Angel Campground. Hydrophytic plant species dominated by willow baccharis, California satintail, and saltgrass were present in the wetland. Hydrology was based on secondary indicators of drainage patterns and positive FAC-neutral test. Soils could not be evaluated further than 4 inches below the surface and were problematic due to red parent material; therefore, soils were assumed hydric based on the presence of wetland vegetation and hydrology. Within the study area, W-14 measures 0.120 acre. Refer to the Wetland Determination Data Form for Sampling Point DP-13 for additional information on vegetation, soil, and hydrology.

Palustrine scrub-shrub wetland W-15 is a riparian fringe wetland in a relatively flat area along Bright Angel Creek. Dominant plant species in this wetland included mule-fat, willow baccharis, and California satintail. Oxidized rhizospheres along living roots were present. Soils were problematic due to red parent material but exhibited redoximorphic features. Within the study area, W-15 measures 0.068 acre. Refer to the Wetland Determination Data Form for Sampling Point DP-18 for additional information on vegetation, soil, and hydrology.

Palustrine scrub-shrub wetland W-16 is a riparian fringe wetland in a relatively flat area along Bright Angel Creek. Dominant plant species in this wetland included mule-fat, willow baccharis, and California satintail. Oxidized rhizospheres along living roots were present. Soils were problematic due to red parent material but exhibited redoximorphic features. Within the study area, W-16 measures 0.015 acre. Refer to the Wetland Determination Data Form for Sampling Point DP-18 for additional information on vegetation, soil, and hydrology.

Palustrine scrub-shrub wetland W-17 is a riparian fringe wetland along Bright Angel Creek. Soils could not be evaluated due to rocky restrictive layer and were assumed hydric. Dominant plant species in this wetland included mule-fat and saltgrass. Within the study

area, W-17 measures 0.035 acre. Refer to the Wetland Determination Data Form for Sampling Point DP-17 for additional information on vegetation, soil, and hydrology.

Palustrine scrub-shrub wetland W-18 is located in an area of effluent discharge downslope of a wastewater treatment plant. Soils were inundated and assumed hydric based on vegetation and hydrologic indicators. Dominant plant species in this wetland included mule-fat and saltgrass. This wetland abuts W-19. Within the study area, W-18 measures 0.099 acre. Refer to the Wetland Determination Data Form for Sampling Point DP-20 for additional information on vegetation, soil, and hydrology.

Palustrine scrub-shrub wetland W-19 is a fringe wetland that abuts the Colorado River. Saturation and high water table were present. Soils were problematic due to red parent material but exhibited redoximorphic features. The dominant plant species in this wetland included willow baccharis, mule-fat, and California satintail. Within the study area, W-19 measures 0.082 acre. Refer to the Wetland Determination Data Form for Sampling Point DP-22 for additional information on vegetation, soil, and hydrology.

Palustrine scrub-shrub wetland W-20 is a fringe wetland that abuts the Colorado River. Saturation was present and water table was encountered at 8 inches. Soils were problematic due to red parent material but exhibited redoximorphic features. The dominant plant species in this wetland included willow baccharis, mule-fat, and California satintail. Within the study area, W-20 measures 0.022 acre. Refer to the Wetland Determination Data Form for Sampling Point DP-22 for additional information on vegetation, soil, and hydrology.

Palustrine scrub-shrub wetland W-21 is a fringe wetland that abuts the Colorado River. Hydrology indicators included salt crust, drift deposits, drainage patterns, and FAC-neutral test. Soils were restricted at 6 inches but exhibited redoximorphic features. Dominant plant species included arrowweed (*Pluchea sericea*), willow baccharis, California satintail, scratchgrass (*Muhlenbergia asperifolia*), and bushy bluestem (*Andropogon glomeratus*). Within the study area, W-21 measures 0.409 acre. Refer to the Wetland Determination Data Form for Sampling Point DP-24 for additional information on vegetation, soil, and hydrology.

Palustrine forested wetland W-22 is a large, depressional fringe wetland lined with boulders adjacent to Garden Creek. This wetland, like other fringe wetlands adjacent to Garden Creek, has been disturbed with areas of fill material. Two inches of surface water were present. Soils were inundated and assumed hydric; no redox was observed but Fe2+ likely in solution. Dominant plant species included velvet ash, Fremont cottonwood, Goodding's willow, willow baccharis, and chairmaker's bulrush (*Schoenoplectus americanus*). Within the study area, W-22 measures 0.408 acre. Refer to the Wetland Determination Data Form for Sampling Point DP-26 for additional information on vegetation, soil, and hydrology.

Palustrine emergent wetland W-23 is a large, spring-fed depressional wetland abutting Garden Creek. Primary hydrology indicators included surface water, high water table, saturation, water-stained leaves, aquatic invertebrates, hydrogen sulfide odor, reduced iron, and thin muck surface. The dominant plant species in this wetland included velvet ash, mule-fat, and chairmaker's bulrush. Within the study area, W-23 measures 0.581 acre. Refer to the Wetland Determination Data Form for Sampling Point DP-28 for additional information on vegetation, soil, and hydrology.

Palustrine emergent wetland W-24 is fed by a spring on the south end of the wetland. Saturation was present and surface water was present in other areas of the wetland but not at the data plot. Soils were problematic due to red parent material but exhibited redoximorphic features. The dominant plant species in this wetland included velvet ash, Goodding's willow, and chairmaker's bulrush. Within the study area, W-24 measures 0.065 acre. Refer to the Wetland Determination Data Form for Sampling Point DP-30 for additional information on vegetation, soil, and hydrology.

6.1.1 NPS Wetlands

Based on the review of desktop materials, all areas identified as exhibiting potential wetland vegetation, soils, or hydrology as defined by Cowardin and FDGC were analyzed in the field for indicators of each as detailed in Section 4.2. In addition, hydrologic data for the project area were reviewed to determine, to the extent practicable, the influence of hydrologic factors on the fluvial system.

Field indicators and professional judgment based on experience with similar drainage systems and wetland delineations throughout the Arid West and Arizona were used to determine the presence of wetlands applicable to NPS wetland protection procedures within the study area.

Twenty-four areas within the study area support wetland vegetation, hydric soils, and/or hydrology. In addition to those 24 wetlands, several areas supported hydrophytic vegetation; however, soils and hydrology were absent. Data sheets for those locations are included in Appendix C. Those areas were characterized by facultative species such as Fremont cottonwood, mule-fat, and saltgrass. Soils were sandy-loam and lacked redox.

6.2 Uplands

Data plots were completed in a representative upland area adjacent to the sampled wetlands. The vegetation communities are non-hydrophytic and the tree and sapling/shrub stratums are populated with Sonoran scrub oak (*Quercus turbinella*), Apache plume (*Fallugia paradoxa*), catclaw acacia (*Senegalia greggii*), honey mesquite (*Prosopis glandulosa*), Grand Canyon century plant (*Agave phillipsiana*), and Fremont cottonwood. The herb stratums were moderately populated and included alkali goldenbush (*Isocoma acradenia*), brittlebush (*Encelia farinosa*), spike dropseed (*Sporobolus contractus*), cheatgrass (*Bromus tectorum*), red brome (*Bromus rubens*), and bermudagrass (*Cynodon dactylon*). None of the soils excavated in upland plots exhibited hydric indicators, and all lacked indicators of wetland hydrology.

6.3 Perennial Streams

Four perennial streams were delineated in the study area: Bright Angel Creek, Pipe Creek, Garden Creek, and the Colorado River (Table 7).

Table 7. Perennial Streams in the Study Area

Feature		Classification		Extent within Study Area	
ID	Name	NWI Code[3]	Category[4]	Acres	Linear Feet
S-1a	Bright Angel Creek	R3UB1H	(a)(2) water	0.022	100.7
S-1b	Bright Angel Creek	R3UB1H	(a)(2) water	0.155	552.6
S-1c	Bright Angel Creek	R3UB1H	(a)(2) water	0.018	124.2
S-1d	Bright Angel Creek	R3UB1H	(a)(2) water	0.167	549.3
S-1e	Bright Angel Creek	R3UB1H	(a)(2) water	0.099	251.7
S-1f	Bright Angel Creek	R3UB1H	(a)(2) water	0.014	78.8
S-1g	Bright Angel Creek	R3UB1H	(a)(2) water	0.044	78.0
S-1h	Bright Angel Creek	R3UB1H	(a)(2) water	0.091	100.7
S-1i	Bright Angel Creek	R3UB1H	(a)(2) water	0.029	124.1
S-1j	Bright Angel Creek	R3UB1H	(a)(2) water	0.041	130.0
S-1k	Bright Angel Creek	R3UB1H	(a)(2) water	0.009	53.8
S-1l	Bright Angel Creek	R3UB1H	(a)(2) water	0.041	127.6
S-1m	Bright Angel Creek	R3UB1H	(a)(2) water	0.187	401.5
S-1n	Bright Angel Creek	R3UB1H	(a)(2) water	0.037	94.1
S-1o	Bright Angel Creek	R3UB1H	(a)(2) water	0.014	93.7
S-1p	Bright Angel Creek	R3UB1H	(a)(2) water	0.056	133.3
S-1q	Bright Angel Creek	R3UB1H	(a)(2) water	0.053	82.3
S-1r	Bright Angel Creek	R3UB1H	(a)(2) water	0.047	96.7
S-1s	Bright Angel Creek	R3UB1H	(a)(2) water	0.125	502.1
S-1t	Bright Angel Creek	R3UB1H	(a)(2) water	0.264	616.5
R-1a	Colorado River	R3UB1H	(a)(1) water	0.031	253.2
R-1b	Colorado River	R3UB1H	(a)(1) water	0.826	294.2
R-1c	Colorado River	R3UB1H	(a)(1) water	0.344	1375.8
R-1d	Colorado River	R3UB1H	(a)(1) water	0.008	57.8
R-1e	Colorado River	R3UB1H	(a)(1) water	0.066	195.6
S-8	Pipe Creek	R5UB1H	(a)(2) water	0.105	284.9
S-14a	Garden Creek	R5UB1H	(a)(2) water	0.014	153.5
S-14b	Garden Creek	R5UB1H	(a)(2) water	0.023	98.7
S-14c	Garden Creek	R5UB1H	(a)(2) water	0.028	80.0
S-14d	Garden Creek	R5UB1H	(a)(2) water	0.006	33.5

[3] according to Cowardin et al. (1979):
R3UB1H: Riverine Upper Perennial Unconsolidated Bottom Cobble-Gravel Permanently Flooded
[4] (a)(1) – traditional navigable water, (a)(2) – perennial tributary of an (a)(1) water

S-14e	Garden Creek	R5UB1H	(a)(2) water	0.039	169.9
S-16a	N/A	R5UB1H	(a)(2) water	0.007	54.4
S-16b	N/A	R5UB1H	(a)(2) water	0.002	15.6
S-17	Garden Creek	R5UB1H	(a)(2) water	0.005	109.3
Total extent of perennial streams in study area:				**3.018**	**7,467.9**

6.4 Intermittent Streams

Intermittent streams are characterized by well-defined channels that contain water for only part of the year, typically during winter and spring when the aquatic bed is below the water table; however, flows in the arid West often are heavily supplemented by stormwater runoff. The jurisdictional status of an intermittent stream is determined based on the presence of intermittent flow and contribution of surface water flow to a TNW or territorial sea in a typical year.

There is one unnamed minor intermittent tributary of Garden Creek in the study area (Table 8). This stream begins south of the study area and flows generally north across Bright Angel Trail towards its confluence with Garden Creek. Surface water was present during the field investigation as shown in Appendix B, Photograph 60.

Table 8. Intermittent Streams in the Study Area

Feature		Classification		Extent within Study Area	
ID	**Name**	**NWI Code[5]**	**Category[6]**	**Acres**	**Linear Feet**
S-18	N/A	R4SB3C	(a)(2) water	0.003	74.4
			Total:	**0.003**	**74.4**

6.5 Ephemeral Features

Thirteen riverine ephemeral (R6) features totaling 0.588 acre were delineated within the study area (

Table 9). The OHWM of these features is defined by a clear break in slope, well-defined banks, and a distinct change in vegetation. These features have morphologies characteristic of ephemeral streams in the region that exhibit flow solely after rain events and only have a hydrological connection downstream from unconsolidated flow immediately following precipitation.

No field indicators were observed during the delineation suggesting soils within these features are inundated or saturated for more than a very short period immediately following rainfall. Data regarding the water surface elevations, flow depths, flow paths, and velocities within these fluvial systems are unavailable for high-flow storm events and it is not possible to determine the presence or absence of saturation or shallow water during the growing season of each year. In addition, it would be difficult to obtain independent data on the

[5] according to Cowardin et al. (1979), R3UB1H = Riverine Intermittent Streambed Cobble-Gravel Seasonally Flooded
[6] (a)(2) – perennial tributary of an (a)(2) water that is an eventual tributary of an (a)(1) water

proportion of transmission losses throughout these fluvial systems as some portions feed deep ground-water recharge, but a large portion is also lost to a combination of channel evapotranspiration as well as wetted channel evaporation.

These features occur in areas that experience stochastic, irregular rainfall events. Based on low and highly variable annual precipitation, hydrologic indicators showing inconsistent shallow surface flows, and professional experience with Arid West systems, it is not expected that these systems receive flows every year. None of these features are applicable to NPS wetland protection procedures.

While some, if not most of these minor unnamed drainages ultimately convey flow into the Colorado River through tributaries, they are ephemeral and do not meet the definition of WOTUS under the Navigable Waters Protection Rule.

Table 9. Ephemeral Features in the Study Area

Feature ID		Extent within Study Area	
Name	**NWI Code[7]**	**Acres**	**Linear Feet**
E-2	R6	0.026	138.9
E-3	R6	0.03	109.5
E-4	R6	0.034	128.5
E-5a	R6	0.152	240.8
E-5b	R6	0.071	155.1
E-6a	R6	0.010	138.6
E-6b	R6	0.013	166.7
E-15	R6	0.005	33.0
E-13	R6	0.091	390.7
E-12	R6	0.011	118.6
E-11	R6	0.015	106.7
E-10	R6	0.004	48.6
E-9	R6	0.002	46.4
	Total:	**0.588 acre**	**1,820.9**

7 Conclusions and Recommendations

The study area contains one TNW—the Colorado River—24 palustrine wetlands totaling 2.592 acres, four perennial streams (including the Colorado River) totaling 3.018 acre (7,467.9 linear feet), one intermittent stream 0.003 acre (74.4 linear feet), and 13 ephemeral streams totaling 0.588 acre (1,820.9 linear feet). All wetlands, perennial streams, and the intermittent stream meet the definition of WOTUS based on the findings collected during the field and desktop investigations conducted as part of this study. In addition, 13 ephemeral features totaling 0.588 acre were mapped and would not currently

[7] according to Cowardin et al. (1979):
R6: Riverine Ephemeral

be considered jurisdictional waters; however, those features have been included since the final determination lies with USACE and the definition of WOTUS at the time of permitting.

7.1 Regulatory and Permitting Discussion

7.1.1 Jurisdictional Determination

Under the Navigable Waters Protection Rule, ephemeral features, irrigation ditches, isolated wetlands, and wetlands that lack a direct hydrologic surface connection in a typical year are not jurisdictional WOTUS. Based on the best professional judgment of HDR's team of CWA permitting specialists with extensive experience in permitting of similar resources in Arizona, it is recommended that NPS request an Approved Jurisdictional Determination (AJD) for the ephemeral features and isolated wetlands to ensure USACE concurs that these features are not jurisdictional. An AJD provides a definitive, official determination that there are, or that there are not, jurisdictional aquatic resources in the study area. In addition, the identification of the geographic limits of jurisdictional aquatic resources on a parcel can only be made through an AJD (USACE 2016). An AJD may be requested for all aquatic resources in the study area or solely for the features that are not jurisdictional. If an AJD is requested for only the features that are not jurisdictional, a Preliminary Jurisdictional Determination may be requested for the jurisdictional features. This approach is recommended if it is determined it is in the best interest of NPS to expeditiously obtain permit authorization and to refrain from requesting an AJD for the potentially jurisdictional features.

7.1.2 Department of the Army Permit

In Arizona, Nationwide Permits (NWP) typically are used for projects with minimal individual and cumulative adverse environmental effects, but they generally cannot be used to authorize structures, work, and/or the discharge of dredged or fill material that would result in the "loss" of wetlands, mudflats, vegetated shallows, or riffle and pool complexes (as defined at 40 CFR Part 230.40–45). The definition of "loss" is the same as the definition of "loss of waters of the United States" used for the NWP program. This Regional Condition applies only within the State of Arizona (USACE 2017). However, in January 2021, USACE reissued the NWP and included four new permits, including NWP 58 for utility line activities for water and other substances. The regional conditions for Arizona were also updated and allow for up to a 0.1-acre loss[8] of wetlands, mudflats, vegetated shallows, or riffle and pool complexes, as defined at 40 CFR Part 230.40–45.

[8] "Loss" means waters of the United States that are permanently adversely affected by filling, flooding, excavation, or drainage because of the regulated activity.

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Appendix A. Figures 4–1 through 8–20

Appendix B. Representative Site Photographs

Appendix C. Wetland and OHWM Data Forms