NTESS Exhibit 14

Use Attainability Analysis for Tijeras Arroyo

Rio Grande to Four Hills Bridge Reach
(Assessment Unit NM-9000.A_070)

Sandia National Laboratories

U.S. Department of Energy
National Nuclear Security Administration
Sandia Field Office
Albuquerque, NM

December 18, 2019

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Acronyms

AU	assessment unit
DOE	United States Department of Energy
EPA	United States Environmental Protection Agency
GIS	geographic information system
HUC	hydrologic unit code
KAFB	Kirtland Air Force Base
NMED	New Mexico Environment Department
NPDES	National Pollutant Discharge Elimination System
NTESS	National Technology and Science Solutions of Sandia
SNL/NM	Sandia National Laboratories, New Mexico
SPI	Standard Precipitation Index
SWQB	Surface Water Quality Bureau
USGS	United States Geologic Survey
UAA	Use Attainability Analysis

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Units of Measure

AF	acre-foot
AF/yr	acre-feet per year
bgs	below ground surface
CF	cubic foot
Cfs	cubic feet per second
CF/yr	cubic feet per year
ft	foot
mm	millimeter
mph	miles per hour
sq mi	square mile

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1. Introduction

This Use Attainability Analysis (UAA) was conducted for the Rio Grande to Four Hills Bridge reach of the Tijeras Arroyo (Assessment Unit [AU] NM-9000.A_070), located in Albuquerque, New Mexico (Figure 1). It was prepared by National Technology & Engineering Solutions of Sandia, LLC (NTESS) personnel on behalf of the United States Department of Energy (DOE)/National Nuclear Security Administration (NNSA)/Sandia Field Office (SFO). NTESS is the management and operating contractor for Sandia National Laboratories, New Mexico (SNL/NM), and the DOE/NNSA/SFO administers the SNL/NM contract. SNL/NM is located on Kirtland Air Force Base (KAFB), in Bernalillo County, New Mexico. KAFB is a 51,559-acre (80.56 sq mi) military installation located adjacent to the City of Albuquerque (Figure 1).

The Rio Grande to Four Hills Bridge reach of Tijeras Arroyo receives stormwater discharged from SNL/NM (as well as from KAFB, the City of Albuquerque, and Bernalillo County). This UAA was conducted to help the New Mexico Environment Department (NMED) and the United States Environmental Protection Agency (EPA) determine whether the reach is most appropriately classified as intermittent or ephemeral. That determination will inform EPA National Pollution Discharge Elimination System (NPDES) regulatory compliance requirements for stormwater permits, specifically, the Multi-Sector General Permit and the Middle Rio Grande Watershed Based Municipal Separate Storm Sewer System Permit.

1.1 Scope of Work

This UAA adheres to an October 23, 2017, work plan, which the New Mexico Environment Department (NMED) Surface Water Quality Bureau (SWQB) approved on February 9, 2018 (Appendix A). As indicated in the work plan, this UAA uses the NMED Hydrology Protocol (NMED 2011a), which was designed specifically for evaluating whether a stream is ephemeral or intermittent under the New Mexico *Standards for Interstate and Intrastate Surface Waters* (20.6.4 NMAC). Additionally, this UAA follows procedures and guidelines listed in the Federal *Water Quality Standards* (40 CFR 131.10).

The study area for this UAA includes the Rio Grande to Four Hills Bridge reach of Tijeras Arroyo (AU NM-9000.A_070) and adjacent areas having the potential to impact flows within the reach. The Tijeras Arroyo is located in the Tijeras Arroyo Watershed; the 10-digit hydrologic unit code (HUC) watershed boundary (Tijeras Arroyo Watershed) is shown in Figure 2.

This UAA presents data and conclusions developed from two primary efforts:

1. A synthesis of existing information related to past and current hydrologic conditions within the watershed that have a bearing on past, present, and potential future flow within the reach
2. Field surveys of the stream channel and adjacent areas to document physical, chemical, and biological conditions that are indicative of flow regime

Results of these activities are provided in Section 2, Section 3, and Section 4, and conclusions are presented in Section 5.

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1.2 Background

The Tijeras Arroyo flows generally from northeast to southwest, from its headwaters in the Sandia and Manzanita mountains to its confluence with the Rio Grande. The total length of the Tijeras Arroyo is approximately 27.5 miles. For regulatory purposes, NMED identifies two separate assessment units (reaches) on the Tijeras Arroyo: the Rio Grande to Four Hills Bridge reach (AU NM-9000.A_070) and the Four Hills Bridge to headwaters reach (AU NM-9000.A_001) (Figure 2).

The upper reach (Four Hills Bridge to headwaters) is classified as perennial and is located entirely upstream of SNL/NM; it is not addressed by this UAA. The lower reach (Rio Grande to Four Hills Bridge) starts approximately two miles upstream of SNL/NM, flows through KAFB adjacent to SNL/NM, and ends at its confluence with the Rio Grande.

The *2016–2018 State of New Mexico Clean Water Act Section 303(d)/Section 305(b) Integrated Report* (NMED 2016) (and subsequently the 2018–2020 issue), Appendix A, "303(d) List" identifies the "Water Type" of the Rio Grande to Four Hills Bridge reach as intermittent. However, a footnote in the 303(d) List states that "application of the SWQB Hydrology Protocol (survey date 6/24/2009) indicates this assessment unit is ephemeral." The footnote further explains that NMED must complete the process detailed in 20.6.4.15 NMAC Subsection C to officially classify the reach as ephemeral, and that until such time the waterbody will continue to be identified as intermittent. This UAA was conducted to provide NMED with the information required to complete the process detailed in 20.6.4.15 NMAC Subsection C. A table listing the stepwise process required to evaluate and change the designation of a water of the State of New Mexico is provided in Appendix B.

1.3 Difference between Intermittent and Ephemeral Waters

The terms *intermittent* and *ephemeral* are defined as follows in 20.6.4.7 NMAC:

- Intermittent: the water body contains water for extended periods only at certain times of the year, such as when it receives seasonal flow from springs or melting snow
- Ephemeral: the water body contains water briefly only in direct response to precipitation; its bed is always above the water table of the adjacent region

The designated uses associated with each water type provided in 20.6.4.900 NMAC are listed in Table 1. As can be seen in Table 1, the difference in designated uses between intermittent and ephemeral waters are in the aquatic life and human contact categories. The difference in water quality standards is that both acute and chronic exposure limits apply to intermittent waters, while only acute exposure limits apply to ephemeral waters. Chronic exposure limits are lower (more stringent) than acute exposure limits because of the longer durations and types of contact that occur with intermittent as compared to ephemeral waters.

This UAA uses the following terms to describe uses, as they are defined in 20.6.4 NMAC:

- Designated use: a use specified in 20.6.4.97 through 20.6.4.899 NMAC for a surface water of the state whether or not it is being attained.

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- Existing use: a use actually attained in a surface water of the state on or after November 28, 1975, whether or not it is a designated use.
- Attainable use: a use achievable by the imposition of effluent limits required under sections 301(b) and 306 of the Clean Water Act and implementation of cost-effective and reasonable best management practices for nonpoint source control.

1.4 Use Attainability Analysis

A UAA is a scientific study conducted for the purpose of assessing the factors affecting the attainment of a designated use. A UAA must be conducted before a designated use can be removed or changed to a category requiring less stringent criteria, and it must demonstrate that attainment of the use is not feasible based on at least one of the factors identified in federal regulation at 40 CFR 131.10(g):

> (1) Naturally occurring pollutant concentrations prevent the attainment of the use; or
> (2) Natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating State water conservation requirements to enable uses to be met; or
> (3) Human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place; or
> (4) Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the water body to its original condition or to operate such modification in a way that would result in the attainment of the use; or
> (5) Physical conditions related to the natural features of the water body, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses; or
> (6) Controls more stringent than those required by sections 301(b) and 306 [technology-based effluent limitations] of the Act would result in substantial and widespread economic and social impact.

Of particular relevance to this UAA is factor 2. Flow in Tijeras Arroyo (Rio Grande to Four Hills Bridge reach, AU NM-9000.A_070) occurs infrequently and briefly, and only in direct response to precipitation. This UAA focuses largely on the reach's ability to support "marginal warmwater aquatic life" and "primary contact" designated uses.

1.4.1 Hydrology Protocol

The NMED allows for an expedited UAA process to reclassify intermittent waters to ephemeral waters. The expedited UAA process focuses on evaluating the aquatic life and contact uses based on a field survey method developed by NMED called the Hydrology Protocol. The Hydrology Protocol is described in detail in *Hydrology Protocol for the Determination of Uses Supported by Ephemeral, Intermittent,*

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and Perennial Waters (NMED 2011a), and in Section II.C of *New Mexico's Water Quality Management Plan and Continuing Planning Process* (NMED 2011b).

The Hydrology Protocol requires use of specific field survey sheets that contain questions about the hydrological, geomorphic, and biological indicators of the persistence of water (Appendix B). A scoring system enables the user to evaluate which aquatic life and contact uses are supported by the water body, and, therefore, whether the water is intermittent or ephemeral. The Hydrology Protocol is organized into a Level 1 and Level 2 evaluation. The Level 1 evaluation consists of 14 indicators (1.1 through 1.14). Level 2 evaluations are conducted for cases deemed "borderline" based on Level 1 results. Results of the Hydrology Protocol were incorporated into this UAA as described in Subsection C of 20.6.4.15 NMAC, and are presented in Section 3.

2. Hydrologic Conditions

There has been substantial environmental characterization conducted at SNL/NM and in surrounding areas close to Tijeras Arroyo over the last 40 or more years. Much of the information presented in this section was obtained from the following documents:

- *SNL/NM Site-Wide Hydrogeologic Characterization Project* (SNL/NM 1994)
- *Annual Groundwater Monitoring Report, Calendar Year 2018* (SNL/NM 2019)
- *2018 Annual Site Environmental Report for Sandia National Laboratories, New Mexico* (SNL/NM 2018)

2.1 Watershed Boundaries

The Tijeras Arroyo is the main surface drainage feature of the Tijeras Arroyo Watershed. The watershed comprises an area of roughly 132 square miles in Bernalillo County in central New Mexico. It is approximately 27.5 miles long, drains portions of the west slopes of the Sandia and the Manzanita mountains, and discharges into the Rio Grande (Figure 2).

The Tijeras Arroyo Watershed (10-digit HUC 1302020302) (Figure 2) is divided into three sub-watersheds (12-digit HUC) as depicted in Figure 3:

- Upper Tijeras Arroyo Sub-watershed (HUC 130202030201)
- Middle Tijeras Arroyo Sub-watershed (HUC 130202030202)
- Lower Tijeras Arroyo Sub-watershed (HUC 130202030203)

The upper sub-watershed is located within the western slopes of the Sandia and Manzanita mountains, to the east and north of KAFB. The middle sub-watershed is located primarily within Tijeras Canyon but extends a short distance into the Albuquerque Basin (see Section 2.2). The lower sub-watershed is completely within the Albuquerque Basin.

The Tijeras Arroyo channel is relatively steep and narrow in the upper watershed, but in the middle and lower watersheds the gradient decreases and the channel becomes wider as it leaves the mountainous terrain and enters the Albuquerque Basin. In parts of the upper and middle sub-watersheds, perennial conditions exist, however, nothing close to perennial conditions are found in

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the lower sub-watershed.. Significant geologic differences exist between the three sub-watersheds, which largely accounts for the differences in flow regime (see Section 2.2 and Section 2.7).

The Rio Grande to Four Hills Bridge reach exists primarily in the Lower Tijeras Arroyo Sub-watershed but extends into the lower part of the middle watershed (Figure 3). The only significant tributary to the Rio Grande to Four Hills Bridge reach is the Arroyo del Coyote, which drains a portion of the Manzanita Mountains, including Madera Canyon, Lurance Canyon, and Sol se Mete Canyon. The Arroyo del Coyote joins Tijeras Arroyo at the upstream extent of the lower sub-watershed (Figure 3).

2.2 Geologic Setting

The Tijeras Arroyo is located within a geologic setting that has been subjected to relatively recent episodes of basaltic volcanism and ongoing regional rifting (crustal extension). The Rio Grande Rift has formed a series of connected down-dropped basins filled with sedimentary deposits that are coincident with the path of the Rio Grande. The Rio Grande Rift extends from north to south for about 450 miles from Leadville, Colorado, through New Mexico, and into Chihuahua, Mexico.

The Albuquerque Basin (Figure 4) is one of several north–south-trending sediment-filled basins formed by the Rio Grande Rift. The Rio Grande has been an aggrading stream for much of its history and has filled the Albuquerque Basin with up to 10,000 ft of alluvial sediments. Sediments are divided into two separate geologic units: the Santa Fe Group and Quaternary alluvium. Santa Fe Group sediments are characterized by poorly to moderately consolidated alluvial and colluvial deposits ranging in size from boulders to clays. Quaternary alluvium overlying deposits of the Santa Fe Group were deposited as a series of coalescing alluvial fans extending westward from the base of the mountains. These sediments range from poorly sorted mudflow material to well-sorted stream gravel.

There are three distinct hydrologic zones underlying Tijeras Arroyo Watershed: (1) the fractured bedrock system of the foothills and mountains, (2) the Tijeras Fault Complex, and (3) the Albuquerque Basin (Figure 5). The headwaters of Tijeras Arroyo are located in the bedrock zone; from there the arroyo flows through the Tijeras Fault Complex and into the Albuquerque Basin.

The Rio Grande to Four Hills Bridge reach of Tijeras Arroyo is located entirely within the Albuquerque Basin hydrologic zone. Within the Albuquerque Basin is a large regional aquifer that lies approximately 500 ft below ground surface (bgs). A small localized perched groundwater system lies approximately 200 ft above the regional aquifer below portions of KAFB and SNL/NM. Figure 6 provides a generalized three-dimensional representation of geologic conditions under the Rio Grande to Four Hills Bridge reach of the Tijeras Arroyo.

Geology is the primary control on how much surface flow occurs in Tijeras Arroyo. In the bedrock hydrologic zone, downward migration of surface flow is slow due to the bedrock's relatively low permeability; flows are largely sustained through this reach. In the Albuquerque Basin hydrologic zone, downward migration of surface flow is rapid due to the relatively high permeability of the basin fill sediments; flows are largely depleted through this reach. Additional discussion of the local hydrogeology is provided in Section 2.7.

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2.3 Topography

Tijeras Arroyo is set in the high desert region of central New Mexico. The most prominent local topographic features are the Sandia and Manzanita mountains. The Sandia Mountains form a 13-mile-long escarpment distinguished by steep cliffs, pinnacles, and narrow canyons; the tallest point is Sandia Crest at 10,678 ft. The Sandia Mountains are separated from the Manzanita Mountains (to the south) by Tijeras Canyon, through which the Tijeras Arroyo flows. West of the mountains lies a broad upland bench called the Llano de Sandia. The Rio Grande lies approximately 10 miles west of the mountain front. The mountains in the east and the plains to the west create a diverse range of geological, hydrological, ecological, and climatic settings.

The Rio Grande to Four Hills Bridge reach of Tijeras Arroyo is located west of the mountains on Llano de Sandia high desert grasslands. The topography of the Llano de Sandia is gently sloping to level. Elevations range from approximately 5,800 ft above mean sea level along its eastern extent to approximately 5,300 ft above mean sea level along its western extent (Figure 7). The predominant direction of surface drainage is from the east to the west with an average slope of about 2.5%; however, localized drainage directions vary. The average slope of the Rio Grande to Four Hills Bridge reach channel was estimated using a geographic information system (GIS) to be approximately 1.5%. The channel gradient is fairly consistent along the entire reach; however, it is slightly higher at the top of the reach (approximately 1.7%) than it is at the bottom of the reach (approximately 1.3%).

2.4 Climate

Large diurnal temperature ranges, summer monsoons, and frequent drying winds are characteristic of the Albuquerque Basin. Temperatures are typical of mid-latitude dry continental climates with summer high temperatures in the basin of approximately 90°F and winter high temperatures around 50°F. Daily low temperatures range from approximately 60°F in the summer to approximately 20°F in the winter. The dry continental climate also produces low average humidity in the late spring and summer prior to the onset of the monsoon season. Daytime relative humidity can be between 10% and 20% in the spring and early summer, with an average humidity near 30%. Winter relative humidity averages near 50%.

Site-specific meteorology is influenced by proximity to topographic features, such as mountains, canyons, and arroyos. These features influence local wind patterns across the site. Canyons and arroyos tend to channel or funnel wind, whereas mountains create an upslope—downslope diurnal pattern to wind flows. Winds tend to blow toward the mountains or up the Rio Grande Valley during the day, and nocturnal winds tend to blow down the mountain toward the Rio Grande Valley. These topographically induced wind flows can be enhanced or negated by weather systems that move across the southwestern United States. The strongest winds occur in the spring when monthly wind speeds average 10.3 mph. Wind gusts commonly reach 50 mph.

Precipitation varies across the area with many locations in the higher elevations of the mountains receiving annual rainfall twice that of locations in the Albuquerque Basin. Nearly all of SNL/NM west of the foothills is considered to be arid, receiving less than 10 inches of rain annually. Some remote test areas in the mountains and foothills may have annual rainfall in excess of 10 inches. Data collected at SNL/NM meteorological Tower A21 (located one-half mile from Tijeras Arroyo;

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see Figure 8) from 1994 to 2016 indicate an average annual rainfall of 8.61 inches. Approximately 61% (approximately 5.3 inches) of the average annual rainfall occurs during four months of the year: July, August, September, and October (Figure 8; also see Appendix C). Precipitation during these months is mainly in the form of brief, heavy monsoonal storm events. The winter season in the Albuquerque Basin is generally dry, with an average of less than two inches of precipitation falling between December and February.

Summer monsoonal storm cells generally develop over relatively small localized areas. It is common to receive substantial rainfall in part of the Tijeras Arroyo watershed and none at all in other parts of the watershed. Significant differences in rainfall can be observed in weather stations located less than 1 mile apart.

2.5 Ecoregions

Ecoregion data were obtained from the United States Forest Service (Griffith et al. 2006).

The mountainous eastern portion of the Tijeras Arroyo Watershed (Four Hills Bridge to headwaters reach) is located primarily within Level III Ecoregion 23, Arizona/New Mexico Mountains. Two Level IV ecoregions exist within the Arizona/New Mexico Mountains ecoregion: 23e, Conifer Woodlands and Savannas, and 23f, Rocky Mountain Conifer Forests.

The western portion of the Tijeras Arroyo Watershed, which includes the Rio Grande to Four Hills Bridge reach, is located primarily within Level III Ecoregion 22 (Arizona/New Mexico Plateau). The Arizona/New Mexico Plateau is comprised of two Level IV ecoregions: 22m, Albuquerque Basin, and 22g, Rio Grande Floodplain. The boundaries of these ecoregions are depicted in Figure 9, and additional detail is provided in Appendix D.

The Arizona/New Mexico Plateau Ecoregion (22) represents a large transitional region between the drier shrublands and wooded higher relief tablelands of the Colorado Plateaus (20) in the north; the lower, hotter, less-vegetated Mojave Basin and Range (14) in the west; and forested mountain ecoregions that border the region on the northeast (21) and south (23). Local relief in the region varies from a few feet on plains and mesa tops to well over 1,000 ft along tableland side slopes. The Continental Divide splits the region, but it is not a prominent topographic feature. The region extends across northern Arizona, northwestern New Mexico, and into Colorado in the San Luis Valley. Gunnison Prairie Dogs are a keystone species in many of the sagebrush ecosystems, and their burrows provide habitat for other wildlife including burrowing owls, weasels, badgers, and a variety of snakes.

The Albuquerque Basin (22m) is lower in elevation, drier, and warmer than surrounding Level IV ecoregions to the north, east, and west. Extending from the La Bajada Escarpment on the north to near Socorro in the south, the region contains some diverse features and transitional characteristics. Unlike most of Ecoregion 22, which has mesic soils, 22m has a largely thermic soil temperature regime with a mix of sand scrub and desert grassland vegetation. Native vegetation includes black grama, sand dropseed, mesa dropseed, blue grama, galleta, sand sage, alkali sacaton, threeawns, and scattered yucca. Juniper occurs primarily in the north. Urban and suburban land uses are spreading.

The portion of Tijeras Arroyo that is within the Rio Grande Floodplain ecoregion (22g) has been channelized and lined with concrete for flood control and stabilization.

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2.6 Soils

Soil maps were obtained from the National Resources Conservation Service National Cooperative Soil Survey Web Soil Survey (USDA 1977) (Figure 10). Detailed descriptions of the most prominent units are provided in Appendix E. Essentially all the active channel in the Rio Grande to Four Hills Bridge reach and much of the floodplain are comprised of Gila fine sandy loam. Gila fine sandy loam is classified under the hydrologic soil group B, which is sandy loam soils with moderately fine to moderately coarse textures. The National Cooperative Soil Survey describes Gila fine sandy loam as being derived from igneous and sedimentary rock, occurring in alluvial fans and flood plains (Appendix E). The typical profile consists of 0–7 inches of fine sandy loam, underlain by stratified gravelly loam to silt loam from 7–60 inches bgs. It is well drained, has a runoff classification of low, and the available water storage within its profile is about 10.5 inches. The most restrictive (slowest) transmitting layer is classified as moderately high to highly permeable with a hydraulic conductivity of 0.60 to 2.00 inches per hour. The physical characteristics of the Gila fine sandy loam promote rapid downward infiltration of surface water.

A number of additional soil series are present in upland areas immediately surrounding the Tijeras Arroyo floodplain; some of the more prevalent are the Bluepoint, Embudo, Latene, Madurez, Tijeras, and Wink (Figure 10). These soils are similar in composition and structure to the Gila fine sandy loam; all are classified as B group soils under the hydrologic soil grouping scheme. With little exception, the soils in and around the Tijeras Arroyo promote rapid infiltration, which decreases runoff and thus flow to and within the stream channel.

2.7 Groundwater Conditions

There are three distinct hydrogeologic zones within the Tijeras Arroyo Watershed: (1) the fractured bedrock system of the foothills and mountains, (2) the Tijeras Fault Complex, and (3) the Albuquerque Basin (Figure 5).

The predominant direction of groundwater flow is from east to west. The Tijeras Fault Complex is a transition zone that separates the fractured bedrock system on the east from the Albuquerque Basin on the west (Figure 5). East of the Tijeras Fault Complex, the hydrogeology is characterized by fractured and faulted bedrock with depths to groundwater ranging from 45 to 325 ft bgs. On the west side of the Tijeras Fault Complex, the hydrogeology is characterized by unconsolidated sediments of the Santa Fe Group with depths to groundwater ranging from approximately 200 to 570 ft bgs (Figure 11a and Figure 11b; Appendix F). The Albuquerque Basin contains a substantial regional aquifer that provides potable water to the Albuquerque metropolitan area. A small perched groundwater system related to anthropogenic activity has also been identified.

2.7.1 Fractured Bedrock Aquifer

Groundwater in the fractured-bedrock system generally flows west out of the canyons toward the Tijeras Fault Complex. The groundwater gradient is relatively steep, 0.03 feet per foot (feet of vertical change per foot of horizontal distance). Across the Tijeras Fault Complex the change in the groundwater elevation is 350 feet; the steep gradient suggests that westward groundwater flow is retarded by the Tijeras Fault Complex. The hydrogeology in this area is poorly understood due to the complex geology created by the fault systems. On the east side of the Tijeras Fault Complex, depth to groundwater ranges from about 45 to 325 ft bgs. Most non-potable water supply and

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monitoring wells east of the faults are completed in fractured bedrock at relatively shallow depths and produce modest yields of groundwater.

2.7.2 Albuquerque Basin Aquifer

West of the Tijeras Fault Complex, within the sediments of the Albuquerque Basin, the Regional Aquifer lies at approximately 500 ft bgs. Within the Regional Aquifer, the gradient is relatively low, averaging about 0.005 feet per foot. The historic direction of regional groundwater flow within the basin was westward from the mountains toward the Rio Grande. Due to groundwater pumping at KAFB, Veterans Administration, and Albuquerque Bernalillo County Water Utility Authority production wells, a depression in the Regional Aquifer has been created originating at the well fields near the northwest corner of KAFB. The impact of the seasonal variation in water production by both KAFB and Albuquerque Bernalillo County Water Utility Authority wells can be observed as minor fluctuations in the groundwater elevations of some SNL/NM and KAFB monitoring wells as far to the southeast as Technical Area III. Pumping and associated decreased groundwater levels have had no effect of surface flows in the Tijeras Arroyo, as there are hundreds of feet separating the stream channel from the shallowest groundwater.

2.7.3 Perched Groundwater System

A diminishing Perched Groundwater System lies above the Regional Aquifer in a portion of northern KAFB (Figure 6). The Perched Groundwater System flows from west to east (opposite of the regional groundwater flow direction), from roughly the eastern extent of the KAFB airfield to the KAFB golf course. It extends north to approximately Southern Boulevard and south to Tijeras Arroyo. The perching layer is discontinuous in the vicinity of the golf course, where perched water drains to the regional aquifer. Depth to water in the perched zone averages 300 ft bgs. Possible recharge sources for the Perched Groundwater System are the Tijeras Arroyo, golf course irrigation, landscape watering, water leakage from utility distribution lines, former septic system discharges, and infiltration from a former unlined KAFB wastewater treatment lagoon system (SNL/NM 1998). Water table elevations in the perched zone have been decreasing over the past 20 years, with trends suggesting that complete dewatering of the perched zone may occur sometime near 2040.

2.7.4 Groundwater-Surface Water Interaction

The depth to first groundwater (perched zone) beneath the Tijeras Arroyo channel is approximately 200 ft bgs. Where the Perched Groundwater System is not present, the depth to first groundwater is as much as 500 feet bgs. Due to the substantial distance from ground surface to the water table, groundwater does not contribute to flow in the Rio Grande to Four Hills Bridge reach.

Groundwater recharge to the Albuquerque Basin occurs primarily along the eastern mountain front and along the major arroyos (SNL/NM 1998). The amount of recharge occurring in the foothills and canyons is not well characterized. Recharge for the portion of Tijeras Arroyo on KAFB was estimated to be approximately 2.2 million CF/yr (50 AF/yr) (SNL/NM 1998). The same study estimated the groundwater recharge associated with Arroyo del Coyote to be about 0.4 million CF/yr (9.2 AF/yr). This recharge occurs exclusively during storm (precipitation) runoff events.

The Rio Grande to Four Hills Bridge reach is a losing stream; surface water infiltrates through the channel bottom and percolates downward to the water table. There is no evidence to suggest that the water table historically intersected ground surface or otherwise promoted flow within the

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Arroyo. To illustrate the historically deep water table, representative hydrographs from along the Rio Grande to Four Hills Bridge reach are provided in Appendix F.

2.8 Surface Water Conditions

The Rio Grande is the major surface hydrologic feature in central New Mexico. The Rio Grande originates in the San Juan Mountains of Colorado and terminates at the Gulf of Mexico, near Brownsville, Texas. The Rio Grande has a total length of 1,760 miles and is the third-longest river system in North America.

Tijeras Arroyo discharges to the Rio Grande (Figure 2) and drains the Tijeras Arroyo Watershed (Section 2.1). The only significant tributary to the Tijeras Arroyo is the Arroyo del Coyote, which intersects Tijeras Arroyo at the top of the Lower Tijeras Arroyo Sub-watershed (Figure 3). Both Tijeras Arroyo and Arroyo del Coyote carry significant runoff after heavy thunderstorms that usually occur from June through August. The Tijeras Arroyo, above the confluence with Arroyo del Coyote, drains about 80 sq mi, while Arroyo del Coyote drains about 39 sq mi (USACE 1979). The total watershed for Tijeras Arroyo is approximately 132 sq mi.

The Tijeras Arroyo channel is relatively narrow and steep in the upper and middle watersheds, but it flattens and widens as it leaves the igneous and metamorphic terrain and enters the poorly consolidated sediments that comprise the Albuquerque Basin. This change in channel morphology and bed material results in a significant increase in infiltration potential. While portions of the upper and middle Tijeras Arroyo have been observed to support flow throughout the year, flow within the lower watershed occurs only for brief periods in response to rainfall and snowmelt.

Several springs on KAFB are associated with the uplifts in the Tijeras Fault Complex and in the Foothills and Canyons hydrogeologic areas (Figure 12): (1) Coyote Springs, Cattail Springs, and G Spring within Arroyo del Coyote, (2) Burn Site Spring in Lurance Canyon, and (3) Sol se Mete Spring within the Manzanita Mountains. Hubbell Spring (a perennial spring) is located just south of KAFB on Isleta Pueblo. Coyote Springs and Sol se Mete are perennial springs (continuously flowing), while the others are ephemeral springs. When flowing, the springs produce surface flows that only last for a short distance, on the order of tens or perhaps hundreds of feet. The springs do not contribute flow to the Tijeras Arroyo.

2.8.1 Flow Gaging

Flow data are available from only one flow gage within the reach—the United States Geologic Survey (USGS) Station 08330600 in Tijeras Arroyo near Albuquerque (Figure 12). The station has a nearly 37-year period of record spanning from September 1982 to the present (May 1, 2019, for this report). Data since October 1, 2017, are provisional, and there are a number of periods prior to that where data does not exist or has not been approved for publication. Most of the days with missing data occurred during the winter months when flow is less likely to occur. Out of the 13,353 days since the period of record began, there are 9,933 days of flow data approved for publication. The following description of flow frequency is based on those 9,933 days. The complete data set used for the analysis in this report is provided in Appendix G.

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Over the period of record, the average number of days per year in which flow at the gage was measured above zero is 37.7 (10.3% of days). The breakdown by month is provided in Table 2. The number of days in each month with measurable flow is depicted graphically in Figure 13.

As can be seen, the months with the highest flow frequency are the summer monsoonal months of July and August. During these months, flow occurs on approximately six days per month. During the remainder of the year, flows occur during roughly two to three days of each month. Occasional large releases from broken water mains, well development, hydrant flushing, or other anthropogenic activities may occur; however, runoff from precipitation is by far the largest contributor of flow to the arroyo. Due to the spatial and temporal variability in rainfall that occurs in Albuquerque, correlations between individual flow and precipitation events for specific days and monitoring stations are difficult to establish. However, comparison of monthly averages, which help smooth out the random spatial distribution of monsoonal storm cells, shows a strong correlation between the number of monthly precipitation events and the number of flow events (Figure 14). Figure 14 illustrates that flow frequency increases linearly with precipitation frequency, indicating that flow is closely tied to precipitation.

The frequency of flow measured at the USGS gage is higher than expected by NTESS staff who work near and see the Tijeras Arroyo daily. The general consensus of these NTESS staff is that flow is observable within Tijeras Arroyo near the Pennsylvania Bridge on approximately 10 days per year, however, there are no data available to support this observation. It is possible that flows occur more frequently at the gage than they do in the vicinity of SNL/NM; that portion of the arroyo is lined with concrete and there are considerable urbanized areas in that general vicinity.

The only NPDES-permitted discharges to the Tijeras Arroyo within the Rio Grande to Four Hills Bridge reach are various stormwater discharges from SNL/NM, KAFB, the City of Albuquerque, and Bernalillo County. Coverage under the NPDES Municipal Separate Storm Sewer System Permit allows these entities to divert stormwater to the Tijeras Arroyo. Stormwater discharges occur in response to direct rainfall and snowmelt; storm drains do not sustain flows beyond a brief period following a storm event. Stormwater outfalls to Tijeras Arroyo that were identified during this investigation are shown in Figure 12; there may be some relatively small outfalls that were not identified.

There are no other NPDES discharges to the reach, including from industrial sites, construction sites, or wastewater reclamation facilities.

2.9 Stream Modifications

Appendix H contains aerial photographs of the Rio Grande to Four Hills Bridge reach from six different years: 1935, 1951, 1959, 1982, 2002, and 2018. The 1935 photos are not used for close-up views of individual sub-reaches because the resolution was too low, however, the 1935 photo for the entire reach is useful for general comparison.

There has been substantial development adjacent to Tijeras Arroyo since 1935; the largest impacts have been residential housing construction in sub-reaches 7 and 8 and the expansion of facilities within KAFB and the City of Albuquerque Sunport near reaches 5 and 6. Numerous stream channel and bank modifications have been implemented or indirectly caused over the last approximately 75

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years. Most of these changes have been erosion control projects, primarily for stabilizing the banks and channel. The following list describes the more notable modifications. The locations of each modification is shown in Figure 15, with numbers in the figure corresponding to numbers in the list.

Reach 8

1. Four Hills Road bridge crossing
2. concrete drop structure immediately downstream of Four Hills Bridge
3. loose concrete rip-rap bank on both sides of the channel for most of the sub-reach
4. concrete bank on the south side of the channel

Reach 7

5. bridge/road crossing and associated channel
6. encroachment on the north side of the channel from landfill
7. concrete bank on the south side of the channel

Reach 6

8. concrete road crossing and low-flow diversion beneath the road
9. dirt road crossing

Reach 5

10. bridge and associated channel
11. encroachment on the north side of channel from landfill
12. concrete drop structure

Reach 4

13. bridge
14. Stabilized channel for bank and structure protection

Reach 3

15. concrete drop structure
16. concrete drop structure

Reach 2

17. grading to stabilize the bank layback
18. Paved road crossing
19. bridge and associated channel

Reach 1

20. I-25 bridge and associated channel stabilization
21. sediment detention basins
22. concrete lined channel

Although changes in the channel resulting from anthropogenic activities have occurred, there is no indication that they have diverted, retained, or otherwise decreased the frequency or magnitude of flows in the arroyo. There is no indication from aerial photographs of uses of surface water that no longer exist. Stormwater flow within the arroyo is likely to be greater today than it was under

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predevelopment conditions due to the increased area of impermeable surfaces (e.g., buildings, roads, and parking lots) that drain to the arroyo.

3. Hydrology Protocol Stream Surveys

Hydrology Protocol stream surveys are guided by questions about the hydrological, geomorphic, and biological indicators of the persistence of water (Appendix B). A numeric scoring system enables ranking of aquatic life and human contact characteristics of the water body and provides an indication of whether the water is intermittent or perennial. The Hydrology Protocol is organized into Level 1 and Level 2 evaluations. The Level 1 evaluation consists of 14 indicators (1.1 through 1.14). The Hydrology Protocol instructs the user that a total score of two or less on indicators 1.1 through 1.6 means "the stream is ephemeral; you may stop the evaluation at this point." Regardless of the score obtained for indicators 1.1 through 1.6, indicators 1.7 through 1.14 were also evaluated to provide the most thorough evaluation possible for this UAA.

Level 2 evaluations can be conducted for cases deemed "borderline" based on Level 1 results. Level 2 evaluations were not conducted during this UAA.

Hydrology Protocol field surveys were conducted June 17–28, 2019, during a period of no rainfall. Above-average rainfall was received during the preceding months. The Standard Precipitation Index (SPI) for New Mexico region 5 (central valley regions) at the end of May 2019 was 0.65 (https://www.ncdc.noaa.gov/monitoring-content/temp-and precip/drought/nadm/indices/spi/data/12mon-spi-us.txt). The Hydrology Protocol requires the 12-month SPI to be above −1.5 to conduct field surveys; the SPI can range from −3 to 3. A period of average precipitation would have an SPI of 0. The SPI, calculated using precipitation data from SNL/NM meteorological Tower A21, was 1.5 at the end of May 2019; this suggests wet conditions in the immediate vicinity of Tijeras Arroyo. Regardless of whether regional or local precipitation data is used, the SPI was above average and well above the −1.5 threshold for conducting field surveys. Additional information regarding the SPI is provided in Appendix C.

Hydrology Protocol field surveys were conducted by SNL/NM personnel; a geologist, a biologist, a surveyor team, and at least two support staff were present for all surveys. Staff from the NMED Oversight Bureau were also present during surveys; they provided technical assistance and served in an advisory capacity in accordance with their contract to DOE to provide assistance and oversight of environmental work at SNL/NM. The NMED DOE Oversight Bureau did not function in an official regulatory capacity; jurisdiction over the UAA falls under the NMED Surface Water Quality Bureau (SWQB).

SWQB representatives were present during surveys at four of the sub-reaches (sub-reaches 2, 3, 7, and 8) to observe the work conducted by SNL/NM personnel. In some instances, SNL/NM personnel discussed field observations and the appropriate application of Hydrology Protocol indicator scores with the NMED DOE Oversight Bureau and SWQB representatives; however, SNL/NM personnel determined the scores assigned and presented in this UAA and they may not necessarily reflect the views of NMED. Neither NMED DOE Oversight Bureau nor SWQB staff conducted the work presented in this report.

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To ensure adequate characterization of the entire Rio Grande to Four Hills Bridge reach, the reach was divided into eight sub-reaches (Figure 16). Each sub-reach is approximately one-mile long. The Hydrology Protocol was applied to seven of the eight sub-reaches (sub-reaches 2–8). Sub-reach 1 has been completely engineered and/or concrete lined for flood control purposes, and application of the Hydrology Protocol would not render meaningful results.

The Hydrology Protocol requires that field surveys consider a length of channel equal to at least 40 times the width of the channel. The typical channel width of the Tijeras Arroyo is about 50 ft; therefore, the Hydrology Protocol field surveys considered typical conditions over a 2,000-ft length of each sub-reach. Sections 3.1 through 3.14 present observations and results for each of the Level 1 indicators (1–14). Sub-reach specific observations and Hydrology Protocol scores for each of the sub-reaches are provided in Section 4 and on Hydrology Protocol field sheets in Appendix I.

3.1 Water in Channel

Water in the Tijeras Arroyo channel was not encountered in any of the sub-reaches. There was no flowing or standing water, and no areas appeared to contain water for extended periods. Tijeras Arroyo was completely dry, and there were no saturated or wet sediments to suggest that water had been in the arroyo within the recent past.

3.2 Fish

There were no fish, or evidence of fish, observed in any of the sub-reaches.

3.3 Benthic Macroinvertebrates

A single macroinvertebrate larval casing was found beneath a rock in sub-reach 6. No living organism was found. The species associated with the casing was not identified.

There was no other evidence of benthic macroinvertebrates encountered in any of the sub-reaches. Although the one exception was observed, it does not appear that the Tijeras Arroyo supports benthic macroinvertebrate life.

3.4 Filamentous Algae/Periphyton

There was no evidence of filamentous algae or periphyton encountered in any of the sub-reaches. Algae can be an indicator of the persistent presence of water and of an established aquatic ecosystem.

3.5 Differences in Vegetation

The types of vegetation within and immediately adjacent to the Tijeras Arroyo channel are the same as those found in adjacent upland areas. The streambanks are lined with shrubs, primarily rabbitbrush (*Ericameria nauseosus*), four-wing saltbush (*Atriplex canescens*), and snakeweed (*Gutierrezia sarothrae*). Where present, the trees found along the stream banks include Siberian elms (*Ulmus pumila*), Fremont cottonwoods (*Populus fremontii*), tamarisk (*Tamarix chinensis*), tree-of-heaven (*Ailanthus altissima*), and desert willow (*Chilopsis linearis*). Upland native bunchgrasses such as galleta (*Pleuraphis jamesii*) and sand dropseed (*Sporobolus cryptandrus*), as well as weedy species such as Russian

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thistle (*Salsola kali*) were also present in varied abundance along the streambanks. The vegetation observed in the adjacent upland areas includes the same shrubs, bunchgrasses, and weedy species as the streambanks with an occasional elm or desert willow tree.

In a number of locations along the reach, vegetation was observed to be denser along the banks of the arroyo than in the adjacent upland areas; this is particularly the case in the immediate vicinity of stormwater outfalls. These denser stands of vegetation are attributed to the greater availability of water from surface flows, but they are comprised of upland plants similar to those found elsewhere along and near the arroyo and are not indicative of riparian conditions.

The occurrence of obligate riparian/wetland plants, facultative riparian plants, and upland plant species in the southwestern United States is complex. Obligate wetland species (commonly called phreatophytes) are found almost exclusively in wetlands. Facultative riparian species are commonly found in both terrestrial upland and riparian areas. Upland species are rarely found in wetlands. However, a significant problem with this classification in the southwest is that species commonly found in uplands at high elevations are also found in riparian areas at lower elevations (McLaughlin, 2004). The cottonwood and tamarisk trees are the only facultative riparian species observed along the reach. No obligate riparian vegetation was observed within the reach.

Although there is no universally accepted definition of what a riparian area is, the following discussion by NMSU ACES professor Dr. Terrell Baker describes the factors that determine the stream classification based on the composition of vegetation (https://aces.nmsu.edu/riparian/whtriparea.html):

> *As a rule, only perennial and intermittent streams can support riparian areas that serve the entire suite of riparian ecological functions. Ephemeral streams generally do not possess the hydrologic conditions that allow true riparian vegetation to grow. Although water flows down ephemeral streams periodically, the water table does not occur sufficiently close to the soil surface to allow water loving vegetation to access the greater quantity of water they need to grow. Vegetation growing along ephemeral watercourses may occur in greater densities or grow more vigorously than vegetation in the adjacent uplands, but generally there are no dramatic compositional differences between the two. Even along those ephemeral streams where vegetation composition differs somewhat from the adjacent uplands, that vegetation does not require as much soil moisture as true riparian plants.*

The vegetation characteristics encountered during HP surveys are consistent with the ephemeral stream conditions described in the passage above. Additional information for each sub-reach is provided in Section 4.

3.6 Absence of Rooted Upland Plants in Streambed

Upland plants were largely absent within the active streambed. Rooted upland plants are present throughout the floodplain and along the channel banks. The lack of rooted upland plants in the active channel appear to be due to a combination of:

- Strong seasonal flows (monsoonal) that prevent rooted upland plants from becoming established by removing seeds or damaging any young plants,

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- a channel composed of deep sand with extremely little to no visible organic material that prevents the establishment of rooted upland plants.

The conditions of this site are consistent with the following guidance provided in *Hydrology Protocol* (NMED 2011a):

> Additionally, in some situations (e.g., high gradient sand bedded streams located within flashy watersheds) highly erosive flows and/or depth of scour in response to extreme rainfall events may limit the presence of rooted vegetation. Under these circumstances the assessor may use professional judgement in selecting the appropriate scoring criteria, and should document on the *Field Sheet* and with photos those factors that explain any alternative scoring methodology.

Although there are few rooted plants of any kind in the active channel, any plants that do occur in the channel are the same species as occur in upland areas away from the channel. Therefore, low scores were assigned for this Level 1 indicator.

3.7 Sinuosity

Sinuosity for each reach was determined using GIS tools and aerial photography for both current (2018) and predevelopment (1935) conditions. The sinuosity for each sub-reach and the entire reach are shown in Table 3. Aerial photographs showing the predevelopment (1935) channel with the current (2018) channel location superimposed on them are provided in Appendix H-9.

For the most part, the sinuosity values observed are < 1.2, which the Hydrology Protocol considers a "weak" or low indicator of intermittent conditions; low sinuosity is characteristic of ephemeral systems. Sinuosity can be an indicator of the amount of energy within a stream; the more energy, the more sinuosity tends to increase. Typically, channels with infrequent flows are less sinuous because there is less flowing water (energy) that needs to be dissipated.

Comparison of predevelopment to current conditions shows there has been a small overall increase in sinuosity (0.05) since 1951. The sinuosity increased markedly in sub-reach 4, likely as a result of anthropogenic alterations made in sub-reach 5. The channel width and sinuosity in sub-reach 5 was decreased by channel stabilization work done adjacent to a landfill and in the vicinity of the Pennsylvania Street Bridge. This may have increased the velocity of flows and energy transferred into sub-reach 4, where an increase in sinuosity occurred in response.

Additional channel stabilization in sub-reaches 6 and 7 and additional stormwater inputs from urbanized areas may have contributed to the increased sinuosity in sub-reach 4 as well. In general, the changes that have occurred to the Rio Grande river channel do not indicate a dramatic shift in flow volume or frequency that might suggest significantly different conditions existed prior to the start of development starting about 1935.

3.8 Floodplain and Channel Dimensions

Floodplain and channel dimensions were determined using on-the-ground surveys conducted by licensed surveyors from the SNL/NM Facilities and Emergency Management organization. The

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field surveys were conducted using a Trimble R7 GNSS receiver at the base station, and a Trimble R8 GNSS receiver with a Trimble TSC-2 data recorder for the rover station. The survey work was conducted using Real Time Kinematic differential positioning, which yields horizontal accuracies in the ± 0.05 ft range and vertical accuracies in the ± 0.10 ft range.

Twelve surveys were conducted for this UAA. At least one channel survey was conducted for each sub-reach; additional channel surveys were conducted in sub-reaches that showed significant variation in channel width or bank structure. The thalwag and bank full elevations were used to determine each channel's maximum depth. The flood-prone area was then determined by surveying the bank or flood plain to a height of twice the maximum depth as described in the Hydrology Protocol guide (NMED 2011a). Survey locations are shown in Figure 16.

Table 4 summarizes results from the surveys. As can be seen in Table 4, the floodplain to channel ratio ranged from 1.05 to 5.94, with a median value of 1.25. The average value is 1.7, which is skewed high due to the atypical conditions encountered in sub-reach 6. Five of the transects had a ratio below 1.2, which the Hydrology Protocol describes as an incised channel with a disconnected floodplain. Six of the transects had a ratio between 1.2 and 2.5, which the Hydrology Protocol describes as a moderately confined channel with a floodplain active during only larger floods. One of the surveys determined a ratio of 5.94 (which was atypically high), indicating a wide active floodplain. This survey was conducted in a low gradient area where the floodplain was much wider than anywhere else in the sub-reach. The median ratio of 1.25 is described by the Hydrology Protocol as a moderately confined channel with a floodplain that is only active during larger floods. This description conforms to observations made in the field; an active floodplain was generally lacking, but very large floods could cause flows to leave the defined channel in some locations.

3.9 In-Channel Structure: Riffle-Pool Sequence

There was very little to no in-stream structure observed in the Tijeras Arroyo sub-reaches. Sub-reach 8, which had the steepest gradient of all the sub-reaches, showed bed structure that suggested riffle-pool sequences might occur when water is present. In the other sub-reaches, no bed structure was observed.

3.10 Particle Size and Stream Substrate Sorting

Particle size and stream substrate sorting were determined using a modified Wolman Pebble Count method called the Zig-Zag Method. The Zig-Zag Method is conducted by walking in a zigzag pattern across the channel from bank to bank, stopping at preselected intervals and picking up a single particle without looking at what is being picked up. The goal is to randomly collect a statistically significant number of particles that are representative of the channel. For this study, a seven-step collection interval was used to collect 100 particles from the channel and 50 particles from areas immediately adjacent to but outside the channel. A total of eight pebble count surveys were conducted, one survey in sub-reaches 2–8 plus one additional survey in sub-reach 5. Detailed maps of pebble count locations are included in Appendix J.

Summaries of results are provided in Table 5 and Table 6. Graphical representations of the data and detailed maps of pebble count locations are provided in Appendix J. In general, the substrate within the sub-reaches is comprised of fines (< 0.5 mm), sands (0.5–2 mm), and gravels (2–64 mm). Cobbles and boulders are limited. In-channel pebble counts determined 16% fines, 31% sand, and

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52% gravel, with the remaining 1% comprised of cobbles and boulders. Out-of-channel pebble counts determined 45% fines, 23% sand, 31% gravel, and 1% cobbles. The primary difference between in-channel and out-of-channel sediment is that there are more fines relative to sand and gravel out of the channel than in the channel. This is the result of finer materials within the channel being transported downstream during flood events. There was essentially no difference in cobble and boulder sized particles.

Within the channel, no substrate sorting was readily observed. Particle sizes within the thalwag, bars, and streambed were all similar. The banks below the bank-full stage level were generally comprised of finer materials than in the main channel, and they were similar to the composition of out-of-channel sediment. This is attributable to the lower-flow velocities that occur along the banks, resulting in less scouring of fines at peak flows and greater deposition as flows recede.

The Hydrology Protocol uses sediment sorting as an indicator of flow frequency. Sediment in the bed of ephemeral channels typically has the same or comparable texture to areas immediately adjacent to the channel, while intermittent and perennial channels more typically exhibit accumulations of larger particles. Generally, the differences that are assessed are the difference in large (cobble and boulder) sized particles as compared to smaller particles (fines, sand, and gravel). While there were differences in fines observed between in-channel and out-of-channel sediments, the non-fine component was similar for in-channel and out-of-channel surveys. The percentage of cobbles and boulders was 1% for both in-channel and out-of-channel surveys.

Relative to the overall range of particle size variation that might be observed, the difference between channel and out of channel sediment size distribution in the Rio Grande to Four Hills Bridge reach are very small. The similarity in distribution of larger particles (cobble and boulder) is more indicative of the flow frequency, duration, and magnitude associated with an ephemeral system than an intermittent system.

3.11 Hydric Soils

Hydric soils were not encountered within any of the sub-reaches.

According to the National Resources Conservation Service, a hydric soil is a soil that formed under conditions of saturation, flooding, or ponding that lasted long enough during the growing season to develop anaerobic conditions. The absence of hydric soils is an indicator that water is not present in Tijeras Arroyo for significant amounts of time.

3.12 Sediment on Plants and Debris

Minimal sediment was observed on plants and debris within the sub-reaches. High-flow events are known to carry sediment, in particular fine materials that are suspended in the water column. As flood waters recede, sediment is deposited on plants and debris. This is especially true in desert environments with a large amount of unconsolidated sediment with little vegetation to stabilize ground surface. The fact that relatively little sediment was observed on plants and debris is likely a reflection of the relatively infrequent flows that occur in the Tijeras Arroyo.

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3.13 Seeps and Springs

No seeps or springs were encountered within any of the sub-reaches. The closest seeps or springs to the sub-reaches are discussed in Section 3.8 and shown in Figure 12. The absence of seeps and springs near the arroyo is due to the deep occurrence of groundwater and the unconsolidated sediments that comprise the Albuquerque Basin. All the springs that occur within the Tijeras Arroyo Watershed (Figure 12) flow from fractures in bedrock within or to the east of the Sandia Fault that forms the boundary between the mountain and basin geology.

None of the flow emanating from the springs reaches the Rio Grande to Four Hills Bridge reach of Tijeras Arroyo.

3.14 Iron Oxidizing Bacteria/Fungi

There was no evidence of iron-oxidizing bacteria or fungi encountered within any of the sub-reaches. Iron-oxidizing bacteria and fungi are often associated with the presence of groundwater, and their presence can be an indicator that flow in the channel is at least partially attributable to groundwater. There was no evidence of groundwater contributing to flow in the channel observed during field surveys.

4. Sub-reach Specific Observations

In general, conditions encountered throughout the Rio Grande to Four Hills Bridge reach did not vary substantially from one sub-reach to another; the overall climate, vegetation, streambed substrate, channel structure, presence of flow and aquatic life, and other indicators of flow regime were consistent. Observations and information specific to each of the sub-reaches, including scores for the Hydrology Protocol field surveys, are presented in the following section. The Hydrology Protocol scores ranged from 5.5 to 8.5 for all sub-reaches, with an average score of 7.0. Hydrology Protocol results are summarized in Table 7.

4.1 Sub-reach 1

Sub-reach 1 flows from the I-25 bridge to the Rio Grande. Immediately below I-25, there is a large (approximately 40 acres) sediment detention basin. The detention basin discharges into a concrete-lined storm drainage channel owned by Albuquerque Metro Area Flood Control Authority, and it flows the rest of the way to the Rio Grande. Sub-reach 1 is entirely engineered and modified for flood control and conveyance purposes.

Hydrology Protocol surveys were not conducted in sub-reach 1 because it is not applicable to a highly modified channel that includes concrete lining and flood control facilities.

4.2 Sub-reach 2

The downstream extent of sub-reach 2 is at the I-25 overpass, where Tijeras Arroyo enters a sediment retention basin operated by the Albuquerque Metro Area Flood Control Authority. The upstream extent of sub-reach 2 occurs at Ira Sprecker Road. The channel and a small overbank flood-prone area in this sub-reach are deeply incised and constrained by terrace walls ranging from approximately 8 to 15 ft high.

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A substantial amount of illegal dumping occurs in the lower part of the sub-reach, which is easily accessible to vehicles from dirt roads adjacent to the arroyo. Tire tracks in the channel are abundant. The Ira Sprecker Road crossing at the top of the sub-reach was the only major channel modification observed.

In several locations, the remnants of an old 42-inch diameter concrete sanitary sewer was observed where bank erosion has exposed and collapsed the line. The sewer line belongs to the City of Albuquerque and runs adjacent to the arroyo from sub-reach 1 all the way to the city's Wastewater Reclamation Plant adjacent to the Rio Grande. Following the erosion and collapse of the old sewer line in the late-1990s, a new line was installed further from the terrace walls.

There is one large inflow to sub-reach 2, which is located near the middle of the sub-reach and conveys stormwater from the Albuquerque Sunport (City of Albuquerque).

Hydrology Protocol surveys resulted in a Level 1 score of 5.5 for sub-reach 2.

4.3 Sub-reach 3

Sub-reach 3 extends upstream from Ira Sprecker Road to the western boundary of KAFB. Sub-reach 3 is similar to sub-reach 2; it is easily accessed by vehicles and shows signs of substantial vehicle traffic in the channel as well as illegal dumping. Collapsed sections of the old sanitary sewer line are also evident. The channel is deeply incised and well constrained within this reach, with approximately 10–20 ft terrace walls on either side.

At the KAFB boundary, an old concrete drop structure has been damaged by erosion on the downstream side. A second damaged concrete drop structure is located approximately 600 ft downstream from the KAFB boundary.

Based on historical photographs, an area adjacent to sub-reach 3 was planted with crops during the late 1960s; planted fields are visible in a 1982 aerial photo, but the crops were gone by 2002. Irrigation water appears to have been stored in uncovered reservoirs; there are no indications that the water in the reservoirs was obtained from surface water diversions.

Hydrology Protocol surveys resulted in a Level 1 score of 5.5 for sub-reach 3.

4.4 Sub-reach 4

Sub-reach 4 extends upstream from the western boundary of KAFB to the Munitions Haul Road Bridge crossing. There is no public access to sub-reach 4, and there was no indication of vehicular traffic, recreational use, or illegal dumping in the channel. Similar to sub-reaches 2 and 3, this sub-reach is deeply incised, with a well-defined channel constrained by terrace walls on both sides that are approximately 10–15 ft high.

Aside from the damaged drop structure at the bottom of the sub-reach and the bridge at the top of the sub-reach, there are no stream modifications in this sub-reach. There is one inflow, which is located near the bottom of the sub-reach and conveys runoff from areas of KAFB and the Albuquerque Sunport (City of Albuquerque).

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The sinuosity of sub-reach 4 is the highest of all the sub-reaches. This is due to a combination of natural and anthropogenic influences. The stream channel gradient in this sub-reach decreases relative to the gradient in upstream sub-reaches, and the channel has historically been more sinuous because of this. However, the sinuosity has increased since predevelopment times, likely in response to straightening and stabilizing the channel upstream.

Hydrology Protocol surveys resulted in a Level 1 score of 8.0 for sub-reach 4, the highest of any sub-reach. The score is above average due to the sinuosity, substrate sorting, and channel dimensions.

4.5 Sub-reach 5

Sub-reach 5 extends from the Munitions Haul Road Bridge to the Pennsylvania Road Bridge. This sub-reach contains significant channel modifications, including two drop structures, a section of straightened channel, and armoring along portions of the bank adjacent to a historic construction material landfill. As discussed in Section 3.7, it is suspected that straightening and stabilizing the channel in portions of this sub-reach enhanced downstream erosion and sinuosity in sub-reaches 3 and 4.

This sub-reach receives stormwater from two large outfalls, one from KAFB and the other from SNL/NM. It also receives inflow from the Arroyo del Coyote. Because of this sub-reach's proximity to restricted access areas on KAFB, surveys were conducted at the lower and upper portions of the sub-reach and not within the middle section.

Sub-reach 5 marks a transition zone in the channel and floodplain structure of Tijeras Arroyo. The top of the sub-reach is markedly less constrained and incised than the bottom of the sub-reach and the downstream sub-reaches. From the top of sub-reach 5 to the top of sub-reach 8, there are in general no steep terrace walls immediately adjacent to the channel. The channel is wider and less constrained within a broader floodplain than other sub-reaches, and the bank is characterized by a berm that is on the order of several feet high, which can be overtopped by very large flood events. There are exceptions to this general trend, including areas where a terrace wall flanks one side of the channel, but in general, the stream channel is less constrained upstream of sub-reach 5 than it is downstream.

Hydrology Protocol surveys resulted in a Level 1 score of 6.0 for sub-reach 5.

4.6 Sub-reach 6

Sub-reach 6 extends form the Pennsylvania Road Bridge to the KAFB boundary. This sub-reach contains significant channel modification in the vicinity of the Pennsylvania Bridge; in particular, the channel and surrounding area have been rerouted and stabilized to direct flows beneath the center of the bridge. In addition, there are two road crossings upstream of the bridge, one dirt and the other paved.

Evidence of benthic macroinvertebrates was found in this reach (the only benthic macroinvertebrate evidence encountered in any reach). A single larval casing was found under a rock in the thalwag along a cutback located on the outside of a sharp bend where scouring has occurred. There is also a stand of trees along this bend, indicating the likeliness of more water than is present elsewhere along

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the channel. The scoured area likely holds water that ponds up to 24 inches deep following flow events. During the field survey, there were no water, hydric soils, or other indicators of the persistence of water at that location.

This reach had visibly more large-sized boulders in the stream channel than sub-reaches 2–5. This may be partially related to the substantial earthwork that has been done in and around the channel over the past 75 years; however, it may also be caused by several natural conditions, including closer proximity to the mountains, the channel and surrounding areas' steeper gradient, and the likeliness of more frequent large flows closer to the mountains.

There is one significant inflow to this reach: a City of Albuquerque stormwater outfall discharges water from an area along south Eubank Road.

Hydrology Protocol surveys resulted in a Level 1 score of 4.0 for sub-reach 6, the lowest of all sub-reaches. The below-average score is a factor of low sinuosity and the floodplain and channel dimensions.

4.7 Sub-reach 7

Sub-reach 7 extends from the KAFB boundary to the Juan Tabo Bridge. It has the most stream modification of all the sub-reaches. There is substantial bank stabilization and a diminished floodplain related to historic landfills and residential construction. Ongoing construction is further diminishing the floodplain's size by channeling and stabilizing the main channel.

Although the floodplain has been encroached upon in this sub-reach, there are areas of braided channel and a much wider active floodplain than exists elsewhere in Tijeras Arroyo. In particular, the area immediately downstream of the Juan Tabo Bridge has numerous channels with no single dominant channel (flow moves from one channel to the other frequently). This area of braided channels exists for approximately 0.75 miles below the Juan Tabo Bridge and for a short distance upstream in sub-reach 8.

There are two inflows to this sub-reach; both are City of Albuquerque stormwater outfalls located near the top of the sub-reach.

Hydrology Protocol surveys resulted in a Level 1 score of 7.0 for sub-reach 7. The above-average score is a factor of the floodplain and channel dimensions related to the braided channels and broad floodplain near the top of the reach.

4.8 Sub-reach 8

Sub-reach 8 extends from the Juan Tabo Bridge to the Four Hills Bridge. There are several stream modifications, including the use of construction debris to stabilize the banks along the upper part of the sub-reach. Toward the bottom of the sub-reach, residential construction has encroached on the floodplain, and concrete walls (or sloped banks) exist on the south side of the channel.

Similar to sub-reach 7, the bottom of the sub-reach has a braided channel with a relatively wide active floodplain. The channel becomes narrower in the upstream direction and is constrained between banks that are between 1 and 3 ft high. The channel exhibits more structure in sub-reach 8

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than in other reaches, which is likely a function of a steeper gradient and more frequent flows due to its proximity to the mountains and bedrock hydrologic zone. The Sandia Fault, which marks the boundary between the bedrock and basin fill materials, runs perpendicular across the channel near the top of sub-reach 8. As discussed in sections 2.2 and 2.7, this geologic change is a primary control on surface flows in Tijeras Arroyo; the basin fill promotes rapid infiltration relative to the bedrock, thus decreasing the channel's ability to sustain flows except during heavy rainfall events.

There are two substantial inflows to this reach, both stormwater discharges. One is located near the bottom of the sub-reach and the other is located at the top of the sub-reach. In both cases, there is more vigorous growth of vegetation in the immediate vicinity of the outfalls; however, the composition of the vegetation is similar to that in the rest of the sub-reaches and is not characteristic of a riparian plant community.

At the bottom of sub-reach 8, a stormwater drain emanates from a residential community that has been recently constructed. A steady flow of approximately 0.25 gallons per minute is emanating from the storm drain. This steady source of flow has caused a persistent flow of water along the margin of the floodplain for approximately 300 ft in the downstream direction. In the immediate vicinity of this flow, more vigorous vegetation has established. The flow does not reach the main channel of the Tijeras Arroyo.

Hydrology Protocol surveys resulted in a Level 1 score of 6.5 for sub-reach 8.

5. Summary Analysis

Based on the information presented in this UAA, the Rio Grande to Four Hills Bridge reach of Tijeras Arroyo (AU NM-9000.A_070) exhibits characteristics of an ephemeral water body. This conclusion is supported by historic and existing hydrologic, geomorphic, and ecologic indicators of flow as presented in this report. This conclusion is also supported by results of field surveys using the NMED Hydrology Protocol method for differentiating ephemeral and intermittent water bodies based on the designated uses supported by a water.

Geology is the primary factor that causes the Rio Grande to Four Hills Bridge reach of Tijeras Arroyo to be ephemeral. The thick sequence of unconsolidated sediment in the Albuquerque Basin and the deep water table promote rapid infiltration of surface water, depleting any base flows that might originate from the shallow bedrock water table located upstream. While perennial flow occurs upstream in the Four Hills Bridge to headwaters reach, these flows infiltrate a short distance beyond the boundary between bedrock and basin fill.

Aside from occasional allowable non-stormwater discharges from municipal activities (such as water main breaks or fire hydrant testing), the only flows that occur in the Rio Grande to Four Hills Bridge reach are the result of localized storm events. No other permitted discharges occur to the reach (NPDES or otherwise). The historic record from a USGS flow gage near the bottom of the reach indicates that flow is detected above 0 CFS on 5–25% of the days in a month, depending upon the time of year (Figure 13). Average daily flow above 1 cfs occurs between 2 and 15% of days, and average daily flow above 10 cfs occurs on 0–5% of days. There is a strong correlation between the number of flow events and the number of rain events that occur during each month of the year (Figure 14). Most flow occurs during the summer monsoon season. Based on near daily

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observations of the Tijeras Arroyo made by NTESS staff during their regular work duties, it is suspected that flows occur more frequently at the USGS gage near the bottom of the reach than they do at upstream locations (there are no data to support this observation).

The hydrogeologic and stream flow conditions described in this UAA *do not* meet the following definition of intermittent listed in 20.6.4.7 NMAC: "the water body contains water for extended periods only at certain times of the year, such as when it receives seasonal flow from springs or melting snow". The hydrogeologic and stream flow conditions described in this UAA *do* meet the following definition of ephemeral listed in 20.6.4.7 NMAC: "the water body contains water briefly only in direct response to precipitation; its bed is always above the water table of the adjacent region".

Vegetation within and adjacent to the reach is similar in composition to upland vegetation outside the active floodplain. No riparian zones were encountered. The density of vegetation near large stormwater outfalls was somewhat greater due to the increased presence of water; however, these areas were not riparian. The vegetation was characteristic of ephemeral conditions.

Water, fish, macroinvertebrates, algae, hydric soils, seeps, springs, and iron oxidizing bacteria were not found anywhere in the reach. Geomorphic characteristics of the reach—including channel structure, substrate sorting, floodplain dimensions, and sinuosity—were all indicative of ephemeral characteristics.

Hydrology protocol scores for individual sub-reaches ranged from 4.0 to 8.0. The overall score for the entire reach was 6.1. The Hydrology Protocol guidelines indicate that a score of 9 or less is an indication of ephemeral conditions.

Based on the designated use definitions provided in 20.6.4.7 NMAC (summarized in Table 1), the information developed during this study clearly show that the primary contact and limited warmwater aquatic life uses supported by intermittent waters are not supported by the Rio Grande to Four Hills Bridge reach. Fishing, boating, swimming, or other "intimate human contact involving considerable risk of ingestion" are not existing or attainable uses within the reach. Similarly, the frequency of the presence of water is not sufficient to support "aquatic life on a continuous annual basis".

6. Conclusions

It is the conclusion of this investigation that the classification of the Rio Grande to Four Hills Bridge reach of Tijeras Arroyo is consistent with ephemeral rather than intermittent waters. This is based on the historical, geomorphic, and ecological indicators of flow as well as field surveys using the NMED Hydrology Protocol. Accordingly, the recommendation is to change the stream type designation from intermittent to ephemeral.

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TABLES

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Table 1. Designated uses associated with intermittent and ephemeral waters in New Mexico

Water Type	Designated Use	Description
Intermittent	Livestock watering	Can be used as a water supply for livestock
	Wildlife habitat	Can be used by plants and animals
	Marginal warmwater aquatic life	Can support limited aquatic life on a continuous annual basis
	Primary human contact	Can support activities involving prolonged and intimate human contact involving considerable risk of ingestion
Ephemeral	Livestock watering	Can be used as a water supply for livestock
	Wildlife habitat	Can be used by plants and animals
	Limited aquatic life	Can support limited aquatic life specifically adapted to rapidly changing environmental conditions
	Secondary human contact	Can support activities involving human contact where risk of ingestion is minimal

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Table 2. Occurrence of flow in Tijeras Arroyo from USGS Gage 08330600 (1984-2018)

Month	Number of Days in Record	Number of Days with Flow[1]	Percent of Days with Flow	Average Daily Flow Rate[2] (cfs)
Jan	512	37	7.2	0.11
Feb	467	34	7.3	0.25
Mar	799	38	4.8	0.13
Apr	977	63	6.5	0.24
May	1,020	71	7.0	0.19
Jun	984	64	6.5	0.24
Jul	987	208	21.0	0.55
Aug	956	198	20.7	1.76
Sept	928	120	12.9	0.86
Oct	967	89	9.2	0.09
Nov	775	56	7.2	0.07
Dec	561	47	8.4	0.10
Total	**9,933**	**1,025**	**10.0**	**0.38**

USGS = United States Geological Survey

[1]Includes any measurable flow above 0 cfs

[2]Average daily flow rate during days when flow occurs (does not include days in which flow does not occur)

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Table 3. Sinuosity calculations

Sub-reach	Current Sinuosity (2018)	Predevelopment Sinuosity (1951)	Change
1	1.00	1.01	−0.01
2	1.17	1.08	0.09
3	1.22	1.13	0.09
4	1.41	1.21	0.20
5	1.12	1.19	−0.07
6	1.08	1.04	0.04
7	1.14	1.04	0.10
8	1.05	1.02	0.03
Entire Reach	1.15	1.10	0.05

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Table 4. Channel and floodplain dimensions

Transect Number	Sub-reach	Maximum Depth (ft)	Channel Width (ft)	Flood Prone Width (ft)	Floodplain to Channel Ratio
1	2	0.84	77.92	102.35	1.31
2	2	1.63	31.94	39.18	1.23
3	3	1.66	38.24	59.35	1.55
4	4	1.23	21.43	44.51	2.08
5	5	1.00	41.79	57.15	1.37
6	5	0.98	36.33	42.11	1.16
7	6	1.10	31.54	38.26	1.05
8	6	0.67	66.11	70.84	1.07
9	6	0.71	28.64	33.63	1.17
10	7	0.70	48.90	54.53	1.12
11	7	0.50	41.24	245.05	5.94
12	8	1.05	46.74	59.16	1.27
Median		**0.99**	**39.74**	**55.84**	**1.25**

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Table 5. In channel particle size distribution

Particle Class	Size Range (mm)	Count								
		Sub-reach 2	Sub-reach 3	Sub-reach 4	Sub-reach 5	Sub-reach 6-1	Sub-reach 6-2	Sub-reach 7	Sub-reach 8	Full Reach
Fines	< 0.5	17	20	11	13	20	24	19	4	128
Sand	0.5–2	62	53	44	18	19	11	26	18	251
Very fine gravel	2–4	13	22	20	38	30	29	32	41	225
Fine gravel	5–8	2	2	10	17	24	16	15	11	97
Medium gravel	9–16	5	3	7	7	5	8	7	13	55
Course gravel	17–32	1	0	4	7	2	6	1	8	29
Very course gravel	33–64	0	0	2	0	0	4	0	3	9
Small cobble	65–90	0	0	1	0	0	0	0	1	2
Medium cobble	91–128	0	0	1	0	0	2	0	0	3
Large cobble	129–256	0	0	0	0	0	0	0	1	1
Small boulder	257–512	0	0	0	0	0	0	0	0	0
Medium boulder	513–1,024	0	0	0	0	0	0	0	0	0
Large boulder	> 1,025	0	0	0	0	0	0	0	0	0

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Particle Class	Size Range (mm)	Percent								
		Sub-reach 2	Sub-reach 3	Sub-reach 4	Sub-reach 5	Sub-reach 6-1	Sub-reach 6-2	Sub-reach 7	Sub-reach 8	Full Reach
Fines	< 0.5	17	20	11	13	20	24	19	4	16.00
Sand	0.5–2	62	53	44	18	19	11	26	18	31.38
Very fine gravel	2–4	13	22	20	38	30	29	32	41	28.13
Fine gravel	5–8	2	2	10	17	24	16	15	11	12.13
Medium gravel	9–16	5	3	7	7	5	8	7	13	6.88
Course gravel	17–32	1	0	4	7	2	6	1	8	3.63
Very course gravel	33–64	0	0	2	0	0	4	0	3	1.13
Small cobble	65–90	0	0	1	0	0	0	0	1	0.25
Medium cobble	91–128	0	0	1	0	0	2	0	0	0.38
Large cobble	129–256	0	0	0	0	0	0	0	1	0.13
Small boulder	257–512	0	0	0	0	0	0	0	0	0.00
Medium boulder	513–1,024	0	0	0	0	0	0	0	0	0.00
Large boulder	> 1,025	0	0	0	0	0	0	0	0	0.00

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Table 6. Out of channel particle size distribution

Particle Class	Size Range (mm)	Count								
		Sub-reach 2	Sub-reach 3	Sub-reach 4	Sub-reach 5	Sub-reach 6-1	Sub-reach 6-2	Sub-reach 7	Sub-reach 8	Full Reach
Fines	< 0.5	28	29	34	25	16	9	10	30	181
Sand	0.5–2	18	19	6	8	9	11	15	4	90
Very fine gravel	2–4	4	1	6	7	12	14	14	8	66
Fine gravel	5–8	0	0	2	4	9	7	7	4	33
Medium gravel	9–16	0	1	1	6	2	6	2	3	21
Course gravel	17–32	0	0	1	0	2	2	1	1	7
Very course gravel	33–64	0	0	0	0	0	1	0	0	1
Small cobble	65–90	0	0	0	0	0	0	1	0	1
Medium cobble	91–128	0	0	0	0	0	0	0	0	0
Large cobble	129–256	0	0	0	0	0	0	0	0	0
Small boulder	257–512	0	0	0	0	0	0	0	0	0
Medium boulder	513–1,024	0	0	0	0	0	0	0	0	0
Large boulder	> 1,025	0	0	0	0	0	0	0	0	0

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Particle Class	Size Range (mm)	Percent								
		Sub-reach 2	Sub-reach 3	Sub-reach 4	Sub-reach 5	Sub-reach 6-1	Sub-reach 6-2	Sub-reach 7	Sub-reach 8	Full Reach
Fines	< 0.5	56	58	68	50	32	18	20	60	45.25
Sand	0.5–2	36	38	12	16	18	22	30	8	22.5
Very fine gravel	2–4	8	2	12	14	24	28	28	16	16.5
Fine gravel	5–8	0	0	4	8	18	14	14	8	8.25
Medium gravel	9–16	0	2	2	12	4	12	4	6	5.25
Course gravel	17–32	0	0	2	0	4	4	2	2	1.75
Very course gravel	33–64	0	0	0	0	0	2	0	0	0.25
Small cobble	65–90	0	0	0	0	0	0	2	0	0.25
Medium cobble	91–128	0	0	0	0	0	0	0	0	0
Large cobble	129–256	0	0	0	0	0	0	0	0	0
Small boulder	257–512	0	0	0	0	0	0	0	0	0
Medium boulder	513–1,024	0	0	0	0	0	0	0	0	0
Large boulder	> 1,025	0	0	0	0	0	0	0	0	0

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Table 7. Summary of Hydrology Protocol Level 1 indicator scores for all sub-reaches

Level 1 Indicator	Sub-reach 2	Sub-reach 3	Sub-reach 4	Sub-reach 5	Sub-reach 6	Sub-reach 7	Sub-reach 8	Average
1.1 Water in Channel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
1.2 Fish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
1.3 Benthic Macroinvertebrates	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
1.4 Filamentous Algae/Periphyton	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
1.5 Differences in Vegetation	1.0	1.0	1.0	1.0	1.0	1.0	1.0	**1.0**
1.6 Absence of Rooted Upland Plants	1.0	1.0	1.0	1.0	1.0	1.0	1.0	**1.0**
1.7 Sinuosity	1.0	1.5	2.0	1.0	1.0	1.0	1.0	**1.2**
1.8 Floodplain and Channel Dimensions	1.5	1.0	1.5	1.0	0.0	3.0	1.0	**1.3**
1.9 In-Channel Structure	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
1.10 Particle Size and Sorting	0.0	0.0	1.5	1.0	0.0	0.0	1.5	**0.6**
1.11 Hydric Soils	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
1.12 Sediment on Plants and Debris	1.0	1.0	1.0	1.0	1.0	1.0	1.0	**1.0**
1.13 Seeps and Springs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
1.14 Iron Oxidizing Bacteria/Fungi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
Total[1]	**5.5**	**5.5**	**8.0**	**6.0**	**4.0**	**7.0**	**6.5**	**6.1**

[1] A total score of less than 9 is considered an indicator of ephemeral conditions. A total score between 9 and 12 is considered borderline. A total score of 12 or greater is considered an indicator of intermittent conditions.

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FIGURES

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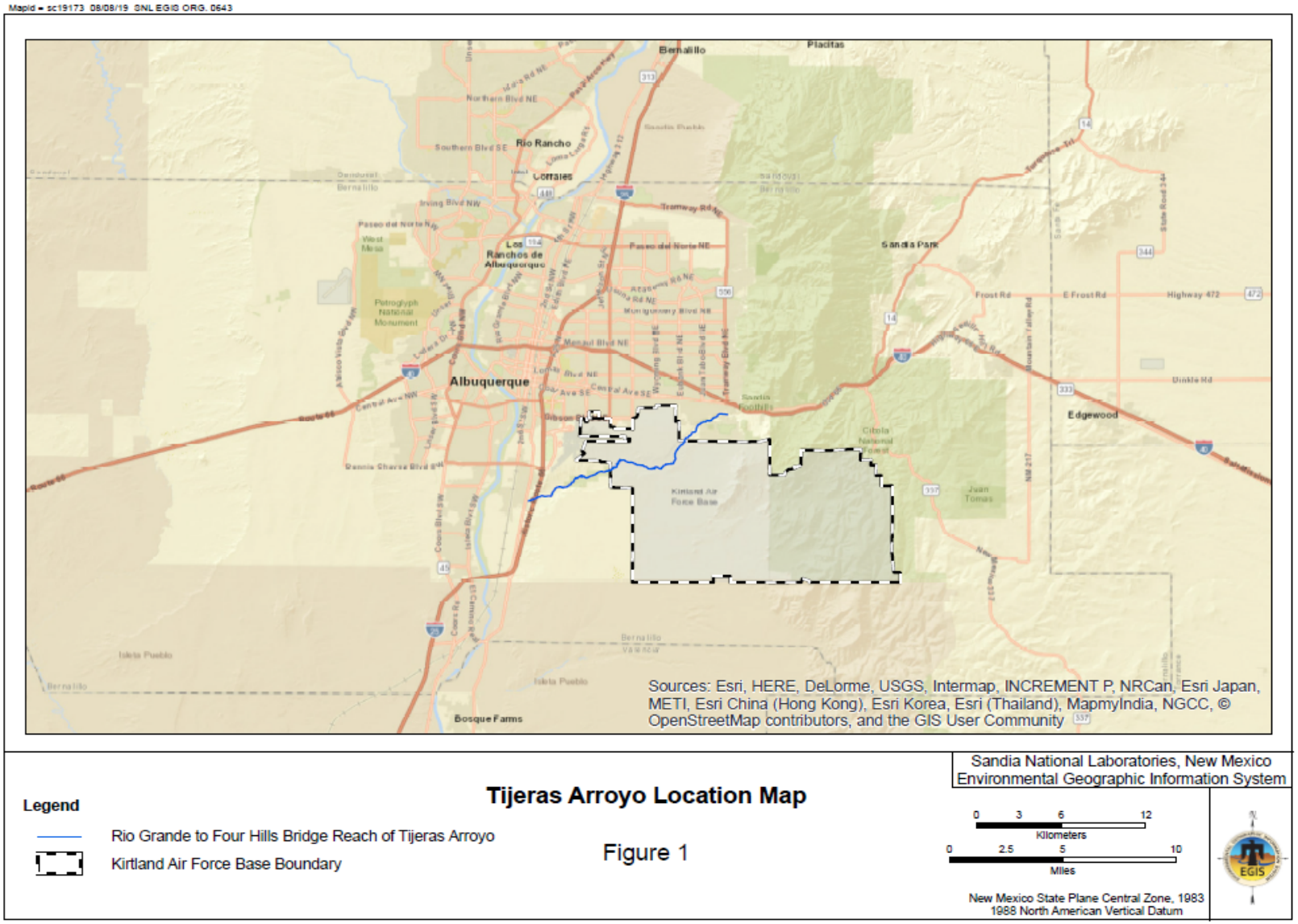


Figure 1. Tijeras Arroyo location map

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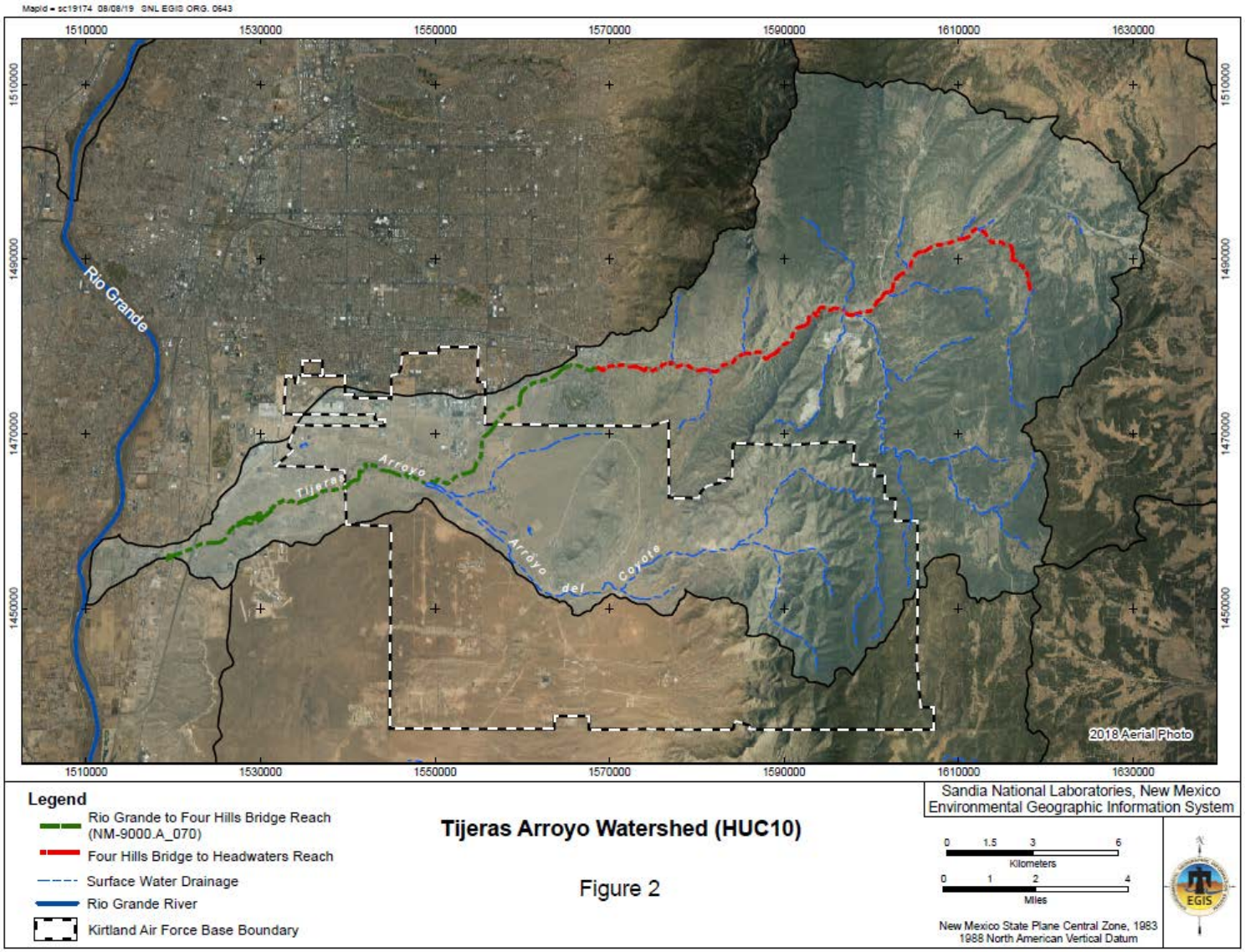


Figure 2. Tijeras Arroyo Watershed (HUC10)

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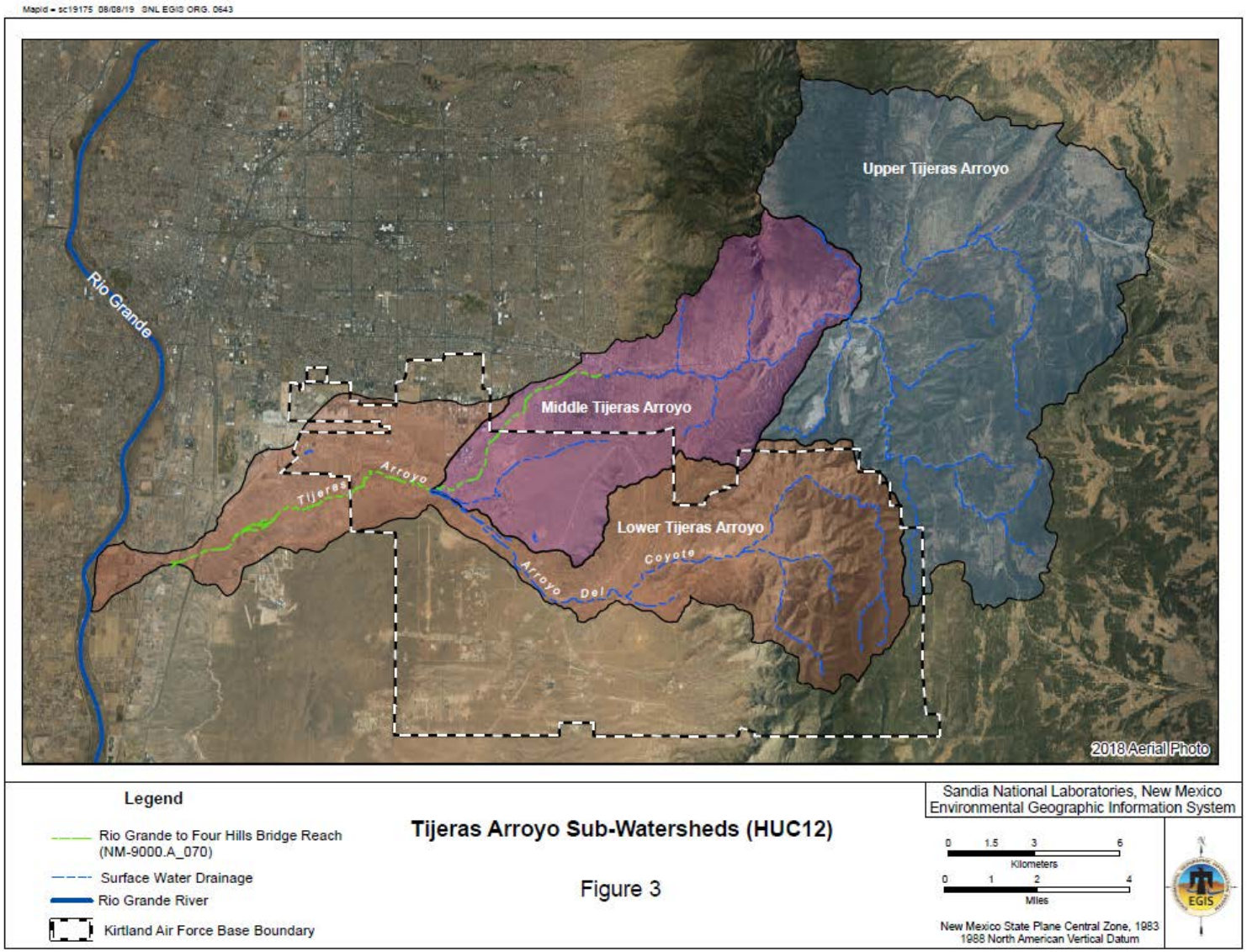


Figure 3. Tijeras Arroyo sub-watersheds (HUC12)

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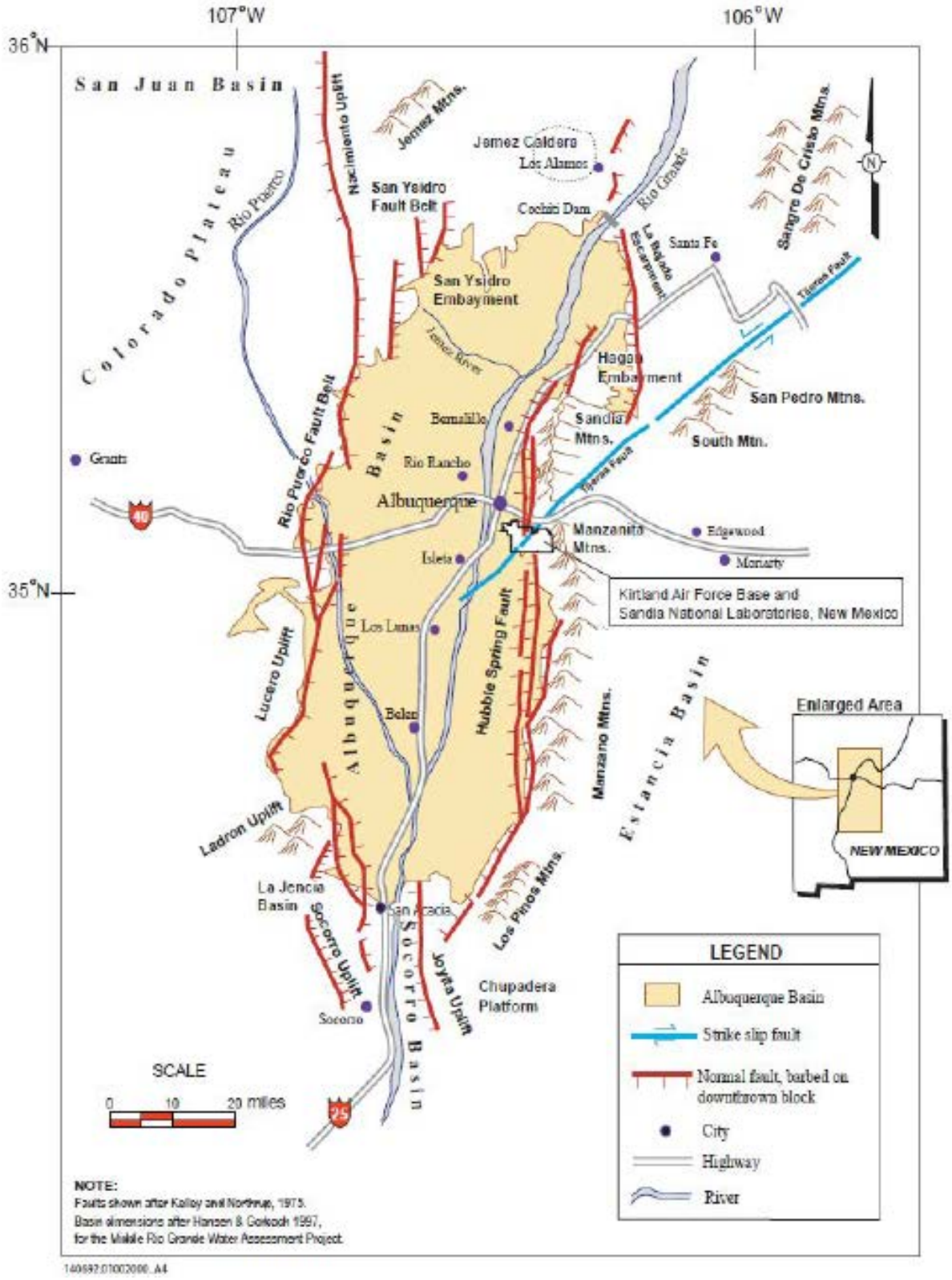


Figure 4. Regional geological setting

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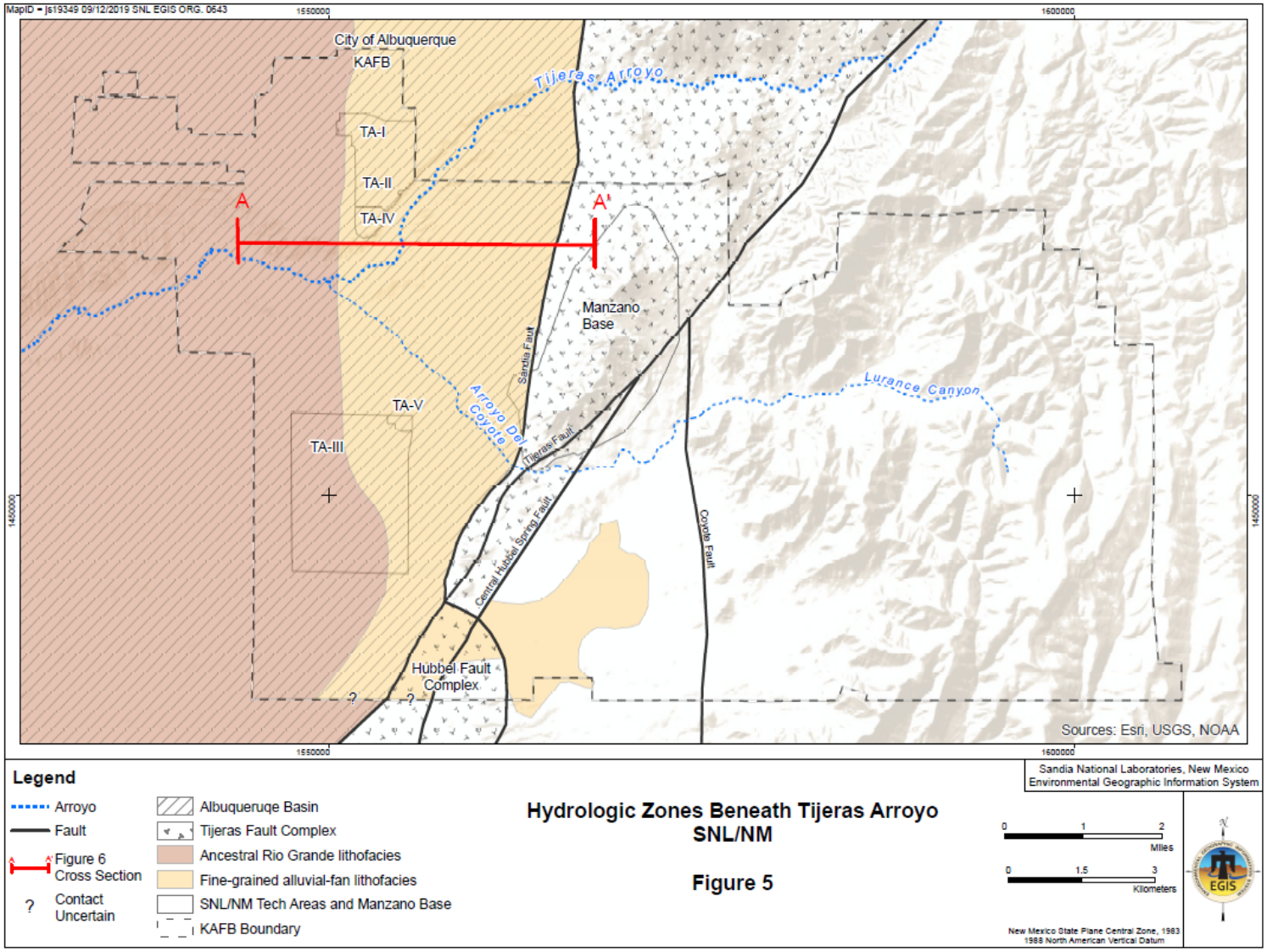


Figure 5. Hydrologic zones beneath Tijeras Arroyo SNL/NM

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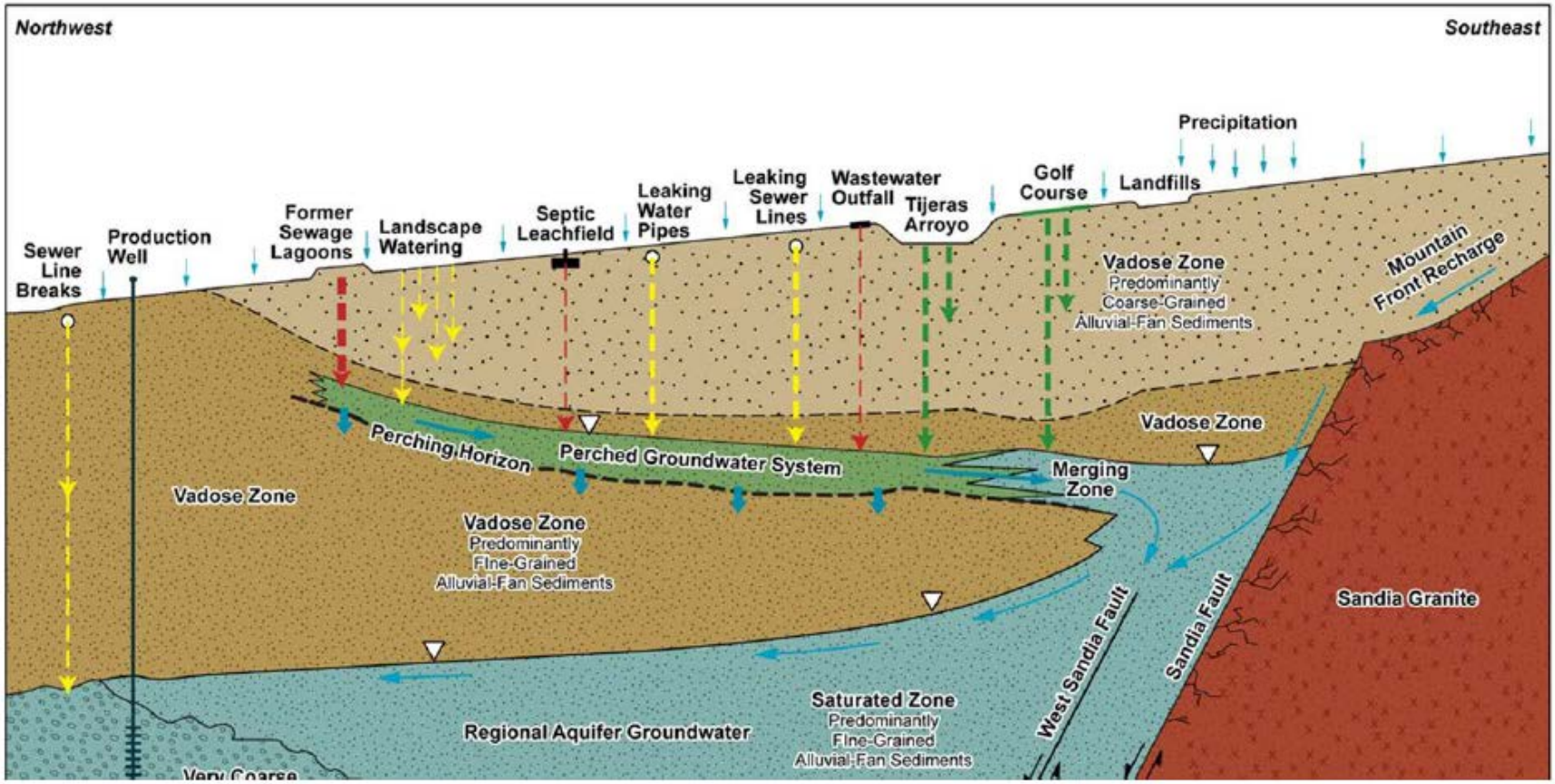


Figure 6. Cross section A-A' showing perched and regional groundwater zones beneath Tijeras Arroyo

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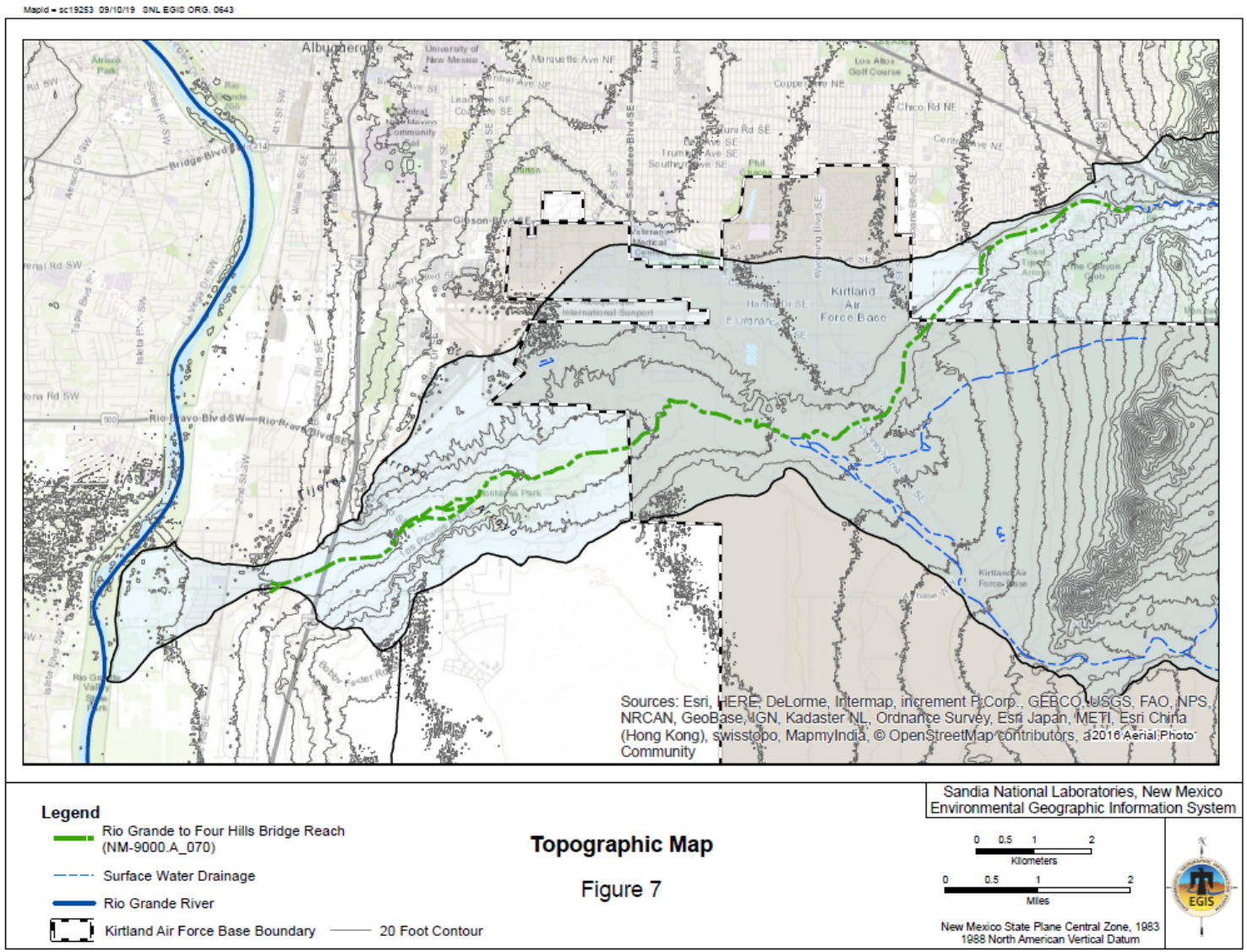


Figure 7. Topographic map

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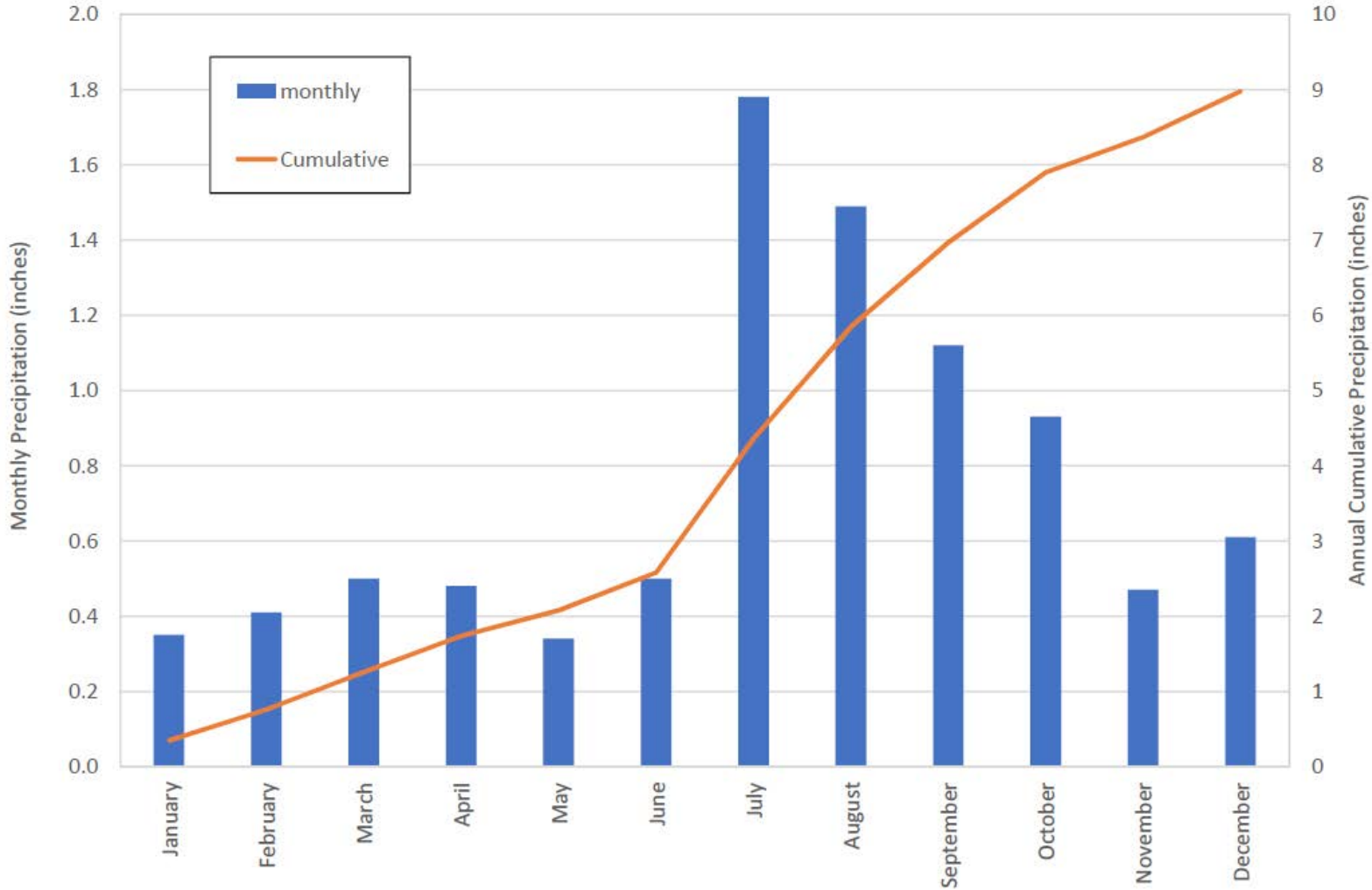


Figure 8. Average precipitation at SNL/NM meteorological Tower A21 (1994–2018)

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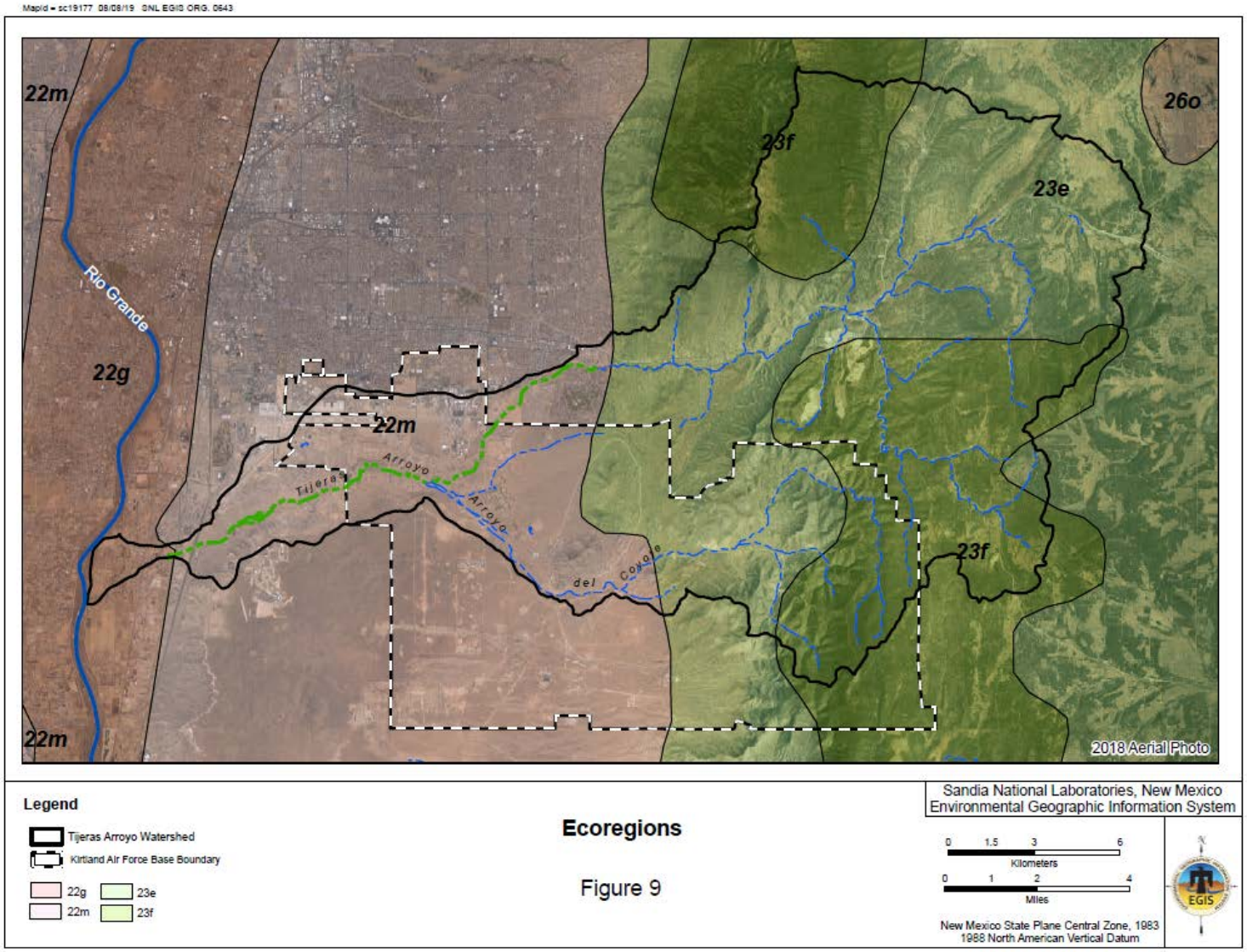


Figure 9. Ecoregions

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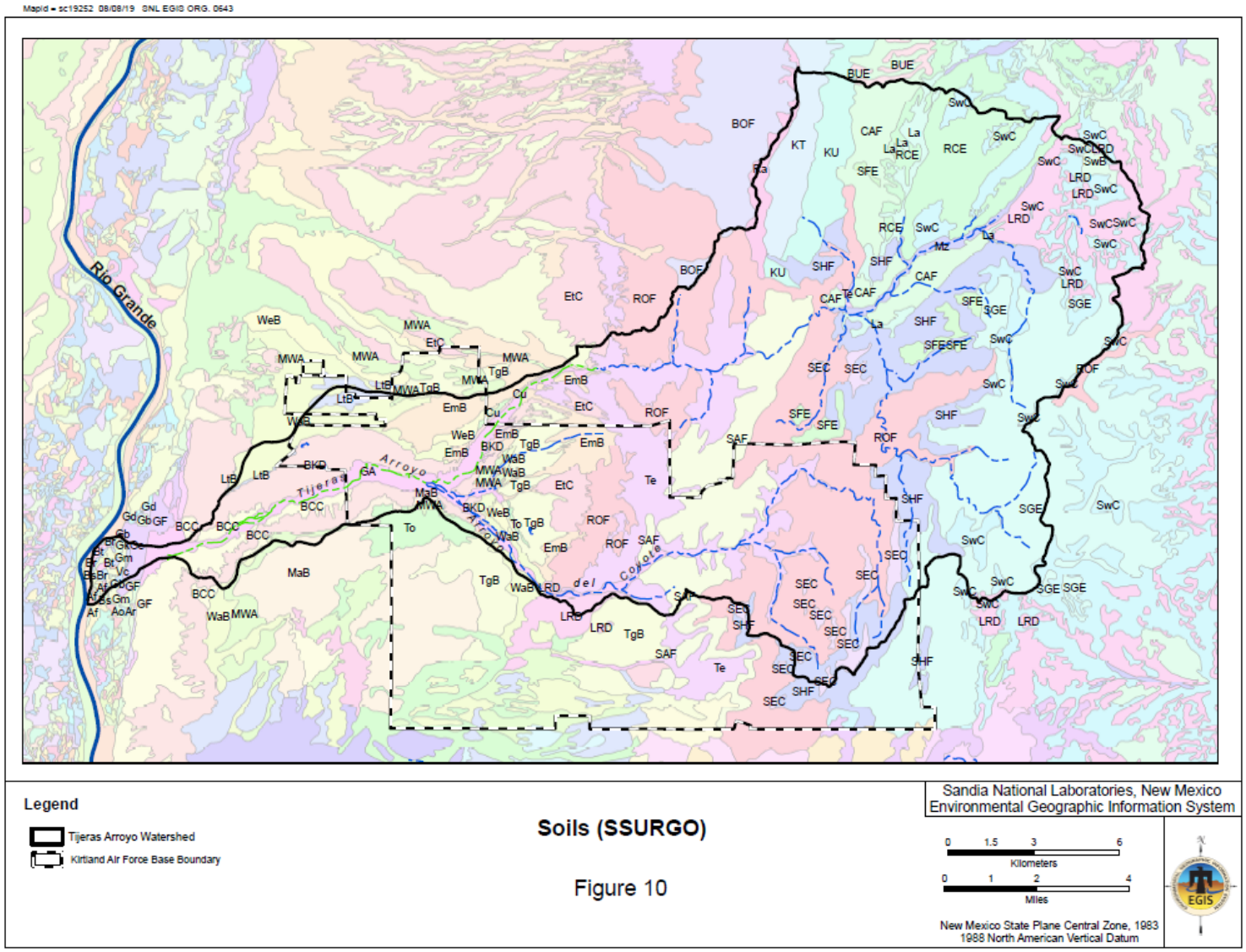


Figure 10. Soils (Natural Resources Conservation Service Soil Survey Geographic Database)

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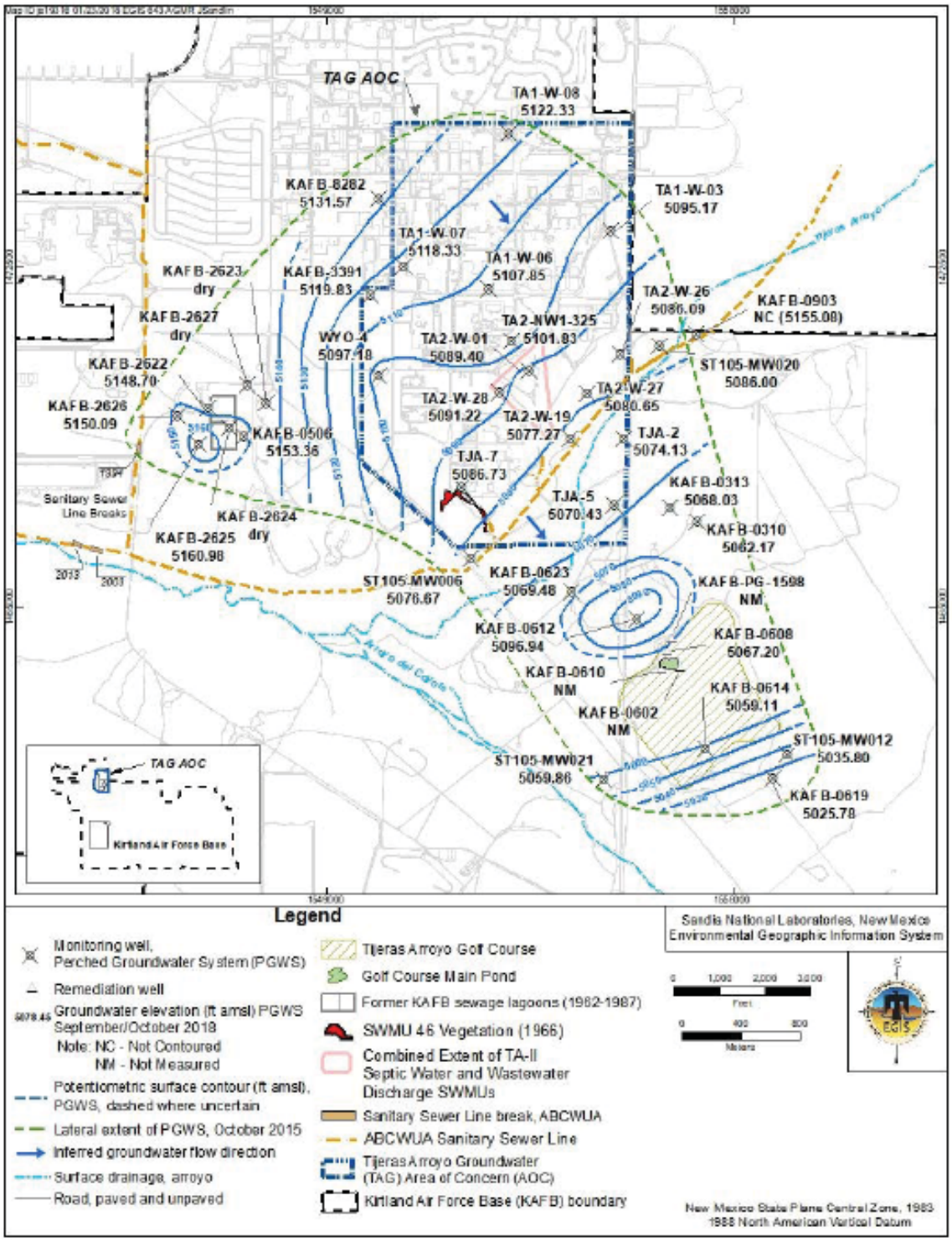


Figure 11a. Potentiometric surface map for the perched groundwater system near sub-reaches 5 and 6 (September/October 2018)

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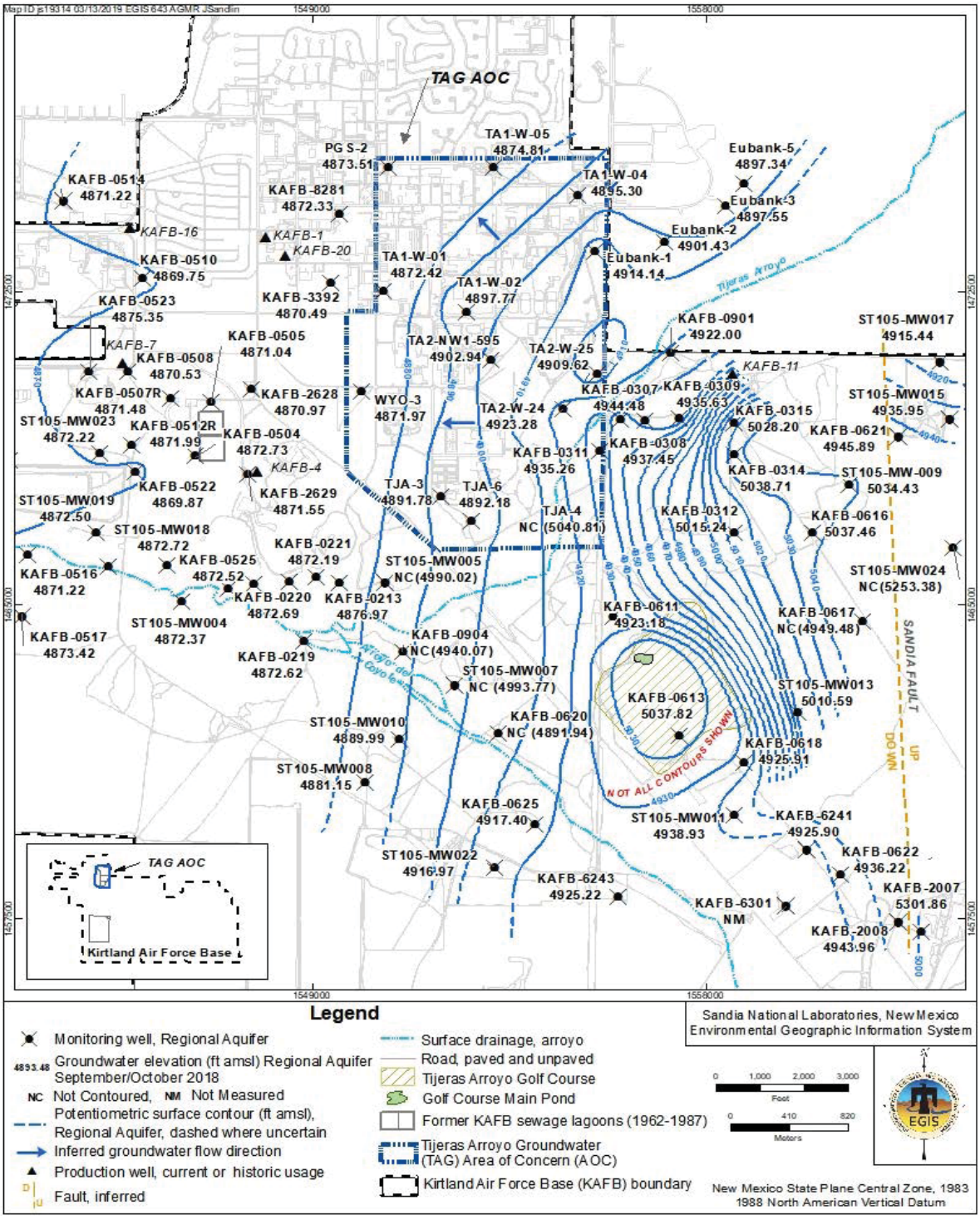


Figure 11b. Potentiometric surface map for the regional groundwater system near sub-reaches 5 and 6 (September/October 2018)

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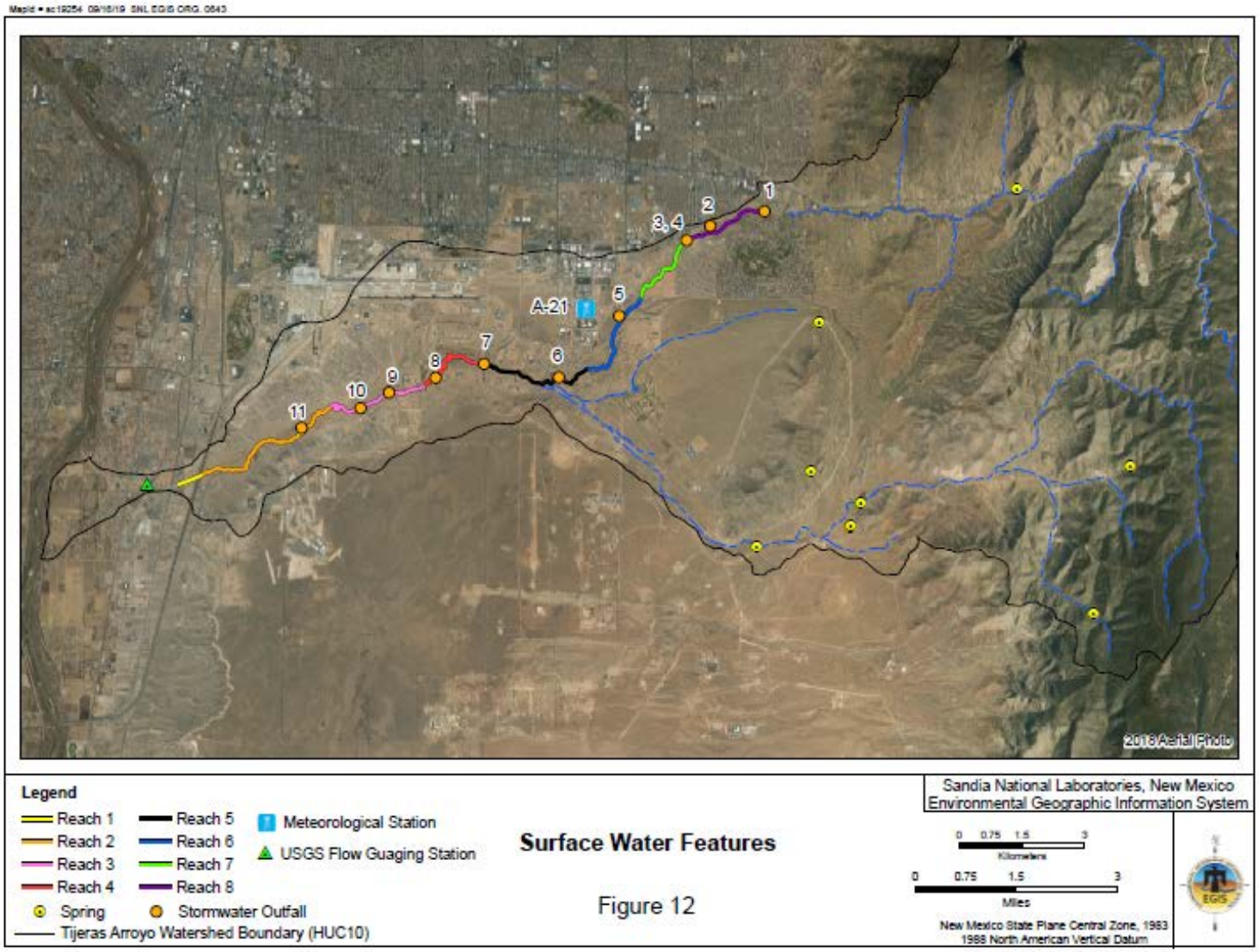


Figure 12. Surface water features

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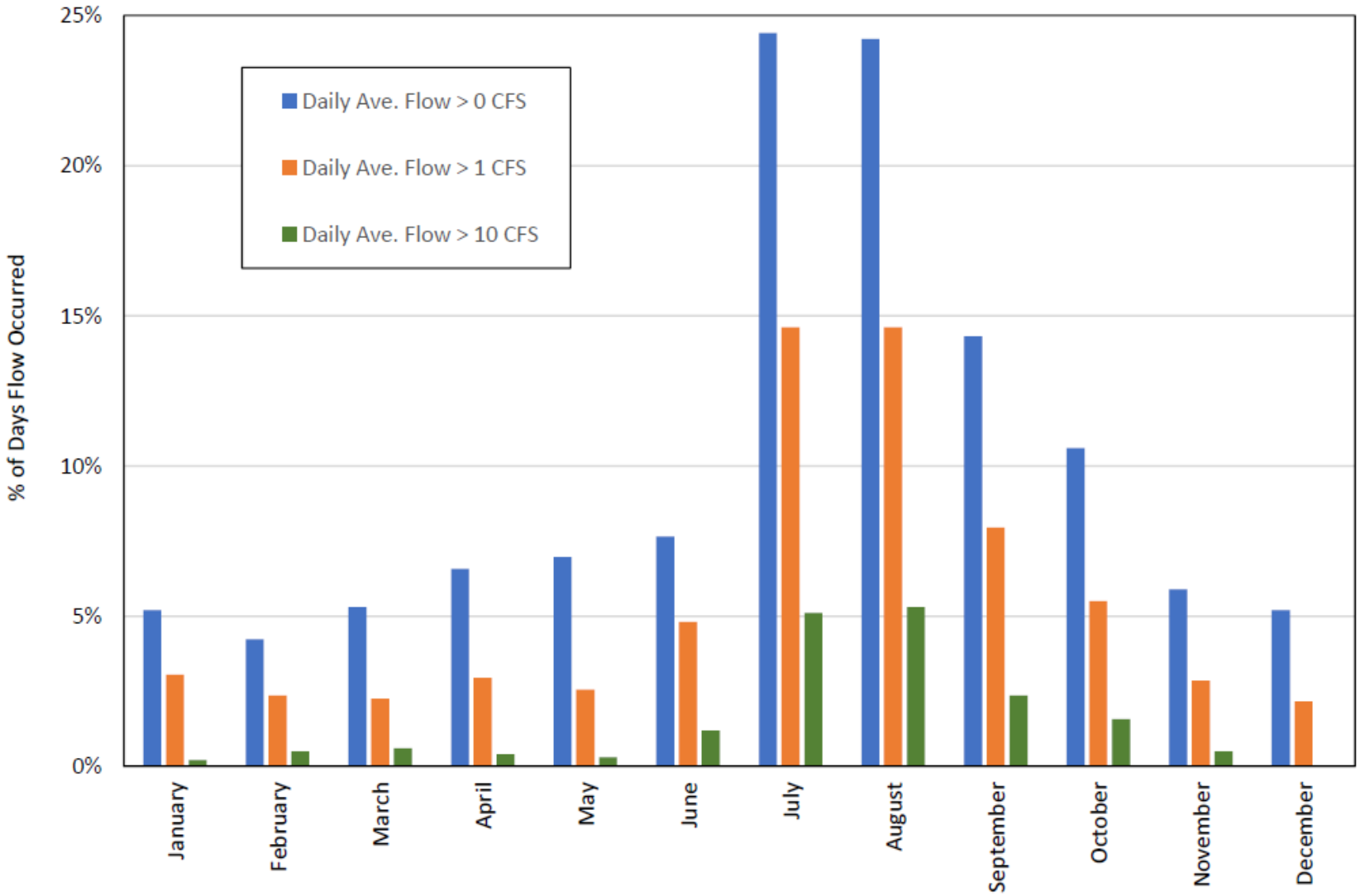


Figure 13. Monthly flow frequency at USGS Tijeras Arroyo gage (1984–2018)

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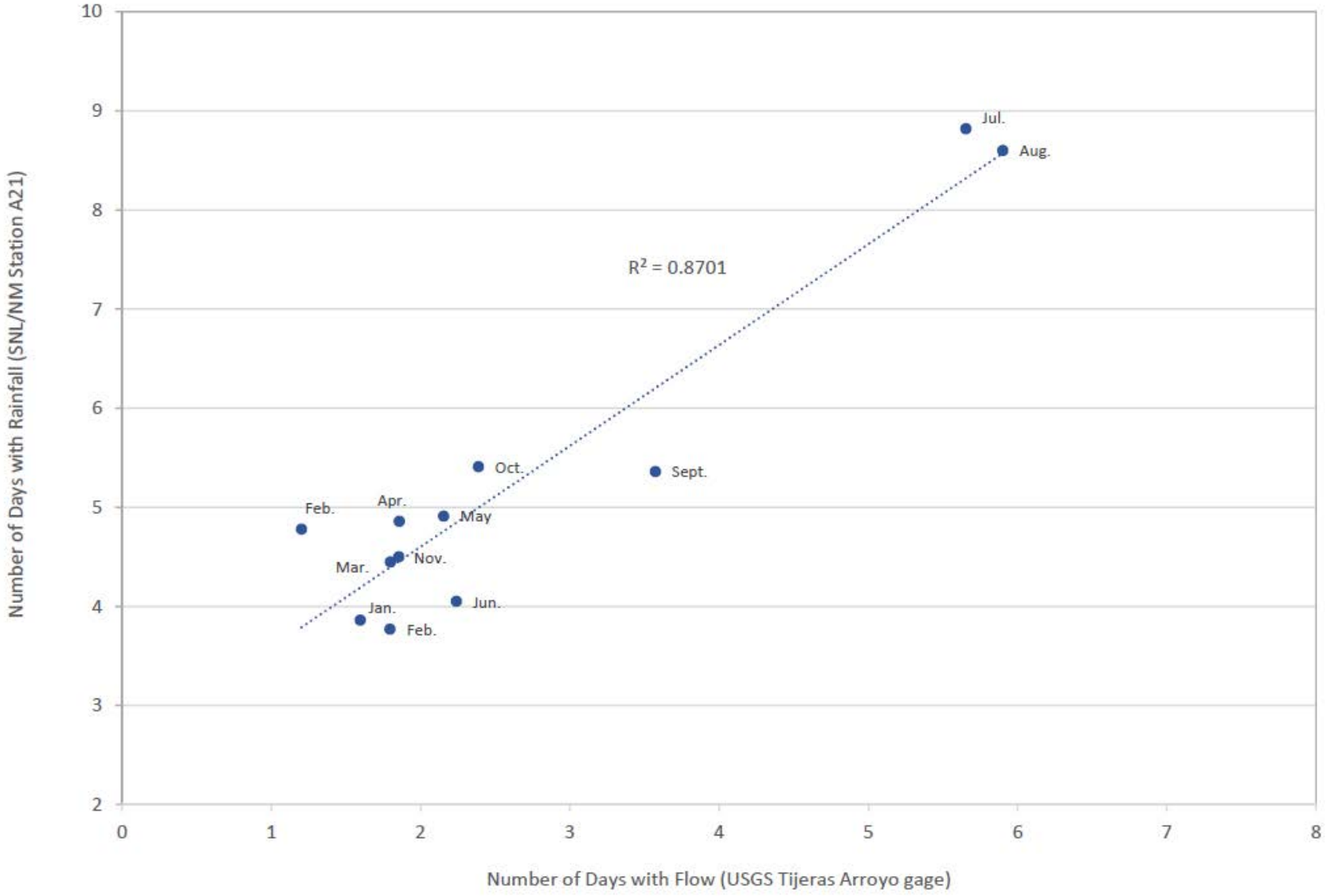


Figure 14. Average monthly days with rainfall versus average monthly days with flow

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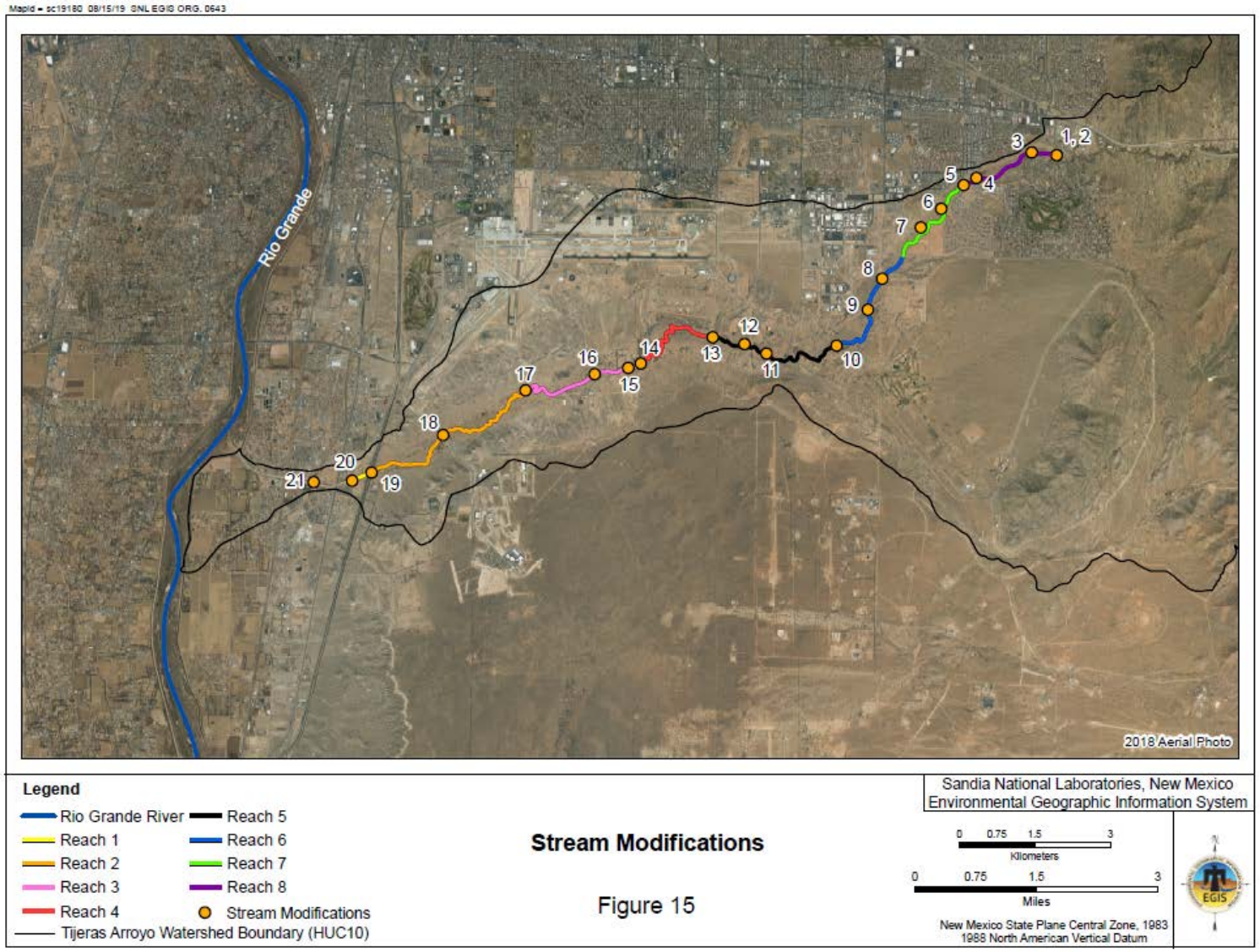


Figure 15. Stream modifications

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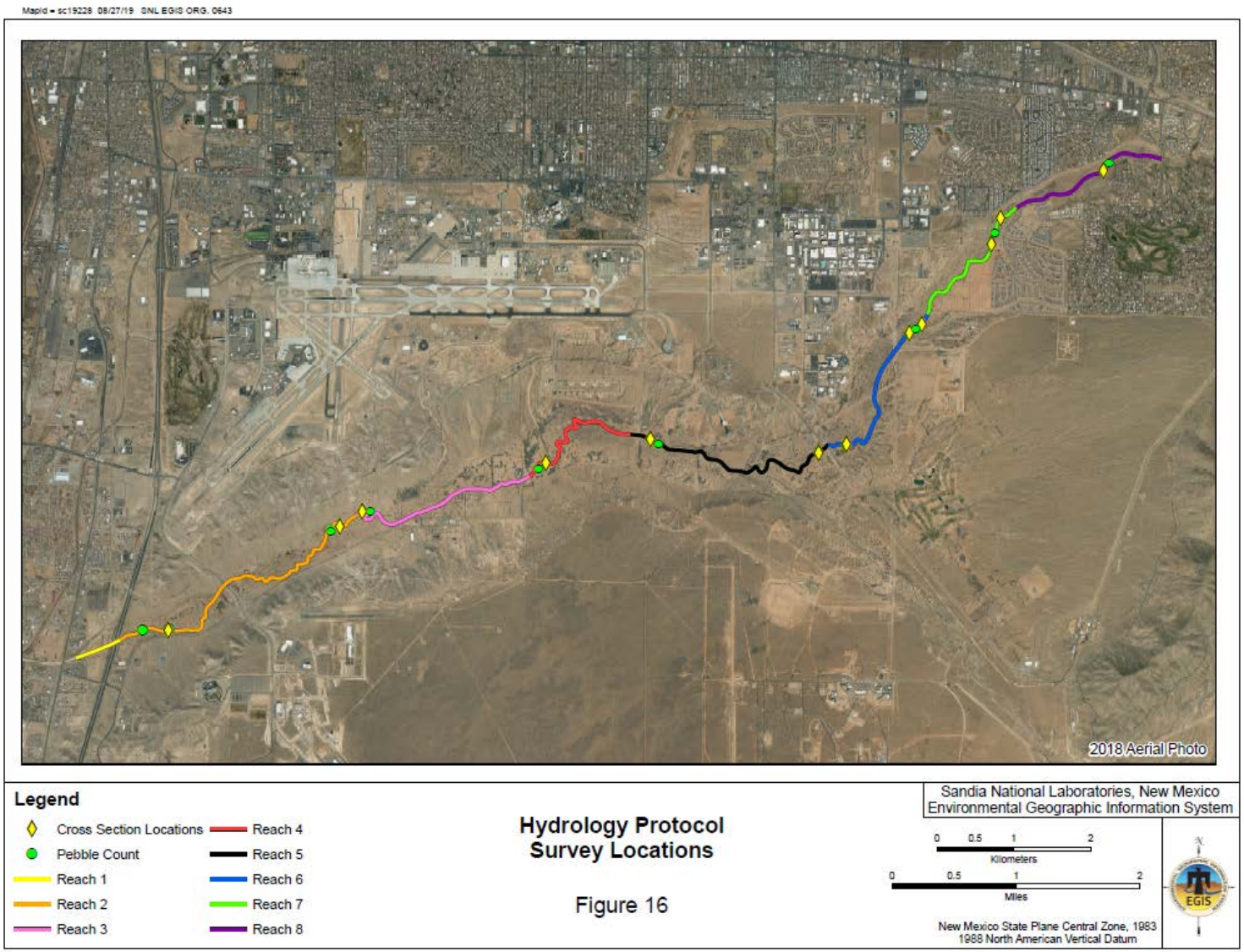


Figure 16. Hydrology Protocol survey locations

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APPENDICES

Appendix A: Approved Work Plan

Appendix B: Regulatory Guidance Documents

Appendix C: Climate Data

Appendix D: Ecoregion Data

Appendix E Soils Data

Appendix F: Groundwater Data

Appendix G: Surface Water Data

Appendix H: Historic Aerial Photographs

Appendix I: Hydrology Protocol Scoring Sheets

Appendix J: Sediment and Substrate Size

Appendix K: Field Photographs

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Appendix A: Work Plan to Conduct UAA

No.	Description
A-1	Work Plan Submitted to NMED
A-2	NMED Approval of Work Plan

Appendix A-1

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WORK PLAN

USE ATTAINABILITY ANALYSIS FOR TIJERAS ARROYO; RIO GRANDE TO FOUR HILLS BRIDGE REACH (ASSESSMENT UNIT ID NM-9000.A_070)

Sandia National Laboratories

U.S. Department of Energy
National Nuclear Security Administration
Sandia Field Office
Albuquerque, NM

October 23, 2017





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SAND2017-12848O



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Attachments

1. NMED's *Hydrology Determination Field Sheet*

2. NMED's *Cover Sheet for the Hydrology Protocol UAA for an Ephemeral Stream*

3. NMED Comments and SFO/NTESS Responses

1. Introduction

This Work Plan was prepared by National Technology & Engineering Solutions of Sandia, LLC (NTESS) and the U.S. Department of Energy (DOE)/National Nuclear Security Administration (NNSA) Sandia Field Office (SFO) to conduct a Use Attainability Analysis (UAA) for a portion of the Tijeras Arroyo (Rio Grande to Four Hills Bridge reach; Assessment Unit ID NM-9000.A_070). This reach of the Tijeras Arroyo receives stormwater discharged from Sandia National Laboratories, New Mexico (SNL/NM).

A UAA is a scientific study conducted for the purpose of assessing the factors affecting the attainment of a designated use. A UAA is required by the U.S. Environmental Protection Agency (EPA) and the New Mexico Environment Department (NMED) to support determination that a designated use is not supported by a Water of the United States (WOTUS) or a Water of the State of New Mexico. A UAA involves the compilation of hydrological, geomorphic, and biological stream characteristics data through GIS mapping, review of existing information, completion of field surveys, and preparation of a report describing which designated uses are supported by the findings. Results are compiled in a report and submitted to NMED and ultimately to EPA for review and approval.

This Work Plan describes data and methods that will be used to prepare the UAA. In accordance with the guidelines provided in 20.6.2.4 NMAC, this Work Plan describes existing information that will be used for the UAA, new data that will be generated during the UAA, factors affecting use attainment that will be analyzed, and provisions for public notice and consultation with government agencies.

This work is being conducted in support of regulatory compliance activities required by National Pollution Discharge Elimination System (NPDES) stormwater permits, specifically, the Multi-Sector General Permit (MSGP) and the Municipal Separate Storm Sewer System (MS4) Permit.

A previous version of this Work Plan (v.1, May 5, 2017) was provided to NMED for review and comment. On September 21, 2017 NMED provided comments and suggestions to SFO and NTESS, which have been incorporated into this v.2. A copy of NMED comments and SFO/NTESS responses to them are provided in Attachment 3.

2. Background

The headwaters of the Tijeras Arroyo are located in Tijeras Canyon and the foothills of the Sandia and Manzano Mountains east of Kirtland Airforce Base (KAFB). The Tijeras Arroyo flows from east to west and terminates where it discharges to the Rio Grande. The total length of the Tijeras Arroyo is approximately 27.5 miles. For regulatory purposes, NMED divides the Tijeras into two separate assessment units (AUs); Rio Grande to Four Hills Bridge (AU ID NM-9000.A_070) and Four Hills Bridge to Headwater (AU NM-9000.A_001).

SNL/NM discharges stormwater to the Tijeras Arroyo (Rio Grande to Four Hills Bridge reach; NM-9000.A_070) within the boundaries of Kirtland Air Force Base (KAFB). The 2016-2018

State of New Mexico Clean Water Act Section 303(d) Integrated Report[1] (303(d) List) identifies the "Water Type" for this reach as ephemeral, but specifies designated uses (and therefore water quality standards) for intermittent waters. A comment for this AU in the 2016-2018 State of New Mexico Clean Water Act 303(d) Integrated List states:

> *Application of the [Surface Water Quality Bureau] SWQB Hydrology Protocol (survey date 6/24/09) indicate [SIC] this assessment unit is ephemeral (Hydrology Protocol score of 3.0 with 89.1% days with no flow at USGS gage 08330600 – see http://www.nmenv.state.nm.us/swqb/Hydrology for additional details on the protocol). NMED must complete the process detailed in 20.6.4.15 NMAC Subsection C in order to a [SIC] waterbody under 20.6.4.97 NMAC. Until such time, this waterbody will remain under 20.6.4.98 NMAC.*

The "process detailed in 20.6.4.15 NMAC Subsection C" is the UAA. NTESS and SFO propose conducting the UAA in order to ensure consistent and appropriate regulation of stormwater discharges from SNL/NM.

2.1 Water Quality Standards, Designated Uses, and Stream Classifications

In New Mexico, water quality standards (WQS) are based upon the designated uses of a water body. Designated uses are assigned by NMED (and approved by EPA) with consideration to the flow regime of the water body (perennial, intermittent, or ephemeral); therefore, WQS are largely a function of whether the water body is perennial, intermittent, or ephemeral.

Intermittent waters have more stringent WQS than ephemeral waters. This is due to the types of aquatic life intermittent waters support, as well as their recreational and economic uses. The terms intermittent and ephemeral are defined as follows in 20.6.4.7 NMAC:

Intermittent: *when used to describe a surface water of the state means the water body contains water for extended periods only at certain times of the year, such as when it receives seasonal flow from springs or melting snow.*

Ephemeral: *when used to describe a surface water of the state means the water body contains water briefly only in direct response to precipitation; its bed is always above the water table of the adjacent region.*

The uses designated for intermittent water bodies and their definitions (20.6.4.98 NMAC) are:

- *livestock watering* (use of a surface water for consumption by livestock),
- *wildlife habitat* (surface water used by plants or animals not considered as pathogens, or vectors for pathogens, or intermediate hosts for pathogens for humans or domesticated livestock and plants),
- *marginal warmwater aquatic life* (natural habitat conditions severely limit the ability of the surface water to sustain a natural aquatic life population on a continuous basis), and

[1] State of New Mexico Clean Water Act §303(d)/§305(b) Integrated Report, Appendix A – Integrated List, page 203 (2016).

- *primary contact* (any recreational or other water use in which there is prolonged or intimate human contact with water, such as swimming and water skiing, involving considerable risk of ingesting water in quantities sufficient to pose a significant health hazard, or any use of the surface water for cultural, religious, or ceremonial purposes in which there is intimate human contact with the water).

The uses designated for ephemeral water bodies (20.6.4.97 NMAC) are:

- *livestock watering* (use of a surface water for consumption by livestock),
- *wildlife habitat* (surface water used by plants or animals not considered as pathogens, or vectors for pathogens, or intermediate hosts for pathogens for humans or domesticated livestock and plants),
- *limited aquatic life* (the surface water is capable of supporting only a limited community of aquatic life), and
- *secondary contact* (a water in which recreational contact may occur, and in which the probability of ingesting appreciable quantities of water is minimal, such as fishing, wading, boating, and limited seasonal contact).

In New Mexico, non-perennial waters (intermittent and ephemeral) are regulated by default under 20.6.4.98 NMAC, unless a UAA has been conducted and indicates a specific water should be classified under 20.6.4.97. In other words, NMED presumes that all waters can support the uses listed under 20.6.4.98 unless a UAA demonstrates otherwise.

2.2 Use Attainability Assessment

A UAA is a scientific study conducted for the purpose of assessing the factors affecting the attainment of a designated use. A UAA must be conducted before a designated use can be removed or changed to a category requiring less stringent criteria, and it must demonstrate that attainment of the use is not feasible based on at least one of the factors identified in federal regulation at 40 CFR 131.10(g):

1) *Naturally occurring pollutant concentrations prevent the attainment of the use;*
2) *Natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating State water conservation requirements to enable uses to be met;*
3) *Human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place;*
4) *Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the water body to its original condition or to operate such modification in a way that would result in the attainment of the use;*
5) *Physical conditions related to the natural features of the water body, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses;*

6) *Controls more stringent than those required by sections 301(b) and 306 [technology-based effluent limitations] of the Act would result in substantial and widespread economic and social impact.*

Of particular relevance to the Rio Grande to Four Hills Bridge reach of the Tijeras Arroyo are factors 2 and 5, which will likely be the factors that determine if the water is intermittent or ephemeral. Flow in Tijeras Arroyo (Rio Grande to Four Hills Bridge reach; Assessment Unit ID NM 9000.A_070) occurs infrequently and only in direct response to precipitation events. For this reason, our analysis will focus largely on the occurrence of water and flow and how it limits the reach's ability to support "marginal warmwater aquatic life" and "primary contact" designated uses. The scoring system provided by the Hydrology Protocol will be used to quantify if the reach is intermittent or ephemeral, but supporting information and analysis will be provided.

2.3 Hydrology Protocol

NMED allows for an expedited UAA process for certain ephemeral waters; this process will be utilized under this Work Plan. The expedited UAA process focuses on evaluating the aquatic life and contact uses, and is based on a field survey method developed by NMED called the *Hydrology Protocol* (HP). The HP is described in detail in *Hydrology Protocol for the Determination of Uses Supported by Ephemeral, Intermittent, and Perennial Waters,* and in Section II.C of *State of New Mexico Water Quality Management Plan and Continuing Planning Process*. A brief summary is provided below.

The HP is guided by field survey sheets containing specific questions that evaluate the hydrological, geomorphic and biological indicators of the persistence of water. A scoring system enables the user to evaluate which aquatic life and contact uses are supported by the water body, and therefore, if the water is intermittent or perennial. The HP is organized into a Level 1 and Level 2 evaluation. The Level 1 evaluation consists of a total of 14 "indicators" (1.1 through 1.14). The HP instructs the user that a total score of less than 2 on indicators 1.1 through 1.6 indicates "the stream is ephemeral; you may stop the evaluation at this point". SFO and NTESS will however, accept NMED's recommendation that indicators 1.1 through 1.14 be evaluated regardless of the score obtained from indicators 1.1. through 1.6, in order to provide the most thorough evaluation possible. Data gathered during the Level 1 evaluation are usually adequate to indicate the hydrological status of the stream. If the Level 1 evaluation is inconclusive, a Level 2 evaluation may be conducted.

Field work will be conducted in collaboration with NMED to ensure proper HP implementation and concurrence on scoring. Representatives from NMED will provide input and be present during field activities, and will serve in an advisory capacity rather than an oversight role. SFO and NTESS will serve as project managers and will be responsible for ensuring the HP is conducted according to this Work Plan and applicable regulations. HP indicator scores will be developed through consultation with NMED with the goal of reaching a consensus. A final determination will be made by SFO and NTESS. All work will be conducted under the NTESS health and safety program.

Results of the HP are incorporated into the UAA as described in Subsection C of 20.6.4.15 NMAC. In addition to the HP, the UAA will present existing information regarding the hydrology, climate, geography, land use, wildlife, vegetation, and any other pertinent information.

3. Scope of Work

This scope of work is guided by requirements listed in Subsection C of 20.6.4.15 NMAC and the NMED document *Hydrology Protocol for the Determination of Uses Supported by Ephemeral, Intermittent, and Perennial Waters.* SFO and NTESS will rely on both existing data as well as newly generated data to compile the UAA.

The study area will include the Tijeras Arroyo (Rio Grande to Four Hills Bridge reach; Assessment Unit ID NM-9000.A_070) and the surrounding area having the potential to impact flows within the reach. The HUC 10 watershed boundary (Tijeras Arroyo) that encompasses this area is shown in Figure 1. The HUC 12 watershed boundaries (Upper Tijeras Arroyo, Middle Tijeras Arroyo, and Lower Tijeras Arroyo) that contribute flow to this reach are shown in Figure 2.

3.1 Project Personnel

A multidisciplinary staff of environmental professionals including, geologists, hydrologists, water quality specialists, biologists, ecologists, meteorologists, geographers, GIS analysts, and field technicians will be utilized to compile the UAA.

The project team for this work will he led by the Stormwater Program. The primary team members are listed in Table 1 below, however, additional expertise will be leveraged as needed.

Table 1: Primary UAA team members.

Team Member	SNL/NM Program	Primary UAA Role
John Kay	Stormwater	Project Lead/geology
Kathie Deal	Stormwater	Program Lead/regulatory review
Carolyn Daniel	Stormwater	Flow and water quality
Jamie Gomez	Stormwater	Sediment/soil
Regina Deola	Meteorology	Climate/precipitation
Jennifer Payne	Ecology	Vegetation/aquatic life
Mike Skelly	Groundwater	Groundwater
Mike Barthel	GIS	Geographic data/maps
Zach Tenorio	Field Services	Stream channel surveys, general assistance
Martin Baca	Field Services	Stream channel surveys, general assistance
Zoe Wiesel	Student Intern	General assistance
Darrell Fong	Management	Oversight and review
Steve Black	SFO	Oversight and review

3.2 Compilation of Existing Data

Existing sources of information will be compiled to generate a comprehensive picture of the hydrologic setting and conditions within the vicinity of Tijeras Arroyo. Geographic information system (GIS) based mapping will be used to analyze and produce aerial photos, topographic maps, surface water drainage maps, geologic maps, soils maps, ecoregion maps, groundwater maps, and vegetation maps. Existing site-specific SNL/NM groundwater, surface water, and climate data specific to SNL/NM will be presented. Additionally, existing USGS surface water data will be presented.

Aerial photos will be used to show the study area, in particular, any impoundments, riparian (streamside) vegetation, and the presence or absence of water in the channel. Aerial photos will be used to show the location of surveys conducted as part of the HP, and to calculate stream channel tortuosity.

Geologic and soil maps will be used to describe the local geologic formations and soil types found within the study area. An overview of the geologic setting and history of the area will be provided. The geology and soils will be discussed relevant to their influence on local hydrology and the occurrence of flow within Tijeras Arroyo.

Topographic maps will be used to show elevation breaks and channel constraints that could indicate a change in hydrology. The topographic maps will also show drainage basin boundaries, tributaries, and other features that impact surface flow to or from the Tijeras Arroyo. National Hydrography Dataset (NHD) or equivalent quality shapefiles will be used to show the location of stream channels on location maps.

Flow data from a USGS stream gauge (Gauge 08330600; TIJERAS ARROYO NR ALBUQUERQUE, NM) will be used do document frequency of flow in the study reach. Nearly 20 years of data are available for this gauge, starting in 1996. Flow data will be compared to precipitation data from various rain gage locations upstream in the drainage basin.

Groundwater wells and surface diversions recorded with the New Mexico Office of State Engineer (NMOSE) will be mapped in relation to the Tijeras Arroyo. Groundwater and surface water diversions recorded with the NMOSE will be reviewed for possible effects on surface flow in the water body. Extensive groundwater monitoring within KAFB will provide ample to data to determine any potential groundwater influences on surface flow within Tijeras Arroyo.

Permitted discharges (NPDES permits) will be identified and mapped to evaluate effects on flow. There are several stormwater outfalls within the study area.

Meteorological data will be reviewed to ensure that extreme drought conditions or precipitation events do not bias the field results. Drought conditions will be appraised using the 12-month Standardized Precipitation Index (SPI). The SPI from the National Drought Mitigation Center (NDMC) will be used, as well as an SPI calculated from on-site meteorological data. An index value of zero indicates the median precipitation. A negative index value indicates below normal precipitation, and less than -1.5 is considered drought conditions. Field surveys (HP) will not be conducted when the SPI is less than -1.5.

Ecoregion maps will be used to show large geographic areas that represent ecosystem variations. An ecoregion is characterized by a certain elevation, air temperature, precipitation, terrain, geology, soils, vegetation and fauna. Ecoregion breaks indicate a significant change in landscape-wide characteristics including hydrology, that may support interpretations of where changes in stream flow type (intermittent, ephemeral) occur.

3.3 Collection of New Data

New data will be collected to characterize the hydrological, geomorphic and biological characteristics of the Tijeras Arroyo (Assessment Unit ID NM-9000.A_070) using the NMED Hydrology Protocol. A total of 9 survey locations will be spaced approximately 1 mile apart over the entire length of the AU (Table 2 and Figure 3). The exact location of each survey will be determined using a handheld GPS unit, and work conducted will be photo documented using a digital camera.

Table 2: Description of hydrology protocol survey locations.

Survey Location #	Description of Location	Latitude	Longitude	Property Ownership
1	Immediately downstream of I-25	35.0009	-106.6534	AMAFCA
2	Downstream boundary of Montessa Park	35.0121	-106.6258	Bernalillo County
3	Upstream boundary of Montessa Park	35.02060	-106.5985	Bernalillo County
4	KAFB South of 6100 Igloos	35.03013	-106.5770	U.S. Department of Defense
5	KAFB South of Wooden Trestle	35.02567	-106.5579	U.S. Department of Defense
6	KAFB near Pennsylvania Ave. Bridge	35.02743	-106.5394	U.S. Department of Defense
7	Upstream boundary of KAFB	35.0411	-106.5308	U.S. Department of Defense
8	Downstream of Juan Tabo Road Bridge	35.0568	-106.51097	City of Albuquerque
9	Immediately Downstream of Four Hills Bridge	35.0602	-106.4916	City of Albuquerque

The following items will be characterized at each survey location:

Photo Documentation will be conducted at each transect location, including upstream and downstream aspects, according to the methods described in the United States Department of Agriculture/Forest Service Photo Point Monitoring Handbook, Part A- Field Procedures (General Technical Report PNW-GTR-526, 2002).

Climate and weather will be summarized. Long term climatic conditions within the study area will be described, in particular precipitation patterns and amounts. The weather at the time of field surveys will be documented. NTESS meteorologists will compute the Standardized Precipitation Index (SPI) using on-site data; if the SPI is less than -1.5 the HP will be postponed until sufficient rainfall occurs to raise the SPI above -1.5.

Stream Modifications and Anthropogenic Impacts will be evaluated using historical aerial photography to identify any major changes to the natural stream channel that have occurred over time. Any man-made structures, channel stabilization, or other activities evident during field surveys will be documented.

Flow in the stream channel or the presence of any standing water will be documented. Evidence of recent high waters will be documented. The presence of pools of water and saturated sediment will be documented.

Aquatic life will be surveyed and documented.

Benthic macroinvertebrates will be documented by searching under rocks, root wads, undercut banks, leaf packs, and any other locations that may provide a cool and damp environment. The sandy channel margins will be searched for mussel and aquatic snail shells and caddisfly casings.

Algae and periphyton will be documented by looking for a film or hair like growth on rocks within the stream channel; it is not anticipated that these exist within the reach.

Stream channel sinuosity will be measured using GIS between adjacent transect locations, and for the entire reach. Sinuosity will also be described during field surveys; some portions of the reach are more sinuous than others, and the reasons for this will be investigated.

Differences in upland vegetation and vegetation in the stream channel and adjacent areas will be described. They type and density of vegetation in the channel and on adjacent upland areas will be documented at each transect. If upland vegetation is absent in the stream channel this will be noted.

Floodplain and channel dimensions will be surveyed across its entire width perpendicular to the direction of flow. Stream channel surveys will be conducted on 2-foot intervals, using a construction quality survey level and rod. The surveys will not be tied to known benchmarks, but elevations will be estimated to within +/- several feet using a handheld GPS unit. The floodplains

on either side of the active stream channel will not be surveyed on 2-foot intervals, but the width of the flood plain will be measured using GIS tools and documented in the UAA.

In channel structure will be documented; riffle-pool sequences that can discerned from the dry channel will be described.

Particle size of streambed substrate will be characterized using a sand gauge reference card or wire screen method. Particle size will also be characterized for an adjacent upland area for comparison with the stream bed.

Hydric soils will be documented within the stream bank. Field guides published by the National Resources Conservation Service will be used to identify hydric soils.

Sediment deposition on plants or debris within the channel will be documented. Upstream sources of anthropogenic sediment will be considered in describing the source and transport of any sediment deposits observed.

Seeps and springs are not known to exist within the reach, but will be documented if encountered.

Iron oxidizing bacteria/fungi will be noted if present. If present, these will present themselves as orange or brown discoloring of rocks and sediments.

All field data will be recorded on the *Hydrology Determination Field Sheet* (field sheet; Attachment 1), as well as in field notebooks and record sheets as needed. Results of the complete evaluation will be documented on the *Cover Sheet for the Hydrology Protocol UAA for an Ephemeral Stream* (Attachment 2).

4. Reporting

The completed UAA will be submitted to NMED for review according to the process described in 20.6.4.15 NMAC, Subsection C. Results of the complete evaluation will be documented on the *Cover Sheet for the Hydrology Protocol UAA for an Ephemeral Stream*. Figures and maps will be included. Attachments to the UAA will provide data tables, stream survey profiles, and photo documentation of stream conditions.

5. Provisions for Public Notice and Consultation with Government Agencies

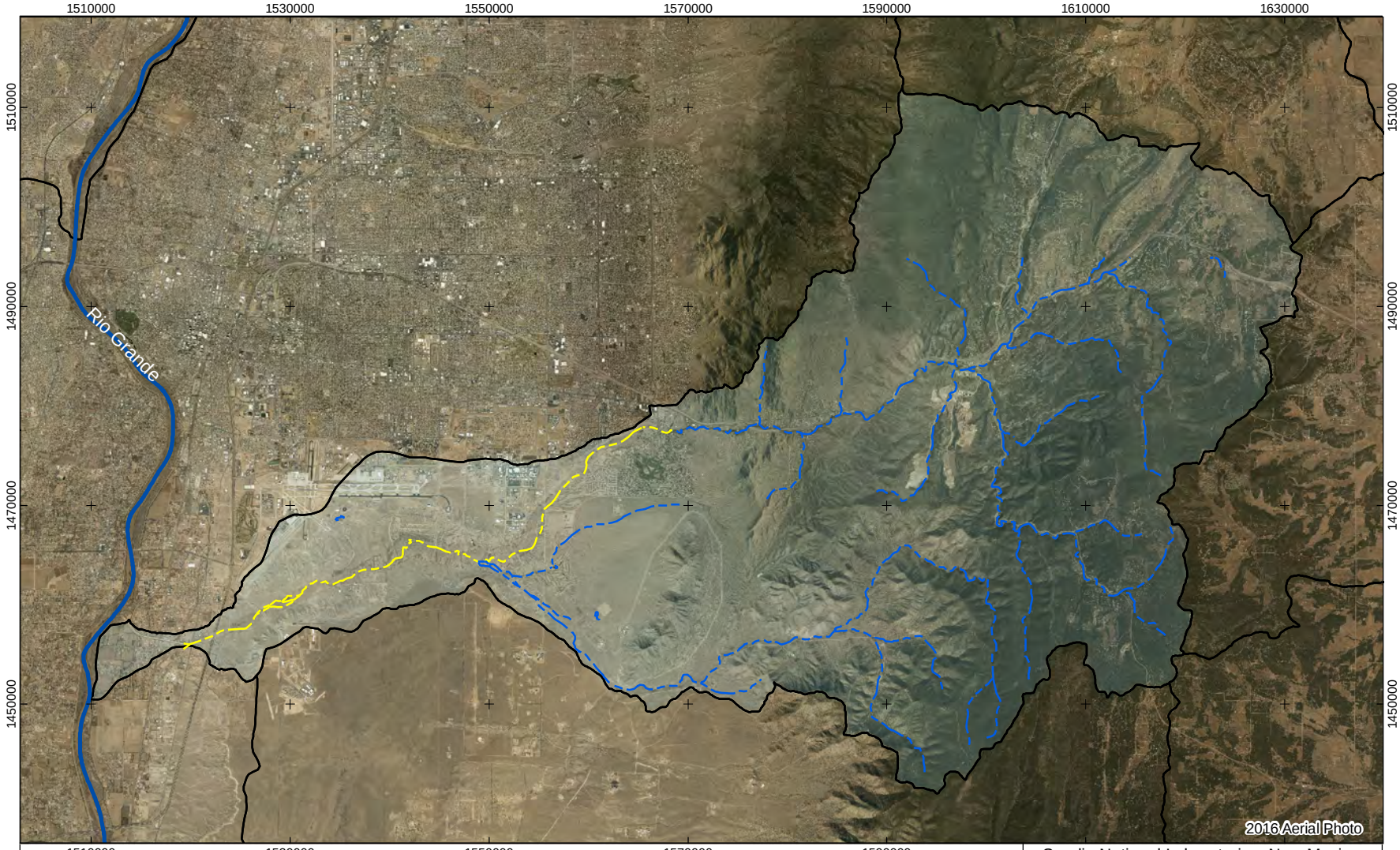
This Work Plan adheres to the UAA process described in 20.6.4 NMAC. NTESS and SFO have consulted with personnel representing Kirtland Air Force Base, Bernalillo County, the City of Albuquerque (COA), and the Albuquerque Metro Area Flood Control Authority (AMAFCA) (the four government entities with jurisdictions through which the reach flows). All of these entities have agreed to provide access for the stream surveys described in Section 3. There are short sections of the reach that pass through privately owned lands; surveys are not being conducted in these sections to minimize inconvenience to the public.

Upon completion of field work, SFO and NTESS will submit the HP UAA to NMED for review. If the UAA demonstrates to the satisfaction of NMED that fishable-swimmable uses are not

attainable in the Tijeras Arroyo (Rio Grande to Four Hills Bridge reach; Assessment Unit ID NM-9000.A_070), the process described in Subsection C of 20.6.4.15 NMAC will be followed. Accordingly, SFO and NTESS will issue a public notice followed by a 30-day public comment period. NMED will publish the UAA on its website and notify interested parties of the 30-day public comment period. After addressing any comments received, SFO and NTESS will submit the final UAA, including a response to comments, to NMED for review and concurrence. NMED will submit the final UAA and response to comments to EPA Region 6 for technical approval. If the technical approval is granted, the reach will be subject to 20.6.4.97 NMAC. NMED will petition the Water Quality Control Commission (WQCC) to list the reach under Subsection C of 20.6.4.97 NMAC during the next triennial review of water quality standards.

If NMED does not concur with the conclusions of the UAA, the third party UAA process described in Subsection D of 20.6.4.15 NMAC may be followed. Under this subsection, SFO and NTESS would petition the WQCC for a regular UAA hearing to modify the water quality standards.

Mapid = sc17210 4/12/17



Legend

- Rio Grande to Four Hills Bridge Reach (NM-9000.A_070)
- Surface Water Drainage
- Rio Grande River

Tijeras Arroyo Watershed (HUC10)

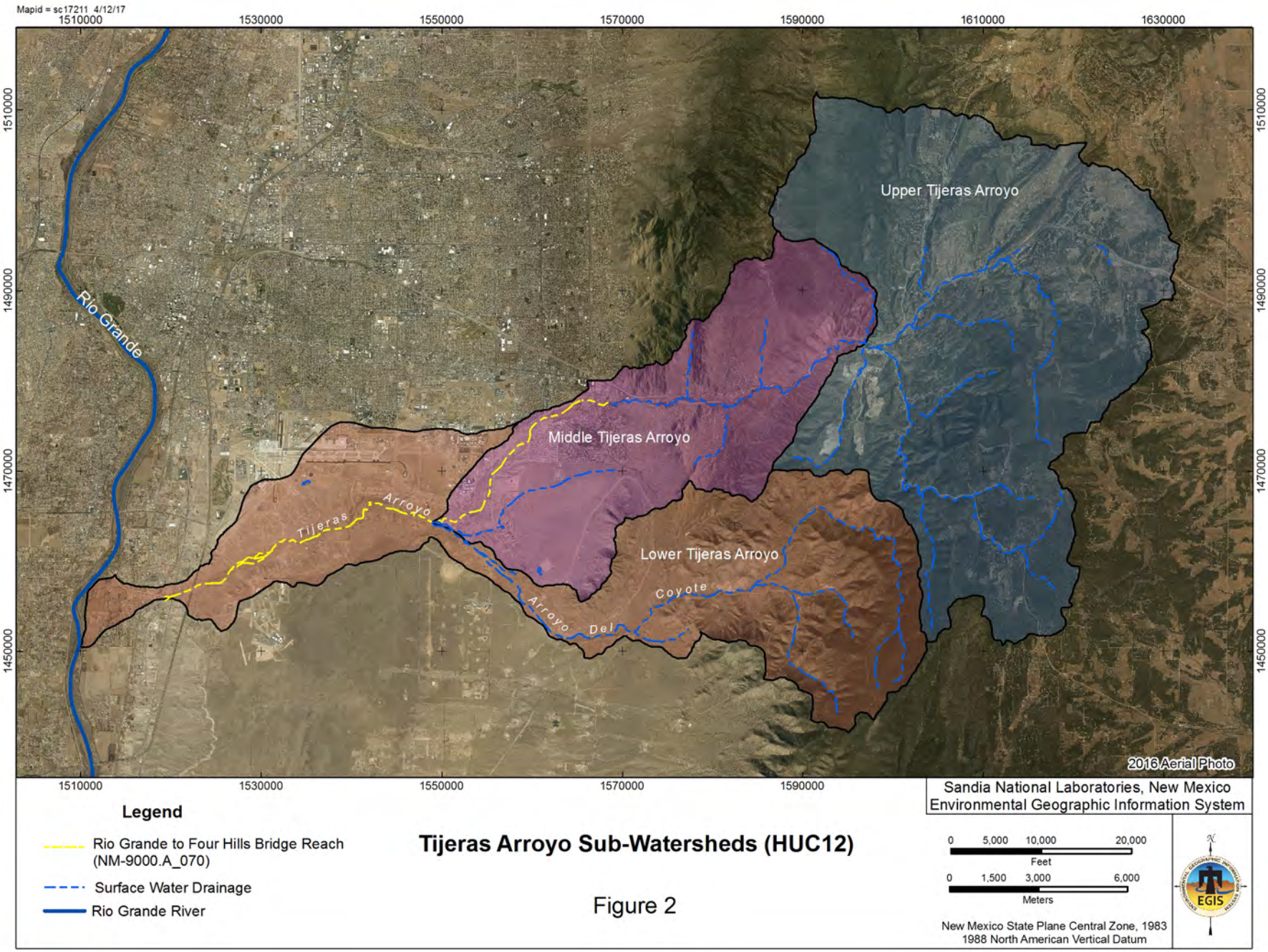
Figure 1

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

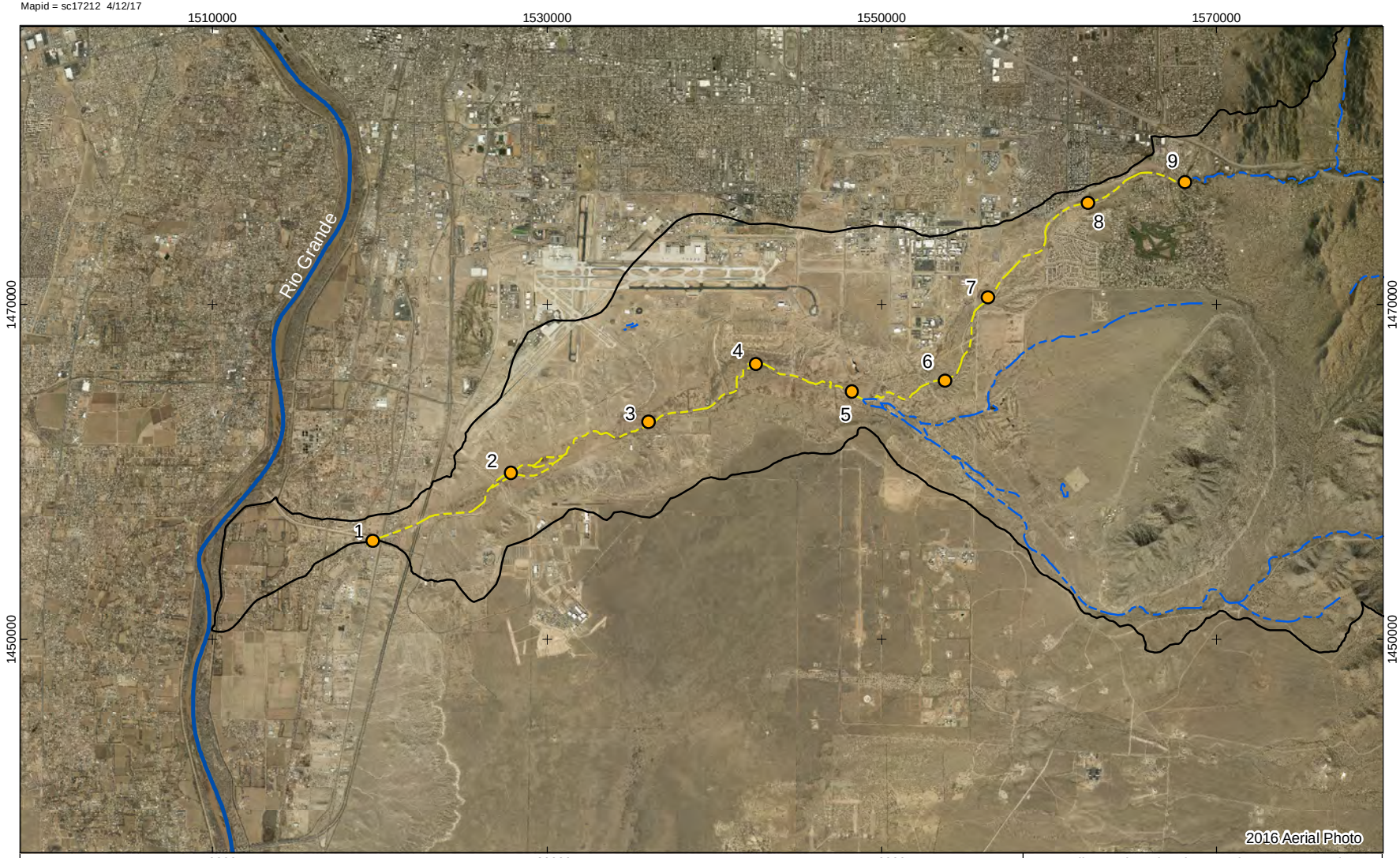
0 5,000 10,000 20,000
Feet

0 1,500 3,000 6,000
Meters

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum


Mapid = sc17211 4/12/17
1510000
1530000
1550000
1570000
1590000
1610000
1630000
1490000
1470000
1450000
Rio Grande
Upper Tijeras Arroyo
Middle Tijeras Arroyo
Lower Tijeras Arroyo
Tijeras Arroyo
Coyote Arroyo Del
2016 Aerial Photo
Legend
Rio Grande to Four Hills Bridge Reach (NM-9000.A_070)
Surface Water Drainage
Rio Grande River
Tijeras Arroyo Sub-Watersheds (HUC12)
Figure 2
Sandia National Laboratories, New Mexico
Environmental Geographic Information System
0 5,000 10,000 20,000
Feet
0 1,500 3,000 6,000
Meters
New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum
N
EGIS

Mapid = sc17212 4/12/17



Legend

- Rio Grande to Four Hills Bridge Reach (NM-9000.A_070)
- Surface Water Drainage
- Rio Grande River
- Tijeras Arroyo Watershed Boundary (HUC10)
- Proposed Survey Location

Proposed Locations for Hydrology Protocol Surveys

Figure 3

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

0 3,250 6,500 13,000
Feet

0 1,000 2,000 4,000
Meters

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Attachment 1

NMED Hydrology Protocol Survey Form

Attachment 2

NMED Hydrology Protocol Cover Sheet

Contents Provided in Appendix B-2

Attachment 3

NMED Comments with SFO/NTESS Responses

Contents Provided in Appendix B-2

NMED Comments and SFO/NTESS Responses

NMED Comment #1: General comment: This UAA work plan appears to be inclusive of the elements that the department incorporates into its own HP UAA work plans. In revising the work plan and drafting the UAA document, SNL is encouraged to review past HP UAAs posted on the bureau's website for elements that make for a successful HP UAA, and reference EPA guidance on the general structure of the UAA. The work plan should not presuppose the conclusion of the UAA.

Response to Comment #1: DOE and NTESS agree with the comment. Past HP UAA's available on the NMED website have been reviewed, EPA guidance is referenced in the work plan, and all presupposition of stream conditions have been removed from the workplan.

NMED Comment #2: General comment: "beneficial uses" and "designated uses" are interchanged throughout this document. For the purpose of this investigation, it is recommended that "designated uses" be applied since *designated use* is defined in the State's water quality standards (20.6.4.7 NMAC) and "beneficial uses" are typically associated with water rights.

Response to Comment #2: DOE and NTESS agree with this comment. The term "beneficial use" has been replaced with "designated use" throughout the work plan.

NMED Comment #3: Substantial elements of the UAA in support of proper hydrologic determination can and should be done prior to field work. This should include, but is not limited to, the aerial photographs/and or satellite imagery noted in section 3.2, page 7. Representative satellite imagery across several years or decades (if available) for the proposed HP field sites should be included as an appendix to the UAA with any identifying features noted.

Response to Comment #3: DOE and NTESS agree with this comment. We will begin compiling the existing information listed in Section 3.2 of the work plan prior to conducting the field portion of the HP UAA. Satellite imagery from numerous years dating back to 1935 will be used to assess changes to the stream over time.

NMED Comment #4: In the introduction, it is noted that the HP UAA is the tool employed to change the designated flow regime of a water of the US/State. To clarify, a UAA is a scientific study designed to assess the factors affecting the attainment of a use (in this case 101(a)(2) uses, a.k.a. "fishable-swimmable" uses, or aquatic life and contact uses). The HP is a methodology for distinguishing between ephemeral, intermittent, and perennial waters in New Mexico, generates documentation of the uses supported by those waters as a result of the flow regime, and provides technical support for the UAA.

Response to Comment #4: DOE and NTESS agree with this comment. The work plan has been modified to provide clarity.

NMED Comment #5: In Section 2, "Background" of the draft work plan, the AU comments in the §303(d)/§305(b) Integrated Report (IR) for Tijeras Arroyo (Rio Grande to Four Hills Bridge) identify the water type as "ephemeral" but specify the designated uses/criteria as intermittent (i.e., 20.6.4.98 NMAC). Pursuant to 20.6.4.11 H NMAC, "[a]n unclassified surface water of the state

is... subject to 20.6.4.98 NMAC if nonperennial or subject to 20.6.4.99 NMAC if perennial." A waterbody may be classified as ephemeral under 20.6.4.97 NMAC only if a UAA demonstrates that attainment of Section 101(a)(2) uses is not feasible. The AU comments provided in the IR are based on preliminary data or best professional judgement, and are used to identify data needs that are essential for management decisions (e.g., to provide technical support for a UAA and hydrologic determination).

Response to Comment #5: DOE and NTESS agree with this comment.

NMED Comment #6: In section 2.1 "stream classifications", the reference to the New Mexico Administrative Code "NMAC" for intermittent and ephemeral waters appear to be inadvertently switched. *i.e.,* Intermittent water bodies are 20.6.4.98, etc.

Response to Comment #6: DOE and NTESS agree with this comment. The references have been corrected.

NMED Comment #7: Section 2.2 "Use Attainability Assessment". SNL's proposed workplan states that a "UAA is a scientific study conducted for assessing if a given water body supports a particular beneficial use". In accordance with 20.6.4.15.A NMAC, a use attainability analysis is a scientific study conducted for the purpose of assessing the factors affecting the attainment of a use. In recounting 40 CFR § 131.1O(g) factors, it is advisable to identify which of the six factors, based on extant data, is believed to apply.

Response to Comment #7: DOE and NTESS agree with the comment. The work plan has been edited to provide clarity. The factors listed in 40 CFR 131.10(g) that are most likely to apply to this UAA are identified in Section 2.2 of the work plan as factors 2 and 5.

NMED Comment #8: While the HP-UAA guidance notes that a Level 1 determination, dependent on scoring may prove to be sufficient, and that the Level 1 HP could conceivably cease based on scoring after indicator number 1.6, the department strongly encourages the HP field data collection team to collect as many indicators as possible (1.1 through 1.14) in support of the highest attainable use determination, especially given the potential anthropogenic influences in this watershed.

Response to Comment #8: DOE and NTESS agree with this comment. Regardless of the score obtained for indicators 1.1 through 1.6, indicators 1.1 through 1.14 will be evaluated in order to provide the most thorough assessment possible.

NMED Comment #9: Wherein questions occur in the field regarding certain indicators, NMED recommends representatives from the SNL collaborate in the field with SWQB to assure proper HP implementation and concurrence on scoring.

Response to Comment #9: DOE and NTESS agree with this comment. DOE and NTESS appreciate any assistance that NMED is willing to provide. Representatives from NMED will provide input and be present during field activities and DOE and NTESS expect that NMED will serve in an advisory capacity rather than an oversight role. DOE and NTESS will serve as project managers and will be responsible for ensuring the HP is conducted according to this work plan and applicable

regulations. HP indicator scores will be developed through consultation with NMED with the goal of reaching a consensus. A final determination will be made by DOE and NTESS. All work will be conducted under the DOE and NTESS health and safety program.

NMED Comment #10: When obtaining new photographic data associated with the HP work such as upstream and downstream aspects, a description of the photo metadata recording and interpretation is necessary. There are several guidance documents on the proper recording of photographic evidence including the United States Department of Agriculture/Forest Service Photo Point Monitoring Handbook, Part A-Field Procedures (General Technical Report PNW-GTR-526, 2001). This handbook is an acceptable resource for photographic data collection. NMED also recommends recording the Standard Precipitation Index for the period associated with any imagery.

Response to Comment #10: DOE and NTESS agree with this comment. Photo Documentation will be conducted at each transect location, including upstream and downstream aspects, according to the methods described in the United States Department of Agriculture/Forest Service Photo Point Monitoring Handbook, Part A- Field Procedures (General Technical Report PNW-GTR-526, 2002).

NMED Comment #11: In Section 3.2 "Compilation of Existing Data": In addition to those existing data sources listed in this section, it would enhance the characterization of the natural hydrology within Tijeras Arroyo if there was the inclusion of the associated geologic and soil characteristics within the watershed.

Response to Comment #11: DOE and NTESS agree with this comment. Geologic maps from the United States Geologic Survey (USGS) and soil maps from the National Resources Conservation Society (NRCS) will be used to describe the local geologic formations and soil types found within the study area. An overview of the geologic setting and history of the area will be provided in the final report.

NMED Comment #12: Section 3.2, "Existing Data-Flow data": This section notes that there is almost 10 years of USGS gage height data (USGS gauging station 08330600), but there also appears that the USGS discharge data at the same site spans 20 years (-1996-Present). The SWQB suggests SNL consider this discharge data for the purposes of this HP UAA, if there is reason to disregard this data set please indicate the reasoning.

Response to Comment #12: DOE and NTESS agree with this comment. All available flow data from USGS gauging station 08330600 will be used.

NMED Comment #13: Section 3.2, "Existing Data-Meteorological data": The Standardized Precipitation Index (SPI) from the National Drought Mitigation Center (NDMC, 1995) is the recommended index for HP investigations. The SPI provides informative background on drought conditions for the period to which data is collected. Ideally, the data collection would occur under a normal precipitation regime however, falling outside the normal precipitation index does not necessarily preclude collection of HP data but would provide the necessary information to determine the veracity of the hydrology protocol findings. The SWQB encourages the

identification and application of other standard precipitation indices (SPEI, for instance) in addition to the SPI, as they may strengthen the establishment of precipitation conditions (a weight of evidence approach).

Response to Comment #13: DOE and NTESS agree with this comment. The SPI from the NDMC will be the primary assessment tool to evaluate drought conditions. For comparison, site-specific climate data will be used to calculate SPI and compare it to the NDMC value. The Palmer Drought Severity Index (PDSI) will also be used to evaluate relative drought conditions.

NMED Comment #14: Section 3.2 "Existing Data": As detailed in 20.6.4.15B NMAC, a use attainability analysis shall assess the physical, chemical, biological, economic or other factors affecting the attainment of a use. This should include identification and characterization of groundwater wells, permitted discharges (as already identified in the work plan), and any water diversions (currently lacking in the work plan) and how they may impact the natural hydrology of Tijeras Arroyo. A ground water contour map, if available, would be helpful in identifying depth to ground water (see definition of "ephemeral' in 20.6.4.7 NMAC) and ground water flow paths to establish the surface water/ground water relationship.

Response to Comment #14: DOE and NTESS agree with this comment. Section 3.2 of the work plan has been updated to specify that groundwater contour maps will be provided, and that all water diversions will be cataloged.

NMED Comment #15: Section 3.3 "Collection of New Data" Table 2: Please include approximate latitude and longitude geospatial data for this table.

Response to Comment #15: Table 2 has been expanded to include the latitude and longitude of each transect location. The assessment locations and coordinates were determined using GIS software. The transect locations in the work plan may be adjusted in the field as conditions dictate to improve exact assessment locations or to maintain safety of field personnel.

NMED Comment #16: Section 3.3 "Collection of New Data": It is suggested that SNL remove suppositions from the text of the collected data parameters *(e.g.,* "flow is not expected"; "aquatic life is not expected to be encountered").

Response to Comment #16: DOE and NTESS agree with this comment. All presuppositions have been removed from the work plan.

NMED Comment #17: Section 4 "Provision for Public Notice and Consultation with Government Agencies": The proper NMAC reference for UAAs is 20.6.4 NMAC, not 20.6.2.4 NMAC. For clarity, NMED recommends that the following paragraphs replace, "A 30-day public review and comment period will be provided once it has been submitted to NMED for review and approval":

> *Upon completion of fieldwork, SNL will draft and submit the HP UAA to NMED for review. If the UAA demonstrates to the satisfaction of NMED that fishable-swimmable uses are not attainable in the water body of interest, the process*

described in Subsection C of 20.6.4.15 NMAC will be followed. Accordingly, SNL will conduct a 30-day public review and comment period. NMED will post the UAA on its website and notify interested parties of the 30-day public comment period. After reviewing any comments received, SNL will submit the final draft UAA, including a response to comments, to NMED for review and concurrence. NMED will submit the final draft UAA and response to comments to EPA Region 6 for technical approval. If technical approval is granted, the water will be subject to 20.6.4.97 NMAC. NMED will petition the Water Quality Control Commission (WQCC) to list ephemeral waters identified through an HP UAA under Subsection C of 20.6.4.97 NMAC during the next triennial review of water quality standards.

If NMED does not concur with the conclusions of the UAA, the third-party UAA process described in Subsection D of 20.6.4.15 NMAC will be followed. Under this subsection, SNL would petition the WQCC for a regular UAA hearing to modify the water quality standards.

Response to Comment #17: DOE and NTESS agree with this comment. The language provided above has been included in the work plan and the citation has been corrected. After adding this language, Sections 4 and 5 were re-ordered.

NMED Comment #18: Section 5 "Reporting" Section: The word "photo" is misspelled.

Response to Comment #18: The typo has been corrected.

Appendix A-2

A printed copy of this document may not be the official version. The official printed copy of this UAA is located in the office of the Environmental Compliance and monitoring (Org. 0641).

NEW MEXICO
ENVIRONMENT DEPARTMENT

SUSANA MARTINEZ
Governor

JOHN A. SANCHEZ
Lt. Governor

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BUTCH TONGATE
Cabinet Secretary

J. C. BORREGO
Deputy Secretary

February 9, 2018

James W. Todd
Assistant Manager for Engineering
U. S. Department of Energy
National Nuclear Security Administration
Sandia Field Office
P. O. Box 5400
Albuquerque, NM 87185

RE: Work Plan: Use Attainability Analysis for Tijeras Arroyo; Rio Grande to Four Hills Bridge Reach (Assessment Unit ID NM-9000.A_70).

Dear Mr. Todd:

On June 20, 2017, the New Mexico Environment Department (NMED or Department) received the above referenced draft work plan via electronic transmission from Sandia National Laboratory/New Mexico (SNL/NM). On July 20, 2017, staff with the NMED Surface Water Quality Bureau (SWQB) met with representatives of SNL/NM to discuss the draft Tijeras Arroyo Hydrology Protocol-Use Attainability Analysis Work Plan (HP-UAA). This work plan proposes performing NMED's Hydrology Protocol to develop a HP-UAA for a section of Tijeras Arroyo from its confluence with the Rio Grande river upstream to the Four Hills Rd SE bridge. On September 21, 2017, the SWQB provided written comments to the work plan to which SNL/NM responded via electronic transmission on December 20, 2017 with a revised work plan for the above-mentioned HP-UAA.

Following review, and pursuant to 20.6.4.15.D New Mexico Administrative Code (NMAC) the workplan as submitted to SWQB on December 20, 2017 (dated October 23, 2017), is hereby approved. In the event SNL/NM determines a deviation from this approved work plan becomes necessary, SNL/NM shall consult with the SWQB to determine the appropriate course of action for the HP-UAA.

If you have any questions or need additional information, please contact Bryan Dail, at bryan.dail@state.nm.us or (505) 476-3799.

Thank you for your patience in this matter.

Sincerely,

Shelly Lemon

Shelly Lemon,
Bureau Chief
Surface Water Quality Bureau

Cc: Darrell Fong, SNL/NM Sandia National Laboratories, P.O. Box 5800 MS 0730, Albuquerque, NM 87185-0730
Kathie Deal, SNL/NM, Sandia National Laboratories, P.O. Box 5800 MS 0730, Albuquerque, NM 87185-0730
John Kay, SNL/NM Sandia National Laboratories, P.O. Box 5800 MS 0730, Albuquerque, NM 87185-0730
Susan Lacy, Sandia Field Office/Engineering, DOE/NNSA, Sandia Field Office, P.O. Box 5400, Albuquerque, NM 87185-5400
Steven Black, Sandia Field Office/Engineering, DOE/NNSA, Sandia Field Office, P.O. Box 5400, Albuquerque, NM 87185-5400
Kris Barrios, Acting Program Manager, Monitoring Assessment and Standards Section, SWQB (via electronic transmission)
Jennifer Fullam, Standards Planning and Reporting Team Leader, SWQB NMED (via electronic transmission)
Bryan Dail, Environmental Scientist & Specialist, SWQB NMED (via electronic transmission)
Heidi Henderson, NMED, TMDL Team Leader, (via electronic transmission)

Appendix B: Regulatory Guidance Documents

No.	Description
B-1	NMED Hydrology Protocol Field Sheets
B-2	UAA Regulatory Review and Approval Process

Appendix B-1

A printed copy of this document may not be the official version. The official printed copy of this UAA is located in the office of the Environmental Compliance and monitoring (Org. 0641).

COVER SHEET
Hydrology Protocol Use Attainability Analysis
For an Ephemeral Stream

Available at the SWQB Hydrology Protocol website:
(http://www.nmenv.state.nm.us/swqb/Hydrology/index.html)

Cover Sheet
Hydrology Protocol Use Attainability Analysis
for an Ephemeral Stream[1]

Stream Name:	Basin:	8-digit HUC:
Reach Description:	**Upstream lat/long:**	**Downstream lat/long:**
Current WQS		**Assessment Unit ID:**
☐ Unclassified 20.6.4.98 or 99 NMAC ☐ Classified 20.6.4. _____ NMAC		

Reach Evaluation (How homogeneity of reach hydrology was verified)	
Methods Used:	(ex. aerial photos, "ground truthing", Google™ Earth, etc.)
Reasoning:	Why is the stream homogeneous?

Hydrology Protocol Results		**Notes**
Location 1 (lat/long):	☐ eph ☐ int ☐ per	
Location 2 (lat/long):	☐ eph ☐ int ☐ per	
Location 3 (lat/long):	☐ eph ☐ int ☐ per	
☐ Additional location results attached.		

Hydroclimatic Conditions		**If "yes" please describe.**
Drought (SPI Value < - 1.5)	☐ yes ☐ no	
Recent Rainfall (within 48 hours)	☐ yes ☐ no	
Gauge data available?	☐ yes ☐ no	
If yes for any of above, please explain why these conditions do not impact the UAA conclusion that *natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use*:		

Hydrologic and Other Modifications		**If "yes" please describe.**
Dam/diversion	☐ yes ☐ no	
Channelization/roads	☐ yes ☐ no	
Groundwater pumping	☐ yes ☐ no	
Agricultural return flows	☐ yes ☐ no	
Existing point source discharge	☐ yes ☐ no	
Planned point source discharge	☐ yes ☐ no	

[1] This form is designed for the UAA process for ephemeral waters described in Subsection C of 20.6.4.15 NMAC.

Hydrologic and Other Modifications		If "yes" please describe.
Other modifications e.g., land use practices	☐ yes ☐ no	*Please explain hydrologic impact*
If yes for any of above, please explain why these modifications do not alter the uses supported by the natural flow regime:		

Current Uses Observed		If "yes" please describe.
Macroinvertebrates	☐ yes ☐ no	
Fish	☐ yes ☐ no	
Recreation (contact use)	☐ yes ☐ no	
If yes for any of the above, please explain why these observed uses are consistent with the UAA conclusion that 101(a)(2) aquatic life and recreational uses are not feasible:		

Additional Comments:

ATTACHMENTS:

☐ Map and Photos (required)
☐ Hydrology Protocol Field Sheets for all locations (required)
☐ Level 2 Analysis (optional)
☐ Additional sites and/or documentation (optional)

CONCLUSION:

This UAA concludes that the stream reach identified above is ephemeral and that Clean Water Act Section 101(a)(2) aquatic life and recreational uses are neither existing nor attainable due to the factor identified in 40 CFR 131.10(g)(2): *natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent.* Based on this conclusion, we recommend that the designated uses and criteria identified in 20.6.4.97 NMAC be applied to this stream reach in accordance with the UAA process set forth in Subsection C of 20.6.4.15 NMAC.

Submitted by:

Signed: _____ Date: _____

Surface Water Quality Bureau concurs with recommendation. ☐ Yes ☐ No

If no, see attached reasons.

Signed: _____ Date: _____

EPA Region 6 technical approval granted. ☐ Yes ☐ No

If no, see attached reasons.

Signed: _____ Date: _____

HYDROLOGY DETERMINATION
FIELD SHEETS

Available at the SWQB Hydrology Protocol website:
(http://www.nmenv.state.nm.us/swqb/Hydrology/index.html)

NMED Surface Water Quality Bureau – LEVEL 1 Hydrology Determination Field Sheet

Date:	**Stream Name:**	**Latitude:**
Evaluator(s):	**Site ID:**	**Longitude:**
TOTAL POINTS: *Stream is at least intermittent if ≥ 12*	**Assessment Unit:**	**Drought Index (12-mo. SPI Value):**

WEATHER CONDITIONS	**NOW:** ___ storm (heavy rain) ___ rain (steady rain) ___ showers (intermittent) ___ %cloud cover ___ clear/sunny	**PAST 48 HOURS:** ___ storm (heavy rain) ___ rain (steady rain) ___ showers (intermittent) ___ %cloud cover ___ clear/sunny	**Has there been a heavy rain in the last 48 hours?** ___ **YES** ___ **NO** **Field evaluations should be performed at least 48 hours after the last known major rainfall event. **OTHER:** **Stream Modifications** ___ **YES** ___ **NO** **Diversions** ___ **YES** ___ **NO** **Discharges** ___ **YES** ___ **NO** ****Explain in further detail in NOTES section**

LEVEL 1 INDICATORS	**STREAM CONDITION**			
	Strong	**Moderate**	**Weak**	**Poor**
1.1. Water in Channel	Flow is evident throughout the reach. Moving water is seen in riffle areas but may not be as evident throughout the runs.	Water is present in the channel but flow is barely discernable in areas of greatest gradient change (i.e. riffles) or floating object is necessary to observe flow.	Dry channel with standing pools. There is some evidence of base flows (i.e. riparian vegetation growing along channel, saturated or moist sediment under rocks, etc)	Dry channel. No evidence of base flows was found.
	6	**4**	**2**	**0**
1.2. Fish	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Fish are not present.
	3	**2**	**1**	**0**
1.3. Benthic Macroinvertebrates	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Macroinvertebrates are not present.
	3	**2**	**1**	**0**
1.4. Filamentous Algae/Periphyton	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Filamentous algae and/or periphyton are not present.
	3	**2**	**1**	**0**
1.5. Differences in Vegetation	Dramatic compositional differences in vegetation are present between the stream banks and the adjacent uplands. A distict riparian vegetation corridor exists along the entire reach – riparian, aquatic, or wetland species dominate the length of the reach.	A distinct riparian vegetation corridor exists along part of the reach. Riparian vegetation is interspersed with upland vegetation along the length of the reach.	Vegetation growing along the reach may occur in greater densities or grow more vigorously than vegetation in the adjacent uplands, but there are no dramatic compositional differences between the two.	No compositional or density differences in vegetation are present between the streambanks and the adjacent uplands.
	3	**2**	**1**	**0**
1.6. Absence of Rooted Upland Plants in Streambed	Rooted upland plants are absent within the streambed/thalweg.	There are a few rooted upland plants present within the streambed/thalweg.	Rooted upland plants are consistently dispersed throughout the streambed/thalweg	Rooted upland plants are prevalent within the streambed/thalweg.
	3	**2**	**1**	**0**
			SUBTOTAL (#1.1 – #1.6)	

If the stream being evaluated has a subtotal ≤ 2 at this juncture, the stream is determined to be EPHEMERAL.
If the stream being evaluated has a subtotal ≥ 18 at this point, the stream is determined to be PERENNIAL.
YOU MAY STOP THE EVALUATION AT THIS POINT. If the stream has a subtotal between 2 and 18 continue the Level 1 Evaluation.

LEVEL 1 INDICATORS	STREAM CONDITION			
	Strong	Moderate	Weak	Poor
1.7. Sinuosity	**Ratio > 1.4.** Stream has numerous, closely-spaced bends, few straight sections.	**Ratio < 1.4.** Stream has good sinuosity with some straight sections.	**Ratio < 1.2.** Stream has very few bends and mostly straight sections.	**Ratio = 1.0.** Stream is completely straight with no bends.
	3	**2**	**1**	**0**
1.8. Floodplain and Channel Dimensions	**Ratio > 2.5.** Stream is minimally confined with a wide, active floodplain.	**Ratio between 1.2 and 2.5.** Stream is moderately confined. Floodplain is present, but may only be active during larger floods.	**Ratio < 1.2.** Stream is incised with a noticeably confined channel. Floodplain is narrow or absent and typically disconnected from the channel.	
	3	**1.5**	**0**	
1.9. In-Channel Structure: Riffle-Pool Sequence	Demonstrated by a frequent number of riffles followed by pools along the entire reach. There is an obvious transition between riffles and pools.	Represented by a less frequent number of riffles and pools. Distinguishing the transition between riffles and pools is difficult.	Stream shows some flow but mostly has areas of pools or of riffles.	There is no sequence exhibited.
	3	**2**	**1**	**0**
			SUBTOTAL (#1.1 – #1.9)	

If the stream being evaluated has a subtotal ≤ 5 at this juncture, the stream is determined to be EPHEMERAL.
If the stream being evaluated has a subtotal ≥ 21 at this point, the stream is determined to be PERENNIAL.
YOU MAY STOP THE EVALUATION AT THIS POINT. If the stream has a subtotal between 5 and 21 continue the Level 1 Evaluation.

1.10. Particle Size or Stream Substrate Sorting	Particle sizes in the channel are noticeably different from particle sizes in areas close to but not in the channel. There is a clear distribution of various sized substrates in the stream channel with finer particles accumulating in the pools, and larger particles accumulating in the riffles/runs.	Particle sizes in the channel are moderately similar to particle sizes in areas close to but not in the channel. Various sized substrates are present in the stream channel and are represented by a higher ratio of larger particles (gravel/cobble).	Particle sizes in the channel are similar or comparable to particle sizes in areas close to but not in the channel. Substrate sorting is not readily observed in the stream channel.
	3	**1.5**	**0**

1.11. Hydric Soils	Hydric soils are found within the study reach.	Hydric soils are not found within the study reach.
	Present = 3	**Absent = 0**

1.12. Sediment on Plants and Debris	Sediment found readily on plants and debris within the stream channel, on the streambank, and within the floodplain throughout the length of the stream.	Sediment found on plants or debris within the stream channel although it is not prevalent along the stream. Mostly accumulating in pools.	Sediment is isolated in small amounts along the stream.	No sediment is present on plants or debris.
	1.5	**1**	**0.5**	**0**
				TOTAL POINTS (#1.1 – #1.12)

SUPPLEMENTAL INDICATORS: **The following indicators do not occur consistently throughout New Mexico but may be useful in the determination of perenniality. If the indicator is present record score below and tally with previous score to compute TOTAL.**

1.13. Seeps and Springs	Seeps and springs are found within the study reach.	Seeps and springs are not found within the study reach.
	Present = 1.5	**Absent = 0**
1.14. Iron Oxidizing Bacteria/Fungi	Iron-oxidizing bacteria and/or fungi are found within the study reach.	Iron-oxidizing bacteria and/or fungi are not found within the study reach.
	Present = 1.5	**Absent = 0**
		TOTAL *plus* SUPPLEMENTAL POINTS (#1.1 – #1.14)

NMED Surface Water Quality Bureau – LEVEL 1 Hydrology Determination Field Sheet

Photo Descriptions and NOTES

Photo #	Description (US, DS, LB, RB, etc.)	Notes

NOTES:

LEVEL 1 Field Measurements

Pebble Count Tally Sheet

Site Name: _____ **Storet ID:** _____

Date: _____ **Crew:** _____

Substrate Type	Diameter Range	In-Channel COUNT	In-Channel % Composition	Out of Channel COUNT	Out of Channel % Composition
Silt/Clay	< 0.06 mm				
Sand	0.06 – 2.0 mm (gritty)				
Gravel	2.0 – 64 mm				
Cobble	64 – 256				
Boulder	> 256 mm				
Bedrock	---				

****Please be sure to measure at least 50 pebbles (10 in 5 transects or 5 in 10 transects-depending on stream size) for accurate distributional representation****

INDICATOR #1.8 (*Floodplain and Channel Dimensions*) – MEASUREMENTS & CALCULATIONS**							
Max Depth (#1)	**Bankfull Stage (#2)**	**Maximum Depth Value (#3)**	**2x Maximum Depth Value (#3)**	**Flood-Prone Area Location (#4)**	**Flood-Prone Area Width (#5)**	**Bankfull Width (#6)**	**Floodplain to Active Channel Ratio** (FPA Width / Bankfull Width)

****REFER to Figure 3 on page 19 for clarification**

NMED Surface Water Quality Bureau –
LEVEL 2 Hydrology Determination Field Sheet
Borderline Cases

Date:	Stream Name:	Latitude:
Evaluator(s):	Site ID:	Longitude:
LEVEL 1 Total Points:	Reach Description:	Drought Index (12-mo. SPI Value):

WEATHER CONDITIONS	**NOW:** ___ storm (heavy rain) ___ rain (steady rain) ___ showers (intermittent) ___ %cloud cover ___ clear/sunny	**PAST 48 HOURS:** ___ storm (heavy rain) ___ rain (steady rain) ___ showers (intermittent) ___ %cloud cover ___ clear/sunny	**Has there been a heavy rain in the last 48 hours?** ___ **YES** ___ **NO** **Field evaluations should be performed at least 48 hours after the last known major rainfall event. **OTHER:** **Stream Modifications** ___ **YES** ___ **NO** **Diversions** ___ **YES** ___ **NO** **Discharges** ___ **YES** ___ **NO** ****Explain in further detail in NOTES section

CHECK the appropriate rating for each indicator.

LEVEL 2 INDICATORS	Stream Condition			
	Strong	Moderate	Weak	Poor
2.1. Water in Channel (OPTIONAL)				
2.2. Hyporheic Zone/Groundwater Table				
2.3. Bivalves	**Present =** ___		**Absent =** ___	
2.4. Amphibians	**Present =** ___		**Absent =** ___	
2.5. Macroinvertebrates (abundance/diversity)**				
2.6. EPT Taxa**	**Present =** ___		**Absent =** ___	
2.7. Fish				

** Macroinvertebrates and EPT Taxa should not be rated until identification and enumeration has been performed in a laboratory setting by a qualified aquatic biologist/environmental scientist.

Photo #	Description (US, DS, LB, RB)	Notes

NOTES: (use back-side of this form for additional notes)

_____

_____

_____

Thermograph Deployment/Download/Retrieval Field Sheet

(Last Revision 01/03/2007)

Thermograph #: HOBO / StowAway

Staff at deployment:

Assessment unit:

Water Quality Standards segment: 20.6.4.

Station name/STORET ID:

Location description:

Lat/Long: **GPS: Y / N**

Date/time deployed:

Medium: Water / Air

Estimate % shade on thermograph:

Download record:	Date	Time removed	Time replaced	Staff	Comments
Download 1					
Download 2					
Download 3					
Download 4					
Retrieval:					

File name:

Additional comments:

Cross section sketch:

Plan view sketch:

Write good directions, draw a good site map, and note triangulation distances.

Take photos from 2 angles (have someone point to or stand next to the thermograph):

PHOTO 1 Description

PHOTO 2 Description

FISH SAMPLING FIELD DATA SHEET

Stream name:			MSB Field No.
Location:			Station ID
Lat N_____ Lon W_____ GPS?		River basin:	
Elevation _____ m	Investigators:		
Designated Use:		Agency:	
Form completed by:	Date: Time:	Reason for survey:	

SAMPLE COLLECTION	**Gear** ❑ back pack (Model: _____) ❑ seine (Size/mesh: _____) ❑ other _____ **Block nets used?** ❑ Upstream ❑ Downstream ❑ None **Barrier extant?** ❑ Upstream ❑ Downstream **Sampling Duration** Start time _____ End time _____ Shock seconds _____ **Stream width (m)** Max_____Mean_____ **Reach length (m)** _____ **Passes:** _____ Specific conductance _____µS/cm Shocker voltage_____ Shocker settings_____ Water temp _____°C Coincident with habitat survey? ❑ Yes ❑ No Reference reach candidate? ❑ Yes ❑ No
HABITAT TYPES	**Indicate the percentage of each habitat type present** ❑ Riffles_____%❑ Pools_____% ❑ Runs_____% ❑ Snags_____% ❑ Submerged Macrophytes_____% ❑ Other ( )_____%
GENERAL COMMENTS	

SPECIES	TOTAL (COUNT)	OPTIONAL: Length (mmTL)/Weight (g) (40 SPECIMEN SUBSAMPLE)					ANOMALIES*							
							D	E	F	L	M	S	T	Z

SPECIES	TOTAL (COUNT)	OPTIONAL: Length (mmTL)/Weight (g) (40 SPECIMEN SUBSAMPLE)					ANOMALIES*							
							D	E	F	L	M	S	T	Z

Appendix B-2

A printed copy of this document may not be the official version. The official printed copy of this UAA is located in the office of the Environmental Compliance and monitoring (Org. 0641).

UAA Actions and Regulatory Crosswalk

Action	Timeline	CWA	40 CFR	WQA	NMAC	WQMP/CPP	Other
Workplan submitted to Department for review and approval	no defined time for EPA or NMED approval				**20.6.4.15.D NMAC** Any person may submit notice to the department stating the intent to conduct a use attainability analysis. The proponent shall develop a work plan to conduct the use attainability analysis and shall submit the work plan to the department and region 6 EPA for review and comment. Upon approval of the work plan by the department, the proponent shall conduct the use attainability analysis in accordance with the approved work plan.		
Conduct Use Attainability Analysis	defined by petitioner		**40 CFR §130.10** States may designate a use, or remove a use that is *not* an existing use, if the State conducts a use attainability analysis as specified in paragraph (j) of this section that demonstrates attaining the use is not feasible because of one of the six factors in this paragraph. If a State adopts a new or revised water quality standard based on a required use attainability analysis, the State shall also adopt the highest attainable use, as defined in §131.3(m)		**20.6.4.15.D NMAC** Upon approval of the work plan by the department, the proponent shall conduct the use attainability analysis in accordance with the approved work plan.		
Submit UAA to SWQB for review	not defined but dependent on information and data provided in UAA				**20.6.4.15.D NMAC** Upon completion of the use attainability analysis, the proponent shall submit the data, findings and conclusions to the department.		
Submit UAA to EPA for technical review	not defined but dependent on information and data provided in UAA						Although not required, input from EPA's review will be submitted as exhibits and testimony for the hearing
Informal stakeholder meetings	none defined so long as sufficient effort made to engage stakeholders					**WQMP/CPP** Public Participation for Water Quality Standards	Information demonstrating outreach with affected stakeholders will be needed for the hearing
Public Comment Period for UAA	Generally no less than 30 days		**40 CFR §131.20** The proposed water quality standards revision and supporting analyses shall be made available to the public prior to the hearing. 40 CFR 25.4 (summarized) encourage and facilitate the public's participation; provide infomrational materials on continuing policy, program, and technical information and assistance; provide one or more central collections of reports, studies, plans in convenient locations; provide copies of documents to the public free or no more than commercial copying costs; maintain an interested parties list. Public notification should be provided far enough in advance of action to permit time for public response (should be no less than 30 days). Public notification should include timetable, issues under consideration, alternative courses of action, listing of applicable laws or regulations, location of available documents, public participation opportunites, contact info. 40 CFR 25.8Each agency which conducts any activities required under this part shall prepare a Responsiveness Summary at specific decision points as specified in program regulations or in the approved public participation work plan. Responsiveness Summaries are also required for rulemaking activities under § 25.10. Each Responsiveness Summary shall identify the public participation activity conducted; describe the matters on which the public was consulted; summarize the public's views, significant comments, criticisms and suggestions; and set forth the agency's specific responses in terms of modifications of the proposed action or an explanation for rejection of proposals made by the public. Responsiveness Summaries prepared by agencies receiving EPA financial assistance shall also include evaluations by the agency of the effectiveness of the public participation program. Assisted agencies shall request such evaluations from any advisory group and provide an opportunity for other participating members of the public to contribute to the evaluation. (In the case of programs with multiple responsiveness summary requirements, these analyses need only be prepared and submitted with the final summary required.) Responsiveness summaries shall be forwarded to the appropriate decision-making official and shall be made available to the public. Responsiveness Summaries shall be used as part of evaluations required under this part or elsewhere in this chapter.			**WQMP/CPP** Public Participation for Water Quality Standards	Information demonstrating adequate outreach to solicit input from the public will be needed for the hearing

UAA Actions and Regulatory Crosswalk

Action	Timeline	CWA	40 CFR	WQA	NMAC	WQMP/CPP	Other
Public Meetings	not defined but generally held in first 2 weeks of public comment period to allow for adequate time for public to provide comment if warranted		**40 CFR 25.6** Public meetings are any assemblies or gathering, (such as conferences, informational sessions, seminars, workshops, or other activities) which the responsible agency intends to be open to anyone wishing to attend. Public meetings are less formal than public hearings. They do not require formal presentations, scheduling of presentations and a record of proceedings. The requirements of § 25.5 (b) and (c) are applicable to public meetings, except that the agency holding the meeting may reduce the notice to not less than 30 days if there is good reason that longer notice cannot be provided. **40 CFR 25.5** (b)Notice. A notice shall be well publicized, and shall also be mailed to the appropriate portions of the list of interested and affected parties required by § 25.4(b)(5). Except as otherwise specifically provided elsewhere in this chapter, these actions must occur at least 45 days prior to the date. However, where EPA determines that there are no substantial documents which must be reviewed for effective hearing participation and that there are no complex or controversial matters to be addressed by the hearing, the notice requirement may be reduced to no less than 30 days. EPA may further reduce or waive the hearing notice requirement in emergency situations where EPA determines that there is an imminent danger to public health. To the extent not duplicative, the agency holding the hearing shall also provide informal notice to all interested persons or organizations that request it. The notice shall identify the matters to be discussed at the meeting and shall include or be accompanied by a discussion of the agency's tentative determination on major issues (if any), information on the availability of a bibliography of relevant materials (if deemed appropriate), and procedures for obtaining further information. Reports, documents and data relevant to the discussion at the public hearing shall be available to the public at least 30 days before the hearing. Earlier availability of materials relevant to the hearing will further assist public participation and is encouraged where possible. (c)Locations and time. Hearings must be held at times and places which, to the maximum extent feasible, facilitate attendance by the public. Accessibility of public transportation, and use of evening and weekend hearings, should be considered. In the case of actions with Statewide interest, holding more than one hearing should be considered.			**WQMP/CPP** Public Participation for Water Quality Standards	Information demonstrating adequate outreach to solicit input from the public will be needed for the hearing
Response to comments (EPA, SWQB and Public) and revise UAA	to be determined by petitioner						Information demonstrating adequate outreach to solicit input from the public will be needed for the hearing
Petition WQCC to be placed on agenda to request a public hearing with a proposed date for such hearing	up to 90 days to petition the WQCC-usually within 30-60 depending on WQCC's meeting schedule		**40 CFR §131.20** The State shall hold one or more public hearings for the purpose of reviewing water quality standards as well as when revising water quality standards, in accordance with provisions of State law and EPA's public participation regulation (40 CFR part 25).	**NM WQA 74-6-6.A NMSA 1978** No regulation or water quality standard or amendment or repeal thereof shall be adopted until after a public hearing.	**20.6.4.15 NMAC** **20.1.6.200 NMAC** WQCC The commission shall determine, at a public meeting occurring no later than *90 days* after receipt of the petition, whether or not to hold a public hearing on the proposal.	**WQMP/CPP** Public Participation for Water Quality Standards	
Hearing notice published in NM Register	At least 60 days prior to hearing but this is dependent on NM Register publication dates and the petitioner's internal procurement process timelines that need to be accounted for.			**NM WQA 74-6-6 NMSA 1978**; At least thirty days prior to the hearing date, notice of the hearing shall be published in the New Mexico register ...	**20.1.6.201 NMAC** Unless otherwise allowed by governing law and specified by the commission, the commission shall provide to the public notice of the proposed rulemaking *at least 60 days prior to the hearing* . Public notice for proposed regulatory changes of general application to the state shall include publication … in the New Mexico register.	**WQMP/CPP** Public Participation for Water Quality Standards	
Hearing notice published in one newspaper of general circulation and in a newspaper of general circulation in the area affected	At least 60 days prior to hearing but this is dependent on newspaper publication dates and the petitioner's internal procurement process timelines that need to be accounted for			**NM WQA 74-6-6 NMSA 1978**; At least thirty days prior to the hearing date, notice of the hearing shall be published in …a newspaper of general circulation in the area affected and mailed to all persons who have made a written request to the commission for advance notice of hearings and who have provided the commission with a mailing address.	**20.1.6.201 NMAC**; … the commission shall provide to the public notice of the proposed rulemaking *at least 60 days prior to the hearing* . Public notice for proposed regulatory changes of general application to the state shall include publication in at least one newspaper of general circulation in the state... Notice for proposed regulatory changes that are confined in effect to a specific geographic area shall also be published in a newspaper of general circulation in the area affected.	**WQMP/CPP** Public Participation for Water Quality Standards	

UAA Actions and Regulatory Crosswalk

Action	Timeline	CWA	40 CFR	WQA	NMAC	WQMP/CPP	Other
Hearing notice sent to other interested parties	At least 60 days prior to hearing			**NM WQA 74-6-6 NMSA 1978**; At least thirty days prior to the hearing date, notice of the hearing shall be …mailed to all persons who have made a written request to the commission for advance notice of hearings and who have provided the commission with a mailing address.	**20.1.6.201 NMAC** …the commission shall provide to the public notice of the proposed rulemaking *at least 60 days prior to the hearing* .Public notice for proposed regulatory changes of general application to the state shall include … other means of providing notice as the commission may direct or are required by law.		
Retain court reporter to record transcript of hearing	Dependent on availability of court reporter schedule and petitioner's internal procurement processes				**20.1.6.303.A NMAC** Unless specified by the commission or the hearing officer, a verbatim transcript shall be made of the hearing, including any deliberations. The cost of the original transcript of the proceeding and of providing a copy for each commission member shall be borne by the petitioner		
Filing of Notice of Intent to testify and prepare written testimony and exhibits	Must file on scheduling order and no later than 20 days before hearing			**NM WQA 74-6-6.D NMSA 1978** At the hearing, the commission shall allow all interested persons reasonable opportunity to submit data, views or arguments orally or in writing and to examine witnesses testifying at the hearing.	**20.1.6.203 NMAC** Any person may file an entry of appearance as a party. The entry of appearance shall be filed *no later than 20 days* before the date of the hearing on the petition.		
Hearing with oral testimony, presentation of exhibits and cross-examination	Dependent on content and complexity of petition can be anywhere from 1 hour to several days.			**NM WQA 74-6-6.A NMSA 1978** No regulation or water quality standard or amendment or repeal thereof shall be adopted until after a public hearing.	**20.1.6.300 NMAC** HEARING PROCEDURES - CONDUCT OF HEARINGS **20.1.6.301 NMAC** TESTIMONY AND CROSS-EXAMINATION **20.1.6.302 NMAC** EXHIBITS	**WQMP/CPP** Public Participation for Water Quality Standards	
WQCC's Deliberation and Decision of the proposed Rule	Depending on complexity of petition and evidence submitted, can be anywhere from immediate deliberation to up to 60 days following close of the record			**NM WQA 74-6-4.E NMSA 1978** directs the commission to adopt, promulgate and publish regulations.	**20.1.6.306 NMAC** If a quorum of the commission attended the hearing, and if the hearing notice indicated that a decision might be made at the conclusion of the hearing, the commission may immediately deliberate and make a decision on the proposed regulatory change….The commission shall reach its decision on the proposed regulatory change within *60 days following the close of the record* or the date the hearing officer's report is filed, whichever is later.	**WQMP/CPP** Public Participation for Water Quality Standards	
NMED's Publication and Effect of Rule for State and federal CWA purposes.	30 days after filing the rule in accordance with State Records-but this filing is dependent on bi-monthly publication dates of the NM register, acquiring purchase order for publication and physical filing of the amendment following review of the State Records Analyst. Effective date for CWA purposes is within 90 days of submitting to EPA.	**33 U.S.C. § 1313** If the Administrator, within sixty days after the date of submission of the revised or new standard, determines that such standard meets the requirements of this chapter, such standard shall thereafter be the water quality standard for the applicable waters of that State. If the Administrator determines that any such revised or new standard is not consistent with the applicable requirements of this chapter, *he shall*	**40 CFR § 131.20** The State shall submit the results of the review, any supporting analysis for the use attainability analysis, the methodologies used for site-specific criteria development, any general policies applicable to water quality standards and any revisions of the standards to the Regional Administrator for review and approval, within 30 days of the final State action to adopt and certify the revised standard... **40 CFR § 131.21** After the State submits its officially adopted revisions, the Regional Administrator shall either: (1) Notify the State within 60 days that the revisions are approved, or (2) *Notify the State within 90 days that the revisions are disapproved* .	**74-6-6 NMSA 1978** No regulation or water quality standard or amendment or repeal thereof adopted by the commission shall become effective *until thirty days after its filing* in accordance with the provisions of the State Rules Act			

Appendix C – Climate Data

No.	Description
C-1	Standardized Precipitation Index Memorandum
C-2	Historic Precipitation Summary

Appendix C-1

A printed copy of this document may not be the official version. The official printed copy of this UAA is located in the office of the Environmental Compliance and monitoring (Org. 0641).

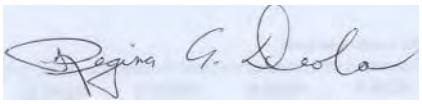
Sandia National Laboratories

Operated for the U.S. Department of Energy by
Sandia Corporation

Albuquerque, New Mexico 87185-0729

date: June 11, 2019

to: John Kay, MS-0730 (0641)



from: Regina A. Deola, MS-0730 (0643)

subject: Local Standardized Precipitation Index to Support the Tijeras Arroyo Use Attainability Study

The Standardized Precipitation Index (SPI) is a single numeric value to represent areal moisture conditions that can be compared across climatic regions. Technically the SPI is the number of standard deviations that the observed measurement would deviate from long term values based on the specific time scale being evaluated. The SPI was developed to express the fact that depending on the time scale being reviewed, the area of interest can be both wet and dry. Table 1 shows the SPI values over various time scales for New Mexico Climate Division 5, Central Valley. Table 1 data reflect the regional SPI values based on the end of May 2019, for the period of record available for the region.

Table 1. SPIs for the Central Valley Region of NM [climate region 5] through May of 2019.

Time Scale in Months	6	9	12	18	24	36	48
Accumulated Precipitation (in.)	3.14	6.93	12.14	13.27	20.33	30.77	41.91
Departure from Normal (in.)	0.21	1.07	1.55	-0.24	-0.84	-0.97	-0.38
Standardized Precipitation Index	0.31	0.58	0.63	0	-0.15	-0.13	-0.01

The local 12-month SPI was calculated to support the Tijeras arroyo study using the precipitation recorded at the A21 monitoring location. Data treatment to develop local SPIs include long time series analyses and gamma transformations of the data. The National Drought Mitigation Center (NDMC) website includes a tool to complete the time series and gamma transformation that is used in the development of the SPI. The tool can be found at the following URL: https://drought.unl.edu/droughtmonitoring/SPI/SPIProgram.aspx.

A 23 year and 50 year time series was used to evaluate the local SPI through May of 2019. The 50 year time series was completed using National Weather Service data from the International Sunport dating back to 1979 to ensure a robust analysis. Figure 1 shows the progression of the 12-month SPI values and TA-II monthly precipitation since June of 2017. The local SPI as of the end of May 2019 is approximately 1.5, a bit wetter than the areal averaged NM climate division value of 0.63 identified in Table 1.

The current conditions are well above the study requirement for the SPI to be above -1.5. While the climate region is generally characterized as near normal [-0.74 to + 0.74] by the NDMC, the local area is

trending very wet [1.25 -1.99] using the 50 year time series. This indicates a wet period and an excellent time for this study to be conducted.

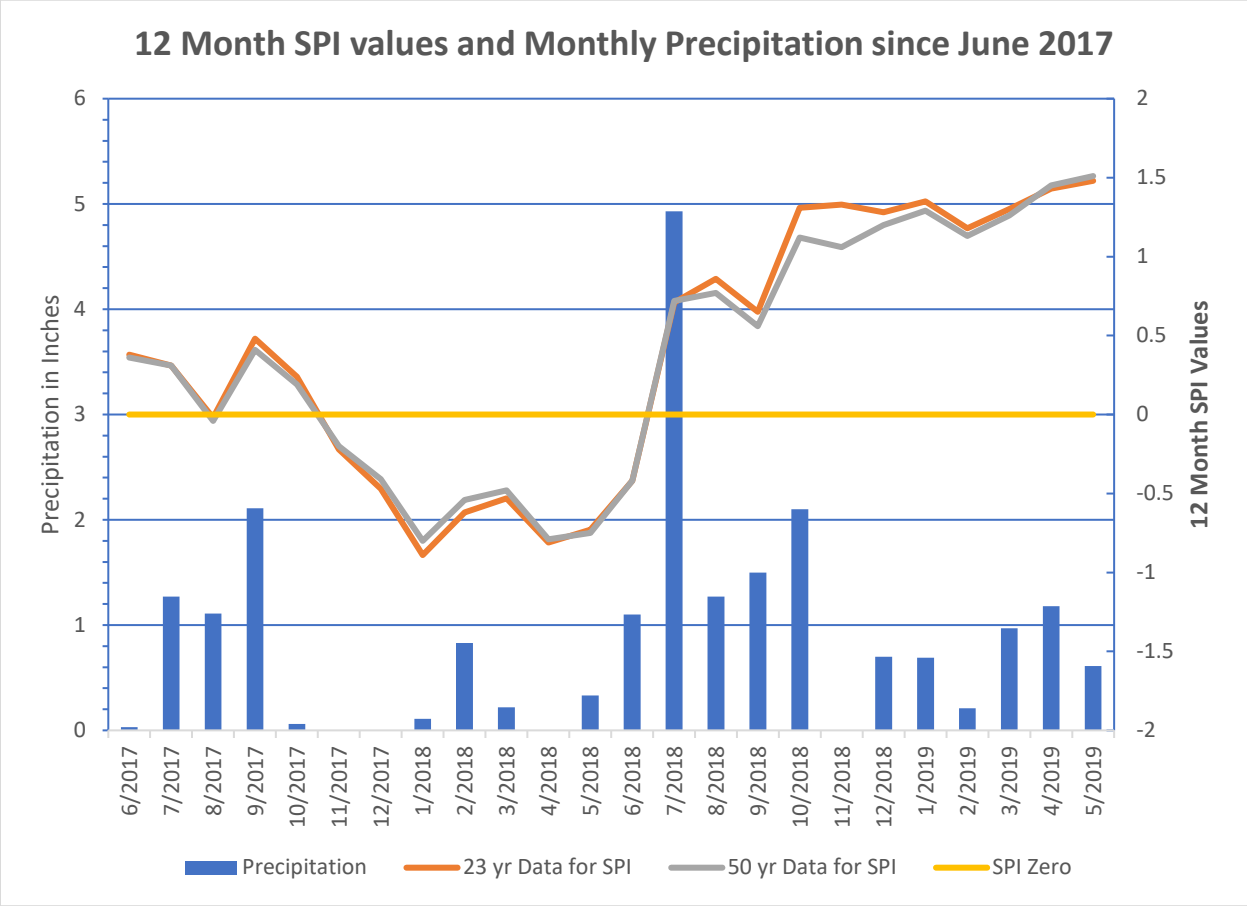


Figure 1. Near Term trace of 12-month SPIs and monthly precipitation for TA-II.

Copy to:
MS-0729 Joseph H. Fontana, Org 0643

Appendix C-2

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Sandia National Laboratories

Operated for the U.S. Department of Energy by
Sandia Corporation

Albuquerque, New Mexico 87185-1042

date: March 23, 2017

to: Kathie Deal and John Kay, MS 0730 (4141)

from: Joseph Fontana, MS-0730 (4143)

subject: Reference Memorandum for Seasonal Precipitation Characteristics and Climate Classification for Sandia National Laboratories, New Mexico [SNL/NM].

Important Note: This memorandum is a revision of a 2013 memo titled "Reference Memorandum for Seasonal Precipitation Characteristics and NPDES Arid Classification for Sandia National Laboratories, New Mexico [SNL/NM]", authored by Regina Deola.

The Meteorology Program operates and maintains a meteorological network at SNL/NM to provide mission support across the laboratory. The program has meteorological records including wind, temperature, humidity, and precipitation that extend back to 1994. Data from this network can be found in summarized form in the Annual Site Environmental Reports published each year. Additional real-time information from the network and GPS locations of all the sites may be found on the Meteorological Program website [http://clean-air.sandia.gov/].

Site Specific Precipitation Data for SNL/NM

Table 1 includes the monthly and annual precipitation for the A36 tower located in the northern part of Technical Area III (TA-III) at the laboratory. This tower was chosen to represent the laboratory due to its central geographic location. Table 1 shows the 1994-2016 precipitation average for TA-III, which is 8.71 inches; data from 2014 are not included in the table due to a rain gauge malfunction that occurred that year. A second precipitation gauge, tower A21, is located approximately three miles north of the A36 tower and represents TA-I and TA-II. It recorded an annual average of 8.06 inches (1995-2014). A third precipitation gauge, tower SC1, located in the foothills east of the main laboratory at an elevation of 5810 feet, recorded an annual average of 10.57 inches (1995-2014). Precipitation increases with increasing elevations towards the mountains east of the main Technical Areas.

The National Weather Service (NWS) at the Albuquerque International Airport has a long term record which supports the finding of the on-site data analysis. This weather station is approximately five miles northwest of TA-III. The 92-year period of record for the NWS Office at the airport includes an annual average of 8.65 inches of precipitation [http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?nm0234]. It should be noted that the NWS 30 year "climate normal" that shifts every decade shows that some decades are wetter than others, but even the wettest 30 year climate [1971-2000] is below 10 inches (9.47 inches/year). Additional on-site calculations in Table 1 include the mean number of days when measureable precipitation was recorded, and the number of days per month when 0.25 inches of precipitation was recorded. Note that during the winter, several months may elapse between precipitation events that produce 0.25 inches of rain.

Seasonal Nature of SNL/NM Precipitation

At SNL/NM, the majority of the average annual precipitation falls during the July-October wet season. The main driver for this seasonal disparity in precipitation is the North American Monsoon pattern and the tropical moisture surges that arrives with it. Though it can be quite variable from year to year, the monsoon season typically manifests in central NM during the first week of July. After arrival, the monsoonal moisture surges will advance and retreat for the next 8 to 10 weeks.

Table 1. Monthly and Annual Precipitation for the A36 tower from 1994 through 2016.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1994	0.01	0.26	0.61	0.06	2.84	0.44	0.97	4.55	1.35	1.73	1.49	0.82	**15.13**
1995	0.52	0.59	0.21	0.46	0.16	0.02	0.95	1.19	1.75	0.00	0.09	0.07	**6.01**
1996	0.34	0.21	0.02	0.00	0.00	1.44	0.60	2.83	0.79	3.00	0.66	0.00	**9.89**
1997	0.53	0.14	0.15	1.68	0.56	0.99	3.53	0.79	1.69	0.21	1.07	1.02	**12.36**
1998	0.17	0.84	2.93	0.68	0.00	0.15	2.46	1.83	0.54	1.57	0.29	0.16	**11.62**
1999	0.24	0.00	1.11	0.76	0.47	0.35	1.64	2.17	0.86	0.30	0.01	0.10	**8.01**
2000	0.14	0.29	1.44	0.00	0.00	0.34	0.40	1.25	0.08	2.45	0.96	0.25	**7.60**
2001	0.32	0.26	0.35	0.46	0.35	1.28	0.97	0.98	0.25	0.01	0.77	0.42	**6.42**
2002	0.31	0.12	0.00	0.56	0.01	0.25	0.42	1.45	1.42	0.78	0.54	0.11	**5.97**
2003	0.00	1.29	1.04	0.00	0.02	0.13	0.19	1.91	0.14	0.93	0.70	0.16	**6.51**
2004	0.17	1.46	0.68	1.12	0.00	1.01	2.53	0.56	0.71	1.09	1.00	0.36	**10.69**
2005	1.79	1.72	0.89	1.10	0.35	0.04	1.26	1.03	1.48	1.03	0.01	0.17	**10.87**
2006	0.02	0.00	0.16	0.09	0.00	1.09	4.06	6.08	0.86	1.57	0.01	1.43	**15.37**
2007	0.26	0.70	0.78	0.92	0.85	0.39	1.65	0.39	0.70	0.08	0.24	1.40	**8.36**
2008	0.47	0.48	0.00	0.36	0.52	0.01	1.67	1.47	0.01	1.35	0.25	0.54	**7.13**
2009	0.00	0.01	0.11	0.26	0.89	0.79	1.07	1.14	1.74	1.60	0.06	0.30	**7.97**
2010	0.92	0.27	0.65	0.57	0.09	1.06	0.98	1.45	1.89	0.75	0.01	1.03	**9.67**
2011	0.01	0.00	0.00	0.09	0.11	0.00	0.71	1.99	0.70	1.35	0.22	1.70	**6.88**
2012	0.44	0.41	0.18	0.59	0.38	0.05	0.81	1.02	0.23	0.00	0.17	0.23	**4.51**
2013	0.16	0.14	0.16	0.08	0.06	0.45	4.75	0.50	4.12	0.16	0.82	0.71	**12.11**
2015	0.64	0.35	0.29	0.43	2.29	0.35	2.30	0.49	0.74	1.29	0.84	0.16	**11.17**
2016	0.45	0.06	0.01	0.48	0.11	0.95	0.95	1.86	0.69	1.23	0.98	0.65	**8.42**
							WET SEASON						
Monthly Means	0.35	0.41	0.50	0.48	0.34	0.50	1.78	1.49	1.12	0.93	0.47	0.61	**8.71**
Days with >=0.01	4.05	4.45	4.78	3.86	4.50	3.77	8.82	8.60	5.36	5.41	4.86	4.91	61.5
Days with >=0.25	0.27	0.59	0.59	0.68	0.55	0.64	1.82	1.78	1.27	1.50	0.55	0.68	10.7

Table 1 indicates that the highest monthly totals and averages occur during the July/August monsoon season. During most years the 4-month period between July and October includes approximately 60 percent of the annual rainfall. The North American Monsoon generally retreats in September, but periodic typhoon, hurricane, or tropical storm remnants can affect the region in the September and October time frame. As can be seen from the monthly totals for September and October over the years, remnants do not affect the area every year.

Climate Considerations and Definition of Arid Areas

The climate of SNL/NM is typical of dry, higher altitude, continental areas with large diurnal temperature ranges and limited rainfall. Most precipitation in this area falls in brief, heavy rain-showers. While various climatic classification schemes may produce slightly different results for this area depending on the atmospheric parameters used, type of evapotranspiration accounting, and the period of record used for the scheme, they all result in a "dry" climate classification, whether it is labeled semi-arid or arid. Peveril Meigs' desert classification system, a widely accepted system used by many organizations including the USGS, defines arid areas as areas with an average annual rainfall of less than 10 inches. This definition of arid areas results in a large portion of the NM laboratory, and all Technical Areas at SNL/NM, being classified as arid.

Periodic Variations in Rainfall Distribution

Winters and most springs lack major precipitation in this area, as can be seen in the monthly averages in Table 1. This is mainly a result of the geographic location, the position of mountain ranges between the laboratory and moisture sources, and the general global circulation pattern. Winter and spring precipitation can vary from normal when the global circulation pattern known as the Southern Oscillation is in an El-Nino phase (ENSO). The El-Nino phase may lead to increased winter and spring precipitation in the central areas of NM. The El-Nino periods do not always result in an increase in each month when the pattern is present, but does tend to increase the annual precipitation for the year. The temporal duration of the El-Nino and La-Nina phases can be as short as 7 months, and as long as 3 years. Historically, the El-Nino return cycle has varied from as few as three years to as long as seven years. During the La-Nina phase of the ENSO, multiple years of below normal rainfall may be recorded. Current climate change research suggests that for many locations in the southwestern US, climate change may result in periods with La-Nina like annual precipitation, with an increase in the intensity and frequency of droughts.

Summary

Virtually all SNL/NM areas west of the foothills are classified as arid areas. Some remote outdoor test areas in the mountains and foothills may have annual rainfall over 10 inches a year. While precipitation is limited in the vicinity of SNL/NM, approximately 60 percent of the annual rainfall occurs in 4 months of the year during the July/August monsoon season and into the early fall. It is during these 4 months from July to October that there is a better chance of having a precipitation event that produces one quarter inch of rain or greater in a 24-hour period.

Associated Documentation

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Appendix D – Ecoregions Descriptions

No.	Description
D-1	NM Ecoregions Map
D-2	Ecoregions Descriptions

Appendix D-1

Ecoregions of New Mexico

Ecoregions denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources; they are designed to serve as a spatial framework for the research, assessment, management, and monitoring of ecosystems and ecosystem components. By recognizing the spatial differences in the capacities and potentials of ecosystems, ecoregions stratify the environment by its probable response to disturbance (Bryce and others, 1999). These general purpose regions are critical for structuring and implementing ecosystem management strategies across federal agencies, state agencies, and nongovernment organizations that are responsible for different types of resources within the same geographical areas (Omernik and others, 2000).

The New Mexico ecoregion map was compiled at a scale of 1:250,000. It revises and subdivides an earlier national ecoregion map that was originally compiled at a smaller scale (USEPA, Omernik, 1987). Ecoregion boundaries were refined mainly based on the premise that ecological regions can be identified through the analysis of the spatial patterns and the composition of biotic and abiotic phenomena that affect or reflect differences in ecosystem quality and integrity (Wiken, 1986; Omernik, 1987, 1995). These phenomena include geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology. The relative importance of each characteristic varies from one ecological region to another regardless of the hierarchical level.

A Roman numerical hierarchical scheme has been adopted for different levels of ecological regions. Level I is the coarsest level, dividing North America into 15 ecological regions. Level II divides the continent into 52 regions (Commission for Environmental Cooperation Working Group, 1997). At level III, the continental United States contains 104 ecoregions and the conterminous United States has 84 ecoregions (United States Environmental Protection Agency [USEPA], 2006). Level IV is a further subdivision of level III ecoregions. Explanations of the methods used to define the USEPA's ecoregions are given in Omernik (1995, 2004), Omernik and others (2000), and Gallant and others (1989).

New Mexico contains semiarid shrub- and grass-covered plains, forested mountains, intermontane basin and valley woodland and shrubland, volcanic and basaltic fields, canyon lands, river floodplains, and arid deserts. Ecological diversity is enormous. There are 8 level III ecoregions and 55 level IV ecoregions in New Mexico and many continue into ecologically similar parts of adjacent states (Griffith and others, 2004; Woods and others, 2005; Chapman and others, 2006).

This poster is part of a collaborative project primarily between USEPA Region VI, USEPA National Health and Environmental Effects Research Laboratory (Corvallis, Oregon), New Mexico Environment Department (NMED), U.S. Department of Agriculture (USDA)–Natural Resources Conservation Service (NRCS), and U.S. Geological Survey (USGS)–National Center for Earth Resources Observation and Science (EROS). The project is associated with an interagency effort to develop a common framework of ecological regions (McMahon and others, 2001). Reaching that objective requires recognition of the differences in the conceptual approaches and mapping methodologies applied to develop the most common ecoregion-type frameworks, including those developed by the USDA–Forest Service (Bailey and others, 1994), the USEPA (Omernik, 1987, 1995), and the NRCS (U.S. Department of Agriculture–Soil Conservation Service, 1981). As each of these frameworks is further refined, their differences are becoming less discernible. Collaborative ecoregion projects, such as this one in New Mexico, are a step toward attaining consensus and consistency in ecoregion frameworks for the entire nation.

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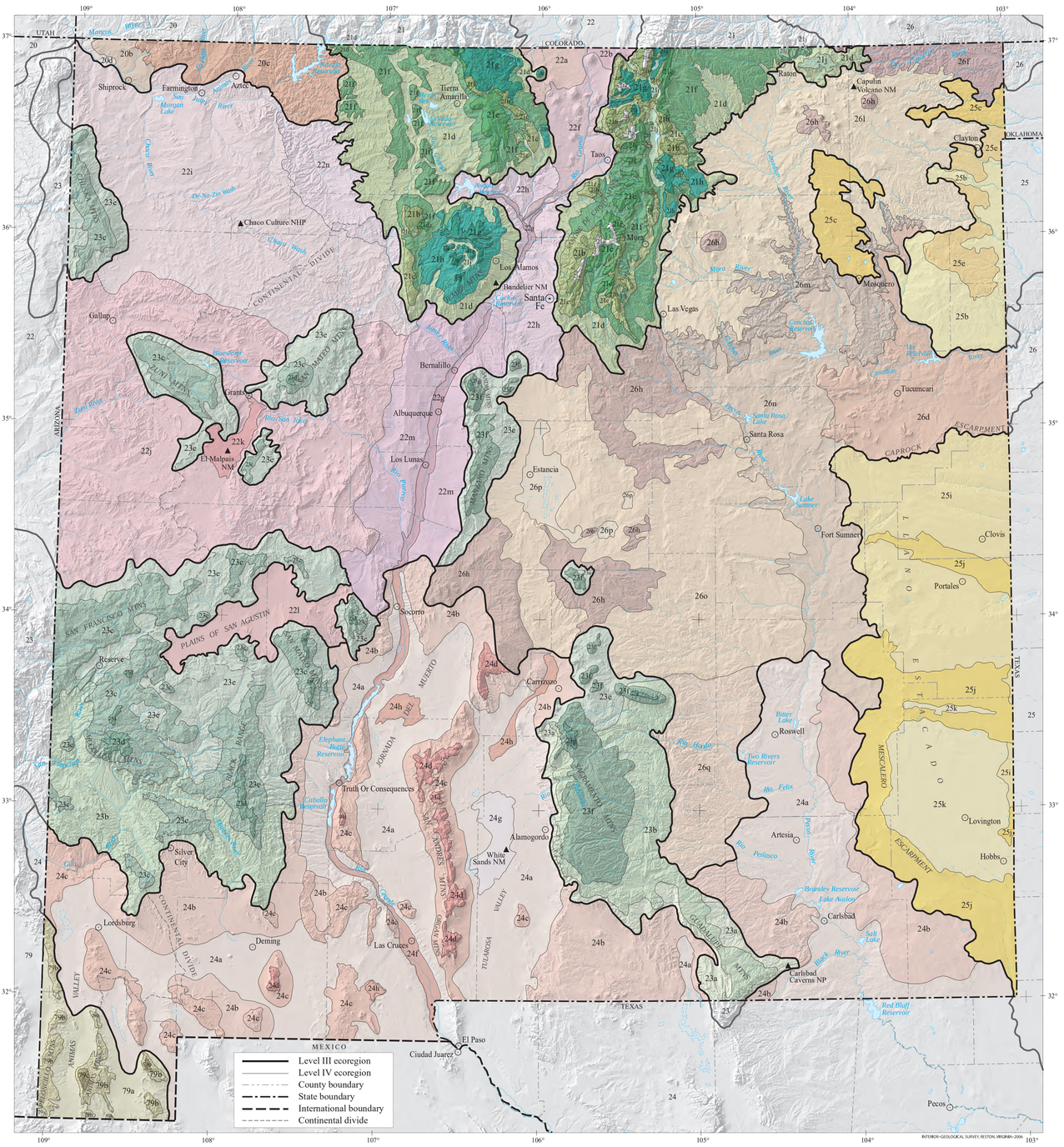
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- 20c Semiarid Benchlands and Canyonlands
- 20d Arid Canyonlands

21 Southern Rockies
- 21a Alpine Zone
- 21b Crystalline Subalpine Forests
- 21c Crystalline Mid-Elevation Forests
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23 Arizona/New Mexico Mountains
- 23a Chihuahuan Desert Slopes
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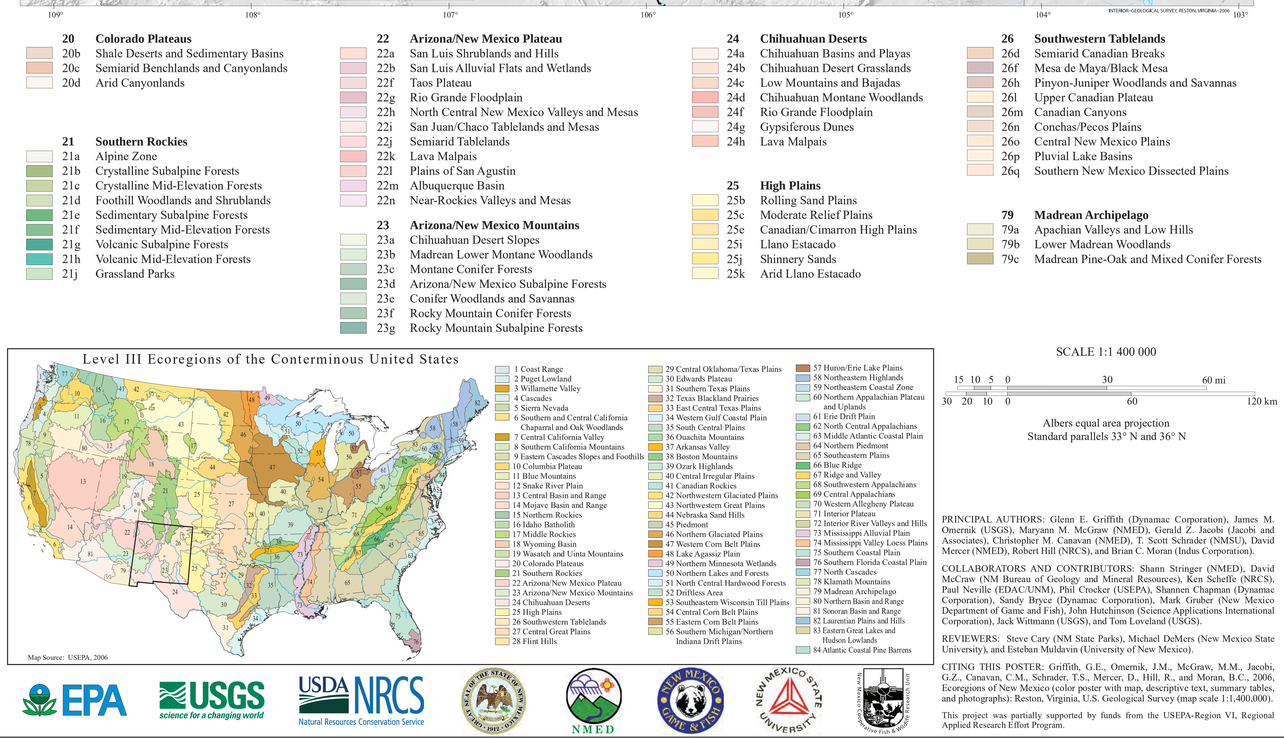
24 Chihuahuan Deserts
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26 Southwestern Tablelands
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- 26o Central New Mexico Plains
- 26p Pluvial Lake Basins
- 26q Southern New Mexico Dissected Plains

79 Madrean Archipelago
- 79a Apachian Valleys and Low Hills
- 79b Lower Madrean Woodlands
- 79c Madrean Pine-Oak and Mixed Conifer Forests

Map Source: USEPA, 2006



SCALE 1:1 400 000

15 10 5 0 30 60 mi
30 20 10 0 60 120 km

Albers equal area projection
Standard parallels 33° N and 36° N

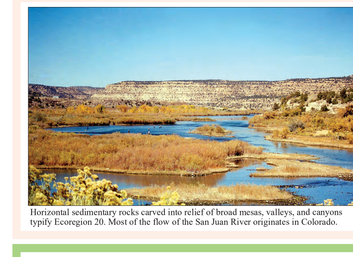
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CITING THIS POSTER: Griffith, G.E., Omernik, J.M., McGraw, M.M., Jacobi, G.Z., Canavan, C.M., Schrader, T.S., Mercer, D., Hill, R., and Moran, B.C., 2006, Ecoregions of New Mexico (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,400,000).

This project was partially supported by funds from the USEPA-Region VI, Regional Applied Research Effort Program.



Horizontal sedimentary rocks carved into relief of broad mesas, valleys, and canyons typify Ecoregion 20. Most of the flow of the San Juan River originates in Colorado.

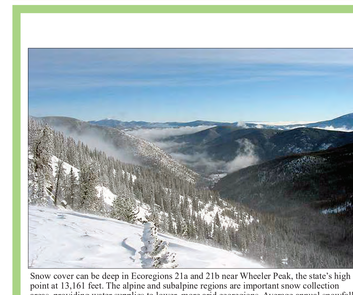
20. Colorado Plateaus

Rugged tableland topography is typical of the Colorado Plateaus ecoregion. Canyons, mesas, plateaus, and mountains expose a long geologic history of rock formations. Precipitous side-walls mark abrupt changes in local relief, often of 1000 to 2000 feet or more. The region contains more pinyon-juniper and Gambel oak woodlands than the Wyoming Basin (18) to the north. However, the region also has large low-lying areas containing saltbush-greasewood communities, and in Utah, blackbrush communities typical of hotter, drier areas. These communities are generally not found in the higher Arizona/New Mexico Plateau (22) to the south where grasslands were typically more common.

20b The arid **Shale Deserts and Sedimentary Basins** ecoregion consists of nearly level basins and valleys, benches, low rounded hills, and badlands. Rock outcrops occur; it is sparsely vegetated with mat saltbush, fourwing saltbush, greasewood, and shadscale. Native grasses included alkali sacaton, galleta grass, poverty threeawn, sand dropseed, and Indian ricegrass. It is lower in elevation with less pinyon-juniper woodland than the adjacent Semiarid Benchlands and Canyonlands (20c).

20c Broad, grass-, shrub-, and woodland-covered benches and mesas characterize the **Semiarid Benchlands and Canyonlands** ecoregion. Areas of high relief alternate with areas of low relief. Bedrock exposures are common along rims, escarpments, and on steep dip slopes. Pinyon and juniper dominate the woodlands and trees. Associated with scattered areas of Gambel oak at higher elevations. On deeper soils, warm season grasses, sagebrush, fourwing saltbush, winterfat, and Mormon tea occur. The vegetation is not as sparse as in drier areas such as Ecoregions 20b and 20d.

20d Occurring primarily in Utah, the **Arid Canyonlands** ecoregion includes the inner gorge of the Colorado River and its major tributaries, including the Green and San Juan rivers. Much of the ecoregion is bounded by very steep vertical canyon walls that separate it from the adjacent, higher benchlands of Ecoregion 20c. Exposed bedrock is common. The New Mexico portion lacks the relief of most of the region in Utah. Soils are shallower with a drier moisture regime than those of Ecoregion 20c. Shadscale, saltbush, some sand sagebrush, and drought tolerant grasses including galleta grass and Indian ricegrass occur. This is the driest area of New Mexico, receiving less than 8 inches of annual rainfall.



Snow cover can be deep in Ecoregions 21a and 21h near Wheeler Peak, the state's high point at 13,161 feet. The alpine and subalpine regions are important snow collection areas, providing water supplies to lower, more arid ecoregions. Average annual snowfall at the higher elevations is often over 100 inches and can exceed 300 inches in a few areas of New Mexico's Southern Rockies.

21. Southern Rockies

The Southern Rockies are composed of high elevation, steep, rugged mountains. Although coniferous forests cover much of the region, as in most of the mountainous regions in the western United States, vegetation, as well as soil and land use, follows a pattern of elevational banding. The lowest elevations are generally grass or shrub covered and heavily grazed. Low to middle elevations are also grazed and covered by a variety of vegetation types including juniper-oak woodlands, ponderosa pine, aspen, and Douglas-fir. Middle to high elevations are largely covered by coniferous forests and have little grazing activity. The highest elevations have alpine characteristics. Numerous perennial mountain streams with deciduous riparian vegetation support coldwater fisheries and serve as wildlife corridors.

21a The **Alpine Zone** occurs on mountain tops above treeline, beginning at about 11,000 to 11,500 feet in New Mexico. It includes alpine meadows as well as talus, rock glaciers, cirques, talus, and glaciated peaks. Annual precipitation ranges from 25 to greater than 50 inches, falling mostly as snow. Vegetation includes low shrubs, cushion plants, and wildflowers and sedges in wet meadows. The forest-tundra interface is sparsely occupied by stunted, deformed Engelmann spruce, subalpine fir, and sometimes bristlecone pine and snow willow (krummholz vegetation). Ecoregion 21a is snow-free only 8 to 10 weeks annually. Snow cover is a major source of water for lower, more arid ecoregions.

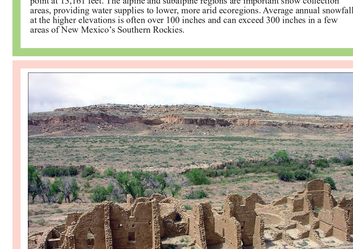
21b The **Crystalline Subalpine Forests** ecoregion occupies a narrow elevational band on the steep, forested slopes of the mountains, becoming more extensive on the north slopes. The elevation range in New Mexico is generally 9000 to 11,500 feet, just below the alpine zone (21a). Numerous perennial streams originate here. Carbonate substrates are not soluble and nutrient rich. Some streams support the endemic Rio Grande cutthroat trout. Soils are generally finer-textured than those found on crystalline or metamorphic substrates of Ecoregion 21b. Subalpine forests dominated by Englemann spruce and subalpine fir are typical, often interspersed with aspen groves or mountain meadows. Some Douglas-fir forests are at lower elevations.

21f The **Sedimentary Mid-Elevation Forests** ecoregion occurs in the western and southern portions of the Southern Rockies in Colorado and in several areas of the Rockies in New Mexico at elevations generally below Ecoregion 21e. The elevation limits and vegetation of this region are similar to the crystalline (21c) and volcanic (21h) mid-elevation forests; however a larger area of Gambel oak woodlands and aspen forest is found in this region. Carbonate substrates are not soluble and nutrient rich. Some streams support the endemic Rio Grande cutthroat trout, a reproducing trout fishery. Soils are generally finer-textured than those found on crystalline and metamorphic substrates typical of Ecoregion 21c.

21g The steep, mountainous **Volcanic Subalpine Forests** ecoregion is composed of Tertiary or Quaternary volcanic rocks, primarily in the southern extension of the San Juan Mountains from Colorado and in parts of the Brazos, Jemez, and Taos mountains of New Mexico. Relatively young geologically, the high, rugged mountains still contain some large areas of intact habitat. Englemann spruce, subalpine fir, and aspen forests support a variety of wildlife.

21h The **Volcanic Mid-Elevation Forests** ecoregion occurs at elevations of about 7500 to 10,000 feet and is composed of igneous rocks of andesite and basalt. The majority of the region is found in the Jemez Mountains with smaller, scattered areas to the north and east. Forests of ponderosa pine, Douglas-fir, and aspen occur. Land use includes wildlife habitat, livestock grazing, logging, and recreation.

21j The **Grassland Parks** ecoregion, occurring primarily in Colorado, consists of high intermontane valleys with sufficient water availability to support grasslands and wet meadows. In New Mexico, the ecoregion is found in the Valle Grande/Valle San Antonio area in the Jemez Mountains, in the Moreno Valley and Costilla-Comanche-Valle Vidal areas in the Sangre de Cristo Mountains, and on top of Johnson Mesa near Raton. Grasslands with bunchgrasses are dominant, and include Parry's oatgrass, Arizona fescue, Idaho fescue, Thurber fescue, mountain muhly, bluebunch wheatgrass, needle-and-thread grass, Junegrass, and slender wheatgrass. There are only a few trees or shrubs, and if present, they are widely scattered and mature. Some springs and wetlands occur. Large elk herds are found in the valley parklands.



Ruins of Puebloan dwellings along Chaco Wash constructed in 1100-1130 A.D. *Photo: USGS*
Below: Cretaceous shale in the De-Na-Zin Wash area of Ecoregion 22i. *Photo: Jim Orr*

22. Arizona/New Mexico Plateau

The Arizona/New Mexico Plateau represents a large transitional region between the drier shrublands and wooded higher relief tablelands of the Colorado Plateaus (20) in the north, the lower, hotter, less vegetated Mojave Basin and Range (14) in the west, and forested mountain ecoregions that border the region on the southeast (21) and south (23). Local relief in the region varies from a few feet on plains and mesa tops to well over 1000 feet along tableland side slopes. The Continental Divide splits the region, but is not a prominent topographic feature. The region extends across northern Arizona, northwestern New Mexico, and into Colorado in the San Luis Valley. Gunnison prairie dogs are a keystone species in many of the sagebrush ecosystems and their burrows provide habitat for other wildlife including burrowing owls, weasels, badgers, and a variety of snakes.

22a The **San Luis Shrublands and Hills** ecoregion, occurring mostly in Colorado, includes the higher relief foothill edges and low mountains within the San Luis Valley. It includes the San Luis Hills in Colorado, a series of low mountains, hills, and tilted mesas. The New Mexico portion includes the area northwest of the Taos Plateau Ecoregion (22f). Big sagebrush, rabbitbrush, and winterfat occur as well as grasslands of western wheatgrass, green needlegrass, blue grama, and needle-and-thread.

22b This region occurs primarily in Colorado, barely extending across the state line into New Mexico. Although precipitation in the **San Luis Alluvial Flats and Wetlands** ecoregion is low, water availability from mountain runoff, a high water table, and associated springs and wetlands have made cropland irrigation possible. The ecoregion was once dominated by shadscale, saltbush and greasewood, but most of the native vegetation has been converted to agriculture. Center pivot cropland is common in the Colorado portion, with barley malt, potatoes, alfalfa, small grains, and hay, and smaller areas of vegetables such as spinach, head lettuce, and carrots. In the New Mexico portion, sagebrush is more common, with some irrigated areas for hay.

22f The **Taos Plateau** is a region of mostly Pliocene basaltic lavas with distinct cones of Pliocene composite volcanoes. This region has higher elevation volcanic cones than the San Luis Hills of 22a in Colorado; several cones are over 9000 feet and Ute Mountain is higher than 10,000 feet. The plateau surface has more sagebrush than Ecoregion 22a in Colorado. The plateau surface has only minor dissection, but the Rio Grande has confined a deep canyon up to 1000 feet deep in places. The ecoregion extends south to include the basalt-capped Black Mesa.

22g Once containing a perennially flowing, meandering, braided river, the **Rio Grande Floodplain** ecoregion has undergone many human alterations to its landscape and hydrology over the past 400 years. The once-shifting Rio Grande had mosaics of riparian woodlands and shrublands, along with a variety of wetland meadows, ponds, and marshes. The gallery forest, or bosque, of cottonwood and willow with understories of coyote willow, New Mexico olive, false indigo, and seepwillow depended on this dynamic system. A long history of irrigation and drainage canals, levees and jetty jacks, and upstream dams have altered river flows and narrowed and straightened the stream channel. Conversion to cropland, urbanization, and rural ranching and urban and suburban uses have also altered the region. Cottonwood and willow, dependent on spring flooding, have been widely replaced by invasive saltcedar and Russian olive.

22h The **North Central New Mexico Valleys and Mesas** is an area of mostly pinyon pine and juniper savanna, and mesa and valley topography similar to some other parts of Ecoregion 22. Situated between portions of the Southern Rockies (21) to the east and west, and dominated by young geologic features of the Espanola rift basin and ancestral Rio Grande floodplain, ecological differences are apparent. It has a cooler climate with slightly greater precipitation, streams tend to have more water flow, and there is a different species mix of flora and fauna compared to 22b, 22g, or 22m. It differs from 22f in geology, topography, and vegetation; from 22i and 22m in elevation, climate, and vegetation. It has a mix of geology, mostly Tertiary sedimentary or Tertiary and Quaternary volcanic rocks.

22i The **San Juan/Chaco Tablelands and Mesas** ecoregion of plateaus, valleys, and canyons contains a mix of desert scrub, semi-desert shrub-steppe, and semi-desert grassland. Shadscale, fourwing saltbush, mormon tea, Indian ricegrass, galleta, and blue and black grama grasses are typical. It is more arid, has generally lower elevations, and less pinyon-juniper than the Semiarid Tablelands (22j) to the south or Ecoregion 22n to the east. It is mostly composed of gently dipping Tertiary and Cretaceous sedimentary rocks. Oil and gas production occurs mostly in the northern part of the region. It contains the upper reaches of the Rio Puerco, an area of severe erosion due to geology, topography, and human influences.



Playa lakes occur in many of the agricultural landscapes of the Llano Estacado (25i). Many playas have been affected by plowing, sedimentation, or use for irrigation. Protection of these shallow, seasonal wetlands is important for waterfowl habitat, recharge of the Ogallala Aquifer and, ultimately, the health of the High Plains economy. In some areas, about 85-90% of the aquifer's recharge is focused through the playa lakes. *Photo: NRCS*

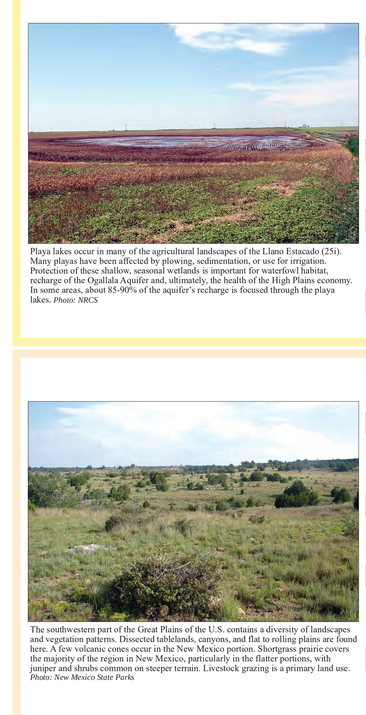
22j With some similarities to Ecoregion 20c, the **Semiarid Tablelands** consists of mesas, plateaus, valleys, and canyons formed mostly from flat to gently dipping sedimentary rocks, along with some areas of Tertiary and Quaternary volcanic fields. The region contains areas of high relief and some low relief plains. Bedrock exposures are common. Grass, shrubs, and woodland cover the tablelands. The vegetation is not as sparse as in Ecoregion 22i to the north or 22m to the east. It lacks the denser pine forests of the higher and more mountainous Ecoregion 23. Scattered junipers occur on shallow, stony soils, and are dense in some areas. Pinyon-juniper woodland is also common in some areas. Saltbush species, alkali sacaton, sand dropseed, and mixed grama grasses occur.

22k Part of the much larger Zuni-Bandera volcanic field, the **Lava Malpais** covers some of the younger Holocene volcanic flows with the least soil development. The youngest flow, called the McCartys flow, dates from about 3000 years ago. Different types of lava flows are found here, as well as lava tubes and ice caves. Some unique flora and fauna not found in surrounding areas occur here, and some species that are more widespread have made adaptations to survive in the specialized habitats here. The lava substrate has the ability in places to trap and retain moisture, allowing for a more mesophytic vegetation, such as stunted Douglas-fir near Ponderosa pine, to occur in some areas. The region is an important area for understanding recent ecological successions, as well as longer term climatic changes.

22l The **Plains of San Agustin** are mostly a topographically closed basin, with some alluvial fans and piedmont slopes near the surrounding mountains of Ecoregion 23. Beach and lacustrine deposits mark various stages of Pleistocene Lake San Agustin. Clay to fine-grained sand lake bed sediments, linear beach-ridge sand deposits, and some sand sheets and dune sand deposits occur. The sandy areas are mostly stabilized by grasses and low shrubs. Vegetation of alkali sacaton, fourwing saltbush, and grassewood is found in the low areas. Some western wheatgrass, vino-mesquite, areas of blue grama and sand dropseed occur. Higher elevation slopes have some pinyon-juniper savanna with an understory of blue grama, dropseeds, Indian ricegrass, and bottlebrush squirreltail grasses. Livestock grazing is the predominant land use.

22m Part of one of the deeper physiographic basins of the Rio Grande rift, the **Albuquerque Basin** ecoregion is lower in elevation, drier, and warmer than surrounding ecoregions to the north, east, and west. The basin is filled with thick sediments of mostly Quaternary and some Tertiary age, with a few areas of volcanic rocks and lava-capped mesas. Extending from the La Bajada Escarpment on the north to near Socorro in the south, the region contains some diverse features and transitional characteristics. Unlike most of Ecoregion 22 which has mesic soils, 22m has a largely thermic soil temperature regime. There is a mix of sand scrub and desert grassland vegetation. Native vegetation includes black grama, sand dropseed, mesa dropseed, blue grama, galleta, sand sage, alkali sacaton, threeawns, and scattered yucca. Juniper occurs primarily in the north. Urban and suburban land uses are spreading. The Santa Fe Group aquifer, the drinking water source for Albuquerque and most of the Middle Rio Grande Valley, has seen some groundwater declines in recent years, along with increases in contaminants.

22n Similar to Ecoregion 22b, the **Near-Rockies Valleys and Mesas** ecoregion is an area of mostly pinyon-juniper woodland, juniper savanna, and mesa and valley topography, with influences of higher elevation vegetation in drainages from the adjacent Southern Rockies (21). Its geology differs from Ecoregion 22b, with older Tertiary and Cretaceous sedimentary rocks. It has generally higher elevations, greater precipitation, and more juniper than Ecoregion 22i to the west. Canyon streams flow intermittently out of the Rockies into the Canon Largo watershed, a tributary to the San Juan River.



The southwestern part of the Great Plains of the U.S. contains a diversity of landscapes and vegetation patterns. Dissected tablelands, canyons, and flat to rolling plains are found here. A few volcanic cones occur in the New Mexico portion. Shortgrass prairie covers the majority of the region in New Mexico, particularly in the flatter portions, with juniper and shrubs common on steeper terrain. Livestock grazing is a primary land use. *Photo: New Mexico State Parks*

23. Arizona/New Mexico Mountains

The Arizona/New Mexico Mountains are distinguished from neighboring mountainous ecoregions by their lower elevations and associated vegetation indicative of drier, warmer environments, due in part to the region's more southerly location. Forests of spruce, fir, and Douglas-fir, common in the Southern Rockies (21) and the Wasatch and Uinta Mountains (19), are only found in limited areas at the highest elevations in this region. Chaparral is common at lower elevations in some areas, pinyon-juniper and oak woodlands are found at lower and middle elevations, and the higher elevations are dominated by ponderosa pine forests. These mountains are the northern extent of some Mexican plant and animal species. Surrounded by deserts or grasslands, these mountains in New Mexico can be considered biogeographical islands.

23a The **Chihuahuan Desert Slopes** are found on the Guadalupe and Sacramento mountains. The lower slopes of these mountains represent a continuation of the Chihuahuan Desert ecosystem; soils and vegetation in much of Ecoregion 23a are similar to those in the Low Mountains and Bajadas (24c) of the Chihuahuan Deserts (24). The lower slopes were once mostly grasslands overgrazed in the late 19th century and subsequently invaded by desert shrubs. Yucca, sotol, lechuguilla, ocotillo, and cacti now dominate the rocky slopes below 5500 feet. Grasslands persist near alluvial fans and on gentle slopes with deeper, sandstone-derived soils. Water is scarce; the few streams that originate from springs at higher elevations do not persist beyond the mouths of major canyons.

23b The **Madrean Lower Montane Woodlands** ecoregion covers the slopes of the Guadalupe, Sacramento, Mimbres, Big Burro, and Mogollon mountains, generally between 5500 to 7200 feet, with densities of juniper, pinyon pine, and oak varying according to aspect. There are some similarities to Ecoregion 23c; however, Ecoregion 23b has milder winters, wetter summers, and inclusions of alligator juniper and Madrean evergreen oak species. At middle elevations, dense thickets of shrubs such as desert ceanothus, alderleaf mountain mahogany, and catclaw mimosa form chaparral communities. Other areas are grassy and park-like with scattered trees. A few small areas of ponderosa pine, Douglas-fir, and occasionally white pine occur at the highest elevations, outliers of Ecoregions 23c or 23f. In the west, the Gila River and tributaries have many endemic aquatic organisms including fish, amphibians, and insects.

23c The **Montane Conifer Forests** are found west of the Rio Grande at elevations from about 7000 to 9500 feet. Ponderosa pine and Gambel oak are common, along with mountain mahogany and serviceberry. Some Douglas-fir, southwestern white pine, and white fir occur in a few areas. Blue spruce may occasionally be found in cool, moist canyons. The influence of the Sierra Madre flora is seen mostly in the southern mountains and diminishes to the north. In the far south, other oaks appear, such as silverleaf oak, netleaf oak, Arizona white oak, and Emory oak. The summer rains are especially important for herbaceous plants. The region is geologically diverse with volcanic, sedimentary, and some intrusive and crystalline rocks. Endemic Gila trout occur in some of the region's streams. Livestock grazing, logging, and recreation are the primary land uses. Wildfire is an important feature influencing the forested ecosystems in this region.

23d The **Arizona/New Mexico Subalpine Forests** occur west of the Rio Grande at the higher elevations, generally above 9500 feet. The region includes parts of the Mogollon Mountains, Black Range, San Mateo Mountains, Magdalena Mountains, and Mount Taylor. The region includes parts of the Sandia Mountains, Capitan Mountains, and Sierra Blanca. The peak elevations are mostly above 10,000 feet, with Sierra Blanca Peak reaching 12,000 feet. There are some differences in flora, fauna, geology, and water quality from the subalpine ecoregion (23d) to the west. The major forest trees include Engelmann spruce, corkbark fir, blue spruce, white fir, and aspen. Some Douglas-fir occurs at lower elevations. There are a few small inclusions of montane grassland. A mix of geology occurs in the region. Sierra Blanca and the Capitan Mountains are composed of Tertiary volcanics and Tertiary intrusives, while the Sandia Mountains to the north have a core of Precambrian rocks capped by Pennsylvanian sedimentary rocks.

The Madrean Lower Montane Woodlands (23b), foreground, contrast with the more rugged Mogollon Mountains of Ecoregions 23c and 23d. The Mogollon Mountains include peaks over 10,000 feet in elevation and form the core of the Gila Wilderness. Created in 1924 at the urging of conservationist Aldo Leopold, the Gila Wilderness was the world's first designated wilderness area. *Photo: April Sterling*

23e The **Conifer Woodlands and Savannas** ecoregion is an area of mostly pinyon-juniper woodlands, with some ponderosa pine at higher elevations. It often intermingles with grasslands and shrublands. Although elevations are higher than surrounding Ecoregion 22 areas, the boundaries tend to be transitional. The region is generally cooler, with more uniform winter and summer seasonal moisture compared to Ecoregion 23b. It lacks the milder winters, wetter summers, chaparral, Madrean oaks, and other species of Ecoregion 23b.

23f The **Rocky Mountain Conifer Forests** are found at elevations from about 7000 to 9600 feet in the mountains east of the Rio Grande. With similarities to Ecoregion 23c, ponderosa pine and Gambel oak are common, with mountain mahogany and a dense understory. Some Douglas-fir, southwestern white pine, and white fir occur in a few areas. Blue spruce may occasionally be found in cool, moist canyons. In the Sandia and Manzano mountains, white fir and Douglas-fir are more extensive than in other parts of the region. Current forests have been shaped by fire and fire suppression. It differs from Ecoregion 23e by some of the flora, fauna, and water quality characteristics that more closely resemble the Southern Rockies (21). The region is geologically diverse with volcanic, sedimentary, and some intrusive and crystalline rocks.

23g The **Rocky Mountain Subalpine Forests** ecoregion occurs east of the Rio Grande at high elevations, generally above 9500 feet. It includes parts of the Sandia Mountains, Capitan Mountains, and Sierra Blanca. The peak elevations are mostly above

Appendix D-2

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Summary Table: Characteristics of the Ecoregions of New Mexico

20. COLORADO PLATEAUS

Level IV Ecoregions	Area (square miles)	Physiography: Elevation/ Local Relief (feet)	Geology: Surficial and Bedrock	Soils: Order (Great Group)	Soils: Common Soil Series	Soils: Temperature/ Moisture Regimes	Climate: Precipitation Mean annual (inches)	Climate: Frost Free Mean annual (days)	Climate: Mean Temperature January min/max; July min/max (°F)	Natural Vegetation	Land Cover and Land Use
20b. Shale Deserts and Sedimentary Basins	233	4900-6070/ 100-400	Quaternary colluvium with large areas of bedrock alluvium and eolian deposits. Cretaceous Mancos Shale.	Aridisols (Haplocambids), Entisols (Torriorthents, T	Littlehat, Persayo, and Fordbutte on uplands; Ravola, Bebeevar, and T San Juan River.	Mesic/ Aridic	8-10	140-150	15/42; 58/95	Salt desert scrub sparsely vegetated with mat saltbush, fourwing saltbush, Nuttall's saltbush, greasewood, and shadscale. Native grasses included alkali sacaton, galleta grass, poverty threeawn, sand dropseed, and Indian ricegrass. Badland areas have little to no vegetation cover.	Shrubland. Some low density livestock grazing, small areas of irrigated cropland of alfalfa, hay. Juan River. Most all is tribal land (Navajo).
20c. Semiarid Benchlands and Canyonlands	1231	5500-7100/ 300-800	Quaternary colluvium, block-rubble colluvium, valley-fill alluvium, and eolian deposits. Tertiary (Eocene, Paleocene) and Cretaceous sandstone, shale, mudstone, and conglomerate. Some Cretaceous coal-bearing formations.	Entisols (Torriorthents, Ustorthents), Aridisols (Haplargids)	Weska, Vessilla, Menefee, Orlie, Blancot, Persayo, Farb, Farview	Mesic/ Ustic Aridic, Aridic Ustic	10-16	120-140	17/41; 58/90	One-seed, Rocky Mountain, and Utah junipers, some pinyon pine at higher elevations, big sagebrush and Bigelow sagebrush, fourwing saltbush, shadscale, antelope bitterbrush, galleta, Indian ricegrass, and blue grama.	Evergreen woodland and shrubland. Livestock grazing, some irrigated cropland of hay and grain for livestock forrages, recreation, wildlife habitat. Oil and gas production, coal mining. Mostly public land (BLM) and tribal land (Ute Mountain).
20d. Arid Canyonlands	54	4650-5020/ 100-300	alluvium. Cretaceous and Jurassic shale, siltstone, and sandstone.	Entisols (Torriorthents, T Aridisols (Haplocalcids)	Claysprings, Tocito, Myton, Nakai, Nageezi, Fruitland, Bebeevar	Mesic/ Aridic	7-9	145-155	15/42; 58/95	Desert scrub with shadscale, mormon tea, four wing saltbush, sand sagebrush, and some drought tolerant grasses including galleta and Indian ricegrass. Blackbrush is common in Utah and Arizona. Floodplains may contain some New Mexico-olive, willow, and Fremont cottonwood.	Shrubland. Low density livestock grazing, wildlife habitat. All in tribal land (Navajo).

21. SOUTHERN ROCKIES

Level IV Ecoregions	Area (square miles)	Physiography: Elevation / Local Relief (feet)	Geology: Surficial and Bedrock	Soils: Order (Great Group)	Soils: Common Soil Series	Soils: Temperature/ Moisture Regimes	Climate: Precipitation Mean annual (inches)	Climate: Frost Free Mean annual (days)	Climate: Mean Temperature January min/max; July min/max (°F)	Natural Vegetation	Land Cover and Land Use
21a. Alpine Zone	95	Mostly glaciated. High mountains with steep slopes, ridges, and exposed rocky peaks above timberline. Some wetlands and glacial lakes. High gradient headwater streams with boulder, cobble, and bedrock substrates.	Quaternary block rubble colluvium and glacial till. Exposed bedrock. Tertiary andesitic lava, basalt, breccia, tuff, and conglomerate. Precambrian schist, quartzite, granite, and granitic gneiss. Permian and Pennsylvanian conglomerate, sandstone, siltstone, and limestone.	Inceptisols (Dystrocryepts)	Penitente, Ptarmigan, Bross, rock outcrop	Cryic/ Udic	25-55 Deep winter snowpack	40-50	2/27; 38/69	Alpine meadows dominated by alpine avens, bistort, alpine sage, tufted hairgrass, alpine fescue, alpine bluegrass, plants such as alpine elovers, alpine forget-me-not, alpine sandwort. Willow thickets occur in depressions and wet meadows. At lower edges, krummholz ("twisted wood") , and sometimes bristlecone pine.	Snow, ice, bare rock, alpine meadows. Recreation, wildlife habitat (including Rocky Mountain bighorn sheep, white-tailed ptarmigan, snowshoe hares, yellow-bellied marmots, and pika). Mostly public land (USDA-FS Carson and Santa Fe National Forests). Snowmelt provides water to lower-elevation ecoregions.
21b. Crystalline Subalpine Forests	617	Mostly 9000-11500; maximum 12115/ 600-2000	Quaternary block-rubble colluvium, colluvium, and some glacial till. Tertiary intrusive rocks; Precambrian metasedimentary, metavolcanic, and intrusive rocks including pelitic schist, amphibolite, quartz-muscovite schist, quartzite, granitic gneiss, and granitic rocks.	Haplocryalfs), Inceptisols (Dystrocryepts, Cryochrepts, Eutrocryepts)	Bundo, Angostura, Tolby, Marosa, Nambe, Braeos, Gromes	Cryic/ Udic, Ustic	24-40 Deep winter snowpack	50-70	6/30; 38/70	interspersed with aspen groves or mountain meadows. Some areas with limber pine and Rocky Mountain bristlecone pine. elevations. Understories may contain myrtle buckleberry, barberry honeysuckle, currants, grouse whortleberry, and many grass and forb species.	Evergreen and some deciduous forest. Timber production, recreation, hunting, wildlife habitat, and seasonal grazing. Some mineral mining. Snow cover is a major source of water for lower, more arid ecoregions. Mostly public land (USDA-FS Carson and Santa Fe National Forests).
21c. Crystalline Mid-Elevation Forests	728	7600-10100/ 600-2000	Quaternary block rubble colluvium, colluvium with Tertiary intrusive rocks; Precambrian metasedimentary, metavolcanic, and intrusive rocks including pelitic schist, amphibolite, quartz-muscovite schist, quartzite, granitic gneiss, and granitic rocks.	Haplustalfs), Inceptisols (Haplustepts, Dystrocryepts), Entisols (Ustorthents)	Bundo, Angostura, Tolby, Cypher, Abreu, Mirabal	Frigid, Cryic/ Udic, Ustic	18-28	70-110	9/36; 42/76	Mostly ponderosa pine forest; some areas with pinyon pine or junipers at low elevations and south slopes. Understory may include Gambel oak, mountain mahogany, antelope bitterbrush, wax currant, skunkbush, wood rose, kinnikinnick, mountain muhly, Junegrass, Arizona fescue, pine dropseed, and various sedges. Higher elevations pine, and a few small areas of aspen.	Evergreen and some deciduous forest. Wildlife habitat, livestock grazing, timber production, recreation, and mineral extraction. Mostly public land (USDA-FS Carson and Santa Fe National Forests).
21d. Foothill Woodlands and Shrublands	3787	Hills, ridges, and footslopes. Moderate to high gradient perennial, intermittent, and ephemeral streams with cobble, gravel, and sandy substrates.	Quaternary block rubble colluvium, colluvium with Tertiary and Cretaceous sandstone, shale, and conglomerate; some Permian and Pennsylvanian sandstone, mudstone, and conglomerate; some Quaternary tuffs, Tertiary basaltic to andesitic lava, and Tertiary intrusive rocks; Precambrian metasedimentary, metavolcanic, and plutonic rocks.	Inceptisols (Haplustepts), Entisols (Ustorthents), Mollisols (Argiustolls, Haplustolls)	Trampas, Mirand, Duviseduro, Espiritu, Wasquie, Hogg, Mara, Rombo, Berryman, Russon, Elpedro, Stout, Pinitos, Menefee, Monteolo, Capillo, Apache	Frigid, Mesic/ Ustic, Aridic Ustic	12-20	90-100	12/40; 48/85	Mostly Mexican pinyon, one-seed juniper, alligator juniper, gray oak, Gambel oak, Emory oak, manzanita, mixed grasses, and threeawn. Some ponderosa pine at higher elevations.	Woodland, shrubland, some grassland. Livestock grazing and some irrigated hayland adjacent to perennial streams. Some public land (USDA-FS Carson and Santa Fe National Forests, BLM) and tribal land (Jicarilla Apache, Jemez, Picuris).
21e. Sedimentary Subalpine Forests	529	High mountains with steep slopes. High gradient perennial streams with boulder, cobble, and bedrock substrates.	Quaternary block-rubble colluvium, colluvium, and some glacial till. Permian and Pennsylvanian conglomerate, sandstone, siltstone, and limestone; some Cretaceous sandstone and shale in the north. In west, Tertiary (Miocene to Eocene) sandstone and conglomerate; some Cretaceous shale and sandstone.	Palecryalfs)	Presa, Jaroso, Angostura, Diamante, Mascarenas	Cryic/ Udic, Ustic	24-40 Deep winter snowpack	50-70	6/30; 38/70	, often interspersed with aspen groves or mountain meadows. Some areas with limber pine and Rocky Mountain bristlecone pine. and southwestern white pine occur at lower elevations. Understories may contain myrtle buckleberry, barberry honeysuckle, currants, grouse whortleberry, and many grass and forb species.	Evergreen and some deciduous forest. Timber production, recreation, hunting, wildlife habitat, and seasonal grazing. Some mineral mining. Snow cover is a major source of water for lower, more arid ecoregions. Mostly public land (USDA-FS Carson and Santa Fe National Forests), some tribal land (Pueblo de Taos).
21f. Sedimentary Mid-Elevation Forests	2997	Low mountain ridges, slopes, and outwash fans. Moderate to high gradient perennial streams with boulder, cobble, and bedrock substrates.	Quaternary block rubble colluvium, colluvium, and some glacial till; sandstone, mudstone, conglomerate, and shale; some Jurassic sandstone; Permian and Pennsylvanian conglomerate, sandstone, siltstone, and limestone.	Inceptisols (Haplustepts), Paleocryalfs), Entisols (Ustorthents), Mollisols (Argiustolls)	Dargol, Fuera, Vamer, Midnight, Capillo, Nabor, Maes, Etoe, Derecho, Diamante	Frigid, Cryic/ Udic, Ustic	16-29	70-110	10/37; 44/78	Mostly ponderosa pine forest; some areas with pinyon pine or junipers. Understory may include Gambel oak, mountain mahogany, antelope bitterbrush, wax currant, skunkbush, wood rose, kinnikinnick, mountain muhly, Junegrass, Arizona fescue, pine dropseed, and various sedges. Higher and a few small areas of aspen.	Evergreen and some deciduous forest. Timber production, summer livestock grazing, wildlife habitat, some mineral mining. Some public land (USDA-FS Carson and Santa Fe National Forests) and tribal land (Jicarilla Apache, Pueblo de Taos).
21g. Volcanic Subalpine Forests	562	High mountains with steep slopes. High gradient perennial streams with boulder, cobble, and bedrock substrates.	Quaternary block-rubble colluvium, colluvium, rhyolitic volcanics, and some glacial till. Quaternary and Tertiary rhyolitic material, breccia, and water-laid volcanics and conglomerates.	Mollisols (Argiustolls), Entisols (Cryorthents)	Redondo, Origo, Marosa, Burnac, Ess, Rusbach	Cryic, Frigid/ Udic, Ustic	24-38 Deep winter snowpack	50-70	6/30; 38/70	interspersed with aspen groves or mountain meadows. Some areas with limber pine and Rocky Mountain bristlecone occur at lower elevations. Understories may contain myrtle buckleberry, bearberry honeysuckle, currants, grouse whortleberry, and many grass and forb species.	Evergreen and some deciduous forest. Timber production, recreation, hunting, wildlife habitat, and seasonal grazing. Some gold mining. Snow cover is a major source of water for lower, more arid ecoregions. Some public land (USDA-FS Carson and Santa Fe National Forests) and tribal land (Jicarilla Apache, Pueblo de Taos).
21h. Volcanic Mid-Elevation Forests	690	Low mountain ridges, slopes, and outwash fans. Moderate to high gradient perennial streams with boulder, cobble, and bedrock substrates.	Quaternary block-rubble colluvium, colluvium, some eolian deposits in the east. Quaternary and Tertiary pyroclastic material, breccia, and water-laid volcanics and conglomerates.	Mollisols (Haplustolls), Inceptisols (Haplustepts)	Jemez, Totavi, Cajete, Burnac, Palon, Origo, Calaveras	Frigid, Cryic/ Ustic	18-28	70-110	9/36; 42/76	Mostly ponderosa pine forest. Understories may include Gambel oak, mountain mahogany, antelope bitterbrush, wax currant, skunkbush, wood rose, kinnikinnick, mountain muhly, Junegrass, Arizona fescue, pine dropseed, and various sedges. Blue spruce occurs on mesic sites. Douglas-fir higher elevations.	Evergreen and some deciduous forest. Wildlife habitat, summer livestock grazing, timber production, and recreation. Some silver and gold mining. Mostly public land (USDA-FS Santa Fe National Forest).
21j. Grassland Parks	204	High intermontane valleys, some basalt mesa tops in the east. Moderate gradient perennial streams with cobble, gravel, and sandy substrates. Some wetlands.	Quaternary alluvium, and on Johnson Mesa some discontinuous eolian deposits. Quaternary and Tertiary lavas and tuffs; in the Moreno Valley a complex mix of Mesozoic and Paleozoic sedimentary rocks, Tertiary intrusives, and Precambrian granite and gneiss.	Mollisols (Haplustolls, Argialbolls, Argiustolls, Haplaquolls, Endoaquolls)	Jarmillo, Transguilar, Jaroilla, Vastine, and Cosey in the Jemez Mountains; Morval, Moreno, Brycan, and Frolic in the Moreno Valley; Raton and Barela on Johnson Mesa.	Frigid/ Ustic	17-24	80-100	6/37; 41/78	Grasslands with bunchgrasses are dominant and include Parry's outgrass, Arizona fescue, Idaho fescue, Thurber fescue, mountain muhly, bluebunch wheatgrass, needle-and-thread grass, Junegrass, and slender wheatgrass.	Grassland. Recreation, livestock grazing, and wildlife habitat. Large elk herds in Moreno Valley, Valles Caldera, and Valle Vidal.

22. ARIZONA/NEW MEXICO PLATEAU

Level IV Ecoregions	Area (square miles)	Physiography: Elevation/ Local Relief (feet)	Geology: Surficial and Bedrock	Soils: Order (Great Group)	Soils: Common Soil Series	Soils: Temperature/ Moisture Regimes	Climate: Precipitation Mean annual (inches)	Climate: Frost Free Mean annual (days)	Climate: Mean Temperature January min/max; July min/max (°F)	Natural Vegetation	Land Cover and Land Use
22a. San Luis Shrublands and Hills	297	Plains, foothills, and some low mountains. Mostly ephemeral and some intermittent streams.	Quaternary colluvium and discontinuous eolian deposits. Tertiary (mostly Pliocene) basaltic to andesitic lava	Aridisols (Haplocalcids, Calciargids)	Travelers, Garita, Luhon, Stunner	Frigid/ Ustic Aridic, Aridic	9-12	95-115	5/37; 47/80	Big sagebrush, rabbitbrush, winterfat, and broom snakeweed occur as well as grasslands of western wheatgrass, green needlegrass, blue grama, and needle-and-thread.	Shrubland and grassland. Low density livestock grazing, wildlife habitat. Mostly public lands (BLM, State).
22b. San Luis Alluvial Flats and Wetlands	67	Irregular plains. In Colorado, wetlands, springs, and areas with a high water table. A few large perennial streams which originate in nearby mountains.	Quaternary alluvium of gravel, sand, and silt. In New Mexico, mostly fan alluvium.	Aridisols (Haplargids, Calciargids)	Tenorio, Fernando, Silva	Mesic/ Aridic, Aridic Ustic	10-14	115-130	7/36; 49/82	Big sagebrush, blue grama, sand dropseed, some rabbitbrush and winterfat.	Shrubland, some grassland. Low density livestock grazing, some irrigated cropland for hay.
22f. Taos Plateau	839	Rolling to level plateau, some volcanic cones, deep river gorge. Mostly ephemeral and intermittent streams, a few perennial streams from surrounding mountain ecoregions.	Quaternary eolian deposits, colluvium, piedmont and fan alluvium, block-rubble colluvium. Tertiary (mostly Pliocene) basalt and volcanic rocks.	Aridisols (Haplocalcids, Haplargids),	Petaca, Servilleta, Chita, Montecito	Mesic/ Ustic Aridic, Aridic Ustic	11-14	100-130	8/38; 50/82	Big sagebrush with winterfat, rabbitbrush, and broom snakeweed; some grasses of western wheatgrass, blue grama, galleta, alkali sacaton, and sand dropseed; a few pinyon pine and juniper.	Shrubland. Rangeland with low density livestock grazing, wildlife habitat, and some small areas of irrigated cropland. Some public land (USDA-FS Carson National Forest, BLM, State) and tribal land (Picuris Pueblo).
22g. Rio Grande Floodplain	363	levees.	Quaternary river alluvium and terrace deposits of sand, silt, and gravel.	Entisols (T Torripsamments)	Gilco, Peralta, Aga, Abiquiu, Alcalde in north; Gila, Brazito, Vinton, Glendale in south.	Mesic in north; thermic to the south/ Ustic, Aridic	8-9	160-190	20/48; 60/92	Bosque of cottonwood and willow with understories of coyote willow, New Mexico olive, false indigo, and sacpwiglass widely replaced by invasive saltcedar and Russian olive.	Pasture, cropland, orchards, vineyards, livestock grazing, and urban. W and habitat are a concern for recovery of the endangered Rio Grande silvery minnow.
22h. North Central New Mexico Valleys and Mesas	1387	Mesas, valleys, piedmont slopes, deep canyons, a few scattered hills. Some perennial and many intermittent streams from surrounding mountain ecoregions.	Quaternary alluvium, and fan alluvium, Tertiary sedimentary, Tertiary and Quaternary volcanic rocks, and some small areas of Cretaceous, Jurassic, or Triassic sedimentary rocks.	Aridisols (Haplocambids, Haplargids, Calciargids, Paleargids), Entisols (Torriorthents, Torripsamments, Ustipsamments), (Haplocambids)	Parida, Palacial, Florita, Pinavetes, Penistaja, Razito, Fruitland, Silver, Pojoaque, Punky, El Rancho, Scholle, Hagerman, Vibo, Rojoso, rock outcrop	Mesic/ Ustic Aridic, Aridic Ustic	10-16	135-170	16/43; 55/87	Pinyon-juniper woodland and juniper savanna with grasses of galleta, Indian ricegrass, blue grama, black grama, threeawns, and sand dropseed.	Grassland, shrubland, evergreen woodland, some urban. Livestock grazing. Some public (USDA-FS, BLM) and land (State, Santa Clara, Jicarilla Apache, Nambe, Pojoaque, Tesuque, Cochiti).
22i. San Juan/Chaco Tablelands and Mesas	6753	Plateaus, mesas, benches, cuestas, hogback ridges, cliffs, canyons, and valleys. Mostly ephemeral and some intermittent streams.	Quaternary discontinuous, thin, sandy eolian deposits; colluvium with large areas of bedrock outcrop, Tertiary (Eocene, Paleocene) and Cretaceous sandstone, shale, mudstone, and conglomerate, including Cretaceous coal-bearing formations.	Aridisols (Haplocambids, Haplargids, Calciargids, Haplocalcids), Entisols (Torriorthents, Torripsamments, T	Shalako, Doak, Littlehat, Persayo, Sheppard, Sparank, Farb, Kirtsonbly, Denazar, Blancot, Tsosie, Doskum, Betonnie	Mesic/ Aridic, some Ustic Aridic	6-10	130-160	18/42; 57/90	Mix of desert scrub, semi-desert shrub-steppe, and semi-desert grasslands. Shadscale, fourwing saltbush, mat saltbush, greasewood, ephedra, Indian ricegrass, alkali sacaton, galleta, blue and black gramas. Some one-seed, Utah, or Rocky Mountain junipers on higher mesas.	Shrubland, some areas of sparse grassland, or barren. Low-density livestock grazing of cattle, sheep, goats, and horses; coal, oil, and gas production; some irrigated agriculture of hay, alfalfa, corn, potatoes, wheat, and apples along and south of San Juan River. Mostly tribal (Navajo) and public (BLM) land.
22j. Semiarid Tablelands	8509	Mesas, plateaus, cliffs, canyons, and valleys. Mostly ephemeral and some intermittent streams.	Cretaceous, Jurassic, and Triassic sedimentary rocks of sandstone, shale, and mudstone, some areas of Tertiary	(T Aridisols (Haplargids, Paleargids), Mollisols (Argiustolls)	Flugle, Pinitos, Silkie, Navajo, Atarque, Celecy, Dziil, Jacec, Geesling, Hubbell, Vessilla, Viada, Veteado, Cabezon, rock outcrop	Mesic/ Aridic Ustic, Aridic	10-15	120-150	15/45; 52/86	Scattered juniper and pinyon-juniper woodland, with alkali sacaton, shadscale, fourwing saltbush, mixed grasses, western wheatgrass, and some winterfat.	Shrubland, woodland, some grassland. Livestock grazing, wildlife habitat. Some tribal land (Zuni, Navajo, Acoma, Laguna) and public land (BLM, State).
22k. Lava Malpais	239	tubes, caves.	Quaternary block rubble colluvium, colluvium with devoid of soils. Variable soils occur in small pockets that may include Viuda or Raton.	Aridisols (Haplargids), Mollisols (Argiustolls)		Mesic/ Ustic Aridic, Ustic	11-13	140-150	14/48; 54/89	Some bare areas, some grasses of blue grama and sideoats grama; shrubs of Apache plume and New Mexico olive, , and ponderosa pine. Some plants indicative of a "mesic island" i.e., moister than the land around it. Ferns may grow in small cracks in shady exposures.	Bare rock, shrubland, woodland. Wildlife habitat, recreation. Most all is public land (NPS-El Malpais National Monument, BLM-El Malpais National Conservation Area).
22l. Plains of San Agustin	1017	Closed basin, playa lake, alluvial fans, piedmont slopes. Ephemeral washes and streams near the margins from surrounding foothills.	Deep Holocene and Pleistocene playa alluvium, shoreline deposits, colluvium and alluvium, and eolian deposits. Tertiary lavas and tuffs.	Inceptisols (Haplustepts), Vertisols Mollisols (Argiustolls), (Haplustalfs)	Telescope, Catman, Hickman, Loare, Augustine	Mesic/ Aridic Ustic	11-13	130-150	18/47; 55/85	In low areas: alkali sacaton, fourwing saltbush, and greasewood. Some western wheatgrass, blue grama, sand dropseed, vine-mesquite. On higher slopes: juniper and some pinyon.	Shrubland, grassland, some barren land. Livestock grazing. Some public land (State, BLM). Space observations (Very Large Array Radio Astronomy Observatory).
22m. Albuquerque Basin	2884	Plains and piedmont plains with alluvial fans and some scattered hills. Mostly ephemeral and intermittent streams.	Quaternary fan alluvium, colluvium, Deep Quaternary and Tertiary sediments, small areas of Quaternary basalt.	Aridisols (Haplocalcids, Calciargids, Haplocambids, Haplargids), Entisols (T Torriorthents, Ustorthents)	Wink, Turney, Madurez, Pajarito, Gila, Kokan, Embudo, Tijeras, Clovis, Zia, Grieta; in the north, Penavetes, San Mateo, Ildefonso, Silver, Harvey, Witt, Sedillo, Placitas, Royosa, Wasmae.	Thermic, Mesic in north/ Aridic,Ustic Aridic	8-11	170-200	19/49; 62/92	Sand scrub and desert grassland including black grama, sand dropseed, mesa dropseed, blue grama, galleta, sand sage, alkali sacaton, and threeawns.	Shrubland and grassland, urban and suburban, barren land. Some livestock grazing. Water withdrawals have lowered groundwater levels in many areas. Some tribal land (Zia, Santa Ana, Santo Domingo, San Felipe, Sandia, Isleta).
22n. Near-Rockies Valleys and Mesas	986	Mesas, benches, cuestas, cliffs, and canyons. Ephemeral and intermittent streams.	Quaternary block-rubble colluvium and colluvium with Tertiary (Eocene, Paleocene) sandstone, shale, and mudstone, small area of Cretaceous sandstone and shale in the far south.	Entisols (Ustorthents, Torriorthents), (Haplargids) Aridisols	Vessilla, Menefee, Orlie, Floria, Penistaja, Travessilla, Weska	Mesic/ Aridic Ustic, Ustic Aridic	10-13	120-140	13/40; 54/85	One-seed and Rocky Mountain junipers, Indian ricegrass, big sagebrush, sand dropseed, galleta, threeawns, blue grama, and rabbitbrush.	Shrubland, evergreen woodland and savanna. Livestock grazing, wildlife habitat, some natural gas production. Mostly public (BLM) and tribal land (Jicarilla Apache).

23. ARIZONA/NEW MEXICO MOUNTAINS

Level IV Ecoregions	Area (square miles)	Physiography: Elevation/ Local Relief (feet)	Geology: Surficial and Bedrock	Soils: Order (Great Group)	Soils: Common Soil Series	Soils: Temperature/ Moisture Regimes	Climate: Precipitation Mean annual (inches)	Climate: Frost Free Mean annual (days)	Climate: Mean Temperature January min/max; July min/max (°F)	Natural Vegetation	Land Cover and Land Use
23a. Chihuahuan Desert Slopes	766	Lower slopes of Guadalupe and Sacramento Mountains, cut by steep canyons. Moderate gradient ephemeral streams that carry water only after periodic storms.	Quaternary block-rubble colluvium, colluvium with in drainages. Mostly Permian limestones, sandstones, and claystones, some Pennsylvanian sedimentary rocks on west side of Sacramento Mountains.	Mollisols (Calciustolls), Aridisols (Haplocalcids, Haplargids), Aridisols (Haplocalcids), Inceptisols (Haplustepts)	Ector, Lozier, rock outcrop, Tence, Tome	Thermic/ Ustic, Aridic	15-18	180-210	29/52; 62/85	On benches and slopes with deeper soil: grasses such as blue, black, and sideoats gramas, purple threeawn, lovegrass, curlyleaf muhly. On rocky slopes and in disturbed grasslands: succulent desert shrubs such as sotol, lechuguilla, yucca, ocotillo, and cacti.	Shrubland and grassland. Wildlife habitat, livestock grazing. Mostly public land (USDA-FS Lincoln and Gila National Forests, BLM, NPS-Carlsbad Caverns National Park), and tribal land (Mescalero Apache) and military land (Fort Bliss).
23b. Madrean Lower Montane Woodlands	4528	High hills and low mountains, some deep canyons. Mostly moderate to high gradient intermittent streams with bedrock, cobble, gravel, and sandy substrates; a few perennial rivers.	block-rubble colluvium. In the east, Permian and some Pennsylvanian limestone, sandstone, and shale. In the west, Quaternary and Tertiary sandstone and conglomerate, Tertiary volcanic tuffs and lavas.	Mollisols (Calciustolls, Argiustolls, Haplustolls), Aridisols (Haplocalcids, Haplargids)	In the east, Deama, Darvey, Asparas, Pena, rock outcrop. In the west, Mayhill, Muzzifet, Jonale, Lonti, Ruidoso, White House, rock outcrop.	Mesic/ Aridic Ustic, Ustic Aridic	13-20	150-200	23/53; 56/87	Mostly Mexican pinyon, one-seed juniper, alligator juniper, gray oak, Gambel oak, Emory oak, manzanita, mixed grasses, and threeawn. Some ponderosa pine at higher elevations.	Woodland, shrubland, some grassland. Livestock grazing, recreation, wildlife habitat. Some public land (USDA-FS Lincoln and Gila National Forests, BLM, NPS-Carlsbad Caverns National Park) and tribal land (Mescalero Apache).
23c. Montane Conifer Forests	4382	Open to low mountains and high mountains with steep slopes, numerous canyons. Mostly moderate to high gradient intermittent and some perennial streams with bedrock, cobble, gravel, and sandy substrates.	Quaternary colluvium, block-rubble colluvium, and Tertiary (Miocene and Oligocene) volcanic lavas, tuffs, breccias, volcaniclastic sedimentary rocks, and Tertiary intrusives in south; Tertiary (Pliocene and Miocene) Taylor and Cebolleta Mesa; Permian sandstone, siltstone, limestone, Precambrian granite, granitic gneiss, schist, and some Triassic sandstone, shale, and mudstone in Zuni Mountains. Tertiary (Oligocene) sandstone and small areas of Tertiary (Miocene and Oligocene) andesite and basaltic andesite in Chuska Mountains.	Mollisols (Haplustolls, Argiustolls), Inceptisols (Haplustepts)	Chuska Mountains: Akhono, Tunticha, Klethin. Zuni Mountains: Mirabal, Zuni, Tampico, Cinnadale, Heckly, Fortwingate, Ouerolge, Jekley Cebolleta Mesa: Cebolleta, Chaes. Gila Mountains area: Smilo, Raton.	Frigid/ Ustic	14-30	90-140	12/44; 47/81	Evergreen forest and woodlands. Timber production, recreation, hunting, wildlife habitat, and recreation. Mostly public land (USDA-FS Gila and Cibola National Forests) and tribal land (Mescalero Apache) and military land (Fort Bliss).
23d. Arizona/New Mexico Subalpine Forests	217	High mountains with steep slopes. Some high gradient perennial and intermittent streams with boulder, cobble, and bedrock substrates.	Not mapped to series level by USDA-FS.	Inceptisols (Dystrocryepts, Cryoborepts), Cryoborafls)		Frigid, some Cryic/ Ustic, some Udic	20-40	70-90	9/38; 45/76	, and Evergreen and some deciduous forest. Recreation, wildlife habitat, some designated wilderness. All in public land (USDA-FS Gila and Cibola National Forests).	
23e. Conifer Woodlands and Savannas	6513	High hills and low mountains, numerous canyons. Mostly moderate to high gradient intermittent streams with bedrock, cobble, gravel, and sandy substrates; a few perennial rivers.	Quaternary colluvium, block-rubble colluvium, Chuska Mountains: Cretaceous and Jurassic sandstone, shale, and mudstone. Zuni Mountains: Triassic and Permian sandstone, limestone, shale. San Mateo Mountains and Cebolleta Mesa: Tertiary basaltic to andesitic lava and Cretaceous sandstone and shale. In south: Tertiary (Miocene and Oligocene) volcanic lavas, tuffs, breccias, volcaniclastic sedimentary rocks.	Inceptisols (Haplustepts), Entisols (Ustorthents), Mollisols (Argiustolls), Calciustolls)	Chuska Mountains: Narbona, Valvetta, Kunz, Iweda, Nontrah, Wetherill. Zuni Mountains: Similarq, Calevar, Fikel, Tucex, Vessilla. San Mateo Mountains: Amcee, Montillo, Toondel, Cebolleta Mesa: Tertiary basaltic to andesitic lava and Cretaceous sandstone and shale. In south: Tertiary (Miocene and Oligocene) volcanic lavas, tuffs, breccias, volcaniclastic sedimentary rocks.	Frigid, Mesic/ Ustic, Aridic Ustic	13-20	120-160	17/46; 52/84	Pinyon-juniper woodlands with one-seed juniper, alligator juniper, Rocky Mountain juniper at higher latitudes and elevations, pinyon pine, blue grama, junegrass, galleta, and bottlebrush squirreltail. Some areas with Gambel oak. Utah juniper and big sagebrush in Chuska Mtns. Some ponderosa pine, mountain muhly, and Arizona fescue at highest elevations, mostly northern San Mateo Mtns. On lower and drier sites, areas of yucca and opuntia.	Evergreen woodland, shrubland, grassland. Livestock grazing, wildlife habitat, recreation. Some public land (USDA-FS Gila and Cibola National Forests) and tribal land (Navajo, Acoma, Zuni).
23f. Rocky Mountain Conifer Forests	1657	Open low mountains and high mountains with steep slopes, numerous canyons. Mostly moderate to high gradient intermittent and some perennial streams with bedrock, cobble, and gravel substrates.	Quaternary block-rubble colluvium, colluvium with Permian and Pennsylvanian limestone, sandstone, and shale; some Tertiary volcanics, Tertiary intrusive rocks, small areas of Cretaceous sandstone and shale, and Precambrian granite, granitic gneiss, schist, and quartzite.	Mollisols (Argiustolls, Paleustolls, Haplustolls), Paleustalfs)	Sandia/Manzano Mountains: Jekley, Pinata, Crest, Oshu, rock outcrop. Sacramento and southern mountains: Caballo, Peso, Gaines, Telefono, Mescalero, Frio, Gavilan, Morgans, Doodee, rock outcrop	Frigid, some Mesic/ Ustic	18-28	90-140	17/43; 47/77	Mostly ponderosa pine and Gambel oak with pinyon pine, mountain mahogany, Arizona sycamore and a dense understory , southwestern white pine, and aspen occur. Blue spruce occasionally found in cool, moist canyons. In the southern Sacramento Mountains, silverleaf, nelleaf, and waxyleaf oak and Russian olive.	Evergreen forest and some deciduous forest. Timber production, recreation, wildlife habitat, some livestock grazing. Source of water and groundwater for lower, more arid ecoregions. Mostly public land (USDA-FS Cibola and Lincoln National Forests) and tribal land (Isleta, Mescalero Apache).
23g. Rocky Mountain Subalpine Forests	45	High mountain peaks and ridges with steep slopes. Some glaciation (Sierra Blanca: southernmost glaciated peak in conterminous U.S.). A few small, high-gradient streams with boulder, cobble, and bedrock substrates.	Quaternary block-rubble colluvium, small area of glacial till on Sierra Blanca. Sandia Mountains: Precambrian granitic rocks capped by Pennsylvanian limestone and shale. Sierra Blanca and Capitan Mountains: Tertiary intrusives and volcanics.	Mollisols (Haplustolls, Haplocryolls)	Caballo, Blanca, Supervisor	Cryic, Frigid/ Ustic	20-30	70-90	13/27; 45/66	Numerous shrub and forb species. .	Evergreen and some deciduous forest. Recreation, wildlife habitat. Mostly public land (USDA-FS Cibola and Lincoln National Forests) and tribal land (Mescalero Apache).

24. CHIHUAHUAN DESERTS

Level IV Ecoregions	Area (square miles)	Physiography: Elevation/ Local Relief (feet)	Geology: Surficial and Bedrock	Soils: Order (Great Group)	Soils: Common Soil Series	Soils: Temperature/ Moisture Regimes	Climate: Precipitation Mean annual (inches)	Climate: Frost Free Mean annual (days)	Climate: Mean Temperature January min/max; July min/max (°F)	Natural Vegetation	Land Cover and Land Use
24a. Chihuahuan Basins and Playas	14029	alluvial basins surrounding major river (Pecos, Rio Grande) or internally drained. Streams ephemeral.	Quaternary and some late Tertiary alluvium and erosional materials from surrounding mountains, including unconsolidated basin deposits of silt, sand, and gravel. Includes piedmont and fan alluvium, river alluvium, lacustrine and playa deposits, eolian deposits, and calcretes.	Aridisols (Haplocalcids, Petrocalcids, Calciargids, Calciargids, Haplogypsids, Haplocambids), Entisols (Torriorthents, Torripsamments)	Holloman, Reeves, Bluepoint, Wink, Huco, Pintura, Dona Ana, Cruces, Berino, Nickel, Tres Hermanos, Caliza, Malargo, Largo, Mimbres, Stellar	Thermic/ Aridic, Ustic Aridic	9-13	190-220	25/57; 66/95	seepweed, pickleweed, and alkali sacaton. Gypsum land: gyp grama, gyp mentzelia, and Torrey ephedra. Desert shrub land: creosotebush, tarbush, yucca, sandsage, viscid acacia, tasajillo, lechuguilla, mesquite, and ceniza.	Shrubland, some remnant grassland, barren land. Wildlife habitat, limited livestock grazing, public (BLM, State) and military land (Fort Bliss). Some irrigated cropland of mostly hay and alfalfa, with some cotton, chile peppers, onions, pecans, and corn or sorghum for silage or greenchop. Dairy farms occur near Roswell. Some urban land.
24b. Chihuahuan Desert Grasslands	8019	Plateaus, high intermountain basins, alluvial fans, and bajadas. Stream segments from occasional only after storm events.	alluvium and piedmont alluvium, discontinuous eolian deposits. Pennsylvanian sandstone, siltstone, gypsum, dolomite, and limestone; Tertiary igneous and volcaniclastic rocks, and some Tertiary sandstones and conglomerates.	Aridisols (Haplocalcids, Petrocalcids, Haplocambids, Calciargids), Entisols (Torriorthents, Torripsamments), Mollisols (Calciustolls)	Pelzer, Reyab, Armesa, Reakor, Ector, Tome, Delmorie, Tres Hermanos, Hap, Eba, Kermit, Berino, Pajar

Appendix E – Soils Descriptions

No.	Description
E-1	NRCS Soil Descriptions

Appendix E-1

A printed copy of this document may not be the official version. The official printed copy of this UAA is located in the office of the Environmental Compliance and monitoring (Org. 0641).

Bernalillo County and Parts of Sandoval and Valencia Counties, New Mexico

BCC—Bluepoint loamy fine sand, 1 to 9 percent slopes

Map Unit Setting

National map unit symbol: 2sy14
Elevation: 4,460 to 6,000 feet
Mean annual precipitation: 6 to 12 inches
Mean annual air temperature: 57 to 70 degrees F
Frost-free period: 170 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Bluepoint and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Bluepoint

Setting

Landform: Stream terraces
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Riser
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Alluvium and/or eolian deposits

Typical profile

C1 - 0 to 5 inches: loamy fine sand
C2 - 5 to 28 inches: loamy fine sand
C3 - 28 to 53 inches: loamy fine sand
C4 - 53 to 60 inches: loamy sand

Properties and qualities

Slope: 1 to 9 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 20.04 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Gypsum, maximum in profile: 1 percent
Salinity, maximum in profile: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 2.0
Available water storage in profile: Low (about 5.7 inches)

Interpretive groups

Land capability classification (irrigated): 3s
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Ecological site: Deep Sand (R042XA054NM)
Hydric soil rating: No

Minor Components

Bluepoint family

Percent of map unit: 6 percent
Hydric soil rating: No

Wink

Percent of map unit: 3 percent
Hydric soil rating: No

Caliza

Percent of map unit: 2 percent
Hydric soil rating: No

Pajarito

Percent of map unit: 2 percent
Hydric soil rating: No

Arizo

Percent of map unit: 1 percent
Hydric soil rating: No

Madurez

Percent of map unit: 1 percent
Hydric soil rating: No

Data Source Information

Soil Survey Area: Bernalillo County and Parts of Sandoval and Valencia Counties, New Mexico
Survey Area Data: Version 13, Sep 12, 2018

Bernalillo County and Parts of Sandoval and Valencia Counties, New Mexico

BKD—Bluepoint-Kokan association, hilly

Map Unit Setting

National map unit symbol: 1vwd
Elevation: 4,850 to 6,000 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 58 to 60 degrees F
Frost-free period: 170 to 195 days
Farmland classification: Not prime farmland

Map Unit Composition

Bluepoint and similar soils: 50 percent
Kokan and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Bluepoint

Setting

Landform: Alluvial flats, flood plains
Landform position (three-dimensional): Rise, talf
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Sandy alluvium and/or eolian sands

Typical profile

H1 - 0 to 8 inches: loamy fine sand
H2 - 8 to 60 inches: stratified fine sand to gravelly loamy fine sand

Properties and qualities

Slope: 5 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 20.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 3 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 2.0
Available water storage in profile: Low (about 4.3 inches)

Interpretive groups

Land capability classification (irrigated): 4s
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A

Ecological site: Deep sand (R042XA054NM)

Description of Kokan

Setting

Landform: Hillslopes, fan piedmonts
Landform position (two-dimensional): Shoulder, backslope, footslope
Landform position (three-dimensional): Side slope, rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from igneous and sedimentary rock

Typical profile

H1 - 0 to 4 inches: gravelly sand
H2 - 4 to 60 inches: stratified very gravelly sand to extremely gravelly loamy coarse sand

Properties and qualities

Slope: 15 to 40 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Very high (20.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 2 percent
Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 2.0
Available water storage in profile: Very low (about 2.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Ecological site: Gravelly sand (R042XA053NM)

Data Source Information

Soil Survey Area: Bernalillo County and Parts of Sandoval and Valencia Counties, New Mexico
Survey Area Data: Version 10, Dec 17, 2013

Bernalillo County and Parts of Sandoval and Valencia Counties, New Mexico

Cu—Cut and fill land

Map Unit Setting

National map unit symbol: 1vwr
Elevation: 4,850 to 6,000 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 58 to 60 degrees F
Frost-free period: 170 to 195 days
Farmland classification: Not prime farmland

Map Unit Composition

Cut and fill land: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Cut And Fill Land

Setting

Landform: Scarp slopes
Down-slope shape: Linear
Across-slope shape: Linear

Data Source Information

Soil Survey Area: Bernalillo County and Parts of Sandoval and Valencia Counties, New Mexico
Survey Area Data: Version 11, Sep 26, 2014

Bernalillo County and Parts of Sandoval and Valencia Counties, New Mexico

EmB—Embudo gravelly fine sandy loam, 0 to 5 percent slopes

Map Unit Setting

National map unit symbol: 1vws
Elevation: 4,850 to 7,000 feet
Mean annual precipitation: 7 to 16 inches
Mean annual air temperature: 48 to 60 degrees F
Frost-free period: 130 to 195 days
Farmland classification: Not prime farmland

Map Unit Composition

Embudo and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Embudo

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Alluvium derived from igneous and sedimentary rock

Typical profile

H1 - 0 to 4 inches: gravelly fine sandy loam
H2 - 4 to 20 inches: gravelly sandy loam
H3 - 20 to 60 inches: stratified very gravelly loamy coarse sand to extremely gravelly loamy sand

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Rare
Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 2.0
Available water storage in profile: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Ecological site: Sandy (R042XA051NM)
Hydric soil rating: No

Minor Components

Tesajo

Percent of map unit:
Ecological site: Gravelly (R035XG114NM)
Hydric soil rating: No

Millett

Percent of map unit:
Ecological site: Gravelly (R035XG114NM)
Hydric soil rating: No

Tijeras

Percent of map unit:
Ecological site: Sandy (R042XA051NM)
Hydric soil rating: No

Data Source Information

Soil Survey Area: Bernalillo County and Parts of Sandoval and Valencia Counties, New Mexico
Survey Area Data: Version 13, Sep 12, 2018

Bernalillo County and Parts of Sandoval and Valencia Counties, New Mexico

GA—Gila fine sandy loam

Map Unit Setting

National map unit symbol: 1vwv
Elevation: 1,400 to 6,500 feet
Mean annual precipitation: 4 to 14 inches
Mean annual air temperature: 57 to 60 degrees F
Frost-free period: 170 to 290 days
Farmland classification: Not prime farmland

Map Unit Composition

Gila and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Gila

Setting

Landform: Alluvial fans, flood plains
Landform position (three-dimensional): Rise, talf
Down-slope shape: Linear, concave
Across-slope shape: Linear
Parent material: Alluvium derived from igneous and sedimentary rock

Typical profile

H1 - 0 to 7 inches: fine sandy loam
H2 - 7 to 60 inches: stratified gravelly sandy loam to silt loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Rare
Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Salinity, maximum in profile: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 2.0
Available water storage in profile: High (about 10.5 inches)

Interpretive groups

Land capability classification (irrigated): 1
Land capability classification (nonirrigated): 7c
Hydrologic Soil Group: B

Ecological site: Bottomland (R042XA057NM)
Hydric soil rating: No

Minor Components

Embudo
Percent of map unit:
Ecological site: Sandy (R042XA051NM)
Hydric soil rating: No

Glendale
Percent of map unit:
Ecological site: Bottomland (R042XA057NM)
Hydric soil rating: No

Bluepoint
Percent of map unit:
Ecological site: Deep Sand (R042XA054NM)
Hydric soil rating: No

Data Source Information

Soil Survey Area: Bernalillo County and Parts of Sandoval and Valencia Counties, New Mexico
Survey Area Data: Version 13, Sep 12, 2018

Bernalillo County and Parts of Sandoval and Valencia Counties, New Mexico

LtB—Latene sandy loam, 1 to 5 percent slopes

Map Unit Setting

National map unit symbol: 1vxm
Elevation: 2,700 to 6,000 feet
Mean annual precipitation: 5 to 12 inches
Mean annual air temperature: 57 to 70 degrees F
Frost-free period: 170 to 250 days
Farmland classification: Not prime farmland

Map Unit Composition

Latene and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Latene

Setting

Landform: Stream terraces, alluvial fans
Landform position (three-dimensional): Tread, rise
Down-slope shape: Concave, linear
Across-slope shape: Linear
Parent material: Alluvium derived from igneous and sedimentary rock

Typical profile

H1 - 0 to 15 inches: sandy loam
H2 - 15 to 60 inches: gravelly sandy loam

Properties and qualities

Slope: 1 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 45 percent
Salinity, maximum in profile: Very slightly saline to slightly saline (2.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 2.0
Available water storage in profile: Moderate (about 6.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B

Ecological site: Loamy (R042XA052NM)
Hydric soil rating: No

Minor Components

Madurez
Percent of map unit:
Ecological site: Deep Sand (R042XA054NM)
Hydric soil rating: No

Wink
Percent of map unit:
Ecological site: Loamy (R042XA052NM)
Hydric soil rating: No

Data Source Information

Soil Survey Area: Bernalillo County and Parts of Sandoval and Valencia Counties, New Mexico
Survey Area Data: Version 13, Sep 12, 2018

Bernalillo County and Parts of Sandoval and Valencia Counties, New Mexico

MaB—Madurez loamy fine sand, 1 to 5 percent slopes

Map Unit Setting

National map unit symbol: 1vxq
Elevation: 2,000 to 6,000 feet
Mean annual precipitation: 5 to 13 inches
Mean annual air temperature: 57 to 70 degrees F
Frost-free period: 170 to 260 days
Farmland classification: Not prime farmland

Map Unit Composition

Madurez and similar soils: 90 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Madurez

Setting

Landform: Fan piedmonts, alluvial fans
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from igneous and sedimentary rock

Typical profile

H1 - 0 to 4 inches: loamy fine sand
H2 - 4 to 21 inches: sandy clay loam
H3 - 21 to 60 inches: sandy loam

Properties and qualities

Slope: 1 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 7 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 2.0
Available water storage in profile: Moderate (about 8.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e

Hydrologic Soil Group: B
Ecological site: Sandy (R042XA051NM)
Hydric soil rating: No

Minor Components

Wink
Percent of map unit:
Ecological site: Loamy (R042XA052NM)
Hydric soil rating: No

Latene
Percent of map unit:
Ecological site: Loamy (R042XA052NM)
Hydric soil rating: No

Pajarito
Percent of map unit:
Ecological site: Sandy (R042XA051NM)
Hydric soil rating: No

Data Source Information

Soil Survey Area: Bernalillo County and Parts of Sandoval and Valencia Counties, New Mexico
Survey Area Data: Version 13, Sep 12, 2018

Bernalillo County and Parts of Sandoval and Valencia Counties, New Mexico

TgB—Tijeras gravelly fine sandy loam, 1 to 5 percent slopes

Map Unit Setting

National map unit symbol: 1vyt
Elevation: 3,900 to 6,500 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 170 to 210 days
Farmland classification: Not prime farmland

Map Unit Composition

Tijeras and similar soils: 80 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tijeras

Setting

Landform: Alluvial fans, fan remnants
Landform position (three-dimensional): Rise
Down-slope shape: Linear, convex
Across-slope shape: Linear, convex
Parent material: Alluvium derived from igneous and sedimentary rock

Typical profile

H1 - 0 to 6 inches: gravelly fine sandy loam
H2 - 6 to 19 inches: sandy clay loam
H3 - 19 to 60 inches: gravelly sandy loam

Properties and qualities

Slope: 1 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 2.0
Available water storage in profile: Low (about 5.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7c

Hydrologic Soil Group: B
Ecological site: Sandy (R042XA051NM)
Hydric soil rating: No

Minor Components

Madurez
Percent of map unit:
Ecological site: Sandy (R042XA051NM)
Hydric soil rating: No

Latene
Percent of map unit:
Ecological site: Loamy (R042XA052NM)
Hydric soil rating: No

Embudo
Percent of map unit:
Ecological site: Sandy (R042XA051NM)
Hydric soil rating: No

Data Source Information

Soil Survey Area: Bernalillo County and Parts of Sandoval and Valencia Counties, New Mexico
Survey Area Data: Version 13, Sep 12, 2018

Bernalillo County and Parts of Sandoval and Valencia Counties, New Mexico

WaB—Wink fine sandy loam, 0 to 5 percent slopes

Map Unit Setting

National map unit symbol: 1vz2
Elevation: 3,900 to 6,000 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 170 to 210 days
Farmland classification: Not prime farmland

Map Unit Composition

Wink and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Wink

Setting

Landform: Fan piedmonts, alluvial fans
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from igneous and sedimentary rock

Typical profile

H1 - 0 to 6 inches: fine sandy loam
H2 - 6 to 60 inches: sandy loam

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Gypsum, maximum in profile: 3 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 2.0
Available water storage in profile: Moderate (about 7.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e

Hydrologic Soil Group: A
Ecological site: Loamy (R042XA052NM)
Hydric soil rating: No

Minor Components

Latene
Percent of map unit:
Ecological site: Loamy (R042XA052NM)
Hydric soil rating: No

Data Source Information

Soil Survey Area: Bernalillo County and Parts of Sandoval and Valencia Counties, New Mexico
Survey Area Data: Version 13, Sep 12, 2018

Bernalillo County and Parts of Sandoval and Valencia Counties, New Mexico

WeB—Wink-Embudo complex, 0 to 5 percent slopes

Map Unit Setting

National map unit symbol: 1vz3
Elevation: 4,850 to 6,500 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 58 to 60 degrees F
Frost-free period: 170 to 195 days
Farmland classification: Not prime farmland

Map Unit Composition

Wink and similar soils: 65 percent
Embudo and similar soils: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Wink

Setting

Landform: Alluvial fans, fan piedmonts
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from igneous and sedimentary rock

Typical profile

H1 - 0 to 6 inches: fine sandy loam
H2 - 6 to 60 inches: sandy loam

Properties and qualities

Slope: 1 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Gypsum, maximum in profile: 2 percent
Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 2.0
Available water storage in profile: Moderate (about 7.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e

Hydrologic Soil Group: A
Ecological site: Loamy (R042XA052NM)

Description of Embudo

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Alluvium derived from igneous and sedimentary rock

Typical profile

H1 - 0 to 4 inches: gravelly fine sandy loam
H2 - 4 to 20 inches: gravelly sandy loam
H3 - 20 to 60 inches: stratified very gravelly loamy coarse sand to extremely gravelly loamy sand

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Rare
Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 2.0
Available water storage in profile: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Ecological site: Sandy (R042XA051NM)

Data Source Information

Soil Survey Area: Bernalillo County and Parts of Sandoval and Valencia Counties, New Mexico
Survey Area Data: Version 11, Sep 26, 2014

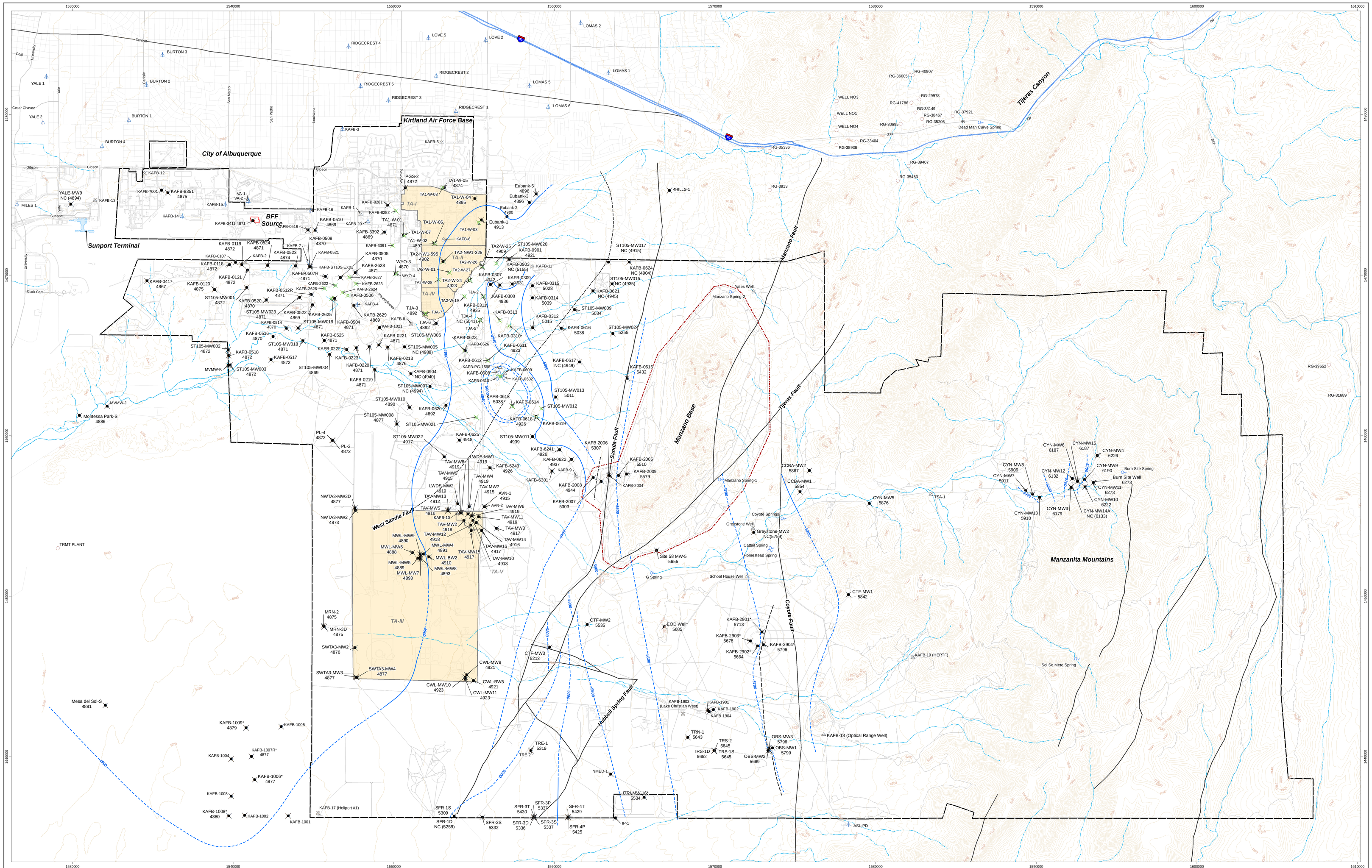
Appendix F – Groundwater Data

No.	Description
F-1	Map of Potentiometric Surfaces for Regional and Perched Groundwater, 2018
F-2	Table of Potentiometric Surfaces for Regional and Perched Groundwater, 2018
F-3	Long Term Hydrographs of Regional and Perched Groundwater

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Appendix F-1

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Legend

- Monitoring Well, Regional Aquifer / Fractured Bedrock System
- Monitoring Well, Perched Groundwater System
- Production Well, potable
- Production Well, non-potable
- Production Well, plugged and abandoned
- Extraction Well
- Injection Well
- Off-base Well, private use
- Spring, current or historical flow
- NC Not Contoured
- * See Note 3

- Potentiometric surface contour (ft amsl), dashed where uncertain
- Fault, exposed and concealed
- Fault, fully concealed
- Surface drainage, arroyo
- Ground surface contour (40 ft interval)
- Bulk Fuels Facility, KAFB
- Golf Course Main Pond, KAFB
- SNL/NM Technical Area (TA) boundary
- Manzano Base boundary
- Kirtland Air Force Base (KAFB) boundary
- Road, paved and unpaved

NOTES:

1. Groundwater elevations for the Regional Aquifer and the Fractured Bedrock System are shown for monitoring wells located near SNL/NM facilities. The wells with no available groundwater elevation have no value plotted.
2. Monitoring wells with anomalous groundwater elevations in the Regional Aquifer or Fractured Bedrock System are shown with an NC (not contoured) label next to the value. Table 2 states the rationale.
3. Groundwater elevations are rounded to the nearest foot. Water levels were measured at SNL/NM wells between 29 September and 23 October 2017. Wells owned by other agencies that were measured outside this date range are noted by an asterisk next to the well number. Groundwater elevations and measurement dates are listed in Table 2.
4. Groundwater elevations were not used for production-potable wells.
5. Groundwater elevations for monitoring wells screened in the Perched Groundwater System are not plotted. A potentiometric surface figure for the Perched Groundwater System is presented in Chapter 6.
6. Potentiometric surface contours for the Regional Aquifer are primarily shown using two intervals: below 5000 ft amsl the contour intervals are 40 and 60 feet; above 5000 ft amsl the contour interval is 100 feet.
7. Most of the monitoring wells located near the KAFB Bulk Fuels Facility and at KAFB Site 58 are not plotted.
8. Decommissioned (plugged and abandoned) monitoring wells are not shown.
9. Principal faults are derived from GRAM and Lettis (1995), Karlstrom et al., (2000), and Van Hart (2003). The dashed faults located near wells KAFB-2007 and OBS-MW1 are inferred from groundwater elevations.
10. West of the Sandia Fault, the Regional Aquifer is present within the unconsolidated Santa Fe Group sediments. Groundwater within and east of the Tijeras Fault Zone (bounded by the Sandia and Tijeras Faults) is primarily present in the Paleozoic and Precambrian bedrock.
11. The West Sandia Fault does not affect the alluvial-fan sediments at the water table.

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Plate 1
Potentiometric Surface for the Regional Aquifer and the Fractured Bedrock System at Sandia National Laboratories/New Mexico and Kirtland Air Force Base for Calendar Year 2017

Transverse Mercator Projection
New Mexico State Plane Coordinate System, Central Zone
1983 North American Horizontal Datum
1988 North American Vertical Datum

5/15/2018 mb18021 SNL EGIS ORG.00643

Sandia National Laboratories

Appendix F-2

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Table 2. Base-Wide Groundwater Elevations for Monitoring Wells Located at Sandia National Laboratories, New Mexico and the Kirtland Air Force Base Vicinity for Calendar Year 2017

Well ID	Measurement Point, (feet amsl, NAVD 88)	Date Measured	Depth to Water (feet btoc)	Groundwater Elevation (feet amsl)	Groundwater Elevation, Rounded (feet amsl)	Comment for Plate 1 Concerning Regional Aquifer and Bedrock Wells, As Needed	Data Source	Well Owner	Screened Unit
AVN-1	5443.00	4-Oct-2017	527.71	4915.29	4915		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
Burn Site Well	6374.66	29-Sep-2017	101.35	6273.31	6273		SNL/NM	SNL/NM	Bedrock (schist and granite)
CCBA-MW1	5902.34	3-Oct-2017	48.08	5854.26	5854		SNL/NM	SNL/NM	Alluvium and bedrock (granite)
CCBA-MW2	5939.28	3-Oct-2017	72.25	5867.03	5867		SNL/NM	SNL/NM	Bedrock (granite)
CTF-MW1	6082.63	6-Oct-2017	240.16	5842.47	5842		SNL/NM	SNL/NM	Bedrock (granite)
CTF-MW2	5578.60	6-Oct-2017	43.85	5534.75	5535		SNL/NM	SNL/NM	Bedrock (granite)
CTF-MW3	5522.82	6-Oct-2017	309.66	5213.16	5213		SNL/NM	SNL/NM	Bedrock (granite)
CWL-BW5	5434.79	2-Oct-2017	513.38	4921.41	4921		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
CWL-MW9	5426.12	2-Oct-2017	504.87	4921.25	4921		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
CWL-MW10	5424.58	2-Oct-2017	501.28	4923.30	4923		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
CWL-MW11	5423.24	2-Oct-2017	500.16	4923.08	4923		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
CYN-MW3	6313.26	26-Sep-2017	134.25	6179.01	6179		SNL/NM	SNL/NM	Bedrock (metamorphics)
CYN-MW4	6455.48	30-Sep-2017	229.43	6226.05	6226		SNL/NM	SNL/NM	Bedrock (quartzite)
CYN-MW5	5984.23	29-Sep-2017	108.69	5875.54	5876		SNL/NM	SNL/NM	Bedrock (quartzite)
CYN-MW6	6343.37	29-Sep-2017	156.19	6187.18	6187		SNL/NM	SNL/NM	Bedrock (metamorphics)
CYN-MW7	6216.35	29-Sep-2017	305.54	5910.81	5911		SNL/NM	SNL/NM	Bedrock (granitic gneiss)
CYN-MW8	6230.11	29-Sep-2017	321.24	5908.87	5909		SNL/NM	SNL/NM	Bedrock (granitic gneiss)
CYN-MW9	6360.67	29-Sep-2017	170.23	6190.44	6190		SNL/NM	SNL/NM	Bedrock (metamorphics)
CYN-MW10	6345.45	29-Sep-2017	123.50	6221.95	6222		SNL/NM	SNL/NM	Bedrock (metamorphics)
CYN-MW11	6374.41	29-Sep-2017	101.03	6273.38	6273		SNL/NM	SNL/NM	Bedrock (metamorphics)
CYN-MW12	6345.16	29-Sep-2017	213.44	6131.72	6132		SNL/NM	SNL/NM	Bedrock (metamorphics)
CYN-MW13	6237.79	29-Sep-2017	327.46	5910.33	5910		SNL/NM	SNL/NM	Bedrock (granitic gneiss)
CYN-MW14A	6315.85	29-Sep-2017	182.76	6133.09	6133	NC - deeper fracture	SNL/NM	SNL/NM	Bedrock (metamorphics)
CYN-MW15	6344.44	29-Sep-2017	157.74	6186.70	6187		SNL/NM	SNL/NM	Bedrock (metamorphics)
Greystone-MW2	5814.20	5-Oct-2017	54.78	5759.42	5759	NC - shallow alluvium	SNL/NM	SNL/NM	Alluvium in arroyo, recent
LWDS-MW1	5423.83	5-Oct-2017	504.71	4919.12	4919		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
LWDS-MW2	5412.41	4-Oct-2017	493.47	4918.94	4919		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
MRN-2	5308.18	6-Oct-2017	433.51	4874.67	4875		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
MRN-3D	5309.34	6-Oct-2017	433.90	4875.44	4875		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
MWL-BW2	5391.02	2-Oct-2017	481.03	4909.99	4910		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
MWL-MW4	5391.70	6-Nov-2017	500.99	4890.71	4891	corrected for inclined casing	SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
MWL-MW5	5382.56	2-Oct-2017	493.55	4889.01	4889		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
MWL-MW6	5375.31	2-Oct-2017	487.20	4888.11	4888		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
MWL-MW7	5383.30	2-Oct-2017	490.12	4893.18	4893		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
MWL-MW8	5384.67	2-Oct-2017	491.69	4892.98	4893		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
MWL-MW9	5381.91	2-Oct-2017	491.88	4890.03	4890		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments

Table 2. Base-Wide Groundwater Elevations for Monitoring Wells Located at Sandia National Laboratories, New Mexico and the Kirtland Air Force Base Vicinity for Calendar Year 2017 *(Continued)*

Well ID	Measurement Point, (feet amsl, NAVD 88)	Date Measured	Depth to Water (feet btoc)	Groundwater Elevation (feet amsl)	Groundwater Elevation, Rounded (feet amsl)	Comment for Plate 1 Concerning Regional Aquifer and Bedrock Wells, As Needed	Data Source	Well Owner	Screened Unit
NWTA3-MW2	5337.49	6-Oct-2017	464.50	4872.99	4873		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
NWTA3-MW3D	5340.80	6-Oct-2017	463.42	4877.38	4877		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
OBS-MW1	5871.42	3-Oct-2017	72.10	5799.32	5799		SNL/NM	SNL/NM	Bedrock (granite)
OBS-MW2	5863.16	3-Oct-2017	174.63	5688.53	5689		SNL/NM	SNL/NM	Bedrock (granite)
OBS-MW3	5865.50	3-Oct-2017	69.40	5796.10	5796		SNL/NM	SNL/NM	Bedrock (granite)
PGS-2	5408.29	4-Oct-2017	536.11	4872.18	4872		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
PL-2	5336.01	6-Oct-2017	463.61	4872.40	4872		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
PL-4	5334.98	6-Oct-2017	463.03	4871.95	4872		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
SFR-1D	5399.13	5-Oct-2017	139.90	5259.23	5259	NC - deeper fracture	SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
SFR-1S	5399.16	5-Oct-2017	90.03	5309.13	5309		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
SFR-2S	5432.77	5-Oct-2017	100.97	5331.80	5332		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
SFR-3D	5497.94	5-Oct-2017	162.25	5335.69	5336		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
SFR-3P	5499.63	5-Oct-2017	162.45	5337.18	5337		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
SFR-3S	5498.24	5-Oct-2017	161.42	5336.82	5337		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
SFR-3T	5498.66	5-Oct-2017	68.82	5429.84	5430		SNL/NM	SNL/NM	Bedrock (sandstone)
SFR-4P	5573.33	5-Oct-2017	148.83	5424.50	5425		SNL/NM	SNL/NM	Bedrock (sandstone)
SFR-4T	5573.95	5-Oct-2017	145.43	5428.52	5429		SNL/NM	SNL/NM	Bedrock (sandstone)
SWTA3-MW2	5325.60	20-Oct-2017	449.20	4876.40	4876		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
SWTA3-MW3	5323.94	20-Oct-2017	446.64	4877.30	4877		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
SWTA3-MW4	5324.81	20-Oct-2017	447.39	4877.42	4877		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
TA1-W-01	5403.82	2-Oct-2017	533.24	4870.58	4871		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
TA1-W-02	5416.62	3-Oct-2017	519.75	4896.87	4897		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
TA1-W-03	5457.03	2-Oct-2017	356.84	5100.19	5100		SNL/NM	SNL/NM	PGWS - SFG sediments
TA1-W-04	5460.98	2-Oct-2017	566.33	4894.65	4895		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
TA1-W-05	5433.84	3-Oct-2017	559.90	4873.94	4874		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
TA1-W-06	5417.10	3-Oct-2017	308.88	5108.22	5108		SNL/NM	SNL/NM	PGWS - SFG sediments
TA1-W-07	5404.92	2-Oct-2017	286.42	5118.50	5119		SNL/NM	SNL/NM	PGWS - SFG sediments
TA1-W-08	5434.19	3-Oct-2017	311.76	5122.43	5122		SNL/NM	SNL/NM	PGWS - SFG sediments
TA2-NW1-325	5421.94	2-Oct-2017	319.49	5102.45	5102		SNL/NM	SNL/NM	PGWS - SFG sediments
TA2-NW1-595	5421.26	2-Oct-2017	519.04	4902.22	4902		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
TA2-W-01	5419.99	2-Oct-2017	329.94	5090.05	5090		SNL/NM	SNL/NM	PGWS - SFG sediments
TA2-W-19	5351.21	2-Oct-2017	273.28	5077.93	5078		SNL/NM	SNL/NM	PGWS - SFG sediments
TA2-W-24	5363.66	2-Oct-2017	440.86	4922.80	4923		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
TA2-W-25	5374.86	2-Oct-2017	466.04	4908.82	4909		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
TA2-W-26	5375.77	2-Oct-2017	288.97	5086.80	5087		SNL/NM	SNL/NM	PGWS - SFG sediments
TA2-W-27	5362.85	2-Oct-2017	281.58	5081.27	5081		SNL/NM	SNL/NM	PGWS - SFG sediments

Table 2. Base-Wide Groundwater Elevations for Monitoring Wells Located at Sandia National Laboratories, New Mexico and the Kirtland Air Force Base Vicinity for Calendar Year 2017 *(Continued)*

Well ID	Measurement Point, (feet amsl, NAVD 88)	Date Measured	Depth to Water (feet btoc)	Groundwater Elevation (feet amsl)	Groundwater Elevation, Rounded (feet amsl)	Comment for Plate 1 Concerning Regional Aquifer and Bedrock Wells, As Needed	Data Source	Well Owner	Screened Unit
TA2-W-28	5412.41	2-Oct-2017	320.55	5091.86	5092		SNL/NM	SNL/NM	PGWS - SFG sediments
TAV-MW2	5427.33	5-Oct-2017	508.96	4918.37	4918		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
TAV-MW3	5464.30	5-Oct-2017	547.48	4916.82	4917		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
TAV-MW4	5427.89	4-Oct-2017	509.00	4918.89	4919		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
TAV-MW5	5408.71	4-Oct-2017	492.26	4916.45	4916		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
TAV-MW6	5431.17	4-Oct-2017	512.53	4918.64	4919		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
TAV-MW7	5430.40	23-Oct-2017	515.07	4915.33	4915		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
TAV-MW8	5417.00	5-Oct-2017	497.59	4919.41	4919		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
TAV-MW9	5416.27	5-Oct-2017	501.08	4915.19	4915		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
TAV-MW10	5437.03	4-Oct-2017	518.68	4918.35	4918		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
TAV-MW11	5440.12	4-Oct-2017	521.57	4918.55	4919		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
TAV-MW12	5435.72	4-Oct-2017	518.07	4917.65	4918		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
TAV-MW13	5409.02	4-Oct-2017	497.37	4911.65	4912		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
TAV-MW14	5441.52	4-Oct-2017	525.32	4916.20	4916		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
TAV-MW15	5437.32	4-Oct-2017	520.15	4917.17	4917		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
TAV-MW16	5448.34	4-Oct-2017	531.68	4916.66	4917		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
TJA-2	5353.20	2-Oct-2017	278.41	5074.79	5075		SNL/NM	SNL/NM	PGWS - SFG sediments
TJA-3	5390.56	2-Oct-2017	498.70	4891.86	4892		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
TJA-4	5341.16	2-Oct-2017	300.24	5040.92	5041	NC - merging zone	SNL/NM	SNL/NM	merging zone – SFG sediments
TJA-5	5341.33	2-Oct-2017	270.38	5070.95	5071		SNL/NM	SNL/NM	PGWS - SFG sediments
TJA-6	5343.16	2-Oct-2017	450.94	4892.22	4892		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
TJA-7	5391.27	2-Oct-2017	304.02	5087.25	5087		SNL/NM	SNL/NM	PGWS - SFG sediments
TRE-1	5497.25	5-Oct-2017	177.80	5319.45	5319		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
TRN-1	5735.62	3-Oct-2017	92.51	5643.11	5643		SNL/NM	SNL/NM	Bedrock (sandstone)
TRS-1D	5779.80	3-Oct-2017	127.56	5652.24	5652		SNL/NM	SNL/NM	Bedrock (limestone)
TRS-1S	5780.07	3-Oct-2017	135.13	5644.94	5645		SNL/NM	SNL/NM	Bedrock (limestone)
TRS-2	5780.76	3-Oct-2017	135.68	5645.08	5645		SNL/NM	SNL/NM	Bedrock (limestone)
WYO-3	5392.09	2-Oct-2017	522.07	4870.02	4870		SNL/NM	SNL/NM	Regional Aquifer – SFG sediments
WYO-4	5392.57	2-Oct-2017	294.25	5098.32	5098		SNL/NM	SNL/NM	PGWS - SFG sediments
Non Sandia Wells									
EOD Well	5829.70	9-Dec-2016	144.91	5684.79	5685		KAFB	KAFB	Bedrock (granite)
Eubank-1	5460.02	2-Oct-2017	546.75	4913.27	4913		SNL/NM	COA EHD	Regional Aquifer – SFG sediments
Eubank-2	5474.39	14-Sep-2017	573.93	4900.46	4900		COA EHD	COA EHD	Regional Aquifer – SFG sediments
Eubank-3	5498.73	14-Sep-2017	602.27	4896.46	4896		COA EHD	COA EHD	Regional Aquifer – SFG sediments
Eubank-5	5507.40	14-Sep-2017	611.26	4896.14	4896		COA EHD	COA EHD	Regional Aquifer – SFG sediments
ITRI-MW-16	5644.91	1-Oct-2016	110.50	5534.41	5534		LRRI	LRRI	Regional Aquifer – SFG sediments

Table 2. Base-Wide Groundwater Elevations for Monitoring Wells Located at Sandia National Laboratories, New Mexico and the Kirtland Air Force Base Vicinity for Calendar Year 2017 *(Continued)*

Well ID	Measurement Point, (feet amsl, NAVD 88)	Date Measured	Depth to Water (feet btoc)	Groundwater Elevation (feet amsl)	Groundwater Elevation, Rounded (feet amsl)	Comment for Plate 1 Concerning Regional Aquifer and Bedrock Wells, As Needed	Data Source	Well Owner	Screened Unit
Non Sandia Wells (Continued)									
KAFB-0118	5320.75	17-Oct-2017	448.59	4872.16	4872		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0119	5315.82	17-Oct-2017	443.99	4871.83	4872		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0120	5292.29	17-Oct-2017	417.20	4875.09	4875		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0121	5307.60	17-Oct-2017	435.73	4871.87	4872		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0213	5286.95	18-Oct-2017	411.10	4875.85	4876		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0219	5263.69	17-Oct-2017	392.77	4870.92	4871		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0220	5265.10	17-Oct-2017	394.12	4870.98	4871		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0221	5274.36	18-Oct-2017	403.28	4871.08	4871		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0307	5364.53	16-Oct-2017	422.25	4942.28	4942		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0308	5381.65	16-Oct-2017	445.27	4936.38	4936		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0309	5411.80	16-Oct-2017	480.51	4931.29	4931		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0310	5416.48	16-Oct-2017	354.29	5062.19	5062		KAFB	KAFB	PGWS - SFG sediments
KAFB-0311	5353.29	16-Oct-2017	418.79	4934.50	4935		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0312	5432.17	16-Oct-2017	417.36	5014.81	5015		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0313	5418.98	16-Oct-2017	350.97	5068.01	5068		KAFB	KAFB	PGWS - SFG sediments
KAFB-0314	5455.75	16-Oct-2017	417.20	5038.55	5039		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0315	5466.11	16-Oct-2017	438.42	5027.69	5028		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0417	5313.07	17-Oct-2017	446.22	4866.85	4867		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0504	5357.87	17-Oct-2017	486.53	4871.34	4871		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0505	5362.81	17-Oct-2017	492.88	4869.93	4870		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0506	5363.47	17-Oct-2017	209.79	5153.68	5154		KAFB	KAFB	PGWS - SFG sediments
KAFB-0507R	5358.21	17-Oct-2017	487.54	4870.67	4871		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0508	5351.88	17-Oct-2017	481.63	4870.25	4870		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0510	5367.10	17-Oct-2017	498.43	4868.67	4869		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0512R	5302.73	17-Oct-2017	431.90	4870.83	4871		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0514	5206.41	17-Oct-2017	336.52	4869.89	4870		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0516	5205.64	17-Oct-2017	335.77	4869.87	4870		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0517	5197.10	17-Oct-2017	325.08	4872.02	4872		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0518	5177.76	17-Oct-2017	305.44	4872.32	4872		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0520	5247.90	17-Oct-2017	378.24	4869.66	4870		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0522	5267.48	17-Oct-2017	398.79	4868.69	4869		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0523	5352.62	17-Oct-2017	478.23	4874.39	4874		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0524	5345.61	17-Oct-2017	474.19	4871.42	4871		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0525	5229.75	17-Oct-2017	358.85	4870.90	4871		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0608	5361.17	18-Oct-2017	293.89	5067.28	5067		KAFB	KAFB	PGWS - SFG sediments

Table 2. Base-Wide Groundwater Elevations for Monitoring Wells Located at Sandia National Laboratories, New Mexico and the Kirtland Air Force Base Vicinity for Calendar Year 2017 *(Continued)*

Well ID	Measurement Point, (feet amsl, NAVD 88)	Date Measured	Depth to Water (feet btoc)	Groundwater Elevation (feet amsl)	Groundwater Elevation, Rounded (feet amsl)	Comment for Plate 1 Concerning Regional Aquifer and Bedrock Wells, As Needed	Data Source	Well Owner	Screened Unit
Non Sandia Wells (Continued)									
KAFB-0611	5386.09	18-Oct-2017	462.94	4923.15	4923		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0612	5385.45	18-Oct-2017	290.19	5095.26	5095		KAFB	KAFB	PGWS - SFG sediments
KAFB-0613	5390.78	18-Oct-2017	353.15	5037.63	5038		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0614	5390.89	18-Oct-2017	331.83	5059.06	5059		KAFB	KAFB	PGWS - SFG sediments
KAFB-0615	5638.43	18-Oct-2017	206.68	5431.75	5432		KAFB	KAFB	Bedrock (granite)
KAFB-0616	5481.07	18-Oct-2017	443.53	5037.54	5038		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0617	5505.78	18-Oct-2017	557.05	4948.73	4949	NC - nearby fault	KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0618	5410.05	18-Oct-2017	484.19	4925.86	4926		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0619	5410.78	18-Oct-2017	385.19	5025.59	5026		KAFB	KAFB	PGWS - SFG sediments
KAFB-0620	5334.64	18-Oct-2017	442.68	4891.96	4892		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0621	5569.89	16-Oct-2017	624.95	4944.94	4945	NC - nearby fault	KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0622	5488.64	18-Oct-2017	551.97	4936.67	4937		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0623	5328.94	16-Oct-2017	259.58	5069.36	5069		KAFB	KAFB	PGWS - SFG sediments
KAFB-0624	5673.78	16-Oct-2017	769.65	4904.13	4904	NC - nearby fault	KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0625	5390.23	18-Oct-2017	472.55	4917.68	4918		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0901	5390.07	16-Oct-2017	468.96	4921.11	4921		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-0903	5391.63	16-Oct-2017	236.85	5154.78	5155	NC - semiconfined?	KAFB	KAFB	merging zone – SFG sediments
KAFB-0904	5291.75	18-Oct-2017	351.70	4940.05	4940	NC - semiconfined?	KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-1006	5257.01	1-Dec-2016	380.28	4876.73	4877		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-1007R	5260.62	1-Dec-2016	383.65	4876.97	4877		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-1008	5260.77	1-Dec-2016	380.71	4880.06	4880		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-1009	5272.16	1-Dec-2016	392.89	4879.27	4879		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-2005	5624.27	18-Oct-2017	114.30	5509.97	5510		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-2006	5590.88	18-Oct-2017	284.18	5306.70	5307		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-2007	5564.48	18-Oct-2017	261.19	5303.29	5303		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-2008	5541.74	18-Oct-2017	597.82	4943.92	4944		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-2009	5655.63	18-Oct-2017	76.77	5578.86	5579		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-2622	5358.14	17-Oct-2017	205.38	5152.76	5153		KAFB	KAFB	PGWS - SFG sediments
KAFB-2624	5362.27	17-Oct-2017	217.60	5144.67	5145		KAFB	KAFB	PGWS - SFG sediments
KAFB-2625	5359.26	17-Oct-2017	197.85	5161.41	5161		KAFB	KAFB	PGWS - SFG sediments
KAFB-2626	5357.51	17-Oct-2017	207.35	5150.16	5150		KAFB	KAFB	PGWS - SFG sediments
KAFB-2627	5367.47	17-Oct-2017	219.47	5148.00	5148		KAFB	KAFB	PGWS - SFG sediments
KAFB-2628	5369.64	17-Oct-2017	498.99	4870.65	4871		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-2629	5361.53	17-Oct-2017	492.04	4869.49	4869		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-2901	5839.08	4-Jan-2017	126.35	5712.73	5713		KAFB	KAFB	Regional Aquifer – SFG sediments

Table 2. Base-Wide Groundwater Elevations for Monitoring Wells Located at Sandia National Laboratories, New Mexico and the Kirtland Air Force Base Vicinity for Calendar Year 2017 *(Continued)*

Well ID	Measurement Point, (feet amsl, NAVD 88)	Date Measured	Depth to Water (feet btoc)	Groundwater Elevation (feet amsl)	Groundwater Elevation, Rounded (feet amsl)	Comment for Plate 1 Concerning Regional Aquifer and Bedrock Wells, As Needed	Data Source	Well Owner	Screened Unit
Non Sandia Wells (Continued)									
KAFB-2902	5832.10	3-Jan-2017	168.45	5663.65	5664		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-2903	5819.46	3-Jan-2017	141.21	5678.25	5678		KAFB	KAFB	Bedrock (Abo Formation)
KAFB-2904	5842.72	4-Jan-2017	46.30	5796.42	5796		KAFB	KAFB	Bedrock (Madera Formation)
KAFB-3391	5396.60	19-Oct-2017	276.54	5120.06	5120		KAFB	KAFB	PGWS - SFG sediments
KAFB-3392	5394.51	19-Oct-2017	525.50	4869.01	4869		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-3411	5342.81	17-Oct-2017	471.53	4871.28	4871		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-6241	5466.50	18-Oct-2017	540.04	4926.46	4926		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-6243	5426.22	18-Oct-2017	500.32	4925.90	4926		KAFB	KAFB	Regional Aquifer – SFG sediments
KAFB-8351	5325.51	17-Oct-2017	450.63	4874.88	4875		KAFB	KAFB	Regional Aquifer – SFG sediments
Mesa del Sol-S	5302.67	30-Oct-2017	421.26	4881.41	4881		USGS	NMOSE	Regional Aquifer – SFG sediments
Montessa Park-S	5102.67	30-Oct-2017	216.84	4885.83	4886		USGS	ABCUWA	Regional Aquifer – SFG sediments
YALE-MW9	5271.06	14-Sep-2017	377.20	4893.86	4894	NC - semiconfined?	ABCUWA	ABCUWA	Regional Aquifer – SFG sediments
ST105-MW001	5279.34	17-Oct-2017	407.82	4871.52	4872		KAFB	KAFB	Regional Aquifer – SFG sediments
ST105-MW002	5180.32	17-Oct-2017	308.50	4871.82	4872		KAFB	KAFB	Regional Aquifer – SFG sediments
ST105-MW003	5174.61	17-Oct-2017	302.75	4871.86	4872		KAFB	KAFB	Regional Aquifer – SFG sediments
ST105-MW004	5234.61	17-Oct-2017	365.90	4868.71	4869		KAFB	KAFB	Regional Aquifer – SFG sediments
ST105-MW005	5287.57	18-Oct-2017	299.20	4988.37	4988	NC - semiconfined?	KAFB	KAFB	Regional Aquifer – SFG sediments
ST105-MW006	5313.26	16-Oct-2017	236.56	5076.70	5077		KAFB	KAFB	PGWS - SFG sediments
ST105-MW007	5311.18	18-Oct-2017	317.50	4993.68	4994	NC - semiconfined?	KAFB	KAFB	Regional Aquifer – SFG sediments
ST105-MW008	5358.94	18-Oct-2017	481.96	4876.98	4877		KAFB	KAFB	Regional Aquifer – SFG sediments
ST105-MW009	5519.71	18-Oct-2017	485.23	5034.48	5034		KAFB	KAFB	Regional Aquifer – SFG sediments
ST105-MW010	5334.70	18-Oct-2017	444.77	4889.93	4890		KAFB	KAFB	Regional Aquifer – SFG sediments
ST105-MW011	5422.66	18-Oct-2017	483.73	4938.93	4939		KAFB	KAFB	Regional Aquifer – SFG sediments
ST105-MW012	5419.90	18-Oct-2017	384.06	5035.84	5036		KAFB	KAFB	PGWS - SFG sediments
ST105-MW013	5447.27	18-Oct-2017	436.73	5010.54	5011		KAFB	KAFB	Regional Aquifer – SFG sediments
ST105-MW015	5623.95	16-Oct-2017	688.64	4935.31	4935	NC - nearby fault	KAFB	KAFB	Regional Aquifer – SFG sediments
ST105-MW017	5621.97	16-Oct-2017	706.66	4915.31	4915	NC - nearby fault	KAFB	KAFB	Regional Aquifer – SFG sediments
ST105-MW018	5221.68	17-Oct-2017	350.49	4871.19	4871		KAFB	KAFB	Regional Aquifer – SFG sediments
ST105-MW019	5217.94	17-Oct-2017	346.78	4871.16	4871		KAFB	KAFB	Regional Aquifer – SFG sediments
ST105-MW020	5383.72	18-Oct-2017	297.06	5086.66	5087		KAFB	KAFB	PGWS - SFG sediments
ST105-MW021	5390.90	18-Oct-2017	331.00	5059.90	5060		KAFB	KAFB	PGWS - SFG sediments
ST105-MW022	5386.66	18-Oct-2017	469.39	4917.27	4917		KAFB	KAFB	Regional Aquifer – SFG sediments
ST105-MW023	5275.86	17-Oct-2017	404.83	4871.03	4871		KAFB	KAFB	Regional Aquifer – SFG sediments
ST105-MW024	5595.67	18-Oct-2017	340.65	5255.02	5255		KAFB	KAFB	Regional Aquifer – SFG sediments
Site 58 MW-5	5716.83	31-Oct-2017	61.87	5654.96	5655		KAFB	KAFB	Bedrock (granite)

Table 2. Base-Wide Groundwater Elevations for Monitoring Wells Located at Sandia National Laboratories, New Mexico and the Kirtland Air Force Base Vicinity for Calendar Year 2017 *(Concluded)*

Notes:

Measuring point is the top of casing elevation used for measuring and calculating the groundwater elevations.

Elevations are relative to the North American Vertical Datum of 1988 (NAVD 88), New Mexico State Plane Coordinate System, Central Zone. Where necessary, elevation data from other government agencies that was based on the National Geodetic Vertical Datum of 1929 (NGVD 29) were converted (re-projected) by +2.671 feet.

As noted on Plate 1, groundwater elevations from the previous year are used for some KAFB and LRRI monitoring wells. The compliance activities for the associated sites have recently changed and the measurement of water levels was no longer required in 2017.

ABCWUA	= Albuquerque Bernalillo County Water Utility Authority.
AVN	= Area V (North).
BW	= Background Well.
CCBA	= Coyote Canyon Blast Area.
COA EHD	= City of Albuquerque Environmental Health Department.
corrected	= MWL-MW4 depth to groundwater was corrected for the inclined well casing (6 degrees).
CTF	= Coyote Test Field.
CWL	= Chemical Waste Landfill.
CYN	= Lurance Canyon.
D	= Deep (deeper well completion).
EOD	= Explosive Ordnance Disposal.
ft amsl	= Feet above mean sea level.
ft btoc	= Feet below top of casing (feet below the measuring point).
ID	= Identifier.
ITRI	= Inhalation Toxicology Research Institute.
KAFB	= Kirtland Air Force Base.
LRRI	= Lovelace Respiratory Research Institute (formerly ITRI).
LWDS	= Liquid Waste Disposal System.
MP	= Measuring point (typically the top of PVC [polyvinyl chloride] well casing).
MRN	= Magazine Road North.
MVMW	= Mountain View Monitoring Well.
MW	= Monitoring Well.
MWL	= Mixed Waste Landfill.
NAVD 88	= North American Vertical Datum of 1988.
NC	= Not contoured (see explanations below).
NC – alluvium	= Well is screened in alluvium along the arroyo channel.
NC – deeper fracture	= Well is screened in a deeper fracture zone at the Burn Site.
NC – merging zone	= Well is screened in a merging zone been the Regional Aquifer and the PGWS.
NC – nearby fault	= A buried (unmapped) fault appears to have a localized effect on groundwater.
NC – semiconfined?	= The screened unit maybe under semiconfined conditions or is hydraulically isolated.
NM	= Not measured.
NWTA3	= Northwest Technical Area III.
OBS	= Old Burn Site.
PGS	= Parade Ground South.
PGWS	= Perched Groundwater System.
PL	= Power Line road (northwest of Technical Area III).
R	= Replacement well (term used by KAFB).
S	= Shallow (shallower well completion).
SFG	= Santa Fe Group.
SFR	= South Fence Road.
SNL/NM	= Sandia National Laboratories/New Mexico.
ST105	= Series of KAFB wells.
SWTA3	= Southwest Technical Area III.
TA1-W	= Technical Area I (Well).
TA2-NW	= Technical Area II (Northwest).
TA2-SW	= Technical Area II (Southwest).
TA2-W	= Technical Area II (Well).
TAV	= Technical Area V.
TJA	= Tijeras Arroyo.
TRE	= Thunder Road East.
TRN	= Target Road North.
TRS	= Target Road South.
W	= Well.
WYO	= Wyoming.
YALE	= Yale Boulevard area.

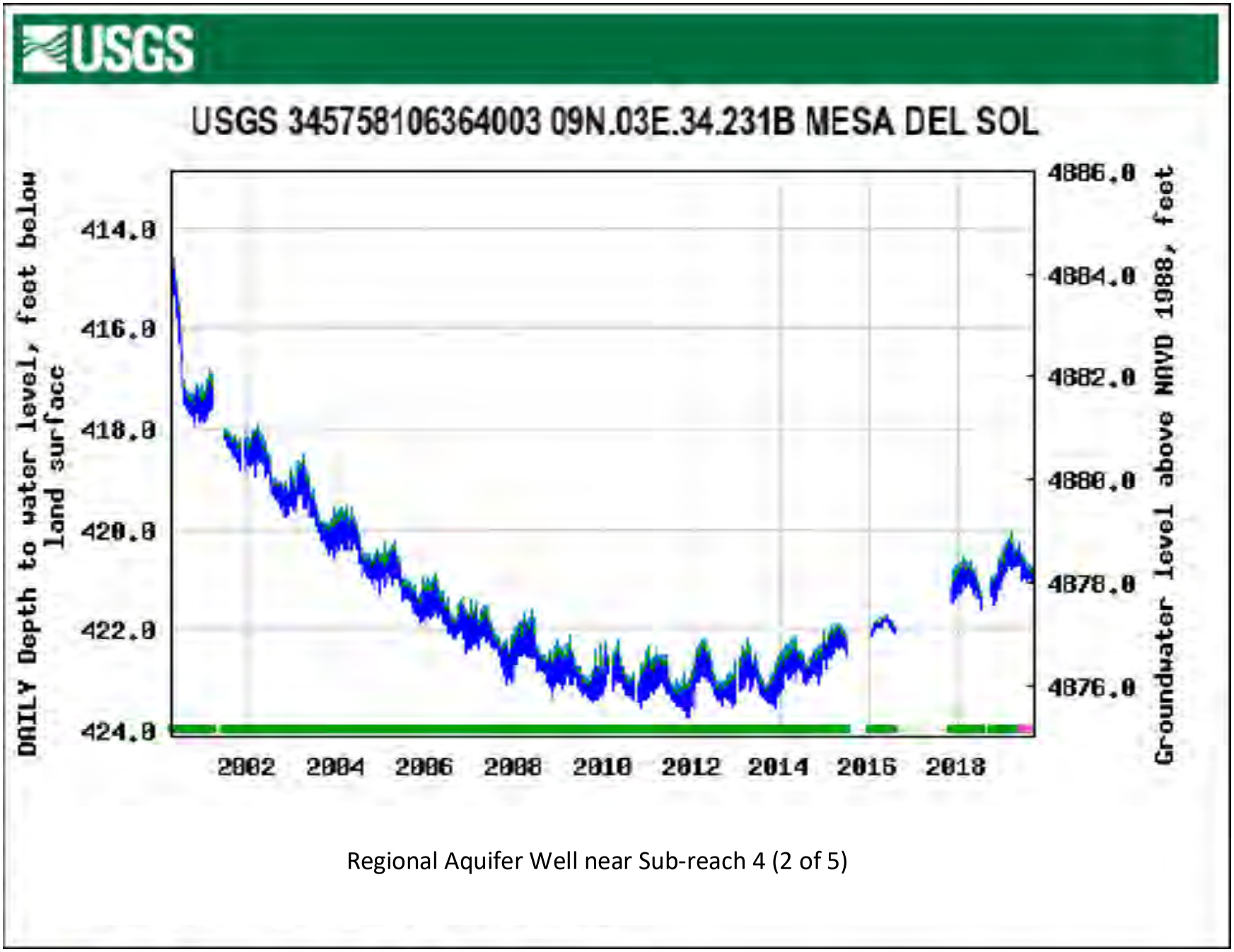
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Appendix F-3

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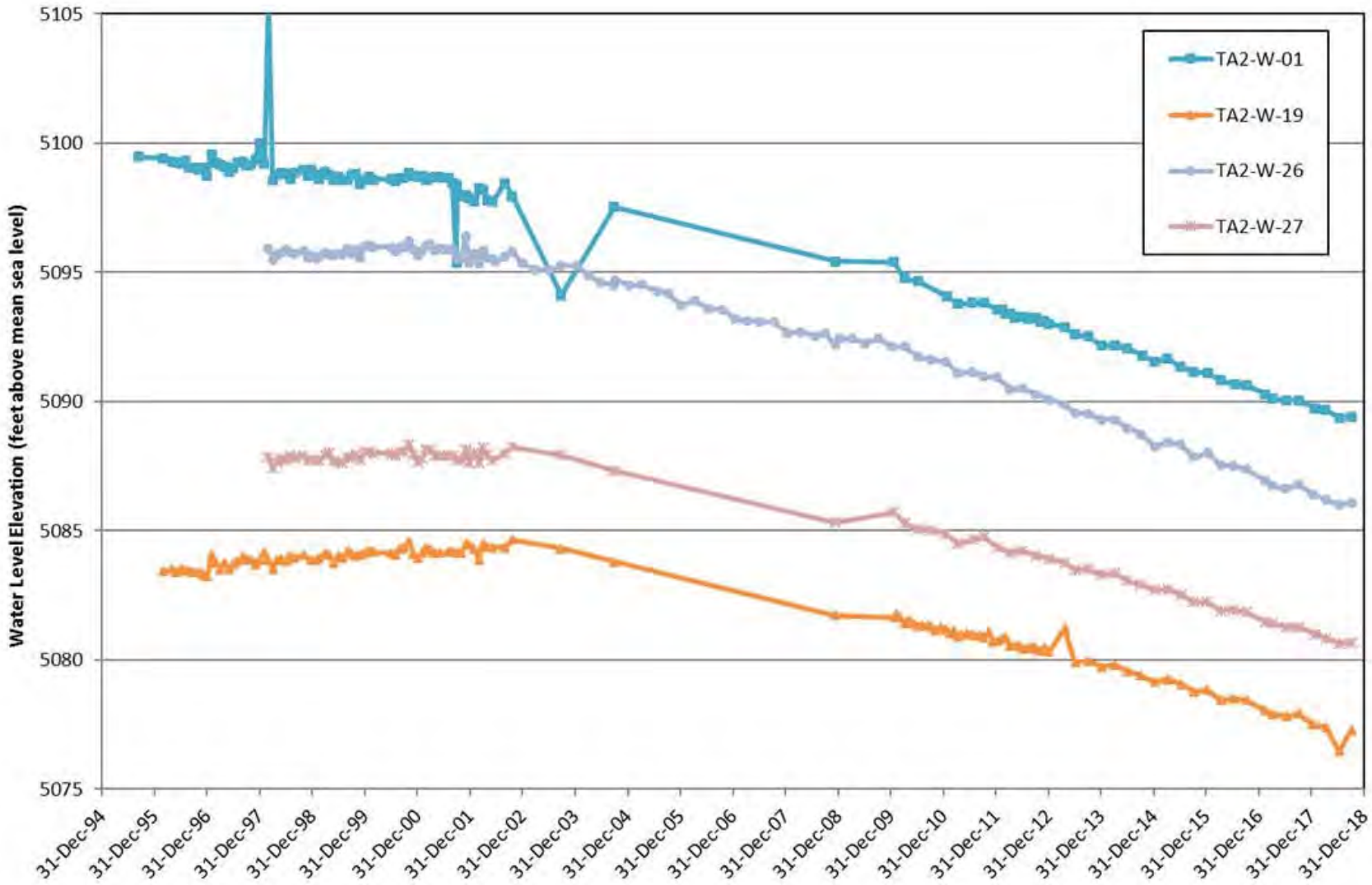
Regional Groundwater Well near Sub-reach 3 (1 of 5)



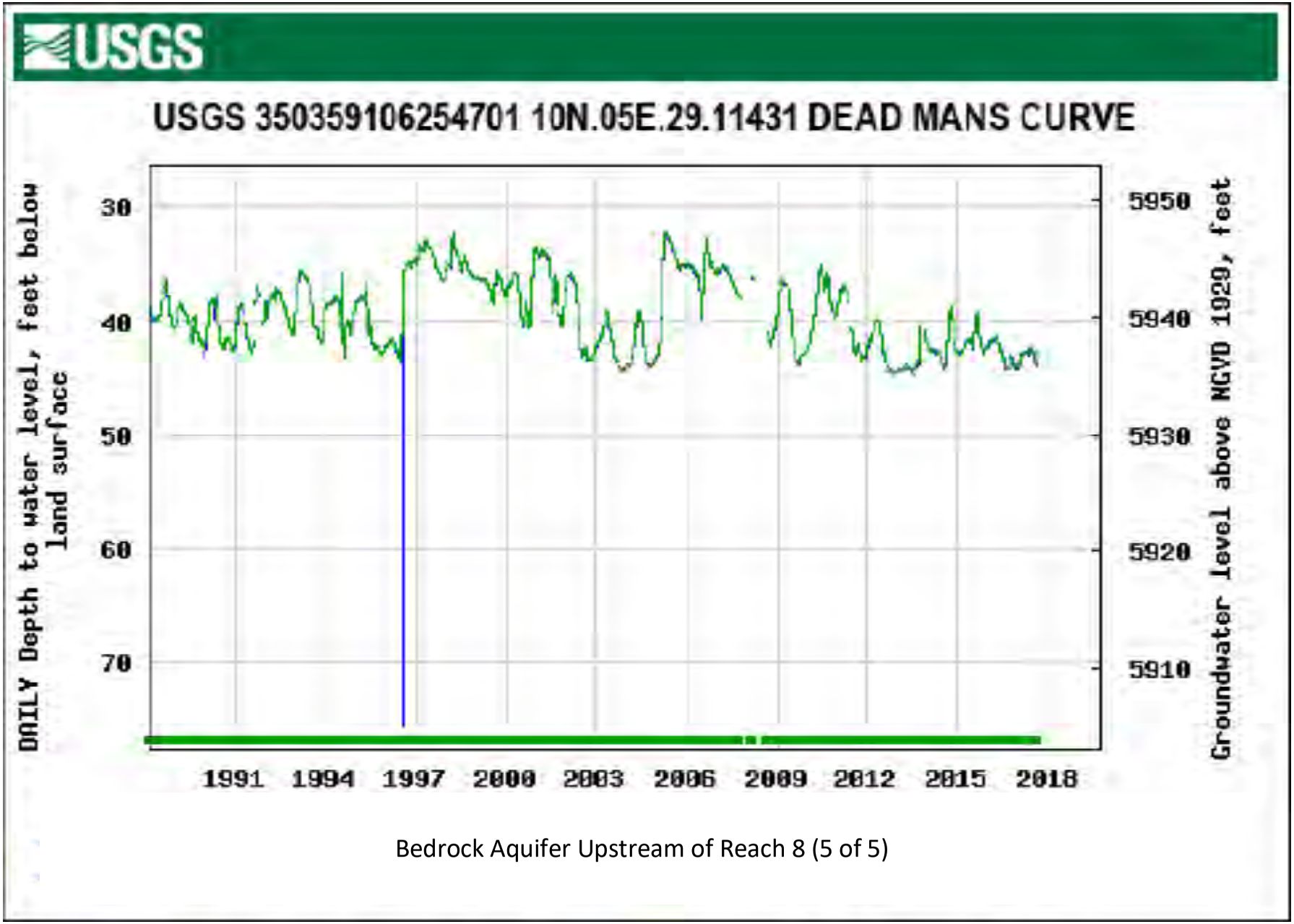
Regional Aquifer Well near Sub-reach 4 (2 of 5)



Regional Aquifer Monitoring Wells near Sub-reach 5 (3 of 5)



Perched Aquifer Monitoring Wells near Sub-reach 6 (4 of 5)



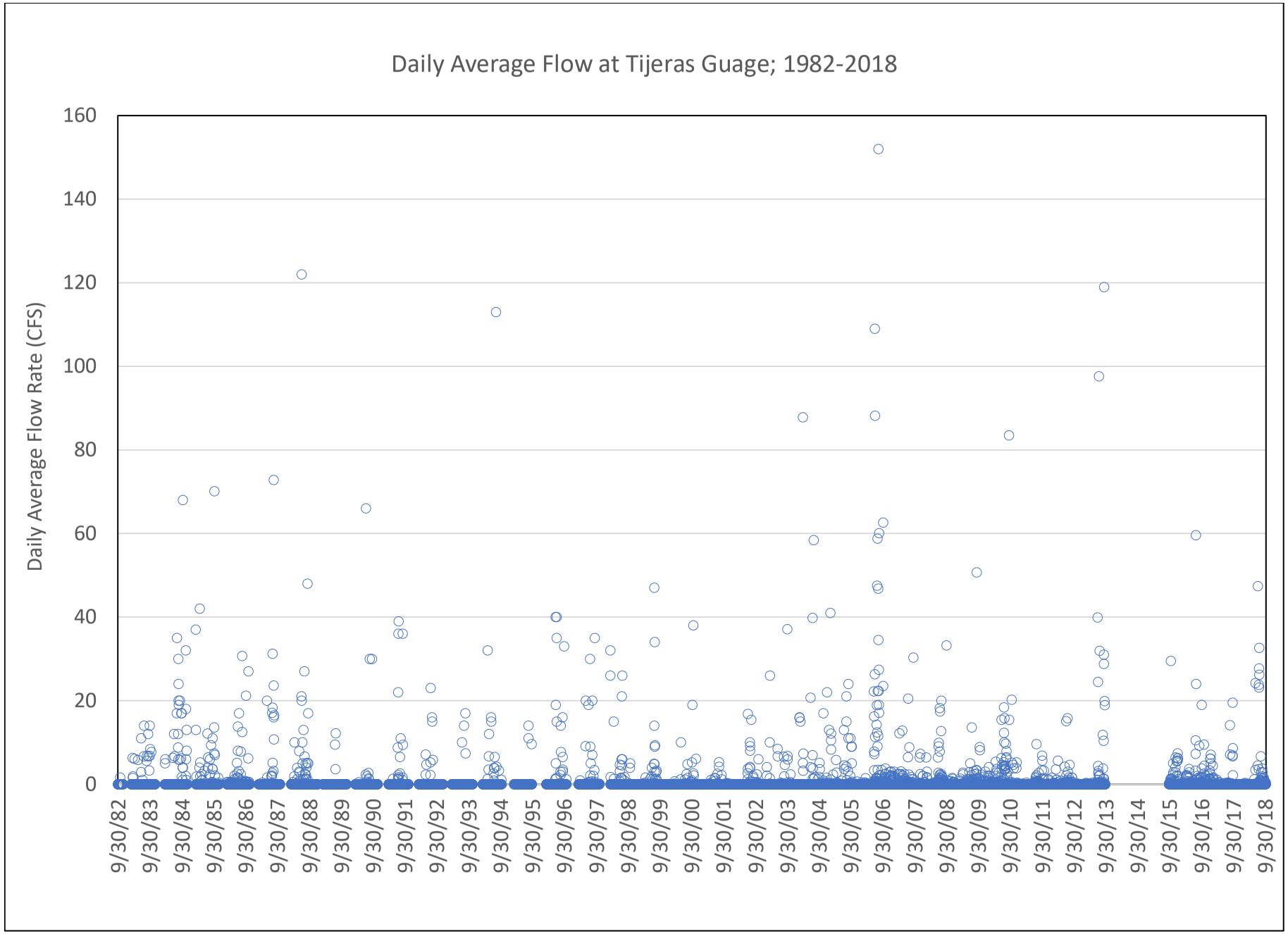
Bedrock Aquifer Upstream of Reach 8 (5 of 5)

Appendix G – Surface Water Data

No.	Description
G-1	Graph of USGS Flow Data for Tijeras Arroyo; Daily Data for Period of Record
G-2	USGS Flow Data for Tijeras Arroyo; Daily Statistics
G-3	USGS Flow Data for Tijeras Arroyo; Monthly Statistics
G-4	USGS Flow Data for Tijeras Arroyo; Annual Statistics

Appendix G-1

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Daily Average Flow at Tijeras Guage; 1982-2018
Daily Average Flow Rate (CFS)
160
140
120
100
80
60
40
20
0
9/30/82
9/30/83
9/30/84
9/30/85
9/30/86
9/30/87
9/30/88
9/30/89
9/30/90
9/30/91
9/30/92
9/30/93
9/30/94
9/30/95
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9/30/08
9/30/09
9/30/10
9/30/11
9/30/12
9/30/13
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9/30/16
9/30/17
9/30/18

Appendix G-2

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US Geological Survey Water Resources Data
retrieved: 2019-09-17 11:46:58 EDT (sdww02)
#
This file contains USGS Surface-Water Daily Statistics
#
Note:The statistics generated from this site are based on approved daily-mean data and may not match those published by the USGS in official publications.
The user is responsible for assessment and use of statistics from this site.
For more details on w visit https://waterdata.usgs.gov/nwis/?dv_statistics_disclaimer.
#
** No Incomplete data have been used for statistical calculation
#
This file includes the following columns:
#
#
agency_cd agency code
site_no USGS site number
#
#
Sites in this file include:
USGS 08330600 TIJER NM
#
Explanation of Parameter Code and ts_id used in the Statistics Data
parameter_cd Parameter Name ts_id Location Name
00060 Discharge cubic feet per second 99866
#
Data heading explanations.
begin_yr_dt ... First complete water year of data of daily mean values for this day.
end_yr_dt ... Last complete water year of data of daily mean values for this day.
max_va ... Maximum of daily mean values for this day.
min_va ... Minimum of daily mean values for this day.
mean_va ... Mean of daily mean values for this day.
#
#

agency_cd	site_no	parameter	ts_id	month_nu	day_nu	begin_yr	end_yr	count_nu	max_va_yr	max_va	min_va_yr	min_va	mean_va
5s	15s	5s	11n	3n	3n	6n	6n	8n	5n	12s	5n	12s	12s
USGS	8330600	60	99866	1	1	1999	2019	19	2017	1.17	1999	0	0.06
USGS	8330600	60	99866	1	2	1999	2019	19	2017	1.39	1999	0	0.13
USGS	8330600	60	99866	1	3	1999	2019	19	2019	2.08	1999	0	0.22
USGS	8330600	60	99866	1	4	1999	2019	19	2005	22	1999	0	1.3
USGS	8330600	60	99866	1	5	1999	2019	19	2016	5.65	1999	0	0.46
USGS	8330600	60	99866	1	6	1999	2019	19	2016	7.4	1999	0	0.79
USGS	8330600	60	99866	1	7	1999	2019	19	2016	5.67	1999	0	0.51
USGS	8330600	60	99866	1	8	1999	2019	19	2016	6.27	1999	0	0.48
USGS	8330600	60	99866	1	9	1999	2019	19	2016	6.17	1999	0	0.5
USGS	8330600	60	99866	1	10	1999	2019	19	2007	2	1999	0	0.22
USGS	8330600	60	99866	1	11	1999	2019	19	2019	6.58	1999	0	0.4
USGS	8330600	60	99866	1	12	1999	2019	19	2019	0.01	1999	0	0
USGS	8330600	60	99866	1	13	1999	2019	19	2019	1.71	1999	0	0.09
USGS	8330600	60	99866	1	14	1999	2019	19	2017	1.31	1999	0	0.08

agency_cd	site_no	parameter	ts_id	month_nu	day_nu	begin_yr	end_yr	count_nu	max_va_yr	max_va	min_va_yr	min_va	mean_va
5s	15s	5s	11n	3n	3n	6n	6n	8n	5n	12s	5n	12s	12s
USGS	8330600	60	99866	1	15	1999	2019	19	2017	6.1	1999	0	0.36
USGS	8330600	60	99866	1	16	1999	2019	19	2017	2.51	1999	0	0.24
USGS	8330600	60	99866	1	17	1999	2019	19	2017	6.15	1999	0	0.32
USGS	8330600	60	99866	1	18	1999	2019	19	2010	0.59	1999	0	0.04
USGS	8330600	60	99866	1	19	1999	2019	19	2010	0.36	1999	0	0.02
USGS	8330600	60	99866	1	20	1999	2019	19	2017	7.03	1999	0	0.39
USGS	8330600	60	99866	1	21	1999	2019	19	2017	5.03	1999	0	0.26
USGS	8330600	60	99866	1	22	1999	2019	19	2010	2	1999	0	0.11
USGS	8330600	60	99866	1	23	1999	2019	19	2010	0.04	1999	0	0
USGS	8330600	60	99866	1	24	1999	2019	19	2012	1.54	1999	0	0.08
USGS	8330600	60	99866	1	25	1999	2019	19	2012	0.06	1999	0	0
USGS	8330600	60	99866	1	26	1999	2019	19	2013	0.1	1999	0	0.01
USGS	8330600	60	99866	1	27	1999	2019	19	2005	13	1999	0	0.68
USGS	8330600	60	99866	1	28	1999	2019	19	2010	1.48	1999	0	0.11
USGS	8330600	60	99866	1	29	1999	2019	19	2008	0.49	1999	0	0.04
USGS	8330600	60	99866	1	30	1999	2019	19	2007	0.41	1999	0	0.02
USGS	8330600	60	99866	1	31	1999	2019	19	2007	0.42	1999	0	0.02
USGS	8330600	60	99866	2	1	1999	2018	18	2016	0.18	1999	0	0.01
USGS	8330600	60	99866	2	2	1999	2018	18	2010	0.83	1999	0	0.05
USGS	8330600	60	99866	2	3	1999	2018	18	2010	4.08	1999	0	0.23
USGS	8330600	60	99866	2	4	1999	2018	18	2010	2.02	1999	0	0.13
USGS	8330600	60	99866	2	5	1999	2018	18	2009	0.06	1999	0	0
USGS	8330600	60	99866	2	6	1999	2018	18	2006	0.4	1999	0	0.02
USGS	8330600	60	99866	2	7	1999	2018	18	2010	0.23	1999	0	0.01
USGS	8330600	60	99866	2	8	1999	2018	18	2007	0.07	1999	0	0
USGS	8330600	60	99866	2	9	1999	2018	18	2012	0.12	1999	0	0.01
USGS	8330600	60	99866	2	10	1999	2018	18	2009	0.06	1999	0	0
USGS	8330600	60	99866	2	11	1999	2018	18	2007	1.02	1999	0	0.06
USGS	8330600	60	99866	2	12	1999	2018	18	2005	41	1999	0	2.5
USGS	8330600	60	99866	2	13	1999	2018	18	2017	4.42	1999	0	0.56
USGS	8330600	60	99866	2	14	1999	2018	18	2007	3	1999	0	0.39
USGS	8330600	60	99866	2	15	1999	2018	18	2007	1.88	1999	0	0.15
USGS	8330600	60	99866	2	16	1999	2018	18	2008	6.4	1999	0	0.43
USGS	8330600	60	99866	2	17	1999	2018	18	2007	0.6	1999	0	0.03
USGS	8330600	60	99866	2	18	1999	2018	18	2005	12.1	1999	0	0.67
USGS	8330600	60	99866	2	19	1999	2018	18	2005	10.5	1999	0	0.67
USGS	8330600	60	99866	2	20	1999	2018	18	2005	8.3	1999	0	0.46
USGS	8330600	60	99866	2	21	1999	2018	18	2008	1.69	1999	0	0.11
USGS	8330600	60	99866	2	22	1999	2018	18	2008	1.5	1999	0	0.09
USGS	8330600	60	99866	2	23	1999	2018	18	2004	15.9	1999	0	1
USGS	8330600	60	99866	2	24	1999	2018	18	2004	16	1999	0	0.89
USGS	8330600	60	99866	2	25	1999	2018	18	1999	0	1999	0	0
USGS	8330600	60	99866	2	26	1999	2018	18	1999	0	1999	0	0
USGS	8330600	60	99866	2	27	1999	2018	18	1999	0	1999	0	0
USGS	8330600	60	99866	2	28	1999	2018	18	1999	0	1999	0	0
USGS	8330600	60	99866	2	29	2000	2016	5	2000	0	2000	0	0
USGS	8330600	60	99866	3	1	1999	2018	18	1999	0	1999	0	0

agency_cd	site_no	parameter	ts_id	month_nu	day_nu	begin_yr	end_yr	count_nu	max_va_yr	max_va	min_va_yr	min_va	mean_va
5s	15s	5s	11n	3n	3n	6n	6n	8n	5n	12s	5n	12s	12s
USGS	8330600	60	99866	3	2	1999	2018	18	1999	0	1999	0	0
USGS	8330600	60	99866	3	3	1999	2018	18	1999	0	1999	0	0
USGS	8330600	60	99866	3	4	1999	2018	18	2004	15	1999	0	0.83
USGS	8330600	60	99866	3	5	1999	2018	18	1999	0	1999	0	0
USGS	8330600	60	99866	3	6	1999	2018	18	2005	0.23	1999	0	0.01
USGS	8330600	60	99866	3	7	1999	2018	18	2010	0.29	1999	0	0.02
USGS	8330600	60	99866	3	8	1999	2018	18	2010	0.73	1999	0	0.05
USGS	8330600	60	99866	3	9	1999	2018	18	2009	1.34	1999	0	0.07
USGS	8330600	60	99866	3	10	1999	2018	18	2012	0.03	1999	0	0
USGS	8330600	60	99866	3	11	1999	2018	18	2012	3.55	1999	0	0.21
USGS	8330600	60	99866	3	12	1999	2018	18	2006	0.44	1999	0	0.02
USGS	8330600	60	99866	3	13	1999	2018	18	2009	0.83	1999	0	0.05
USGS	8330600	60	99866	3	14	1999	2018	18	2005	2.3	1999	0	0.13
USGS	8330600	60	99866	3	15	1999	2018	18	2006	0.35	1999	0	0.02
USGS	8330600	60	99866	3	16	1999	2018	18	1999	0	1999	0	0
USGS	8330600	60	99866	3	17	1999	2018	18	1999	0	1999	0	0
USGS	8330600	60	99866	3	18	1999	2018	18	2003	1.44	1999	0	0.14
USGS	8330600	60	99866	3	19	1999	2018	18	2003	10	1999	0	0.65
USGS	8330600	60	99866	3	20	1999	2018	18	2010	0.43	1999	0	0.03
USGS	8330600	60	99866	3	21	1999	2018	18	2003	26	1999	0	1.4
USGS	8330600	60	99866	3	22	1999	2018	18	2006	1.44	1999	0	0.14
USGS	8330600	60	99866	3	23	1999	2018	18	2007	0.31	1999	0	0.02
USGS	8330600	60	99866	3	24	1999	2018	18	2007	2.38	1999	0	0.14
USGS	8330600	60	99866	3	25	1999	2018	18	1999	0	1999	0	0
USGS	8330600	60	99866	3	26	1999	2018	18	1999	0.21	2000	0	0.01
USGS	8330600	60	99866	3	27	1999	2018	18	2018	0.31	1999	0	0.02
USGS	8330600	60	99866	3	28	1999	2018	18	2017	0.25	1999	0	0.01
USGS	8330600	60	99866	3	29	1999	2018	18	2017	0.05	1999	0	0
USGS	8330600	60	99866	3	30	1999	2018	18	1999	0	1999	0	0
USGS	8330600	60	99866	3	31	1999	2018	18	1999	0	1999	0	0
USGS	8330600	60	99866	4	1	1999	2018	18	2017	1.09	1999	0	0.06
USGS	8330600	60	99866	4	2	1999	2018	18	2004	5.07	1999	0	0.31
USGS	8330600	60	99866	4	3	1999	2018	18	2004	87.8	1999	0	5.2
USGS	8330600	60	99866	4	4	1999	2018	18	2004	3.2	1999	0	0.18
USGS	8330600	60	99866	4	5	1999	2018	18	2006	0.17	1999	0	0.01
USGS	8330600	60	99866	4	6	1999	2018	18	2007	0.29	1999	0	0.02
USGS	8330600	60	99866	4	7	1999	2018	18	2007	1	1999	0	0.08
USGS	8330600	60	99866	4	8	1999	2018	18	2004	7.33	1999	0	0.41
USGS	8330600	60	99866	4	9	1999	2018	18	2007	2.46	1999	0	0.16
USGS	8330600	60	99866	4	10	1999	2018	18	1999	0	1999	0	0
USGS	8330600	60	99866	4	11	1999	2018	18	2009	2.38	1999	0	0.13
USGS	8330600	60	99866	4	12	1999	2018	18	2009	2.74	1999	0	0.17
USGS	8330600	60	99866	4	13	1999	2018	18	2007	12.2	1999	0	0.68
USGS	8330600	60	99866	4	14	1999	2018	18	2007	0.1	1999	0	0.01
USGS	8330600	60	99866	4	15	1999	2018	18	2016	0.3	1999	0	0.02
USGS	8330600	60	99866	4	16	1999	2018	18	2005	5.8	1999	0	0.44
USGS	8330600	60	99866	4	17	1999	2018	18	2016	2.23	1999	0	0.24

agency_cd	site_no	parameter	ts_id	month_nu	day_nu	begin_yr	end_yr	count_nu	max_va_yr	max_va	min_va_yr	min_va	mean_va
5s	15s	5s	11n	3n	3n	6n	6n	8n	5n	12s	5n	12s	12s
USGS	8330600	60	99866	4	18	1999	2018	18	2016	1.72	1999	0	0.17
USGS	8330600	60	99866	4	19	1999	2018	18	2016	1.86	1999	0	0.12
USGS	8330600	60	99866	4	20	1999	2018	18	1999	0	1999	0	0
USGS	8330600	60	99866	4	21	1999	2018	18	1999	0	1999	0	0
USGS	8330600	60	99866	4	22	1999	2018	18	2010	5.38	1999	0	0.3
USGS	8330600	60	99866	4	23	1999	2018	18	2010	2.8	1999	0	0.16
USGS	8330600	60	99866	4	24	1999	2018	18	2005	2.8	2000	0	0.18
USGS	8330600	60	99866	4	25	1999	2018	18	1999	1.6	2000	0	0.11
USGS	8330600	60	99866	4	26	1999	2018	18	1999	0	1999	0	0
USGS	8330600	60	99866	4	27	1999	2018	18	1999	0	1999	0	0
USGS	8330600	60	99866	4	28	1999	2018	18	2017	0.42	1999	0	0.03
USGS	8330600	60	99866	4	29	1999	2018	18	2016	1.5	1999	0	0.11
USGS	8330600	60	99866	4	30	1999	2018	18	2016	0.72	1999	0	0.04
USGS	8330600	60	99866	5	1	1999	2018	18	2007	2.38	1999	0	0.17
USGS	8330600	60	99866	5	2	1999	2018	18	2010	3.63	1999	0	0.42
USGS	8330600	60	99866	5	3	1999	2018	18	2010	0.38	1999	0	0.05
USGS	8330600	60	99866	5	4	1999	2018	18	2005	0.37	1999	0	0.02
USGS	8330600	60	99866	5	5	1999	2018	18	1999	0	1999	0	0
USGS	8330600	60	99866	5	6	1999	2018	18	1999	0	1999	0	0
USGS	8330600	60	99866	5	7	1999	2018	18	1999	0	1999	0	0
USGS	8330600	60	99866	5	8	1999	2018	18	2007	0.71	1999	0	0.06
USGS	8330600	60	99866	5	9	1999	2018	18	2007	0.61	1999	0	0.03
USGS	8330600	60	99866	5	10	1999	2018	18	2013	0.34	1999	0	0.02
USGS	8330600	60	99866	5	11	1999	2018	18	2012	0.83	1999	0	0.05
USGS	8330600	60	99866	5	12	1999	2018	18	2012	0.3	1999	0	0.02
USGS	8330600	60	99866	5	13	1999	2018	18	1999	0	1999	0	0
USGS	8330600	60	99866	5	14	1999	2018	18	2007	1.46	1999	0	0.16
USGS	8330600	60	99866	5	15	1999	2018	18	2016	1.51	1999	0	0.11
USGS	8330600	60	99866	5	16	1999	2018	18	2007	1.99	1999	0	0.12
USGS	8330600	60	99866	5	17	1999	2018	18	2007	12.8	1999	0	0.91
USGS	8330600	60	99866	5	18	1999	2018	18	2016	2.82	1999	0	0.21
USGS	8330600	60	99866	5	19	1999	2018	18	2007	0.83	1999	0	0.06
USGS	8330600	60	99866	5	20	1999	2018	18	2007	0.04	1999	0	0
USGS	8330600	60	99866	5	21	1999	2018	18	2018	0.15	1999	0	0.02
USGS	8330600	60	99866	5	22	1999	2018	18	2009	0.72	1999	0	0.08
USGS	8330600	60	99866	5	23	1999	2018	18	2009	1.15	1999	0	0.07
USGS	8330600	60	99866	5	24	1999	2018	18	2009	0.28	1999	0	0.02
USGS	8330600	60	99866	5	25	1999	2018	18	2007	2.1	1999	0	0.12
USGS	8330600	60	99866	5	26	1999	2018	18	1999	0	1999	0	0
USGS	8330600	60	99866	5	27	1999	2018	18	2010	0.61	1999	0	0.04
USGS	8330600	60	99866	5	28	1999	2018	18	2010	2.81	1999	0	0.16
USGS	8330600	60	99866	5	29	1999	2018	18	1999	0	1999	0	0
USGS	8330600	60	99866	5	30	1999	2018	18	2009	0.09	1999	0	0.01
USGS	8330600	60	99866	5	31	1999	2018	18	2017	0.17	1999	0	0.01
USGS	8330600	60	99866	6	1	1999	2018	18	2016	0.5	1999	0	0.03
USGS	8330600	60	99866	6	2	1999	2018	18	2000	1.2	1999	0	0.08
USGS	8330600	60	99866	6	3	1999	2018	18	2000	10	1999	0	0.78

agency_cd	site_no	parameter	ts_id	month_nu	day_nu	begin_yr	end_yr	count_nu	max_va_yr	max_va	min_va_yr	min_va	mean_va
5s	15s	5s	11n	3n	3n	6n	6n	8n	5n	12s	5n	12s	12s
USGS	8330600	60	99866	6	4	1999	2018	18	2018	0.62	1999	0	0.03
USGS	8330600	60	99866	6	5	1999	2018	18	2016	0.22	1999	0	0.01
USGS	8330600	60	99866	6	6	1999	2018	18	1999	0	1999	0	0
USGS	8330600	60	99866	6	7	1999	2018	18	1999	0	1999	0	0
USGS	8330600	60	99866	6	8	1999	2018	18	1999	0	1999	0	0
USGS	8330600	60	99866	6	9	1999	2018	18	2007	2.45	1999	0	0.17
USGS	8330600	60	99866	6	10	1999	2018	18	2009	1.06	1999	0	0.06
USGS	8330600	60	99866	6	11	1999	2018	18	2007	0.83	1999	0	0.05
USGS	8330600	60	99866	6	12	1999	2018	18	2007	1.23	1999	0	0.07
USGS	8330600	60	99866	6	13	1999	2018	18	1999	0	1999	0	0
USGS	8330600	60	99866	6	14	1999	2018	18	2013	0.33	1999	0	0.02
USGS	8330600	60	99866	6	15	1999	2018	18	2010	0.27	1999	0	0.02
USGS	8330600	60	99866	6	16	1999	2018	18	2018	32.2	1999	0	1.8
USGS	8330600	60	99866	6	17	1999	2018	18	2018	7.92	2000	0	0.81
USGS	8330600	60	99866	6	18	1999	2018	18	2003	8.44	1999	0	0.48
USGS	8330600	60	99866	6	19	1999	2018	18	1999	1.3	2000	0	0.07
USGS	8330600	60	99866	6	20	1999	2018	18	2009	0.47	1999	0	0.03
USGS	8330600	60	99866	6	21	1999	2018	18	2012	4.22	1999	0	0.28
USGS	8330600	60	99866	6	22	1999	2018	18	2012	0.45	1999	0	0.03
USGS	8330600	60	99866	6	23	1999	2018	18	2009	2.92	1999	0	0.16
USGS	8330600	60	99866	6	24	1999	2018	18	2009	1.24	1999	0	0.07
USGS	8330600	60	99866	6	25	1999	2018	18	2009	0.11	1999	0	0.01
USGS	8330600	60	99866	6	26	1999	2018	18	2006	22.2	1999	0	1.7
USGS	8330600	60	99866	6	27	1999	2018	18	2006	7.8	1999	0	0.56
USGS	8330600	60	99866	6	28	1999	2018	18	2004	20.7	1999	0	2.2
USGS	8330600	60	99866	6	29	1999	2018	18	2006	16.2	1999	0	1.7
USGS	8330600	60	99866	6	30	1999	2018	18	2006	7.22	1999	0	0.4
USGS	8330600	60	99866	7	1	1999	2018	18	2000	0.14	1999	0	0.02
USGS	8330600	60	99866	7	2	1999	2018	18	2001	0.77	1999	0	0.12
USGS	8330600	60	99866	7	3	1999	2018	18	2013	39.9	1999	0	3
USGS	8330600	60	99866	7	4	1999	2018	18	1999	1.9	2000	0	0.29
USGS	8330600	60	99866	7	5	1999	2018	18	2006	26.3	2000	0	1.8
USGS	8330600	60	99866	7	6	1999	2018	18	2006	109	1999	0	6.6
USGS	8330600	60	99866	7	7	1999	2018	18	2012	0.61	1999	0	0.07
USGS	8330600	60	99866	7	8	1999	2018	18	2006	88.2	1999	0	7
USGS	8330600	60	99866	7	9	1999	2018	18	2012	15.1	1999	0	1.8
USGS	8330600	60	99866	7	10	1999	2018	18	2002	16.8	1999	0	1.2
USGS	8330600	60	99866	7	11	1999	2018	18	2018	4.58	1999	0	0.54
USGS	8330600	60	99866	7	12	1999	2018	18	2018	0.27	1999	0	0.03
USGS	8330600	60	99866	7	13	1999	2018	18	2013	3.17	1999	0	0.26
USGS	8330600	60	99866	7	14	1999	2018	18	2018	46.9	1999	0	2.6
USGS	8330600	60	99866	7	15	1999	2018	18	2018	0.49	1999	0	0.03
USGS	8330600	60	99866	7	16	1999	2018	18	2008	1.06	1999	0	0.06
USGS	8330600	60	99866	7	17	1999	2018	18	2005	13	1999	0	0.83
USGS	8330600	60	99866	7	18	1999	2018	18	2008	7.82	2000	0	0.82
USGS	8330600	60	99866	7	19	1999	2018	18	2013	97.6	1999	0	6.5
USGS	8330600	60	99866	7	20	1999	2018	18	2008	2.24	2000	0	0.3

agency_cd	site_no	parameter	ts_id	month_nu	day_nu	begin_yr	end_yr	count_nu	max_va_yr	max_va	min_va_yr	min_va	mean_va
5s	15s	5s	11n	3n	3n	6n	6n	8n	5n	12s	5n	12s	12s
USGS	8330600	60	99866	7	21	1999	2018	18	2009	13.6	2001	0	1.3
USGS	8330600	60	99866	7	22	1999	2018	18	2008	17.4	1999	0	1.9
USGS	8330600	60	99866	7	23	1999	2018	18	2004	39.8	1999	0	3.2
USGS	8330600	60	99866	7	24	1999	2018	18	2007	20.5	1999	0	1.6
USGS	8330600	60	99866	7	25	1999	2018	18	2010	12.3	1999	0	1.3
USGS	8330600	60	99866	7	26	1999	2018	18	2013	31.9	1999	0	4.5
USGS	8330600	60	99866	7	27	1999	2018	18	2018	23.9	1999	0	2.6
USGS	8330600	60	99866	7	28	1999	2018	18	2018	31.5	1999	0	3.4
USGS	8330600	60	99866	7	29	1999	2018	18	2010	4.28	1999	0	0.57
USGS	8330600	60	99866	7	30	1999	2018	18	2018	25.7	1999	0	2.3
USGS	8330600	60	99866	7	31	1999	2018	18	2006	47.5	1999	0	5.6
USGS	8330600	60	99866	8	1	1999	2018	18	2006	12.4	1999	0	1.1
USGS	8330600	60	99866	8	2	1999	2018	18	1999	4.9	2000	0	0.4
USGS	8330600	60	99866	8	3	1999	2018	18	1999	47	2000	0	3.9
USGS	8330600	60	99866	8	4	1999	2018	18	2016	59.6	2000	0	9
USGS	8330600	60	99866	8	5	1999	2018	18	2016	24	2000	0	4
USGS	8330600	60	99866	8	6	1999	2018	18	2006	58.8	2000	0	4.3
USGS	8330600	60	99866	8	7	1999	2018	18	2002	3.86	1999	0	0.45
USGS	8330600	60	99866	8	8	1999	2018	18	1999	34	2001	0	2.1
USGS	8330600	60	99866	8	9	1999	2018	18	2006	22.3	2001	0	1.9
USGS	8330600	60	99866	8	10	1999	2018	18	1999	9.3	2000	0	0.56
USGS	8330600	60	99866	8	11	1999	2018	18	1999	1.1	2000	0	0.13
USGS	8330600	60	99866	8	12	1999	2018	18	2006	0.21	1999	0	0.01
USGS	8330600	60	99866	8	13	1999	2018	18	2006	46.8	1999	0	3.4
USGS	8330600	60	99866	8	14	1999	2018	18	2006	11.6	1999	0	1.4
USGS	8330600	60	99866	8	15	1999	2018	18	2006	34.5	2000	0	3.7
USGS	8330600	60	99866	8	16	1999	2018	18	2006	152	1999	0	9.4
USGS	8330600	60	99866	8	17	1999	2018	18	2018	6.31	1999	0	0.82
USGS	8330600	60	99866	8	18	1999	2018	18	2000	4.8	1999	0	0.36
USGS	8330600	60	99866	8	19	1999	2018	18	2006	22.3	1999	0	2.3
USGS	8330600	60	99866	8	20	1999	2018	18	2006	19	1999	0	1.1
USGS	8330600	60	99866	8	21	1999	2018	18	2006	27.4	1999	0	1.6
USGS	8330600	60	99866	8	22	1999	2018	18	2010	7.9	1999	0	0.69
USGS	8330600	60	99866	8	23	1999	2018	18	2006	17.1	2000	0	1.7
USGS	8330600	60	99866	8	24	1999	2018	18	2006	60.1	1999	0	3.6
USGS	8330600	60	99866	8	25	1999	2018	18	2006	2.04	1999	0	0.19
USGS	8330600	60	99866	8	26	1999	2018	18	1999	1.3	2000	0	0.08
USGS	8330600	60	99866	8	27	1999	2018	18	2009	0.36	1999	0	0.02
USGS	8330600	60	99866	8	28	1999	2018	18	1999	3.2	2000	0	0.29
USGS	8330600	60	99866	8	29	1999	2018	18	2017	14.1	2000	0	1.1
USGS	8330600	60	99866	8	30	1999	2018	18	2017	7.09	1999	0	0.83
USGS	8330600	60	99866	8	31	1999	2018	18	2003	1.86	1999	0	0.16
USGS	8330600	60	99866	9	1	1999	2018	18	2013	11.8	1999	0	0.86
USGS	8330600	60	99866	9	2	1999	2018	18	2013	3.77	1999	0	0.5
USGS	8330600	60	99866	9	3	1999	2018	18	2018	1.75	2000	0	0.16
USGS	8330600	60	99866	9	4	1999	2018	18	1999	0	1999	0	0
USGS	8330600	60	99866	9	5	1999	2018	18	2007	0.12	1999	0	0.01

agency_cd	site_no	parameter	ts_id	month_nu	day_nu	begin_yr	end_yr	count_nu	max_va_yr	max_va	min_va_yr	min_va	mean_va
5s	15s	5s	11n	3n	3n	6n	6n	8n	5n	12s	5n	12s	12s
USGS	8330600	60	99866	9	6	1999	2018	18	2005	24	1999	0	1.5
USGS	8330600	60	99866	9	7	1999	2018	18	2005	11	1999	0	1
USGS	8330600	60	99866	9	8	1999	2018	18	2010	3.08	1999	0	0.36
USGS	8330600	60	99866	9	9	1999	2018	18	2018	1.3	1999	0	0.18
USGS	8330600	60	99866	9	10	1999	2018	18	2013	10.4	1999	0	0.89
USGS	8330600	60	99866	9	11	1999	2018	18	2016	9.21	1999	0	0.85
USGS	8330600	60	99866	9	12	1999	2018	18	2013	31	1999	0	1.8
USGS	8330600	60	99866	9	13	1999	2018	18	2001	2.2	1999	0	0.29
USGS	8330600	60	99866	9	14	1999	2018	18	2013	28.8	1999	0	1.7
USGS	8330600	60	99866	9	15	1999	2018	18	2013	119	1999	0	6.7
USGS	8330600	60	99866	9	16	1999	2018	18	2009	3.39	1999	0	0.2
USGS	8330600	60	99866	9	17	1999	2018	18	2009	50.7	1999	0	2.8
USGS	8330600	60	99866	9	18	1999	2018	18	2009	1.44	1999	0	0.11
USGS	8330600	60	99866	9	19	1999	2018	18	2004	1.15	1999	0	0.16
USGS	8330600	60	99866	9	20	1999	2018	18	2007	30.3	1999	0	1.8
USGS	8330600	60	99866	9	21	1999	2018	18	2006	3.39	1999	0	0.33
USGS	8330600	60	99866	9	22	1999	2018	18	2010	83.5	1999	0	5.8
USGS	8330600	60	99866	9	23	1999	2018	18	2013	18.9	1999	0	1.9
USGS	8330600	60	99866	9	24	1999	2018	18	1999	0	1999	0	0
USGS	8330600	60	99866	9	25	1999	2018	18	2018	0.3	1999	0	0.02
USGS	8330600	60	99866	9	26	1999	2018	18	2018	0.49	1999	0	0.03
USGS	8330600	60	99866	9	27	1999	2018	18	2017	6.88	1999	0	0.38
USGS	8330600	60	99866	9	28	1999	2018	18	2017	6.65	1999	0	0.48
USGS	8330600	60	99866	9	29	1999	2018	18	2017	19.5	1999	0	1.8
USGS	8330600	60	99866	9	30	1999	2018	18	2017	2.17	1999	0	0.21
USGS	8330600	60	99866	10	1	1999	2019	19	2018	8.63	1999	0	0.48
USGS	8330600	60	99866	10	2	1999	2019	19	2019	0.11	1999	0	0.01
USGS	8330600	60	99866	10	3	1999	2019	19	2017	1.84	1999	0	0.12
USGS	8330600	60	99866	10	4	1999	2019	19	2012	3.35	1999	0	0.21
USGS	8330600	60	99866	10	5	1999	2019	19	2009	33.2	1999	0	2.2
USGS	8330600	60	99866	10	6	1999	2019	19	2016	0.23	1999	0	0.01
USGS	8330600	60	99866	10	7	1999	2019	19	2004	37.1	1999	0	2.2
USGS	8330600	60	99866	10	8	1999	2019	19	2004	5.9	1999	0	1.1
USGS	8330600	60	99866	10	9	1999	2019	19	2007	62.6	1999	0	4.8
USGS	8330600	60	99866	10	10	1999	2019	19	2007	23.5	1999	0	1.6
USGS	8330600	60	99866	10	11	1999	2019	19	2005	5.1	1999	0	0.32
USGS	8330600	60	99866	10	12	1999	2019	19	2001	19	1999	0	1
USGS	8330600	60	99866	10	13	1999	2019	19	2005	3.6	1999	0	0.19
USGS	8330600	60	99866	10	14	1999	2019	19	2009	0.91	1999	0	0.07
USGS	8330600	60	99866	10	15	1999	2019	19	2006	8.98	1999	0	0.49
USGS	8330600	60	99866	10	16	1999	2019	19	2006	5	1999	0	0.26
USGS	8330600	60	99866	10	17	1999	2019	19	1999	0	1999	0	0
USGS	8330600	60	99866	10	18	1999	2019	19	2006	0.66	1999	0	0.03
USGS	8330600	60	99866	10	19	1999	2019	19	2016	1.21	1999	0	0.07
USGS	8330600	60	99866	10	20	1999	2019	19	2010	8.9	2000	0	0.55
USGS	8330600	60	99866	10	21	1999	2019	19	2016	29.5	1999	0	3
USGS	8330600	60	99866	10	22	1999	2019	19	2011	5.16	1999	0	0.35

agency_cd	site_no	parameter	ts_id	month_nu	day_nu	begin_yr	end_yr	count_nu	max_va_yr	max_va	min_va_yr	min_va	mean_va
5s	15s	5s	11n	3n	3n	6n	6n	8n	5n	12s	5n	12s	12s
USGS	8330600	60	99866	10	23	1999	2019	19	2001	38	1999	0	2.7
USGS	8330600	60	99866	10	24	1999	2019	19	2019	13.6	1999	0	0.88
USGS	8330600	60	99866	10	25	1999	2019	19	2019	0.19	1999	0	0.01
USGS	8330600	60	99866	10	26	1999	2019	19	2012	1.44	2000	0	0.08
USGS	8330600	60	99866	10	27	1999	2019	19	1999	3.9	2000	0	0.38
USGS	8330600	60	99866	10	28	1999	2019	19	2001	2.1	1999	0	0.16
USGS	8330600	60	99866	10	29	1999	2019	19	2010	0.6	1999	0	0.05
USGS	8330600	60	99866	10	30	1999	2019	19	2016	1.27	1999	0	0.1
USGS	8330600	60	99866	10	31	1999	2019	19	1999	5	2000	0	0.33
USGS	8330600	60	99866	11	1	1999	2019	19	2007	2.39	1999	0	0.13
USGS	8330600	60	99866	11	2	1999	2019	19	2007	1.6	1999	0	0.09
USGS	8330600	60	99866	11	3	1999	2019	19	2007	1.5	1999	0	0.09
USGS	8330600	60	99866	11	4	1999	2019	19	2017	2.51	1999	0	0.3
USGS	8330600	60	99866	11	5	1999	2019	19	2017	9.46	1999	0	0.7
USGS	8330600	60	99866	11	6	1999	2019	19	2017	4.41	1999	0	0.32
USGS	8330600	60	99866	11	7	1999	2019	19	2007	0.64	1999	0	0.03
USGS	8330600	60	99866	11	8	1999	2019	19	2007	0.67	1999	0	0.04
USGS	8330600	60	99866	11	9	1999	2019	19	2011	4.65	1999	0	0.29
USGS	8330600	60	99866	11	10	1999	2019	19	2003	5.98	1999	0	0.32
USGS	8330600	60	99866	11	11	1999	2019	19	1999	0	1999	0	0
USGS	8330600	60	99866	11	12	1999	2019	19	2004	0.45	1999	0	0.02
USGS	8330600	60	99866	11	13	1999	2019	19	2004	2.34	1999	0	0.25
USGS	8330600	60	99866	11	14	1999	2019	19	1999	0	1999	0	0
USGS	8330600	60	99866	11	15	1999	2019	19	2011	3.83	1999	0	0.33
USGS	8330600	60	99866	11	16	1999	2019	19	2016	4.99	1999	0	0.26
USGS	8330600	60	99866	11	17	1999	2019	19	2016	2.84	1999	0	0.15
USGS	8330600	60	99866	11	18	1999	2019	19	2013	0.13	1999	0	0.01
USGS	8330600	60	99866	11	19	1999	2019	19	2005	0.45	1999	0	0.02
USGS	8330600	60	99866	11	20	1999	2019	19	1999	0	1999	0	0
USGS	8330600	60	99866	11	21	1999	2019	19	2017	2.02	1999	0	0.11
USGS	8330600	60	99866	11	22	1999	2019	19	2017	0.89	1999	0	0.1
USGS	8330600	60	99866	11	23	1999	2019	19	2005	17	1999	0	1.2
USGS	8330600	60	99866	11	24	1999	2019	19	1999	0	1999	0	0
USGS	8330600	60	99866	11	25	1999	2019	19	1999	0	1999	0	0
USGS	8330600	60	99866	11	26	1999	2019	19	1999	0	1999	0	0
USGS	8330600	60	99866	11	27	1999	2019	19	2009	0.72	1999	0	0.04
USGS	8330600	60	99866	11	28	1999	2019	19	2010	0.01	1999	0	0
USGS	8330600	60	99866	11	29	1999	2019	19	2007	0.12	1999	0	0.01
USGS	8330600	60	99866	11	30	1999	2019	19	2008	0.36	1999	0	0.02
USGS	8330600	60	99866	12	1	1999	2019	19	2008	6.43	1999	0	0.34
USGS	8330600	60	99866	12	2	1999	2019	19	2019	2.88	1999	0	0.15
USGS	8330600	60	99866	12	3	1999	2019	19	2012	0.2	1999	0	0.01
USGS	8330600	60	99866	12	4	1999	2019	19	1999	0	1999	0	0
USGS	8330600	60	99866	12	5	1999	2019	19	1999	0	1999	0	0
USGS	8330600	60	99866	12	6	1999	2019	19	1999	0	1999	0	0
USGS	8330600	60	99866	12	7	1999	2019	19	2019	4.01	1999	0	0.22
USGS	8330600	60	99866	12	8	1999	2019	19	2010	0.59	1999	0	0.03

agency_cd	site_no	parameter	ts_id	month_nu	day_nu	begin_yr	end_yr	count_nu	max_va_yr	max_va	min_va_yr	min_va	mean_va
5s	15s	5s	11n	3n	3n	6n	6n	8n	5n	12s	5n	12s	12s
USGS	8330600	60	99866	12	9	1999	2019	19	2009	1.5	1999	0	0.08
USGS	8330600	60	99866	12	10	1999	2019	19	2008	2.43	1999	0	0.13
USGS	8330600	60	99866	12	11	1999	2019	19	2008	7.26	1999	0	0.38
USGS	8330600	60	99866	12	12	1999	2019	19	2016	4.09	1999	0	0.27
USGS	8330600	60	99866	12	13	1999	2019	19	2016	6.4	1999	0	0.42
USGS	8330600	60	99866	12	14	1999	2019	19	2016	2.82	1999	0	0.26
USGS	8330600	60	99866	12	15	1999	2019	19	2009	1.28	1999	0	0.11
USGS	8330600	60	99866	12	16	1999	2019	19	2011	3.82	1999	0	0.23
USGS	8330600	60	99866	12	17	1999	2019	19	2011	5.24	1999	0	0.32
USGS	8330600	60	99866	12	18	1999	2019	19	2009	0.5	1999	0	0.03
USGS	8330600	60	99866	12	19	1999	2019	19	2007	2.89	1999	0	0.21
USGS	8330600	60	99866	12	20	1999	2019	19	2007	1.77	1999	0	0.09
USGS	8330600	60	99866	12	21	1999	2019	19	2008	0.16	1999	0	0.01
USGS	8330600	60	99866	12	22	1999	2019	19	2017	2.1	1999	0	0.11
USGS	8330600	60	99866	12	23	1999	2019	19	2010	3.02	1999	0	0.22
USGS	8330600	60	99866	12	24	1999	2019	19	2010	0.73	1999	0	0.06
USGS	8330600	60	99866	12	25	1999	2019	19	2017	0.32	1999	0	0.02
USGS	8330600	60	99866	12	26	1999	2019	19	2019	4.03	1999	0	0.34
USGS	8330600	60	99866	12	27	1999	2019	19	2016	5.46	1999	0	0.35
USGS	8330600	60	99866	12	28	1999	2019	19	2016	2	1999	0	0.19
USGS	8330600	60	99866	12	29	1999	2019	19	2016	0.35	1999	0	0.02
USGS	8330600	60	99866	12	30	1999	2019	19	2005	1.53	1999	0	0.08
USGS	8330600	60	99866	12	31	1999	2019	19	2017	1.14	1999	0	0.06

Appendix G-3

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This file includes the following columns:
#
#
agency_cd agency code
site_no USGS site number
parameter_cd
ts_id
year_nu Calendar year for value
month_nu Month for value
mean_va monthly-mean value.
if there is not complete record
for a month this field is blank
#
#
Sites in this file include:
USGS 0833 NM
#
Explanation of Parameter Code and ts_id used in the Statistics Data
parameter_ Parameter Name ts_id Location Name
00060 Discharge cubic feet per second 99866
#

agency_cd	site_no	parameter_cd	ts_id	year_nu	month_nu	mean_va
5s	15s	5s	3n	4s	2s	12n
USGS	8330600	60	99866	1998	10	0.293
USGS	8330600	60	99866	1998	11	0
USGS	8330600	60	99866	1998	12	0
USGS	8330600	60	99866	1999	1	0
USGS	8330600	60	99866	1999	2	0
USGS	8330600	60	99866	1999	3	0.007
USGS	8330600	60	99866	1999	4	0.065
USGS	8330600	60	99866	1999	5	0
USGS	8330600	60	99866	1999	6	0.044
USGS	8330600	60	99866	1999	7	0.246
USGS	8330600	60	99866	1999	8	4.35
USGS	8330600	60	99866	1999	9	0.026
USGS	8330600	60	99866	1999	10	0
USGS	8330600	60	99866	1999	11	0
USGS	8330600	60	99866	1999	12	0
USGS	8330600	60	99866	2000	1	0
USGS	8330600	60	99866	2000	2	0
USGS	8330600	60	99866	2000	3	0.029
USGS	8330600	60	99866	2000	4	0
USGS	8330600	60	99866	2000	5	0
USGS	8330600	60	99866	2000	6	0.373
USGS	8330600	60	99866	2000	7	0.04
USGS	8330600	60	99866	2000	8	0.285
USGS	8330600	60	99866	2000	9	0.026
USGS	8330600	60	99866	2000	10	2.2
USGS	8330600	60	99866	2000	11	0.207
USGS	8330600	60	99866	2000	12	0
USGS	8330600	60	99866	2001	1	0

agency_cd	site_no	parameter_cd	ts_id	year_nu	month_nu	mean_va
5s	15s	5s	3n	4s	2s	12n
USGS	8330600	60	99866	2001	2	0
USGS	8330600	60	99866	2001	3	0
USGS	8330600	60	99866	2001	4	0.006
USGS	8330600	60	99866	2001	5	0.032
USGS	8330600	60	99866	2001	6	0.05
USGS	8330600	60	99866	2001	7	0.151
USGS	8330600	60	99866	2001	8	0.315
USGS	8330600	60	99866	2001	9	0.113
USGS	8330600	60	99866	2001	10	0
USGS	8330600	60	99866	2001	11	0.015
USGS	8330600	60	99866	2001	12	0
USGS	8330600	60	99866	2002	1	0
USGS	8330600	60	99866	2002	2	0
USGS	8330600	60	99866	2002	3	0
USGS	8330600	60	99866	2002	4	0
USGS	8330600	60	99866	2002	5	0
USGS	8330600	60	99866	2002	6	0.001
USGS	8330600	60	99866	2002	7	0.794
USGS	8330600	60	99866	2002	8	1.65
USGS	8330600	60	99866	2002	9	0.128
USGS	8330600	60	99866	2002	10	0.094
USGS	8330600	60	99866	2002	11	0.212
USGS	8330600	60	99866	2002	12	0
USGS	8330600	60	99866	2003	1	0
USGS	8330600	60	99866	2003	2	0.219
USGS	8330600	60	99866	2003	3	1.21
USGS	8330600	60	99866	2003	4	0
USGS	8330600	60	99866	2003	5	0
USGS	8330600	60	99866	2003	6	0.504
USGS	8330600	60	99866	2003	7	0.012
USGS	8330600	60	99866	2003	8	0.277
USGS	8330600	60	99866	2003	9	0.156
USGS	8330600	60	99866	2003	10	1.62
USGS	8330600	60	99866	2003	11	0.093
USGS	8330600	60	99866	2003	12	0
USGS	8330600	60	99866	2004	1	0
USGS	8330600	60	99866	2004	2	1.1
USGS	8330600	60	99866	2004	3	0.484
USGS	8330600	60	99866	2004	4	3.45
USGS	8330600	60	99866	2004	5	0
USGS	8330600	60	99866	2004	6	0.827
USGS	8330600	60	99866	2004	7	1.67
USGS	8330600	60	99866	2004	8	1.98
USGS	8330600	60	99866	2004	9	0.038
USGS	8330600	60	99866	2004	10	0.345
USGS	8330600	60	99866	2004	11	0.609
USGS	8330600	60	99866	2004	12	0.049
USGS	8330600	60	99866	2005	1	1.15
USGS	8330600	60	99866	2005	2	2.61

agency_cd	site_no	parameter_cd	ts_id	year_nu	month_nu	mean_va
5s	15s	5s	3n	4s	2s	12n
USGS	8330600	60	99866	2005	3	0.083
USGS	8330600	60	99866	2005	4	0.287
USGS	8330600	60	99866	2005	5	0.021
USGS	8330600	60	99866	2005	6	0.028
USGS	8330600	60	99866	2005	7	0.681
USGS	8330600	60	99866	2005	8	1.33
USGS	8330600	60	99866	2005	9	1.71
USGS	8330600	60	99866	2005	10	0.781
USGS	8330600	60	99866	2005	11	0
USGS	8330600	60	99866	2005	12	0.02
USGS	8330600	60	99866	2006	1	0
USGS	8330600	60	99866	2006	2	0.014
USGS	8330600	60	99866	2006	3	0.072
USGS	8330600	60	99866	2006	4	0.006
USGS	8330600	60	99866	2006	5	0
USGS	8330600	60	99866	2006	6	1.91
USGS	8330600	60	99866	2006	7	10.4
USGS	8330600	60	99866	2006	8	16.2
USGS	8330600	60	99866	2006	9	0.297
USGS	8330600	60	99866	2006	10	2.83
USGS	8330600	60	99866	2006	11	0.509
USGS	8330600	60	99866	2006	12	0.23
USGS	8330600	60	99866	2007	1	0.655
USGS	8330600	60	99866	2007	2	0.361
USGS	8330600	60	99866	2007	3	0.097
USGS	8330600	60	99866	2007	4	0.548
USGS	8330600	60	99866	2007	5	0.874
USGS	8330600	60	99866	2007	6	0.151
USGS	8330600	60	99866	2007	7	0.961
USGS	8330600	60	99866	2007	8	0.48
USGS	8330600	60	99866	2007	9	1.09
USGS	8330600	60	99866	2007	10	0.009
USGS	8330600	60	99866	2007	11	0.022
USGS	8330600	60	99866	2007	12	0.528
USGS	8330600	60	99866	2008	1	0.163
USGS	8330600	60	99866	2008	2	0.445
USGS	8330600	60	99866	2008	3	0
USGS	8330600	60	99866	2008	4	0.005
USGS	8330600	60	99866	2008	5	0.034
USGS	8330600	60	99866	2008	6	0.214
USGS	8330600	60	99866	2008	7	2.53
USGS	8330600	60	99866	2008	8	1.42
USGS	8330600	60	99866	2008	9	0.002
USGS	8330600	60	99866	2008	10	1.11
USGS	8330600	60	99866	2008	11	0.024
USGS	8330600	60	99866	2008	12	0.163
USGS	8330600	60	99866	2009	1	0.006
USGS	8330600	60	99866	2009	2	0.004
USGS	8330600	60	99866	2009	3	0.07

agency_cd	site_no	parameter_cd	ts_id	year_nu	month_nu	mean_va
5s	15s	5s	3n	4s	2s	12n
USGS	8330600	60	99866	2009	4	0.176
USGS	8330600	60	99866	2009	5	0.113
USGS	8330600	60	99866	2009	6	0.23
USGS	8330600	60	99866	2009	7	0.763
USGS	8330600	60	99866	2009	8	0.214
USGS	8330600	60	99866	2009	9	2.12
USGS	8330600	60	99866	2009	10	0.65
USGS	8330600	60	99866	2009	11	0.078
USGS	8330600	60	99866	2009	12	0.234
USGS	8330600	60	99866	2010	1	0.144
USGS	8330600	60	99866	2010	2	0.256
USGS	8330600	60	99866	2010	3	0.08
USGS	8330600	60	99866	2010	4	0.395
USGS	8330600	60	99866	2010	5	0.24
USGS	8330600	60	99866	2010	6	0.929
USGS	8330600	60	99866	2010	7	2.69
USGS	8330600	60	99866	2010	8	1.72
USGS	8330600	60	99866	2010	9	3.41
USGS	8330600	60	99866	2010	10	0.86
USGS	8330600	60	99866	2010	11	0.283
USGS	8330600	60	99866	2010	12	0.318
USGS	8330600	60	99866	2011	1	0.004
USGS	8330600	60	99866	2011	2	0.005
USGS	8330600	60	99866	2011	3	0
USGS	8330600	60	99866	2011	4	0.012
USGS	8330600	60	99866	2011	5	0
USGS	8330600	60	99866	2011	6	0.005
USGS	8330600	60	99866	2011	7	0.214
USGS	8330600	60	99866	2011	8	0.58
USGS	8330600	60	99866	2011	9	0.055
USGS	8330600	60	99866	2011	10	0.715
USGS	8330600	60	99866	2011	11	0
USGS	8330600	60	99866	2011	12	0.076
USGS	8330600	60	99866	2012	1	0.055
USGS	8330600	60	99866	2012	2	0.037
USGS	8330600	60	99866	2012	3	0.184
USGS	8330600	60	99866	2012	4	0.204
USGS	8330600	60	99866	2012	5	0.036
USGS	8330600	60	99866	2012	6	0.156
USGS	8330600	60	99866	2012	7	1.29
USGS	8330600	60	99866	2012	8	0.253
USGS	8330600	60	99866	2012	9	0.159
USGS	8330600	60	99866	2012	10	0
USGS	8330600	60	99866	2012	11	0.005
USGS	8330600	60	99866	2012	12	0.001
USGS	8330600	60	99866	2013	1	0.003
USGS	8330600	60	99866	2013	2	0.011
USGS	8330600	60	99866	2013	3	0.007
USGS	8330600	60	99866	2013	4	0.007

agency_cd	site_no	parameter_cd	ts_id	year_nu	month_nu	mean_va
5s	15s	5s	3n	4s	2s	12n
USGS	8330600	60	99866	2013	5	0.011
USGS	8330600	60	99866	2013	6	0.011
USGS	8330600	60	99866	2013	7	6.8
USGS	8330600	60	99866	2013	8	0.063
USGS	8330600	60	99866	2015	10	1.18
USGS	8330600	60	99866	2015	11	0.362
USGS	8330600	60	99866	2015	12	0.767
USGS	8330600	60	99866	2016	1	1.13
USGS	8330600	60	99866	2016	2	0.006
USGS	8330600	60	99866	2016	3	0
USGS	8330600	60	99866	2016	4	0.346
USGS	8330600	60	99866	2016	5	0.297
USGS	8330600	60	99866	2016	6	0.024
USGS	8330600	60	99866	2016	7	0.682
USGS	8330600	60	99866	2016	8	2.9
USGS	8330600	60	99866	2016	9	0.582
USGS	8330600	60	99866	2016	10	0.801
USGS	8330600	60	99866	2016	11	0.65
USGS	8330600	60	99866	2016	12	0.162
USGS	8330600	60	99866	2017	1	1.16
USGS	8330600	60	99866	2017	2	0.309
USGS	8330600	60	99866	2017	3	0.01
USGS	8330600	60	99866	2017	4	0.086
USGS	8330600	60	99866	2017	5	0.011
USGS	8330600	60	99866	2017	6	0.008
USGS	8330600	60	99866	2017	7	0.027
USGS	8330600	60	99866	2017	8	0.73
USGS	8330600	60	99866	2017	9	1.18
USGS	8330600	60	99866	2017	10	0.283
USGS	8330600	60	99866	2017	11	0
USGS	8330600	60	99866	2017	12	0
USGS	8330600	60	99866	2018	1	0
USGS	8330600	60	99866	2018	2	0.029
USGS	8330600	60	99866	2018	3	0.013
USGS	8330600	60	99866	2018	4	0
USGS	8330600	60	99866	2018	5	0.022
USGS	8330600	60	99866	2018	6	1.5
USGS	8330600	60	99866	2018	7	6.17
USGS	8330600	60	99866	2018	8	0.425
USGS	8330600	60	99866	2018	9	0.428
USGS	8330600	60	99866	2018	10	0.853
USGS	8330600	60	99866	2018	11	0
USGS	8330600	60	99866	2018	12	0.369
USGS	8330600	60	99866	2019	1	0.425

Appendix G-4

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This file contains USGS Surface-Water Annual Statistics
#
Note:The statistics generated from this site are based on approved daily-mean data and may not mat
The user is responsible for assessment and use of statistics from this site.
For more detai visit https://waterdata.usgs.gov/nwis/?dv_statistics_disclaimer.
#
** No Incomplete data have been used for statistical calculation
#
This file includes the following columns:
#
#
agency_cd agency code
site_no   USGS site number
parameter_cd
ts_id
year_nu   Water year for value
mean_va   annual-mean value.
if there is not complete record
for a year this field is blank
#
Explanation of Parameter Code and ts_id used in the Statistics Data
parameter_cd Parameter Name
00060   Discharge   cubic feet per second   99866
#
#

agency_cd	site_no	parameter_cd	ts_id	year_nu	mean_va
5s	15s	5s	3n	4s	12n
USGS	8330600	60	99866	1999	0.427
USGS	8330600	60	99866	2000	0.063
USGS	8330600	60	99866	2001	0.26
USGS	8330600	60	99866	2002	0.219
USGS	8330600	60	99866	2003	0.224
USGS	8330600	60	99866	2004	0.936
USGS	8330600	60	99866	2005	0.727
USGS	8330600	60	99866	2006	2.51
USGS	8330600	60	99866	2007	0.737
USGS	8330600	60	99866	2008	0.452
USGS	8330600	60	99866	2009	0.417
USGS	8330600	60	99866	2010	0.904
USGS	8330600	60	99866	2011	0.197
USGS	8330600	60	99866	2012	0.266
USGS	8330600	60	99866	2013	1.27
USGS	8330600	60	99866	2016	0.697
USGS	8330600	60	99866	2017	0.428
USGS	8330600	60	99866	2018	0.748

Appendix H – Historic Aerial Photos

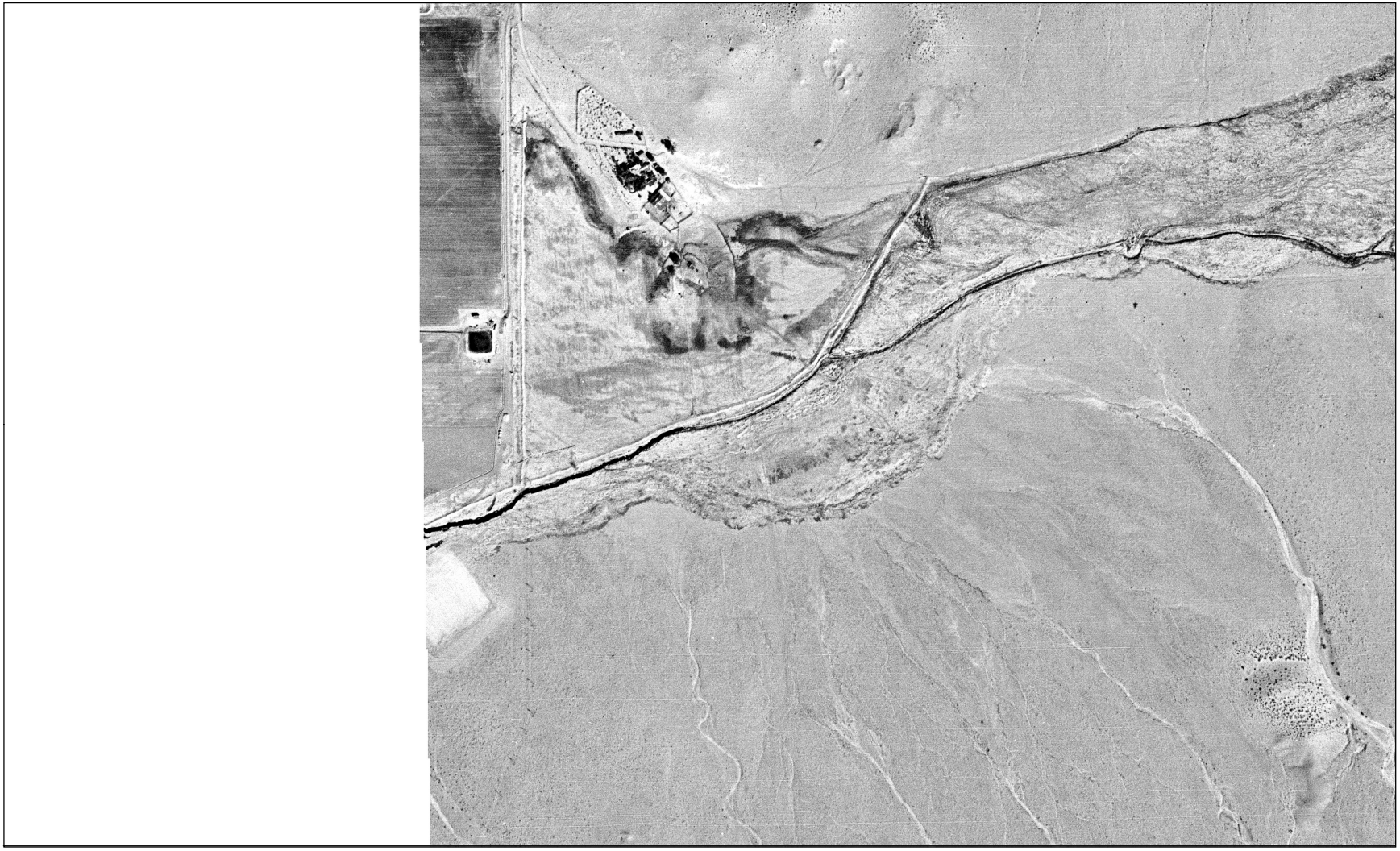
No.	Description
H-1	Sub-Reach 1 (Years 1951, 1959, 1982, 2002, 2018)
H-2	Sub-Reach 2 (Years 1951, 1959, 1982, 2002, 2018)
H-3	Sub-Reach 3 (Years 1951, 1959, 1982, 2002, 2018)
H-4	Sub-Reach 4 (Years 1951, 1959, 1982, 2002, 2018)
H-5	Sub-Reach 5 (Years 1951, 1959, 1982, 2002, 2018)
H-6	Sub-Reach 6 (Years 1951, 1959, 1982, 2002, 2018)
H-7	Sub-Reach 7 (Years 1951, 1959, 1982, 2002, 2018)
H-8	Sub-Reach 8 (Years 1951, 1959, 1982, 2002, 2018)
H-9	Entire Reach (Years 1935, 1951, 1959, 1982, 2002, 2018)

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Appendix H-1

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Mapid = sc19223 08/27/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 1 1951 Aerial Photo

Appendix H

0 62.5 125 250
Meters

0 0.05 0.1 0.2
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19224 08/27/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 1 1959 Aerial Photo

Appendix H

0 62.5 125 250
Meters

0 0.05 0.1 0.2
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19225 08/27/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 1 1982 Aerial Photo

Appendix H

0 62.5 125 250
Meters

0 0.05 0.1 0.2
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19226 08/27/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 1 2002 Aerial Photo

Appendix H

0 62.5 125 250
Meters

0 0.05 0.1 0.2
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19227 08/27/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 1 2018 Aerial Photo

Appendix H

0 62.5 125 250
Meters

0 0.05 0.1 0.2
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

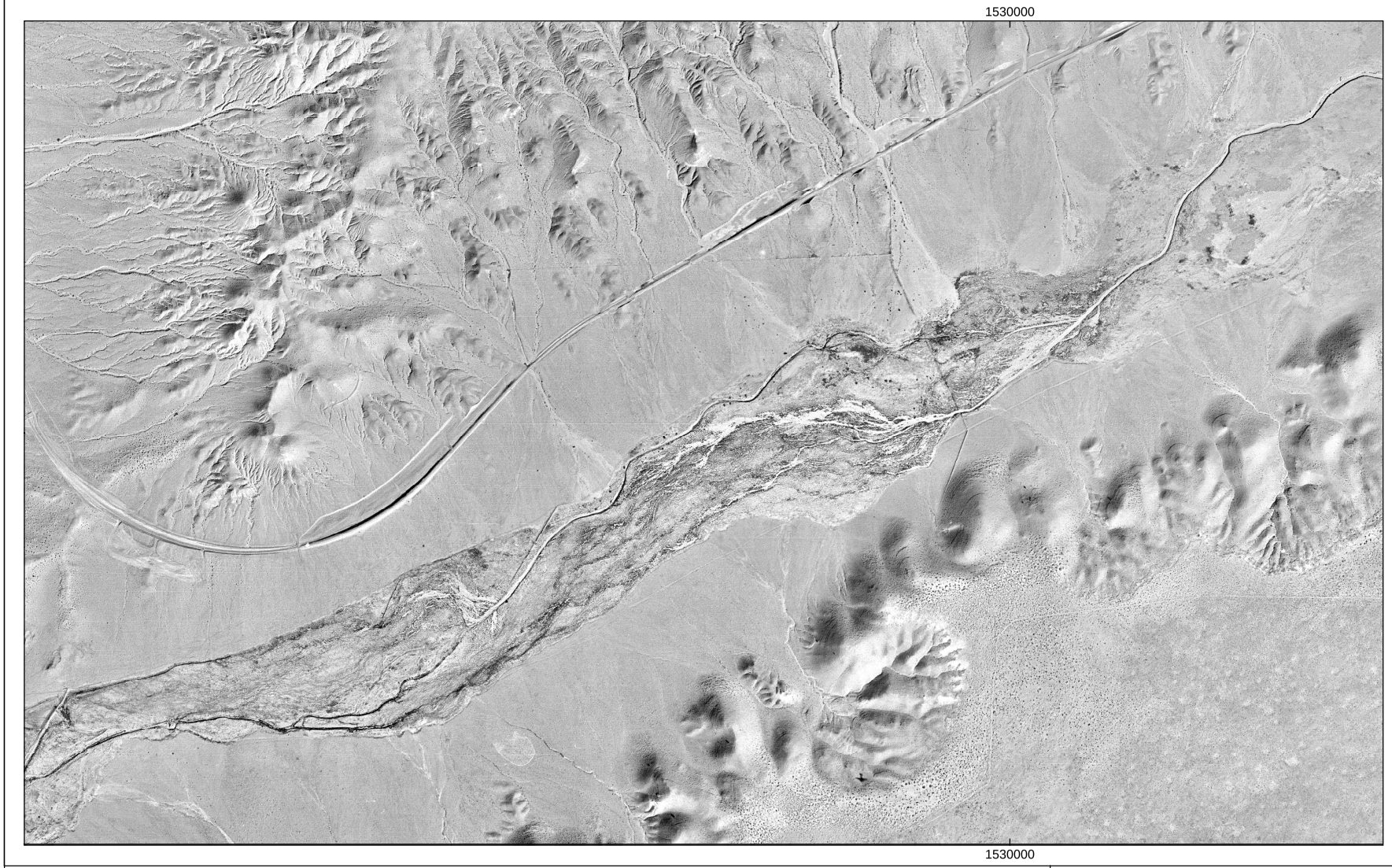
N

EGIS

Appendix H-2

A printed copy of this document may not be the official version. The official printed copy of this UAA is located in the office of the Environmental Compliance and monitoring (Org. 0641).

Mapid = sc19217 08/27/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 2 1951 Aerial Photo

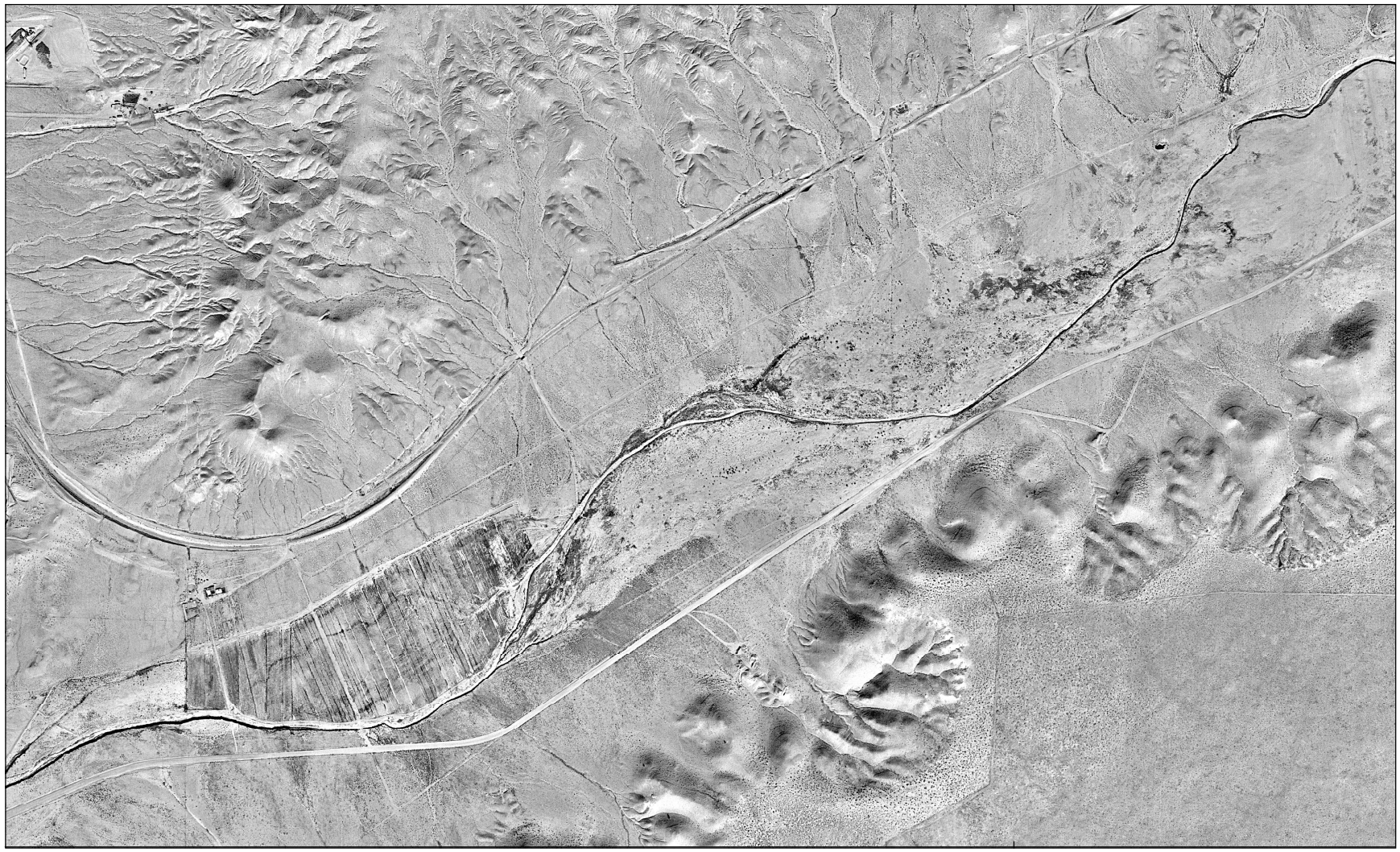
Appendix H

0 125 250 500
Meters

0 0.125 0.25 0.5
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19218 08/27/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 2 1959 Aerial Photo

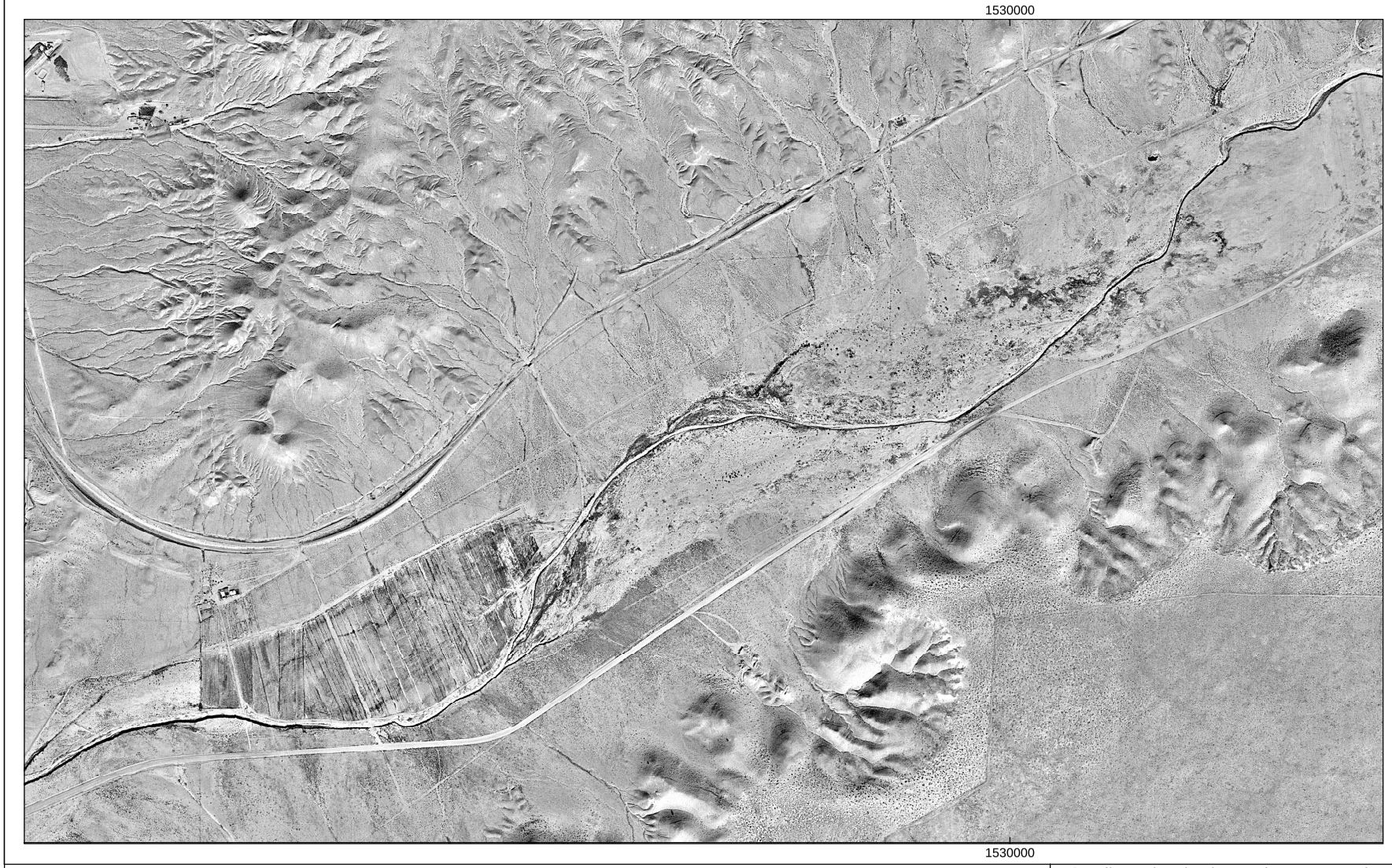
Appendix H

0 125 250 500
Meters

0 0.125 0.25 0.5
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19219 08/27/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 2 1982 Aerial Photo

Appendix H

0 125 250 500
Meters

0 0.125 0.25 0.5
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19220 08/27/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 2 2002 Aerial Photo

Appendix H

0 125 250 500
Meters

0 0.125 0.25 0.5
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19221 08/27/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 2 2018 Aerial Photo

Appendix H

0 125 250 500
Meters

0 0.125 0.25 0.5
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Appendix H-3

Mapid = sc19212 08/23/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 3 1951 Aerial Photo

Appendix H

0 87.5 175 350
Meters

0 0.075 0.15 0.3
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19213 08/23/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 3 1982 Aerial Photo

Appendix H

0 87.5 175 350
Meters

0 0.075 0.15 0.3
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19214 08/23/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 3 2002 Aerial Photo

Appendix H

0 87.5 175 350
Meters

0 0.075 0.15 0.3
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19215 08/23/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 3 2018 Aerial Photo

Appendix H

0 87.5 175 350
Meters

0 0.075 0.15 0.3
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Appendix H-4

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Mapid = sc19206 08/23/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 4 1951 Aerial Photo

Appendix H

0 50 100 200
Meters

0 0.05 0.1 0.2
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19207 08/23/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 4 1959 Aerial Photo

Appendix H

0 50 100 200
Meters

0 0.05 0.1 0.2
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19208 08/23/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 4 1982 Aerial Photo

Appendix H

0 50 100 200
Meters

0 0.05 0.1 0.2
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19209 08/23/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 4 2002 Aerial Photo

Appendix H

0 50 100 200
Meters

0 0.05 0.1 0.2
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

N

EGIS

Mapid = sc19210 08/23/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 4 2018 Aerial Photo

Appendix H

0 50 100 200
Meters

0 0.05 0.1 0.2
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Appendix H-5

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Mapid = sc19200 08/23/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 5 1951 Aerial Photo

Apendix H

0 112.5 225 450
Meters

0 0.1 0.2 0.4
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19201 08/23/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 5 1959 Aerial Photo

Appendix H

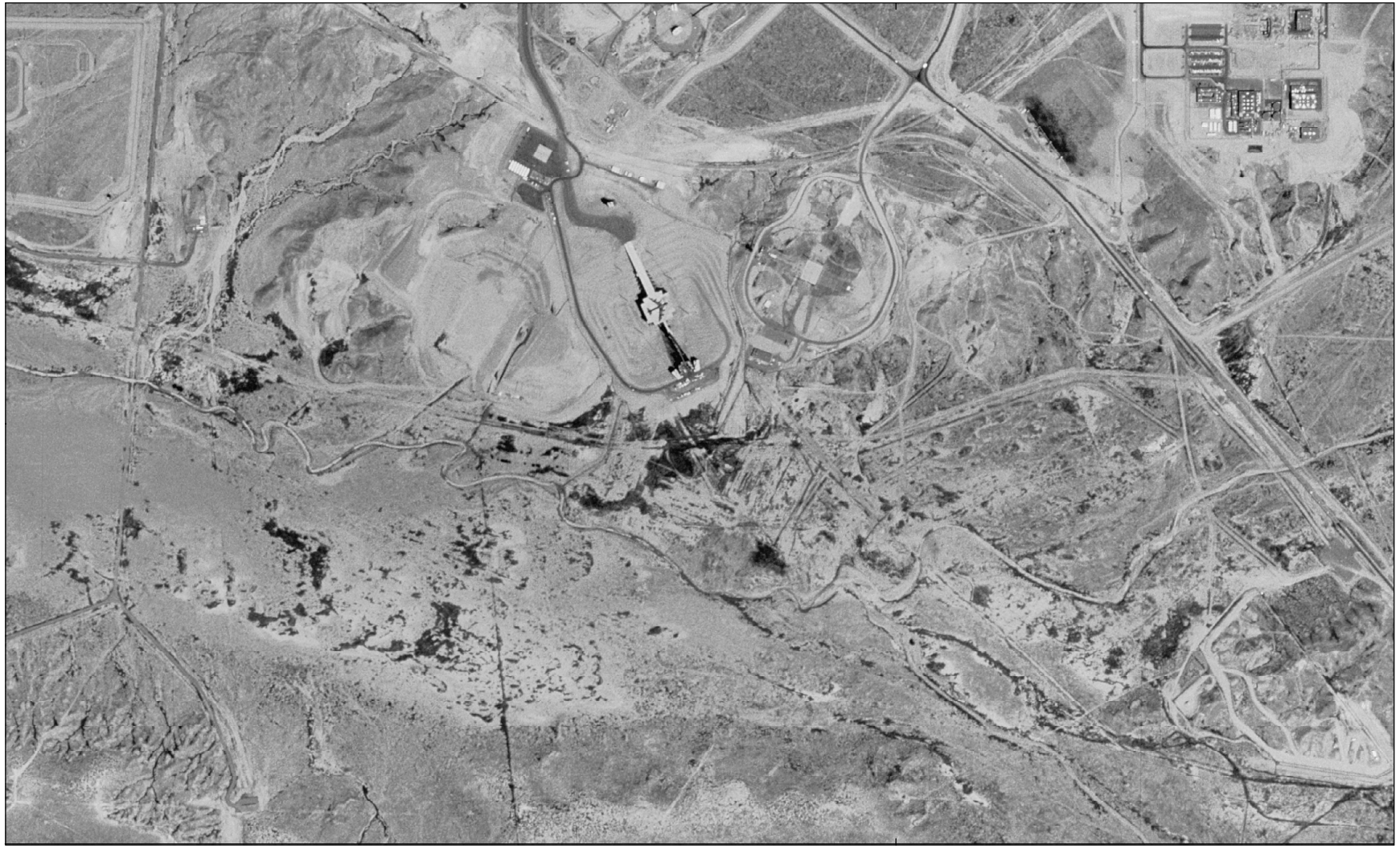
0 112.5 225 450
Meters

0 0.1 0.2 0.4
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19202 08/23/19 SNL EGIS ORG. 0643

1550000



1550000

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 5 1982 Aerial Photo

Appendix H

0 112.5 225 450
Meters

0 0.1 0.2 0.4
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19203 08/23/19 SNL EGIS ORG. 0643

1550000



1550000

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 5 2002 Aerial Photo

Appendix H

0 112.5 225 450
Meters

0 0.1 0.2 0.4
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19204 08/23/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 5 2018 Aerial Photo

Appendix H

0 112.5 225 450
Meters

0 0.1 0.2 0.4
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Appendix H-6

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Mapid = sc19194 08/23/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 6 1951 Aerial Photo

Appendix H

0 112.5 225 450
Meters

0 0.1 0.2 0.4
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19195 08/23/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 6 1959 Aerial Photo

Appendix H

0 112.5 225 450
Meters

0 0.1 0.2 0.4
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19196 08/23/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 6 1982 Aerial Photo

Appendix H

0 112.5 225 450
Meters

0 0.1 0.2 0.4
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19197 08/23/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 6 2002 Aerial Photo

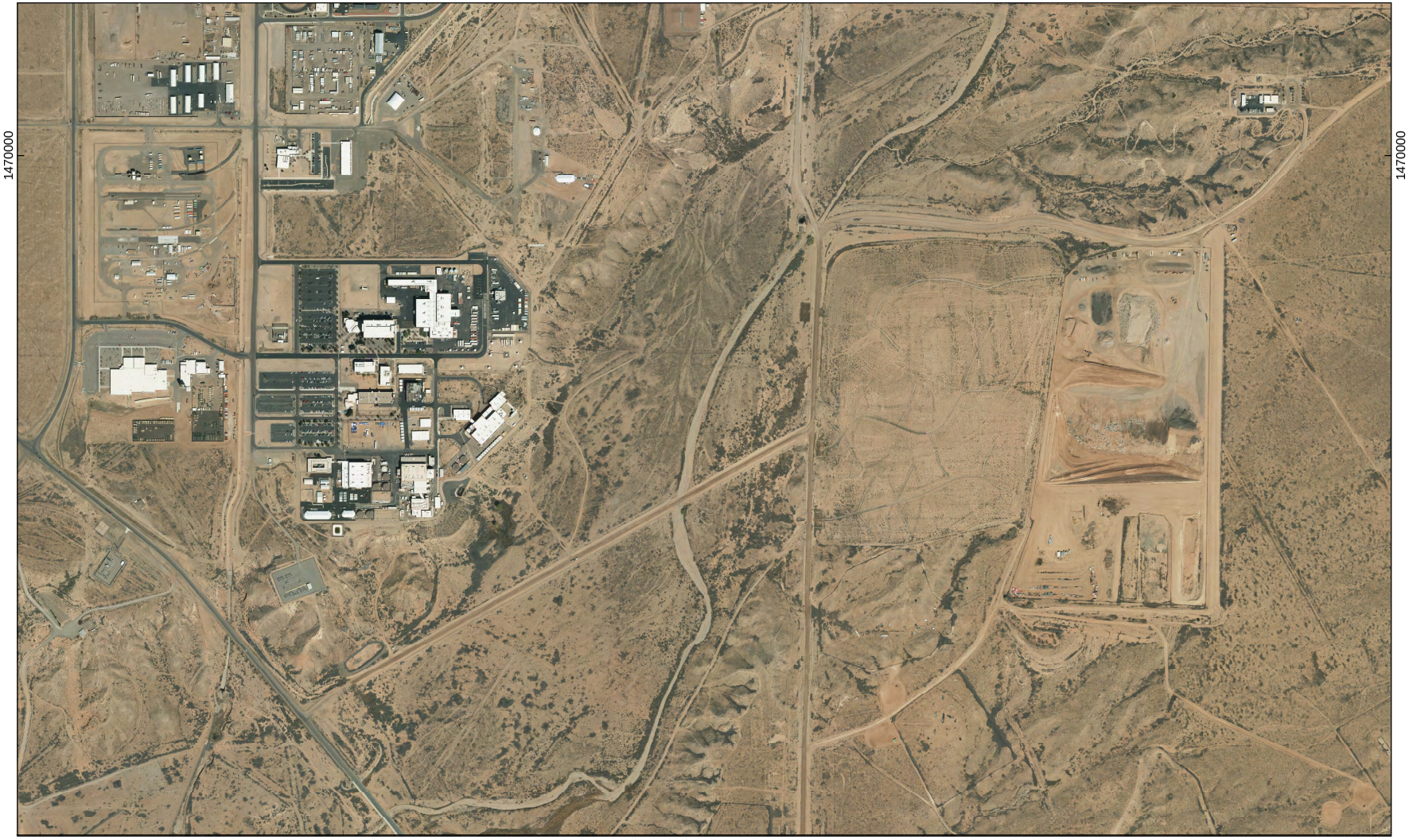
Appendix H

0 112.5 225 450
Meters

0 0.1 0.2 0.4
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19198 08/23/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 6 2018 Aerial Photo

Appendix H

0 112.5 225 450
Meters

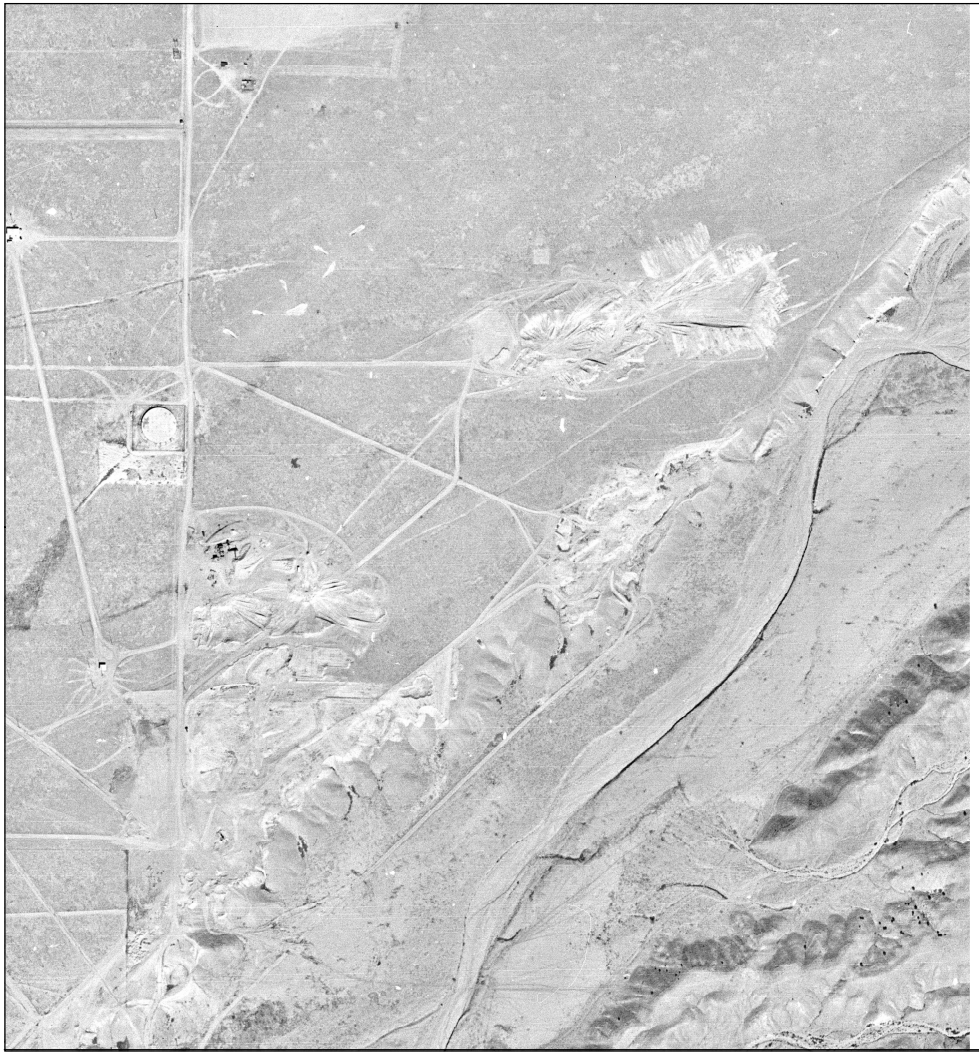
0 0.1 0.2 0.4
Miles

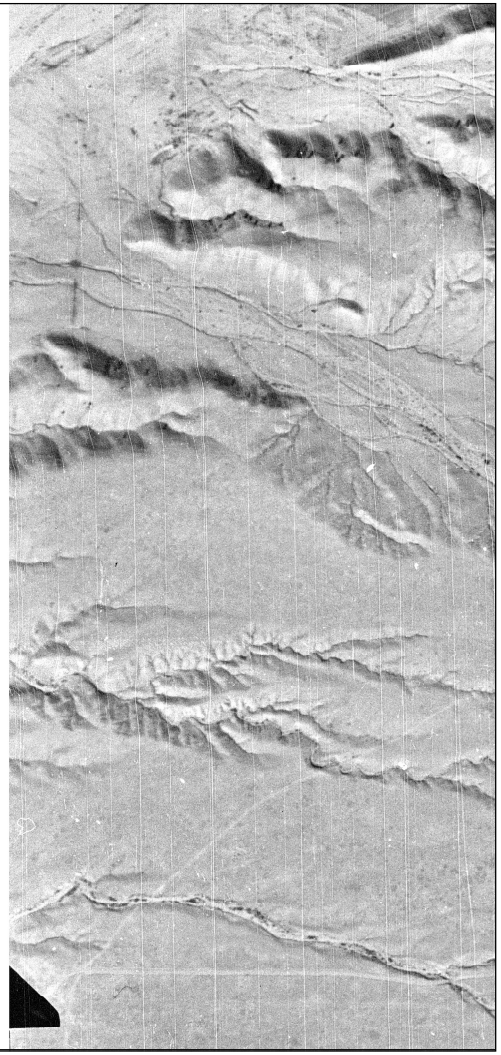
New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Appendix H-7

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Mapid = sc19188 08/23/19 SNL EGIS ORG. 0643





Reach 7 1951 Aerial Photo

Appendix H

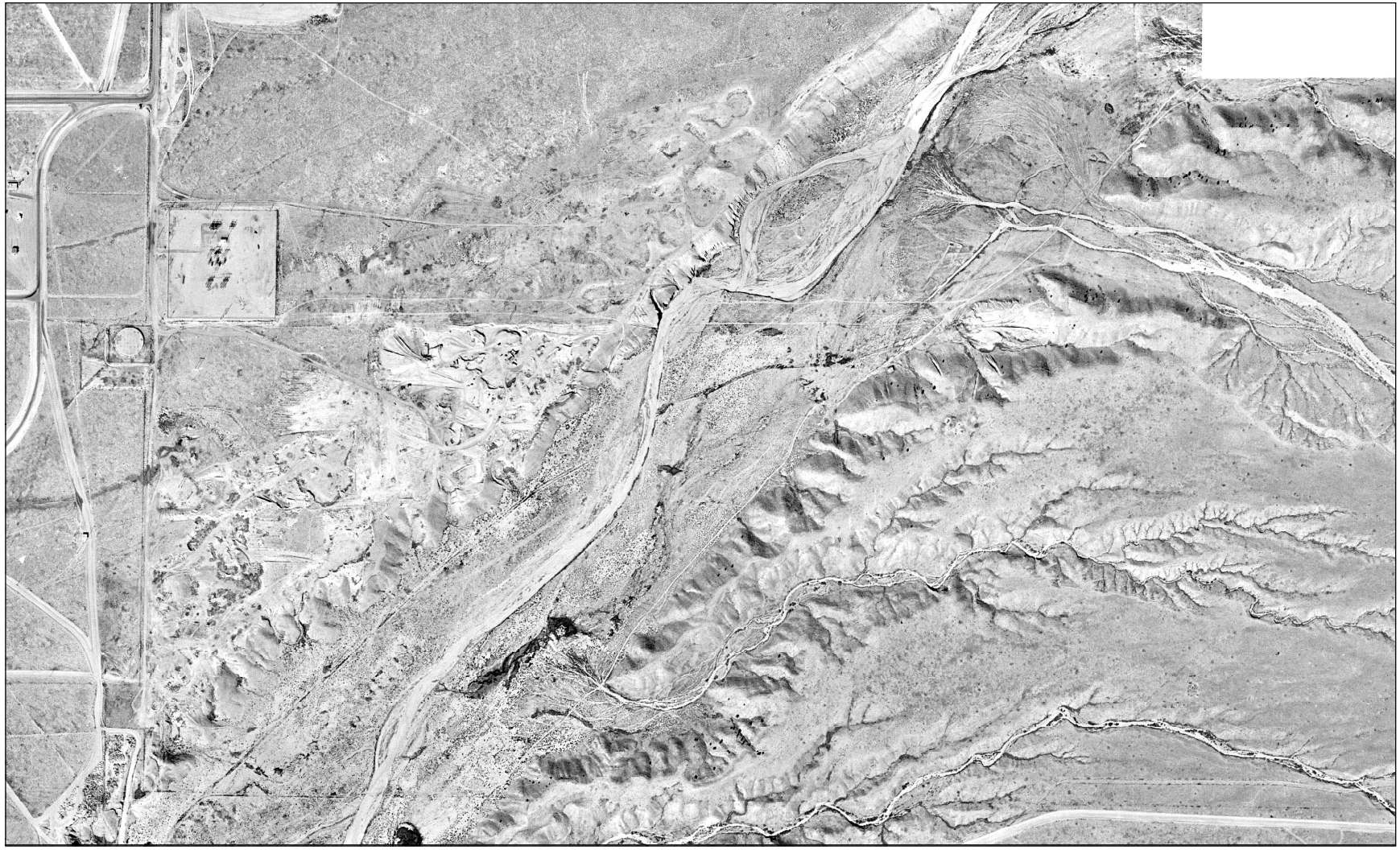
Sandia National Laboratories, New Mexico
Environmental Geographic Information System

0 87.5 175 350
Meters

0 0.075 0.15 0.3
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19189 08/23/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 7 1959 Aerial Photo

Appendix H

0 87.5 175 350
Meters

0 0.075 0.15 0.3
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19190 08/23/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 7 1982 Aerial Photo

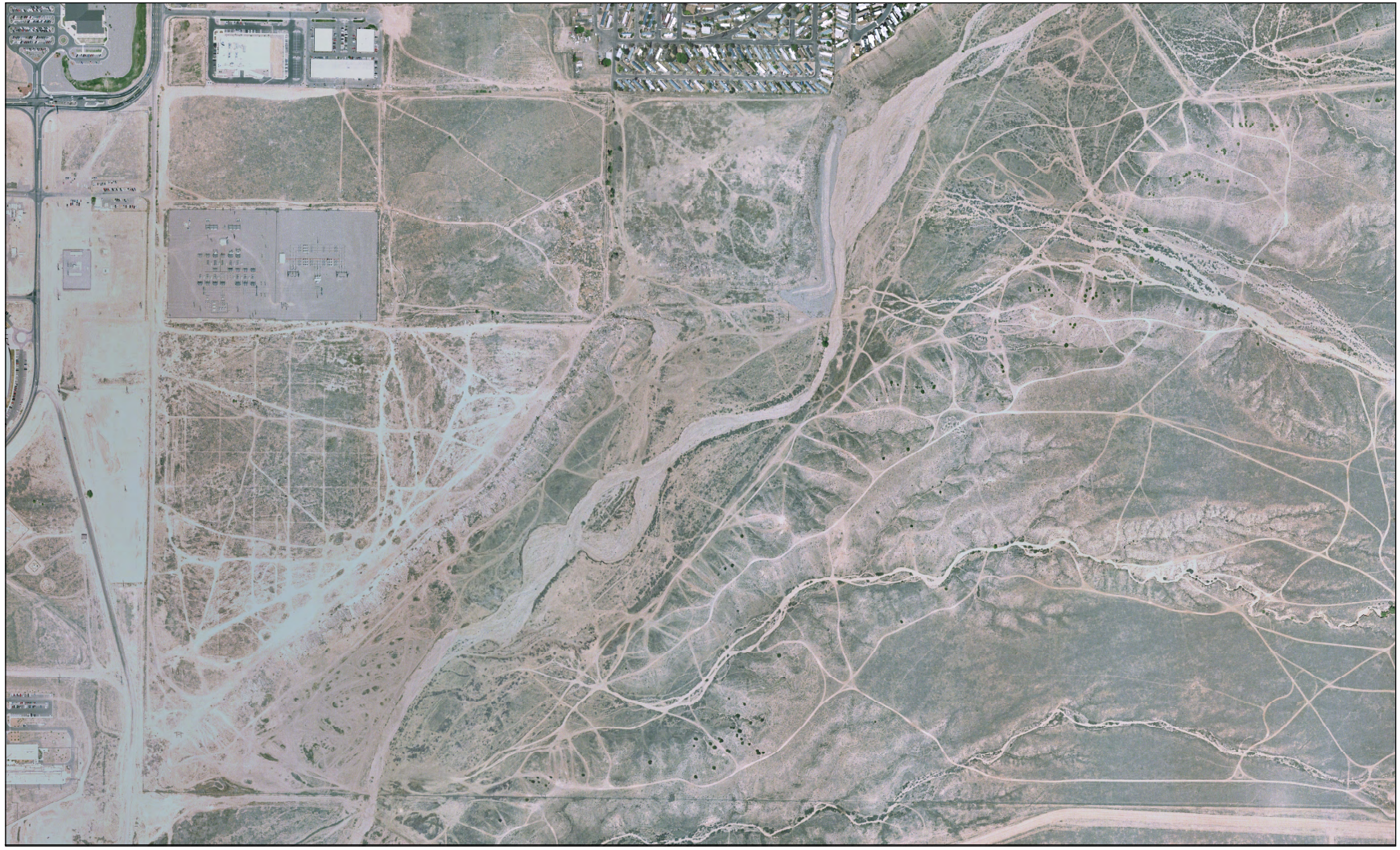
Appendix H

0 87.5 175 350
Meters

0 0.075 0.15 0.3
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19191 08/23/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 7 2002 Aerial Photo

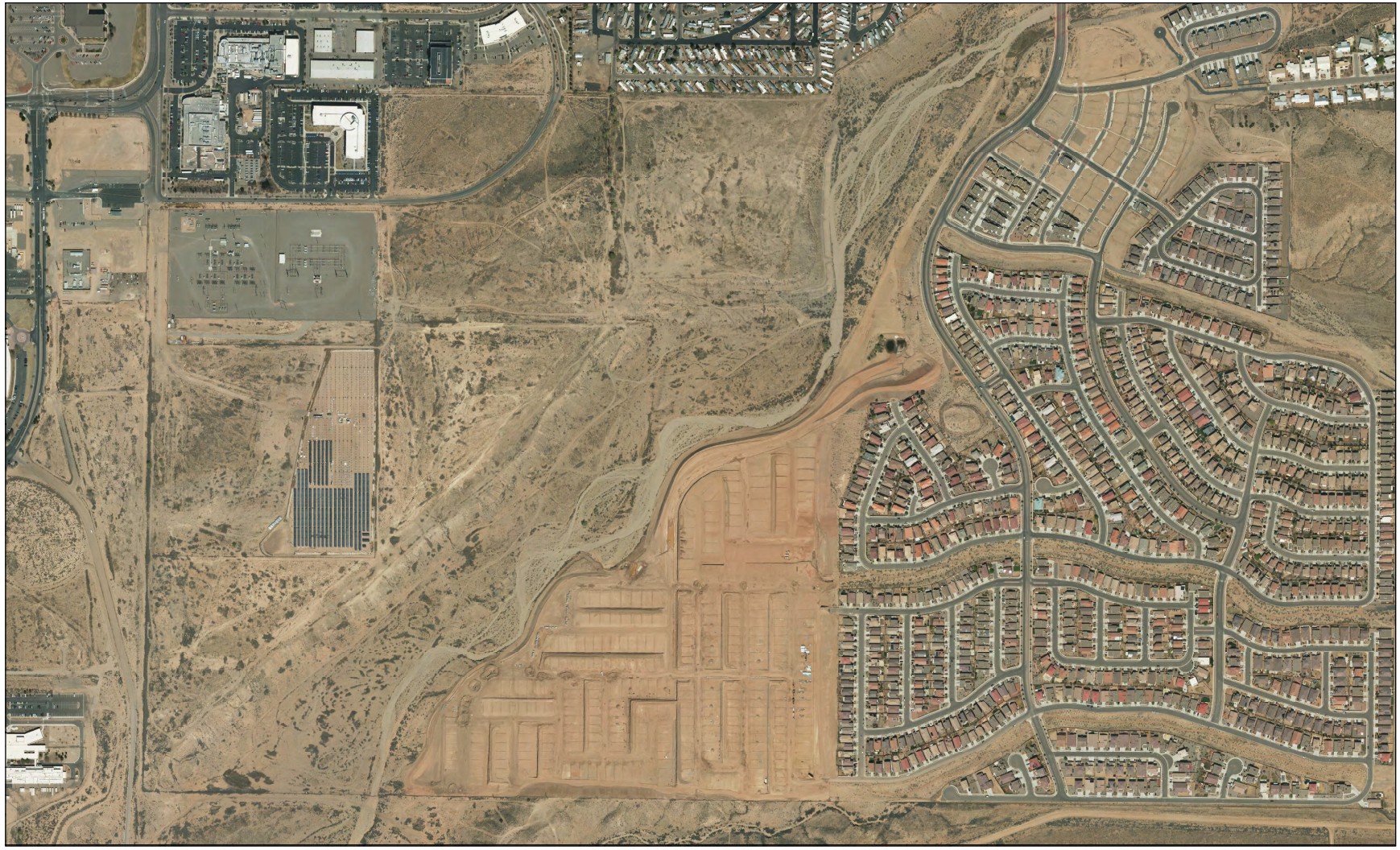
Appendix H

0 87.5 175 350
Meters

0 0.075 0.15 0.3
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19192 08/23/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 7 2018 Aerial Photo

Appendix H

0 87.5 175 350
Meters

0 0.075 0.15 0.3
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

N

EGIS

Appendix H-8

Mapid = sc19183 08/23/19 SNL EGIS ORG. 0643



Reach 8 1951 Aerial Photo

Appendix H

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

0 75 150 300
Meters

0 0.05 0.1 0.2
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

N

EGIS

Mapid = sc19184 08/23/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 8 1982 Aerial Photo

Appendix H

0 75 150 300
Meters

0 0.05 0.1 0.2
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

N

EGIS

Mapid = sc19185 08/23/19 SNL EGIS ORG. 0643



Reach 8 2002 Aerial Photo

Appendix H

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

0 75 150 300
Meters

0 0.05 0.1 0.2
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19186 08/23/19 SNL EGIS ORG. 0643



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Reach 8 2018 Aerial Photo

Appendix H

0 75 150 300
Meters

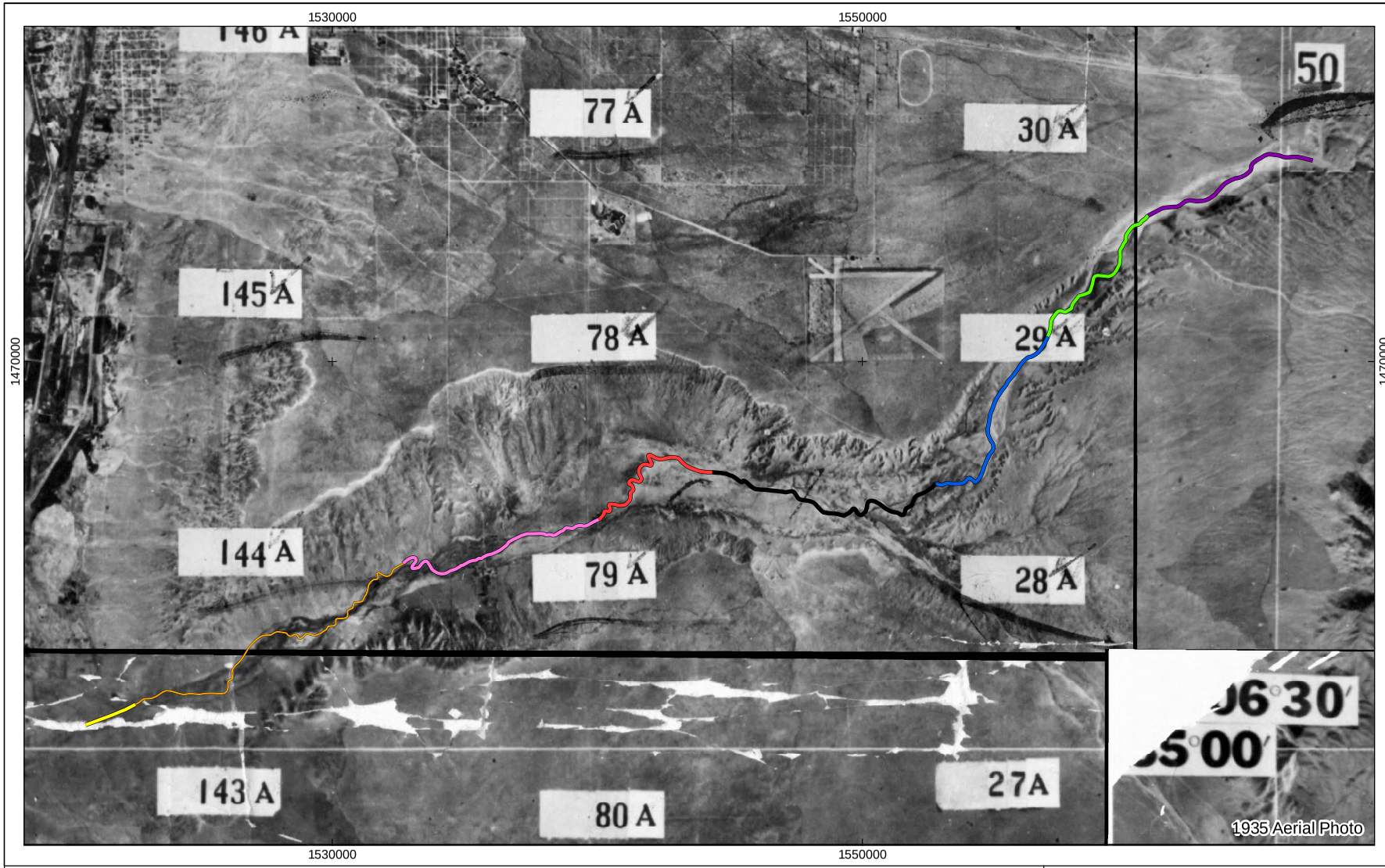
0 0.05 0.1 0.2
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Appendix H-9

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Mapid = sc19245 08/27/19 SNL EGIS ORG. 0643



Legend

- Reach 1
- Reach 2
- Reach 3
- Reach 4
- Reach 5
- Reach 6
- Reach 7
- Reach 8

Hydrology Protocol Survey 1935 Aerial with 2018 Sinuosity

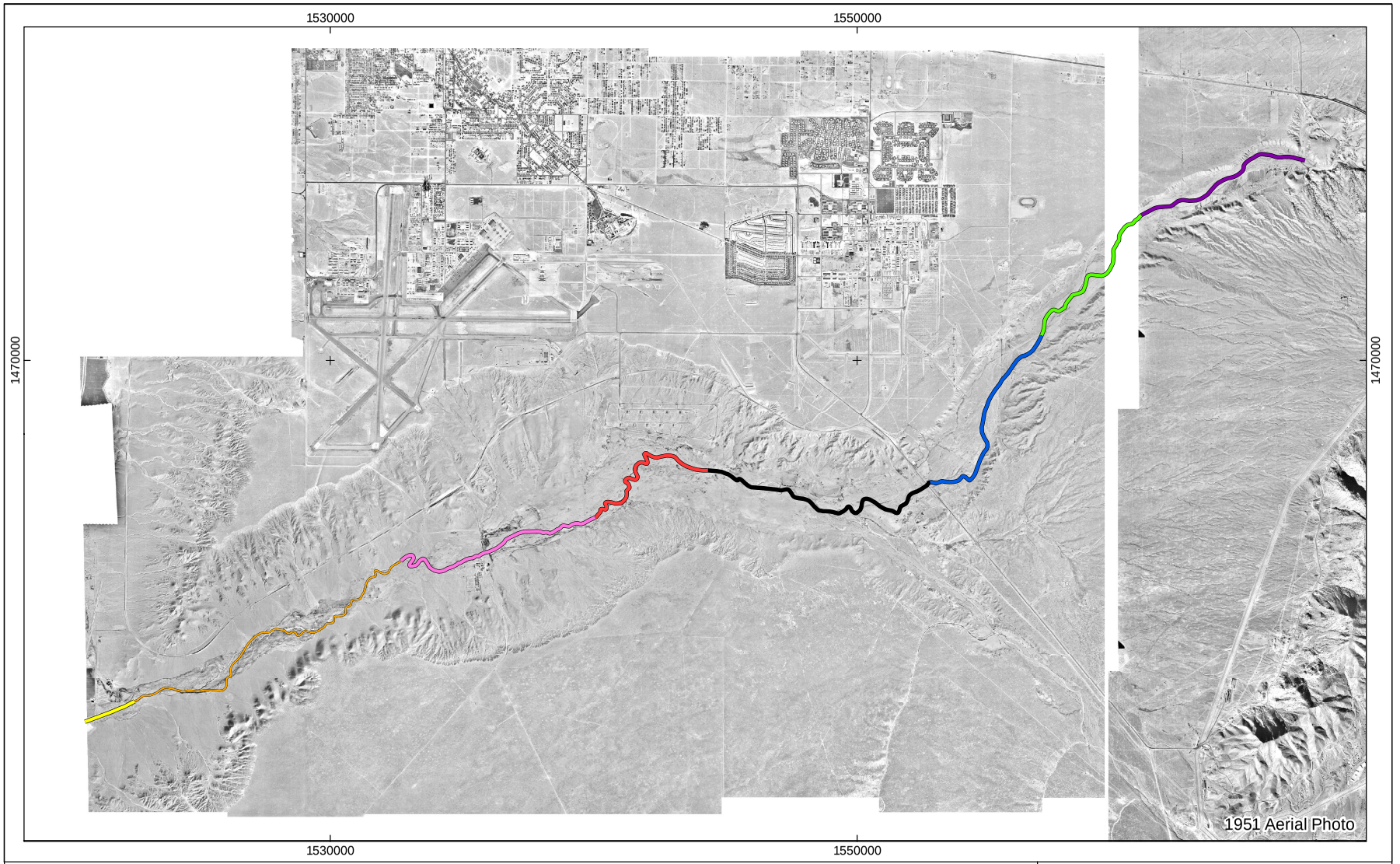
Sandia National Laboratories, New Mexico
Environmental Geographic Information System

0 625 1,250 2,500
Meters

0 0.5 1 2
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19246 08/27/19 SNL EGIS ORG. 0643



Legend

- Reach 1
- Reach 2
- Reach 3
- Reach 4
- Reach 5
- Reach 6
- Reach 7
- Reach 8

Hydrology Protocol Survey 1951 Aerial with 2018 Sinuosity

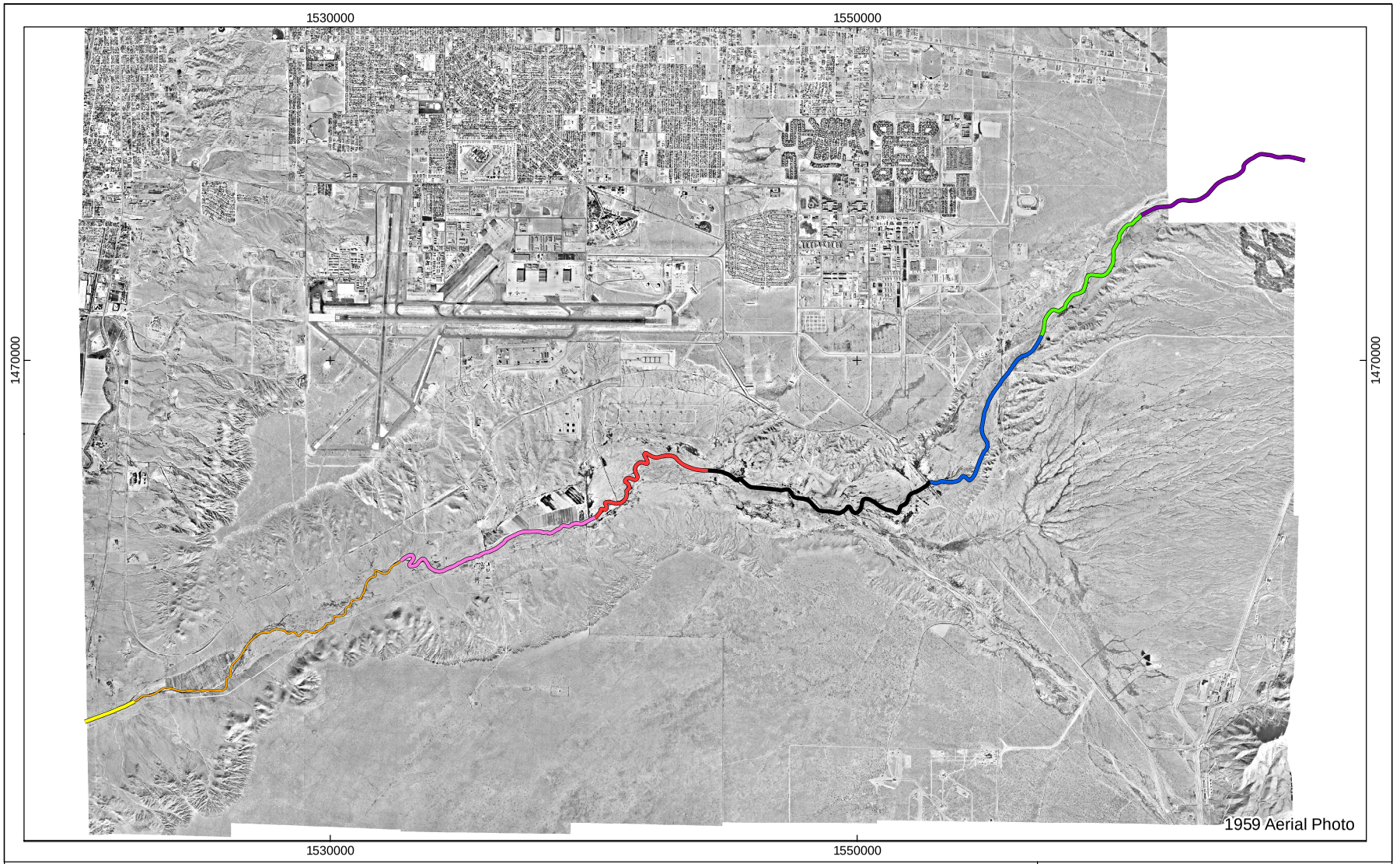
Sandia National Laboratories, New Mexico
Environmental Geographic Information System

0 625 1,250 2,500
Meters

0 0.5 1 2
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19247 08/27/19 SNL EGIS ORG. 0643



Legend

- Reach 1
- Reach 2
- Reach 3
- Reach 4
- Reach 5
- Reach 6
- Reach 7
- Reach 8

Hydrology Protocol Survey 1959 Aerial with 2018 Sinuosity

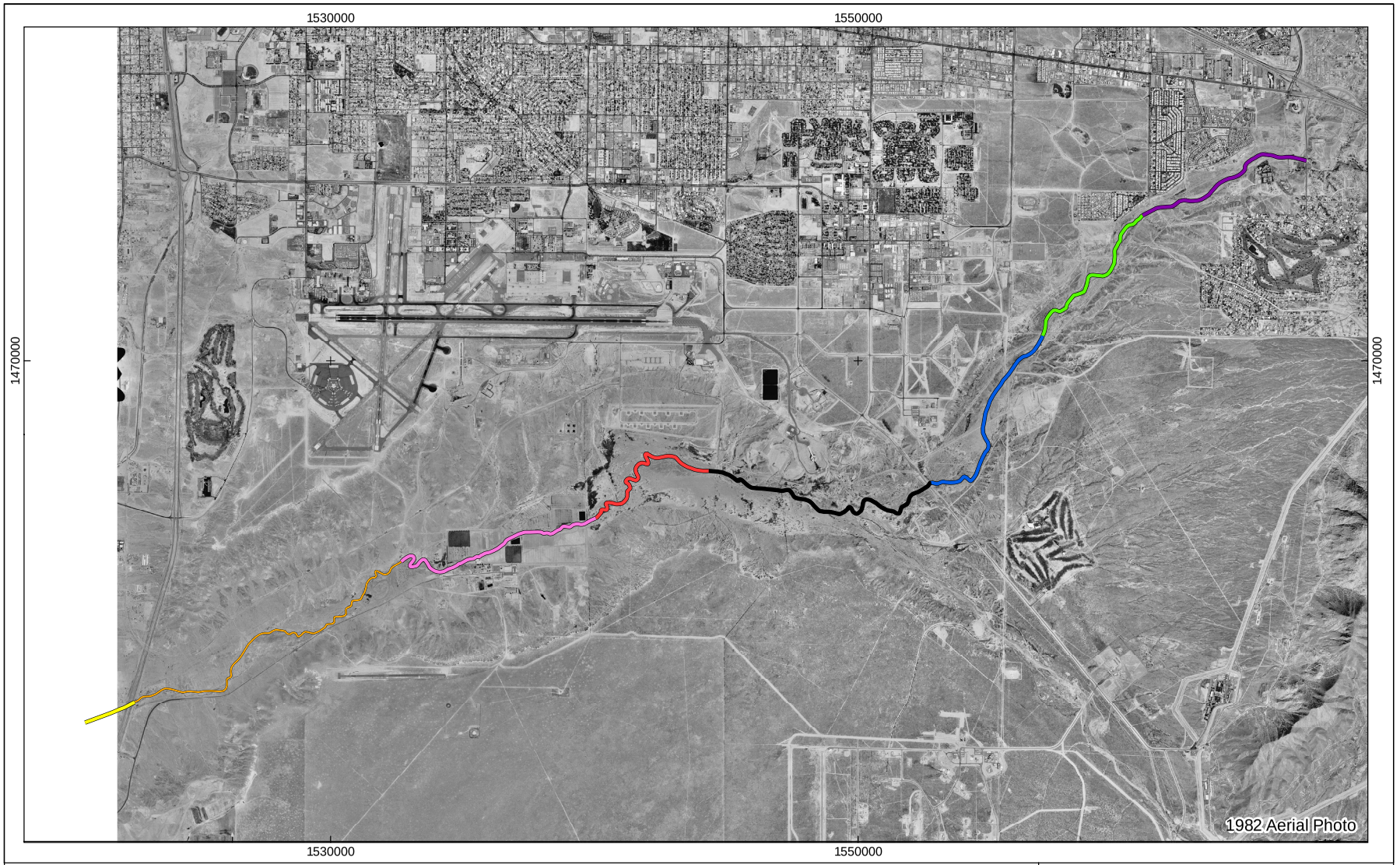
Sandia National Laboratories, New Mexico
Environmental Geographic Information System

0 625 1,250 2,500
Meters

0 0.5 1 2
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19248 08/27/19 SNL EGIS ORG. 0643



Legend

- Reach 1
- Reach 2
- Reach 3
- Reach 4
- Reach 5
- Reach 6
- Reach 7
- Reach 8

Hydrology Protocol Survey 1982 Aerial with 2018 Sinuosity

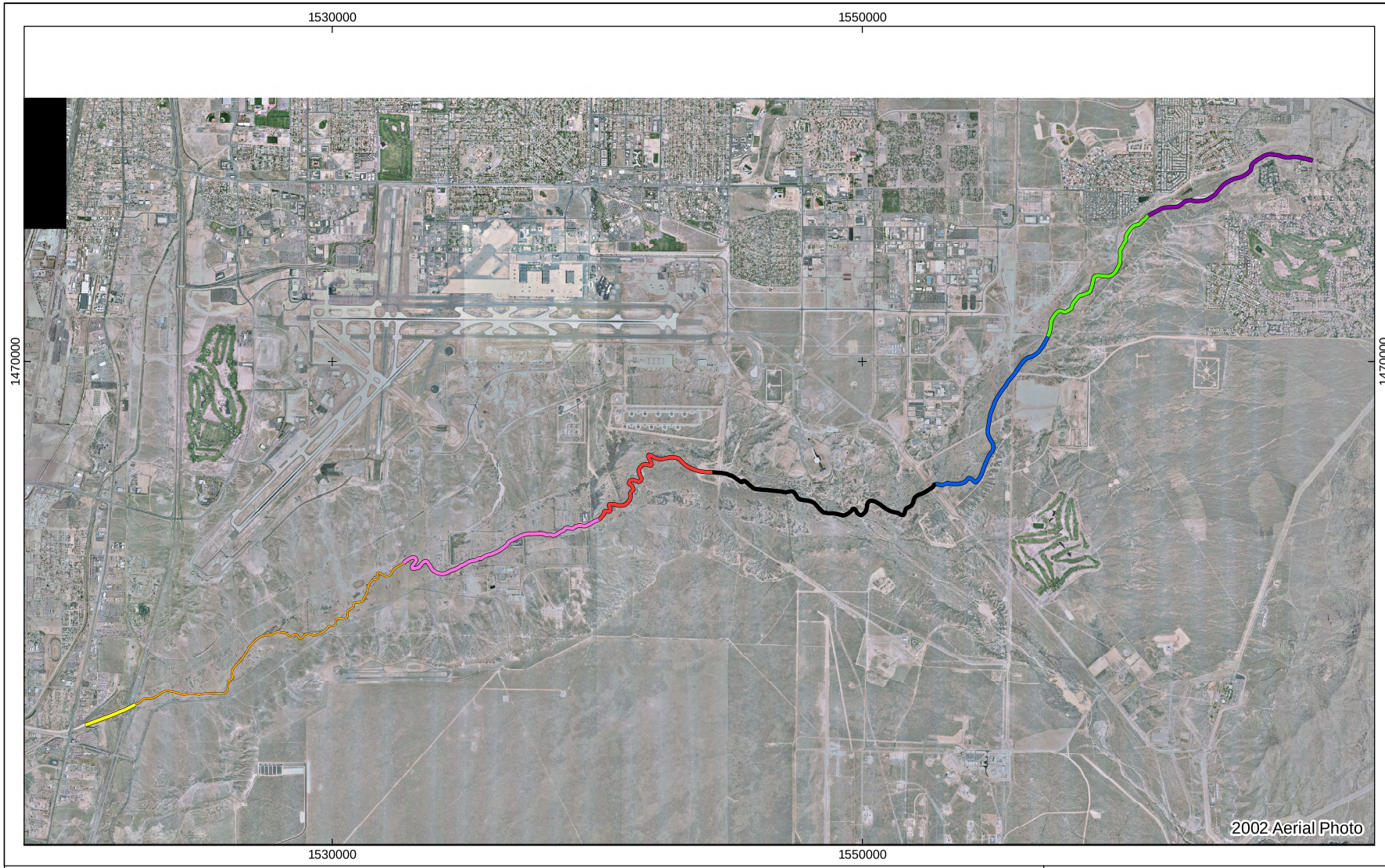
Sandia National Laboratories, New Mexico
Environmental Geographic Information System

0 625 1,250 2,500
Meters

0 0.5 1 2
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19249 08/27/19 SNL EGIS ORG. 0643



Legend

- Reach 1
- Reach 2
- Reach 3
- Reach 4
- Reach 5
- Reach 6
- Reach 7
- Reach 8

Hydrology Protocol Survey 2002 Aerial with 2018 Sinuosity

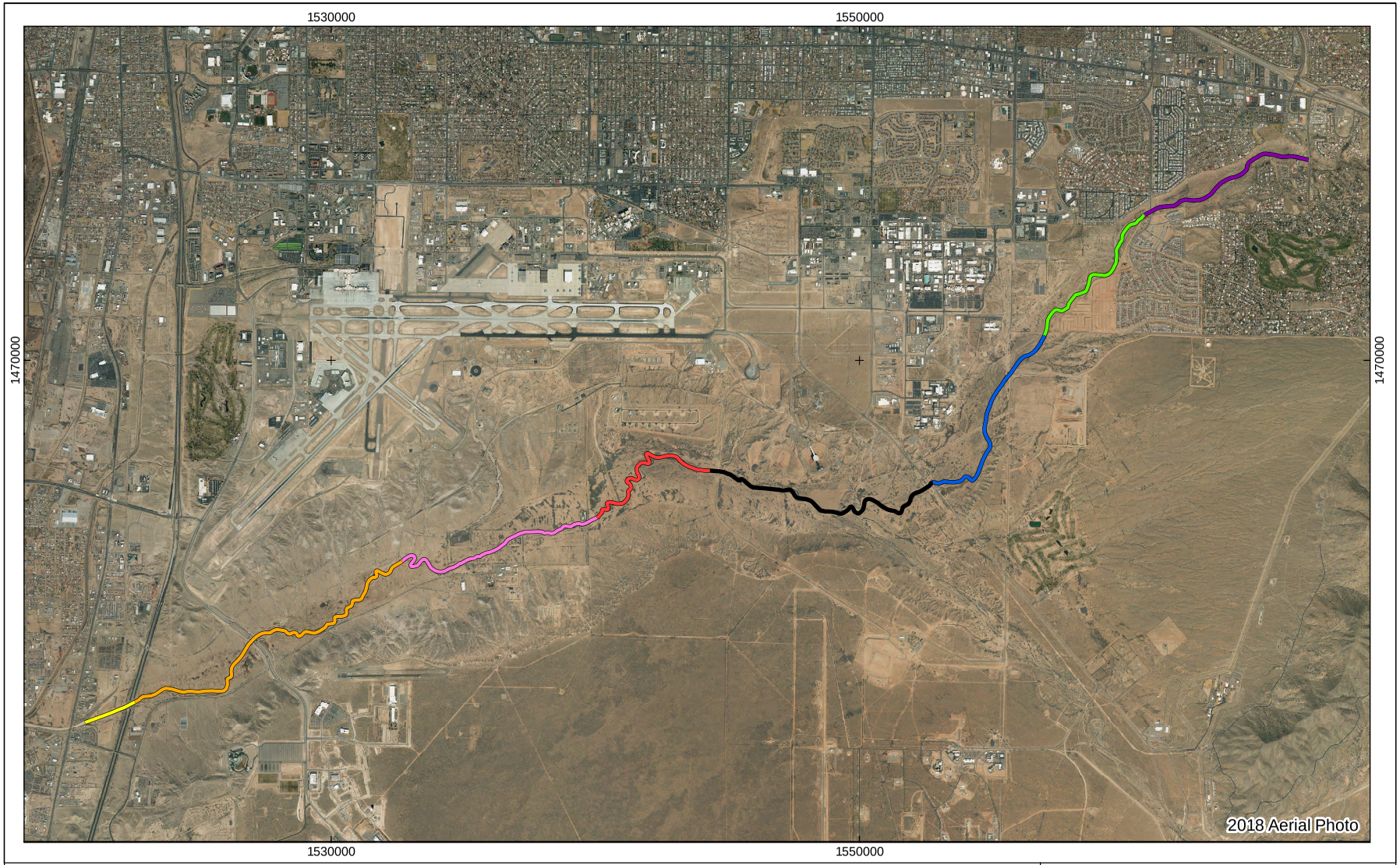
Sandia National Laboratories, New Mexico
Environmental Geographic Information System

0 625 1,250 2,500
Meters

0 0.5 1 2
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19250 08/27/19 SNL EGIS ORG. 0643



Legend

- Reach 1
- Reach 2
- Reach 3
- Reach 4
- Reach 5
- Reach 6
- Reach 7
- Reach 8

Hydrology Protocol Survey 2018 Aerial with 2018 Sinuosity

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

0 625 1,250 2,500
Meters

0 0.5 1 2
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Appendix I – Hydrology Protocol Score Sheets

No.	Description
I-1	Cover Sheet for Full Reach
I-2	HP Score Sheet for Sub-Reach 2
I-3	HP Score Sheet for Sub-Reach 3
I-4	HP Score Sheet for Sub-Reach 4
I-5	HP Score Sheet for Sub-Reach 5
I-6	HP Score Sheet for Sub-Reach 6
I-7	HP Score Sheet for Sub-Reach 7
I-8	HP Score Sheet for Sub-Reach 8

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Appendix I-1

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Cover Sheet
Hydrology Protocol Use Attainability Analysis for an Ephemeral Stream[1]

Stream Name:	Basin:	8-digit HUC:
TIJERAS ARROYO	Rio Grande - ABQ	13020203
Reach Description:	**Upstream lat/long:**	**Downstream lat/long:**
Rio Grande to Four Hills Bridge	35.06 / -106.50	35.00 / -106.65
Current WQS		**Assessment Unit ID:**
☒ Unclassified 20.6.4.98 or 99 NMAC ☐ Classified 20.6.4. ____ NMAC		NM9000.A_070

Reach Evaluation (How homogeneity of reach hydrology was verified)	
Methods Used:	(ex. aerial photos, "ground truthing", Google™ Earth, etc.) Aerial photos + ground truthing
Reasoning:	Why is the stream homogeneous? Similar vegetation & channel structure

Hydrology Protocol Results		**Notes**
Location 1 (lat/long):	☒ eph ☐ int ☐ per	
Location 2 (lat/long):	☒ eph ☐ int ☐ per	
Location 3 (lat/long):	☒ eph ☐ int ☐ per	
☒ Additional location results attached. Total of 8 sub-reaches (7 scored)		

Hydroclimatic Conditions		**If "yes" please describe.**
Drought (SPI Value < -1.5)	☐ yes ☒ no	SPI = 0.65
Recent Rainfall (within 48 hours)	☐ yes ☒ no	
Gauge data available?	☒ yes ☐ no	USGS TIJERAS ARROYO
If yes for any of above, please explain why these conditions do not impact the UAA conclusion that *natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use:*		

Hydrologic and Other Modifications		**If "yes" please describe.**
Dam/diversion	☐ yes ☒ no	
Channelization/roads	☒ yes ☐ no	road crossings, channel stabilization
Groundwater pumping	☒ yes ☐ no	pumping from regional aquifer ~ 500' bgs.
Agricultural return flows	☐ yes ☒ no	
Existing point source discharge	☐ yes ☒ no	
Planned point source discharge	☐ yes ☒ no	

[1] This form is designed for the UAA process for ephemeral waters described in Subsection C of 20.6.4.15 NMAC.

Hydrologic and Other Modifications		If "yes" please describe.
Other modifications e.g., land use practices	☒ yes ☐ no	*Please explain hydrologic impact* urbanization, landfills
If yes for any of above, please explain why these modifications do not alter the uses supported by the natural flow regime: does not alter ephemeral conditions (SEE REPORT)		

Current Uses Observed		If "yes" please describe.
Macroinvertebrates	☐ yes ☒ no	a single larval casing was observed. No other signs of macroinvertebrates
Fish	☐ yes ☒ no	
Recreation (contact use)	☐ yes ☒ no	
If yes for any of the above, please explain why these observed uses are consistent with the UAA conclusion that 101(a)(2) aquatic life and recreational uses are not feasible: SEE REPORT		

Additional Comments:

ATTACHMENTS:

- ☒ Map and Photos (required)
- ☒ Hydrology Protocol Field Sheets for all locations (required)
- ☐ Level 2 Analysis (optional)
- ☒ Additional sites and/or documentation (optional)

CONCLUSION:

This UAA concludes that the stream reach identified above is ephemeral and that Clean Water Act Section 101(a)(2) aquatic life and recreational uses are neither existing nor attainable due to the factor identified in 40 CFR 131.10(g)(2): *natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent.* Based on this conclusion, we recommend that the designated uses and criteria identified in 20.6.4.97 NMAC be applied to this stream reach in accordance with the UAA process set forth in Subsection C of 20.6.4.15 NMAC.

Submitted by:

Signed: John G Date: 10/7/19

Surface Water Quality Bureau concurs with recommendation. ☐ Yes ☐ No

If no, see attached reasons.

Signed: _____ Date: _____

EPA Region 6 technical approval granted. ☐ Yes ☐ No

If no, see attached reasons.

Signed: _____ Date: _____

Appendix I-2

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NMED Surface Water Quality Bureau – LEVEL 1 Hydrology Determination Field Sheet

Date: 6/28/19	**Stream Name:** TIJERAS ARROYO	**Latitude:** 35.004212
Evaluator(s): J. Kay, J. Payne	**Site ID:** Sub-reach 2	**Longitude:** -106.643507
TOTAL POINTS: 5.5 *Stream is at least intermittent if ≥ 12*	**Assessment Unit:** NM9000.A_070	**Drought Index (12-mo. SPI Value):** 0.65

	NOW:	PAST 48 HOURS:	Has there been a heavy rain in the last 48 hours?
WEATHER CONDITIONS	___ storm (heavy rain) ___ rain (steady rain) ___ showers (intermittent) ___ %cloud cover X clear/sunny	___ storm (heavy rain) ___ rain (steady rain) ___ showers (intermittent) ___ %cloud cover X clear/sunny	___ YES X NO **Field evaluations should be performed at least 48 hours after the last known major rainfall event.

OTHER:
Stream Modifications X YES ___ NO
Diversions ___ YES X NO
Discharges X YES ___ NO
**Explain in further detail in NOTES section

LEVEL 1 INDICATORS	STREAM CONDITION			
	Strong	**Moderate**	**Weak**	**Poor**
1.1. Water in Channel	Flow is evident throughout the reach. Moving water is seen in riffle areas but may not be as evident throughout the runs.	Water is present in the channel but flow is barely discernable in areas of greatest gradient change (i.e. riffles) or floating object is necessary to observe flow.	Dry channel with standing pools. There is some evidence of base flows (i.e. riparian vegetation growing along channel, saturated or moist sediment under rocks, etc)	Dry channel. No evidence of base flows was found.
	6	4	2	(0)
1.2. Fish	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Fish are not present.
	3	2	1	(0)
1.3. Benthic Macroinvertebrates	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Macroinvertebrates are not present.
	3	2	1	(0)
1.4. Filamentous Algae/Periphyton	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Filamentous algae and/or periphyton are not present.
	3	2	1	(0)
1.5. Differences in Vegetation	Dramatic compositional differences in vegetation are present between the stream banks and the adjacent uplands. A distict riparian vegetation corridor exists along the entire reach – riparian, aquatic, or wetland species dominate the length of the reach.	A distinct riparian vegetation corridor exists along part of the reach. Riparian vegetation is interspersed with upland vegetation along the length of the reach.	Vegetation growing along the reach may occur in greater densities or grow more vigorously than vegetation in the adjacent uplands, but there are no dramatic compositional differences between the two.	No compositional or density differences in vegetation are present between the streambanks and the adjacent uplands.
	3	2	(1)	0
1.6. Absence of Rooted Upland Plants in Streambed	Rooted upland plants are absent within the streambed/thalweg.	There are a few rooted upland plants present within the streambed/thalweg.	Rooted upland plants are consistently dispersed throughout the streambed/thalweg	Rooted upland plants are prevalent within the streambed/thalweg.
	3	2	(1)	0
			SUBTOTAL (#1.1 – #1.6)	2.0

If the stream being evaluated has a subtotal ≤ 2 at this juncture, the stream is determined to be EPHEMERAL.
If the stream being evaluated has a subtotal ≥ 18 at this point, the stream is determined to be PERENNIAL.
YOU MAY STOP THE EVALUATION AT THIS POINT. If the stream has a subtotal between 2 and 18 continue the Level 1 Evaluation.

LEVEL 1 INDICATORS	STREAM CONDITION			
	Strong	Moderate	Weak	Poor
1.7. Sinuosity	**Ratio > 1.4.** Stream has numerous, closely-spaced bends, few straight sections.	**Ratio < 1.4.** Stream has good sinuosity with some straight sections.	**Ratio < 1.2.** Stream has very few bends and mostly straight sections.	**Ratio = 1.0.** Stream is completely straight with no bends.
	3	2	(1)	0
1.8. Floodplain and Channel Dimensions	**Ratio > 2.5.** Stream is minimally confined with a wide, active floodplain.	**Ratio between 1.2 and 2.5.** Stream is moderately confined. Floodplain is present, but may only be active during larger floods.	**Ratio < 1.2.** Stream is incised with a noticeably confined channel. Floodplain is narrow or absent and typically disconnected from the channel.	
	3	(1.5)	0	
1.9. In-Channel Structure: Riffle-Pool Sequence	Demonstrated by a frequent number of riffles followed by pools along the entire reach. There is an obvious transition between riffles and pools.	Represented by a less frequent number of riffles and pools. Distinguishing the transition between riffles and pools is difficult.	Stream shows some flow but mostly has areas of pools or of riffles.	There is no sequence exhibited.
	3	2	1	(0)
			SUBTOTAL (#1.1 – #1.9)	4.5

If the stream being evaluated has a subtotal ≤ 5 at this juncture, the stream is determined to be EPHEMERAL.
If the stream being evaluated has a subtotal ≥ 21 at this point, the stream is determined to be PERENNIAL.
YOU MAY STOP THE EVALUATION AT THIS POINT. If the stream has a subtotal between 5 and 21 continue the Level 1 Evaluation.

1.10. Particle Size or Stream Substrate Sorting	Particle sizes in the channel are noticeably different from particle sizes in areas close to but not in the channel. There is a clear distribution of various sized substrates in the stream channel with finer particles accumulating in the pools, and larger particles accumulating in the riffles/runs.	Particle sizes in the channel are moderately similar to particle sizes in areas close to but not in the channel. Various sized substrates are present in the stream channel and are represented by a higher ratio of larger particles (gravel/cobble).	Particle sizes in the channel are similar or comparable to particle sizes in areas close to but not in the channel. Substrate sorting is not readily observed in the stream channel.
	3	1.5	(0)
1.11. Hydric Soils	Hydric soils are found within the study reach.		Hydric soils are <u>not</u> found within the study reach.
	Present = 3		**Absent = 0**
1.12. Sediment on Plants and Debris	Sediment found readily on plants and debris within the stream channel, on the streambank, and within the floodplain throughout the length of the stream.	Sediment found on plants or debris within the stream channel although it is not prevalent along the stream. Mostly accumulating in pools.	Sediment is isolated in small amounts along the stream.	No sediment is present on plants or debris.
	1.5	(1)	0.5	0
			TOTAL POINTS (#1.1 – #1.12)	5.5

SUPPLEMENTAL INDICATORS: **The following indicators do not occur consistently throughout New Mexico but may be useful in the determination of perenniality. <u>If the indicator is present</u> record score below and tally with previous score to compute TOTAL.**		
1.13. Seeps and Springs	Seeps and springs are found within the study reach.	Seeps and springs are <u>not</u> found within the study reach.
	Present = 1.5	**Absent = (0)**
1.14. Iron Oxidizing Bacteria/Fungi	Iron-oxidizing bacteria and/or fungi are found within the study reach.	Iron-oxidizing bacteria and/or fungi are <u>not</u> found within the study reach.
	Present = 1.5	**Absent = (0)**
		TOTAL *plus* SUPPLEMENTAL POINTS (#1.1 – #1.14) 5.5

NMED Surface Water Quality Bureau – LEVEL 1 Hydrology Determination Field Sheet

Photo Descriptions and NOTES

Photo #	Description (US, DS, LB, RB, etc.)	Notes
	SEE APPENDIX K OF UAA.	

NOTES:

STREAM MODIFICATIONS: SEE UAA Section 3.10 & FIGURE 15

DISCHARGES: SEE UAA Section 3.9 & FIGURE 12

LEVEL 1 Field Measurements

Pebble Count Tally Sheet

Site Name: Sub-reach 2 **Storet ID:** _____

Date: 6/28/19 **Crew:** J. Ga, M. Baca

Substrate Type	Diameter Range	In-Channel COUNT	In-Channel % Composition	Out of Channel COUNT	Out of Channel % Composition
Silt/Clay	< 0.06 mm	17	17	28	56
Sand	0.06 – 2.0 mm (gritty)	62	62	18	36
Gravel	2.0 – 64 mm	21	21	4	8
Cobble	64 – 256	0	0	0	0
Boulder	> 256 mm	0	0	0	0
Bedrock	---	0	0	0	0

****Please be sure to measure at least 50 pebbles (10 in 5 transects or 5 in 10 transects-depending on stream size) for accurate distributional representation****

INDICATOR #1.8 (*Floodplain and Channel Dimensions*) – MEASUREMENTS & CALCULATIONS**							
Max Depth (#1)	**Bankfull Stage (#2)**	**Maximum Depth Value (#3)**	**2x Maximum Depth Value (#3)**	**Flood-Prone Area Location (#4)**	**Flood-Prone Area Width (#5)**	**Bankfull Width (#6)**	**Floodplain to Active Channel Ratio** (FPA Width / Bankfull Width)
5019.12'	5019.96	0.84'	1.68'	5020.8	102.35'	77.92'	1.31

****REFER to Figure 3 on page 19 for clarification**

Appendix I-3

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NMED Surface Water Quality Bureau – LEVEL 1 Hydrology Determination Field Sheet

Date: 6/28/19	**Stream Name:** TIJERAS ARROYO	**Latitude:** 35.018701
Evaluator(s): J. Kay, J. Payne	**Site ID:** Sub-Reach 3	**Longitude:** -106.610395
TOTAL POINTS: 5.5 *Stream is at least intermittent if ≥ 12*	**Assessment Unit:** NM-9000.A_70	**Drought Index (12-mo. SPI Value):** 0.65

	NOW:	PAST 48 HOURS:	Has there been a heavy rain in the last 48 hours?
WEATHER CONDITIONS	___ storm (heavy rain) ___ rain (steady rain) ___ showers (intermittent) ___ %cloud cover X clear/sunny	___ storm (heavy rain) ___ rain (steady rain) ___ showers (intermittent) ___ %cloud cover X clear/sunny	___ YES X NO **Field evaluations should be performed at least 48 hours after the last known major rainfall event.

OTHER:
Stream Modifications X YES ___ NO
Diversions ___ YES X NO
Discharges X YES ___ NO
**Explain in further detail in NOTES section

LEVEL 1 INDICATORS	STREAM CONDITION			
	Strong	**Moderate**	**Weak**	**Poor**
1.1. Water in Channel	Flow is evident throughout the reach. Moving water is seen in riffle areas but may not be as evident throughout the runs.	Water is present in the channel but flow is barely discernable in areas of greatest gradient change (i.e. riffles) or floating object is necessary to observe flow.	Dry channel with standing pools. There is some evidence of base flows (i.e. riparian vegetation growing along channel, saturated or moist sediment under rocks, etc)	Dry channel. No evidence of base flows was found.
	6	4	2	(0)
1.2. Fish	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Fish are not present.
	3	2	1	(0)
1.3. Benthic Macroinvertebrates	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Macroinvertebrates are not present.
	3	2	1	(0)
1.4. Filamentous Algae/Periphyton	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Filamentous algae and/or periphyton are not present.
	3	2	1	(0)
1.5. Differences in Vegetation	Dramatic compositional differences in vegetation are present between the stream banks and the adjacent uplands. A distict riparian vegetation corridor exists along the entire reach – riparian, aquatic, or wetland species dominate the length of the reach.	A distinct riparian vegetation corridor exists along part of the reach. Riparian vegetation is interspersed with upland vegetation along the length of the reach.	Vegetation growing along the reach may occur in greater densities or grow more vigorously than vegetation in the adjacent uplands, but there are no dramatic compositional differences between the two.	No compositional or density differences in vegetation are present between the streambanks and the adjacent uplands.
	3	2	(1)	0
1.6. Absence of Rooted Upland Plants in Streambed	Rooted upland plants are absent within the streambed/thalweg.	There are a few rooted upland plants present within the streambed/thalweg.	Rooted upland plants are consistently dispersed throughout the streambed/thalweg	Rooted upland plants are prevalent within the streambed/thalweg.
	3	2	(1)	0
			SUBTOTAL (#1.1 – #1.6)	2.0

If the stream being evaluated has a subtotal ≤ 2 at this juncture, the stream is determined to be EPHEMERAL.
If the stream being evaluated has a subtotal ≥ 18 at this point, the stream is determined to be PERENNIAL.
YOU MAY STOP THE EVALUATION AT THIS POINT. If the stream has a subtotal between 2 and 18 continue the Level 1 Evaluation.

LEVEL 1 INDICATORS	STREAM CONDITION			
	Strong	Moderate	Weak	Poor
1.7. Sinuosity	**Ratio > 1.4.** Stream has numerous, closely-spaced bends, few straight sections.	**Ratio < 1.4.** Stream has good sinuosity with some straight sections.	**Ratio < 1.2.** Stream has very few bends and mostly straight sections.	**Ratio = 1.0.** Stream is completely straight with no bends.
	3	2	(1.5) 1	0
1.8. Floodplain and Channel Dimensions	**Ratio > 2.5.** Stream is minimally confined with a wide, active floodplain.	**Ratio between 1.2 and 2.5.** Stream is moderately confined. Floodplain is present, but may only be active during larger floods.	**Ratio < 1.2.** Stream is incised with a noticeably confined channel. Floodplain is narrow or absent and typically disconnected from the channel.	
	3	1.5	(1.0)	0
1.9. In-Channel Structure: Riffle-Pool Sequence	Demonstrated by a frequent number of riffles followed by pools along the entire reach. There is an obvious transition between riffles and pools.	Represented by a less frequent number of riffles and pools. Distinguishing the transition between riffles and pools is difficult.	Stream shows some flow but mostly has areas of pools or of riffles.	There is no sequence exhibited.
	3	2	1	(0)
				SUBTOTAL (#1.1 – #1.9) 4.5

If the stream being evaluated has a subtotal ≤ 5 at this juncture, the stream is determined to be EPHEMERAL.
If the stream being evaluated has a subtotal ≥ 21 at this point, the stream is determined to be PERENNIAL.
YOU MAY STOP THE EVALUATION AT THIS POINT. If the stream has a subtotal between 5 and 21 continue the Level 1 Evaluation.

1.10. Particle Size or Stream Substrate Sorting	Particle sizes in the channel are noticeably different from particle sizes in areas close to but not in the channel. There is a clear distribution of various sized substrates in the stream channel with finer particles accumulating in the pools, and larger particles accumulating in the riffles/runs.	Particle sizes in the channel are moderately similar to particle sizes in areas close to but not in the channel. Various sized substrates are present in the stream channel and are represented by a higher ratio of larger particles (gravel/cobble).	Particle sizes in the channel are similar or comparable to particle sizes in areas close to but not in the channel. Substrate sorting is not readily observed in the stream channel.
	3	1.5	(0)

1.11. Hydric Soils	Hydric soils are found within the study reach.	Hydric soils are not found within the study reach.
	Present = 3	**Absent = (0)**

1.12. Sediment on Plants and Debris	Sediment found readily on plants and debris within the stream channel, on the streambank, and within the floodplain throughout the length of the stream.	Sediment found on plants or debris within the stream channel although it is not prevalent along the stream. Mostly accumulating in pools.	Sediment is isolated in small amounts along the stream.	No sediment is present on plants or debris.
	1.5	(1)	0.5	0
				TOTAL POINTS (#1.1 – #1.12) 5.5

SUPPLEMENTAL INDICATORS: **The following indicators do not occur consistently throughout New Mexico but may be useful in the determination of perenniality. If the indicator is present record score below and tally with previous score to compute TOTAL.**

1.13. Seeps and Springs	Seeps and springs are found within the study reach.	Seeps and springs are not found within the study reach.
	Present = 1.5	**Absent = (0)**
1.14. Iron Oxidizing Bacteria/Fungi	Iron-oxidizing bacteria and/or fungi are found within the study reach.	Iron-oxidizing bacteria and/or fungi are not found within the study reach.
	Present = 1.5	**Absent = (0)**
		TOTAL *plus* SUPPLEMENTAL POINTS (#1.1 – #1.14) 5.5

NMED Surface Water Quality Bureau – LEVEL 1 Hydrology Determination Field Sheet

Photo Descriptions and NOTES

Photo #	Description (US, DS, LB, RB, etc.)	Notes
	SEE APPENDIX IC OF	UAA

NOTES:

STREAM MODIFICATIONS: SEE UAA Section 3.10 & FIGURE 15
DISCHARGES: SEE UAA SECTION 3.9 & FIGURE 12

LEVEL 1 Field Measurements

Pebble Count Tally Sheet

Site Name: Sub-reach 3 **Storet ID:** _____

Date: 6/28/19 **Crew:** J. Kg, M. Baca

Substrate Type	Diameter Range	In-Channel COUNT	In-Channel % Composition	Out of Channel COUNT	Out of Channel % Composition
Silt/Clay	< 0.06 mm	20	20	29	58
Sand	0.06 – 2.0 mm (gritty)	53	53	19	38
Gravel	2.0 – 64 mm	27	27	2	4
Cobble	64 – 256	0	0	0	0
Boulder	> 256 mm	0	0	0	0
Bedrock	---	0	0	0	0

****Please be sure to measure at least 50 pebbles (10 in 5 transects or 5 in 10 transects- depending on stream size) for accurate distributional representation****

INDICATOR #1.8 (*Floodplain and Channel Dimensions*) – MEASUREMENTS & CALCULATIONS**							
Max Depth (#1)	**Bankfull Stage (#2)**	**Maximum Depth Value (#3)**	**2x Maximum Depth Value (#3)**	**Flood-Prone Area Location (#4)**	**Flood-Prone Area Width (#5)**	**Bankfull Width (#6)**	**Floodplain to Active Channel Ratio** (FPA Width / Bankfull Width)
5094.84	5096.5	1.66'	3.32'	5098.16'	59.35'	38.24	1.55

****REFER to Figure 3 on page 19 for clarification**

Appendix I-4

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NMED Surface Water Quality Bureau – LEVEL 1 Hydrology Determination Field Sheet

Date: 6/19/19	**Stream Name:** TIJERAS ARROYO	**Latitude:** 35.023110
Evaluator(s):	**Site ID:** Sub-reach 4	**Longitude:** -106.586189
TOTAL POINTS: 8.0 *Stream is at least intermittent if ≥ 12*	**Assessment Unit:** NM-9000.A-70	**Drought Index (12-mo. SPI Value):** 0.65

	NOW:	**PAST 48 HOURS:**	**Has there been a heavy rain in the last 48 hours?**
WEATHER CONDITIONS	___ storm (heavy rain) ___ rain (steady rain) ___ showers (intermittent) ___ %cloud cover X clear/sunny	___ storm (heavy rain) ___ rain (steady rain) ___ showers (intermittent) ___ %cloud cover X clear/sunny	___ YES X NO **Field evaluations should be performed at least 48 hours after the last known major rainfall event.

OTHER:
Stream Modifications X YES ___ NO
Diversions ___ YES X NO
Discharges X YES ___ NO
**Explain in further detail in NOTES section

LEVEL 1 INDICATORS	STREAM CONDITION			
	Strong	**Moderate**	**Weak**	**Poor**
1.1. Water in Channel	Flow is evident throughout the reach. Moving water is seen in riffle areas but may not be as evident throughout the runs.	Water is present in the channel but flow is barely discernable in areas of greatest gradient change (i.e. riffles) or floating object is necessary to observe flow.	Dry channel with standing pools. There is some evidence of base flows (i.e. riparian vegetation growing along channel, saturated or moist sediment under rocks, etc)	Dry channel. No evidence of base flows was found.
	6	4	2	(0)
1.2. Fish	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Fish are not present.
	3	2	1	(0)
1.3. Benthic Macroinvertebrates	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Macroinvertebrates are not present.
	3	2	1	(0)
1.4. Filamentous Algae/Periphyton	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Filamentous algae and/or periphyton are not present.
	3	2	1	(0)
1.5. Differences in Vegetation	Dramatic compositional differences in vegetation are present between the stream banks and the adjacent uplands. A distict riparian vegetation corridor exists along the entire reach – riparian, aquatic, or wetland species dominate the length of the reach.	A distinct riparian vegetation corridor exists along part of the reach. Riparian vegetation is interspersed with upland vegetation along the length of the reach.	Vegetation growing along the reach may occur in greater densities or grow more vigorously than vegetation in the adjacent uplands, but there are no dramatic compositional differences between the two.	No compositional or density differences in vegetation are present between the streambanks and the adjacent uplands.
	3	2	(1)	0
1.6. Absence of Rooted Upland Plants in Streambed	Rooted upland plants are absent within the streambed/thalweg.	There are a few rooted upland plants present within the streambed/thalweg.	Rooted upland plants are consistently dispersed throughout the streambed/thalweg	Rooted upland plants are prevalent within the streambed/thalweg.
	3	2	(1)	0
			SUBTOTAL (#1.1 – #1.6)	2.0

If the stream being evaluated has a subtotal ≤ 2 at this juncture, the stream is determined to be EPHEMERAL.
If the stream being evaluated has a subtotal ≥ 18 at this point, the stream is determined to be PERENNIAL.
YOU MAY STOP THE EVALUATION AT THIS POINT. If the stream has a subtotal between 2 and 18 continue the Level 1 Evaluation.

LEVEL 1 INDICATORS	STREAM CONDITION			
	Strong	Moderate	Weak	Poor
1.7. Sinuosity	**Ratio > 1.4.** Stream has numerous, closely-spaced bends, few straight sections.	**Ratio < 1.4.** Stream has good sinuosity with some straight sections.	**Ratio < 1.2.** Stream has very few bends and mostly straight sections.	**Ratio = 1.0.** Stream is completely straight with no bends.
	3	(2)	1	0
1.8. Floodplain and Channel Dimensions	**Ratio > 2.5.** Stream is minimally confined with a wide, active floodplain.	**Ratio between 1.2 and 2.5.** Stream is moderately confined. Floodplain is present, but may only be active during larger floods.	**Ratio < 1.2.** Stream is incised with a noticeably confined channel. Floodplain is narrow or absent and typically disconnected from the channel.	
	3	(1.5)	0	
1.9. In-Channel Structure: Riffle-Pool Sequence	Demonstrated by a frequent number of riffles followed by pools along the entire reach. There is an obvious transition between riffles and pools.	Represented by a less frequent number of riffles and pools. Distinguishing the transition between riffles and pools is difficult.	Stream shows some flow but mostly has areas of pools or of riffles.	There is no sequence exhibited.
	3	2	1	(0)
			SUBTOTAL (#1.1 – #1.9)	5.5

If the stream being evaluated has a subtotal ≤ 5 at this juncture, the stream is determined to be EPHEMERAL.
If the stream being evaluated has a subtotal ≥ 21 at this point, the stream is determined to be PERENNIAL.
YOU MAY STOP THE EVALUATION AT THIS POINT. If the stream has a subtotal between 5 and 21 continue the Level 1 Evaluation.

1.10. Particle Size or Stream Substrate Sorting	Particle sizes in the channel are noticeably different from particle sizes in areas close to but not in the channel. There is a clear distribution of various sized substrates in the stream channel with finer particles accumulating in the pools, and larger particles accumulating in the riffles/runs.	Particle sizes in the channel are moderately similar to particle sizes in areas close to but not in the channel. Various sized substrates are present in the stream channel and are represented by a higher ratio of larger particles (gravel/cobble).	Particle sizes in the channel are similar or comparable to particle sizes in areas close to but not in the channel. Substrate sorting is not readily observed in the stream channel.
	3	(1.5)	0

1.11. Hydric Soils	Hydric soils are found within the study reach.	Hydric soils are <u>not</u> found within the study reach.
	Present = 3	**Absent = 0**

1.12. Sediment on Plants and Debris	Sediment found readily on plants and debris within the stream channel, on the streambank, and within the floodplain throughout the length of the stream.	Sediment found on plants or debris within the stream channel although it is not prevalent along the stream. Mostly accumulating in pools.	Sediment is isolated in small amounts along the stream.	No sediment is present on plants or debris.
	1.5	(1)	0.5	0
			TOTAL POINTS (#1.1 – #1.12)	8.0

SUPPLEMENTAL INDICATORS: **The following indicators do not occur consistently throughout New Mexico but may be useful in the determination of perenniality. <u>If the indicator is present</u> record score below and tally with previous score to compute TOTAL.**

1.13. Seeps and Springs	Seeps and springs are found within the study reach.	Seeps and springs are <u>not</u> found within the study reach.
	Present = 1.5	**Absent = (0)**
1.14. Iron Oxidizing Bacteria/Fungi	Iron-oxidizing bacteria and/or fungi are found within the study reach.	Iron-oxidizing bacteria and/or fungi are <u>not</u> found within the study reach.
	Present = 1.5	**Absent = (0)**
		TOTAL *plus* SUPPLEMENTAL POINTS (#1.1 – #1.14) 8.0

NMED Surface Water Quality Bureau – LEVEL 1 Hydrology Determination Field Sheet

Photo Descriptions and NOTES

Photo #	Description (US, DS, LB, RB, etc.)	Notes
	SEE APPENDIX K OF UAA	

NOTES:

STREAM MODIFICATIONS: SEE UAA SECTION 3.10 & FIGURE 15
DISCHARGES: SEE UAA SECTION 3.9 & FIGURE 12

LEVEL 1 Field Measurements

Pebble Count Tally Sheet

Site Name: Sub-reach 4 **Storet ID:** _____

Date: 6/19/19 **Crew:** J. Kay, M. Baca

Substrate Type	Diameter Range	In-Channel COUNT	In-Channel % Composition	Out of Channel COUNT	Out of Channel % Composition
Silt/Clay	< 0.06 mm	11	11	34	68
Sand	0.06 – 2.0 mm (gritty)	44	44	6	12
Gravel	2.0 – 64 mm	43	43	10	20
Cobble	64 – 256	2	2	0	0
Boulder	> 256 mm	0	0	0	0
Bedrock	---	0	0	0	0

****Please be sure to measure at least 50 pebbles (10 in 5 transects or 5 in 10 transects- depending on stream size) for accurate distributional representation****

INDICATOR #1.8 (*Floodplain and Channel Dimensions*) – MEASUREMENTS & CALCULATIONS**							
Max Depth (#1)	**Bankfull Stage (#2)**	**Maximum Depth Value (#3)**	**2x Maximum Depth Value (#3)**	**Flood-Prone Area Location (#4)**	**Flood-Prone Area Width (#5)**	**Bankfull Width (#6)**	**Floodplain to Active Channel Ratio** (FPA Width / Bankfull Width)
5163.305'	5164.53'	1.23'	2.46'	5165.76'	44.52'	21.43'	2.08

****REFER to Figure 3 on page 19 for clarification**

Appendix I-5

A printed copy of this document may not be the official version. The official printed copy of this UAA is located in the office of the Environmental Compliance and monitoring (Org. 0641).

NMED Surface Water Quality Bureau – LEVEL 1 Hydrology Determination Field Sheet

Date: 6/17/19	**Stream Name:** Tijeras Arroyo	**Latitude:** 35.028409
Evaluator(s): J. Kay, E. Fahey	**Site ID:** Sub-reach 5	**Longitude:** -106.569670
TOTAL POINTS: 6.0 *Stream is at least intermittent if ≥ 12*	**Assessment Unit:** NM9000.A-70	**Drought Index (12-mo. SPI Value):** 0.65

	NOW:	PAST 48 HOURS:	Has there been a heavy rain in the last 48 hours?
WEATHER CONDITIONS	___ storm (heavy rain) ___ rain (steady rain) ___ showers (intermittent) ___ %cloud cover X clear/sunny	___ storm (heavy rain) ___ rain (steady rain) ___ showers (intermittent) ___ %cloud cover X clear/sunny	___ YES ___ NO **Field evaluations should be performed at least 48 hours after the last known major rainfall event. **OTHER:** **Stream Modifications** X YES ___ NO **Diversions** ___ YES X NO **Discharges** X YES ___ NO **Explain in further detail in NOTES section

LEVEL 1 INDICATORS	STREAM CONDITION			
	Strong	**Moderate**	**Weak**	**Poor**
1.1. Water in Channel	Flow is evident throughout the reach. Moving water is seen in riffle areas but may not be as evident throughout the runs.	Water is present in the channel but flow is barely discernable in areas of greatest gradient change (i.e. riffles) or floating object is necessary to observe flow.	Dry channel with standing pools. There is some evidence of base flows (i.e. riparian vegetation growing along channel, saturated or moist sediment under rocks, etc)	Dry channel. No evidence of base flows was found.
	6	4	2	(0)
1.2. Fish	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Fish are not present.
	3	2	1	(0)
1.3. Benthic Macroinvertebrates	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Macroinvertebrates are not present.
	3	2	1	(0)
1.4. Filamentous Algae/Periphyton	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Filamentous algae and/or periphyton are not present.
	3	2	1	(0)
1.5. Differences in Vegetation	Dramatic compositional differences in vegetation are present between the stream banks and the adjacent uplands. A distict riparian vegetation corridor exists along the entire reach – riparian, aquatic, or wetland species dominate the length of the reach.	A distinct riparian vegetation corridor exists along part of the reach. Riparian vegetation is interspersed with upland vegetation along the length of the reach.	Vegetation growing along the reach may occur in greater densities or grow more vigorously than vegetation in the adjacent uplands, but there are no dramatic compositional differences between the two.	No compositional or density differences in vegetation are present between the streambanks and the adjacent uplands.
	3	2	(1)	0
1.6. Absence of Rooted Upland Plants in Streambed	Rooted upland plants are absent within the streambed/thalweg.	There are a few rooted upland plants present within the streambed/thalweg.	Rooted upland plants are consistently dispersed throughout the streambed/thalweg	Rooted upland plants are prevalent within the streambed/thalweg.
	3	2	(1)	0
			SUBTOTAL (#1.1 – #1.6)	2.0

If the stream being evaluated has a subtotal ≤ 2 at this juncture, the stream is determined to be EPHEMERAL.
If the stream being evaluated has a subtotal ≥ 18 at this point, the stream is determined to be PERENNIAL.
YOU MAY STOP THE EVALUATION AT THIS POINT. If the stream has a subtotal between 2 and 18 continue the Level 1 Evaluation.

LEVEL 1 INDICATORS	STREAM CONDITION			
	Strong	**Moderate**	**Weak**	**Poor**
1.7. Sinuosity	**Ratio > 1.4.** Stream has numerous, closely-spaced bends, few straight sections.	**Ratio < 1.4.** Stream has good sinuosity with some straight sections.	**Ratio < 1.2.** Stream has very few bends and mostly straight sections.	**Ratio = 1.0.** Stream is completely straight with no bends.
	3	2	(1)	0
1.8. Floodplain and Channel Dimensions	**Ratio > 2.5.** Stream is minimally confined with a wide, active floodplain.	**Ratio between 1.2 and 2.5.** Stream is moderately confined. Floodplain is present, but may only be active during larger floods.	**Ratio < 1.2.** Stream is incised with a noticeably confined channel. Floodplain is narrow or absent and typically disconnected from the channel.	
	3	1.5	(1.0)	0
1.9. In-Channel Structure: Riffle-Pool Sequence	Demonstrated by a frequent number of riffles followed by pools along the entire reach. There is an obvious transition between riffles and pools.	Represented by a less frequent number of riffles and pools. Distinguishing the transition between riffles and pools is difficult.	Stream shows some flow but mostly has areas of pools or of riffles.	There is no sequence exhibited.
	3	2	1	(0)
			SUBTOTAL (#1.1 – #1.9)	4.0

If the stream being evaluated has a subtotal ≤ 5 at this juncture, the stream is determined to be EPHEMERAL.
If the stream being evaluated has a subtotal ≥ 21 at this point, the stream is determined to be PERENNIAL.
YOU MAY STOP THE EVALUATION AT THIS POINT. If the stream has a subtotal between 5 and 21 continue the Level 1 Evaluation.

1.10. Particle Size or Stream Substrate Sorting	Particle sizes in the channel are noticeably different from particle sizes in areas close to but not in the channel. There is a clear distribution of various sized substrates in the stream channel with finer particles accumulating in the pools, and larger particles accumulating in the riffles/runs.	Particle sizes in the channel are moderately similar to particle sizes in areas close to but not in the channel. Various sized substrates are present in the stream channel and are represented by a higher ratio of larger particles (gravel/cobble).	Particle sizes in the channel are similar or comparable to particle sizes in areas close to but not in the channel. Substrate sorting is not readily observed in the stream channel.	
	3	1.5	(1.0)	0
1.11. Hydric Soils	Hydric soils are found within the study reach.		Hydric soils are not found within the study reach.	
	Present = 3		**Absent = (0)**	
1.12. Sediment on Plants and Debris	Sediment found readily on plants and debris within the stream channel, on the streambank, and within the floodplain throughout the length of the stream.	Sediment found on plants or debris within the stream channel although it is not prevalent along the stream. Mostly accumulating in pools.	Sediment is isolated in small amounts along the stream.	No sediment is present on plants or debris.
	1.5	(1)	0.5	0
			TOTAL POINTS (#1.1 – #1.12)	6.0

SUPPLEMENTAL INDICATORS: **The following indicators do not occur consistently throughout New Mexico but may be useful in the determination of perenniality. If the indicator is present record score below and tally with previous score to compute TOTAL.**

1.13. Seeps and Springs	Seeps and springs are found within the study reach.	Seeps and springs are not found within the study reach.
	Present = 1.5	**Absent = (0)**
1.14. Iron Oxidizing Bacteria/Fungi	Iron-oxidizing bacteria and/or fungi are found within the study reach.	Iron-oxidizing bacteria and/or fungi are not found within the study reach.
	Present = 1.5	**Absent = (0)**
	TOTAL *plus* SUPPLEMENTAL POINTS (#1.1 – #1.14)	6.0

NMED Surface Water Quality Bureau – LEVEL 1 Hydrology Determination Field Sheet

Photo Descriptions and NOTES

Photo #	Description (US, DS, LB, RB, etc.)	Notes
	SEE APPENDIX K IN UAA	

NOTES:

STORM MODIFICATIONS: SEE UAA SECTION 3.1 & FIGURE 15

DISCHARGES: SEE UAA SECTION 3.9 & FIGURE 12

LEVEL 1 Field Measurements

Pebble Count Tally Sheet

Site Name: Sub-reach 5 **Storet ID:**

Date: 6/17/19 **Crew:** J. Kay, M. Baca

Substrate Type	Diameter Range	In-Channel COUNT	In-Channel % Composition	Out of Channel COUNT	Out of Channel % Composition
Silt/Clay	< 0.06 mm	13	13	25	50
Sand	0.06 – 2.0 mm (gritty)	18	18	8	16
Gravel	2.0 – 64 mm	69	69	17	34
Cobble	64 – 256	0	0	0	0
Boulder	> 256 mm	0	0	0	0
Bedrock	---	0	0	0	0

****Please be sure to measure at least 50 pebbles (10 in 5 transects or 5 in 10 transects- depending on stream size) for accurate distributional representation****

INDICATOR #1.8 (*Floodplain and Channel Dimensions*) – MEASUREMENTS & CALCULATIONS**							
Max Depth (#1)	**Bankfull Stage (#2)**	**Maximum Depth Value (#3)**	**2x Maximum Depth Value (#3)**	**Flood-Prone Area Location (#4)**	**Flood-Prone Area Width (#5)**	**Bankfull Width (#6)**	**Floodplain to Active Channel Ratio** (FPA Width / Bankfull Width)
5211.48	5212.48	1.00	2.00	5213.48	57.15	41.79	1.37

****REFER to Figure 3 on page 19 for clarification**

Appendix I-6

A printed copy of this document may not be the official version. The official printed copy of this UAA is located in the office of the Environmental Compliance and monitoring (Org. 0641).

NMED Surface Water Quality Bureau – LEVEL 1 Hydrology Determination Field Sheet

Date: 6/18/19	**Stream Name:** TIJERAS ARROYO	**Latitude:** 35.027240
Evaluator(s): J. Kay, E. Fahey	**Site ID:** SUB-REACH 6	**Longitude:** -106.593028
TOTAL POINTS: 4.0 *Stream is at least intermittent if ≥ 12*	**Assessment Unit:** NM9000.A_070	**Drought Index (12-mo. SPI Value):** 0.65

WEATHER CONDITIONS	**NOW:**	**PAST 48 HOURS:**	**Has there been a heavy rain in the last 48 hours?**
	___ storm (heavy rain) ___ rain (steady rain) ___ showers (intermittent) ___ %cloud cover X clear/sunny	___ storm (heavy rain) ___ rain (steady rain) ___ showers (intermittent) ___ %cloud cover X clear/sunny	___ YES X NO **Field evaluations should be performed at least 48 hours after the last known major rainfall event. **OTHER:** **Stream Modifications** X YES ___ NO **Diversions** ___ YES X NO **Discharges** X YES ___ NO **Explain in further detail in NOTES section

LEVEL 1 INDICATORS	**STREAM CONDITION**			
	Strong	**Moderate**	**Weak**	**Poor**
1.1. Water in Channel	Flow is evident throughout the reach. Moving water is seen in riffle areas but may not be as evident throughout the runs.	Water is present in the channel but flow is barely discernable in areas of greatest gradient change (i.e. riffles) or floating object is necessary to observe flow.	Dry channel with standing pools. There is some evidence of base flows (i.e. riparian vegetation growing along channel, saturated or moist sediment under rocks, etc)	Dry channel. No evidence of base flows was found.
	6	4	2	(0)
1.2. Fish	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Fish are not present.
	3	2	1	(0)
1.3. Benthic Macroinvertebrates	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Macroinvertebrates are not present.
	3	2	1	(0)
1.4. Filamentous Algae/Periphyton	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Filamentous algae and/or periphyton are not present.
	3	2	1	(0)
1.5. Differences in Vegetation	Dramatic compositional differences in vegetation are present between the stream banks and the adjacent uplands. A distict riparian vegetation corridor exists along the entire reach – riparian, aquatic, or wetland species dominate the length of the reach.	A distinct riparian vegetation corridor exists along part of the reach. Riparian vegetation is interspersed with upland vegetation along the length of the reach.	Vegetation growing along the reach may occur in greater densities or grow more vigorously than vegetation in the adjacent uplands, but there are no dramatic compositional differences between the two.	No compositional or density differences in vegetation are present between the streambanks and the adjacent uplands.
	3	2	(1)	0
1.6. Absence of Rooted Upland Plants in Streambed	Rooted upland plants are absent within the streambed/thalweg.	There are a few rooted upland plants present within the streambed/thalweg.	Rooted upland plants are consistently dispersed throughout the streambed/thalweg	Rooted upland plants are prevalent within the streambed/thalweg.
	3	2	(1)	0
			SUBTOTAL (#1.1 – #1.6)	2.0

If the stream being evaluated has a subtotal ≤ 2 at this juncture, the stream is determined to be EPHEMERAL.
If the stream being evaluated has a subtotal ≥ 18 at this point, the stream is determined to be PERENNIAL.
YOU MAY STOP THE EVALUATION AT THIS POINT. If the stream has a subtotal between 2 and 18 continue the Level 1 Evaluation.

LEVEL 1 INDICATORS	STREAM CONDITION			
	Strong	Moderate	Weak	Poor
1.7. Sinuosity	**Ratio > 1.4.** Stream has numerous, closely-spaced bends, few straight sections.	**Ratio < 1.4.** Stream has good sinuosity with some straight sections.	**Ratio < 1.2.** Stream has very few bends and mostly straight sections.	**Ratio = 1.0.** Stream is completely straight with no bends.
	3	2	(1)	0
1.8. Floodplain and Channel Dimensions	**Ratio > 2.5.** Stream is minimally confined with a wide, active floodplain.	**Ratio between 1.2 and 2.5.** Stream is moderately confined. Floodplain is present, but may only be active during larger floods.	**Ratio < 1.2.** Stream is incised with a noticeably confined channel. Floodplain is narrow or absent and typically disconnected from the channel.	
	3	1.5	(0)	
1.9. In-Channel Structure: Riffle-Pool Sequence	Demonstrated by a frequent number of riffles followed by pools along the entire reach. There is an obvious transition between riffles and pools.	Represented by a less frequent number of riffles and pools. Distinguishing the transition between riffles and pools is difficult.	Stream shows some flow but mostly has areas of pools or of riffles.	There is no sequence exhibited.
	3	2	1	(0)
SUBTOTAL (#1.1 – #1.9)				3.0

If the stream being evaluated has a subtotal ≤ 5 at this juncture, the stream is determined to be EPHEMERAL.
If the stream being evaluated has a subtotal ≥ 21 at this point, the stream is determined to be PERENNIAL.
YOU MAY STOP THE EVALUATION AT THIS POINT. If the stream has a subtotal between 5 and 21 continue the Level 1 Evaluation.

1.10. Particle Size or Stream Substrate Sorting	Particle sizes in the channel are noticeably different from particle sizes in areas close to but not in the channel. There is a clear distribution of various sized substrates in the stream channel with finer particles accumulating in the pools, and larger particles accumulating in the riffles/runs.	Particle sizes in the channel are moderately similar to particle sizes in areas close to but not in the channel. Various sized substrates are present in the stream channel and are represented by a higher ratio of larger particles (gravel/cobble).	Particle sizes in the channel are similar or comparable to particle sizes in areas close to but not in the channel. Substrate sorting is not readily observed in the stream channel.
	3	1.5	(0)

1.11. Hydric Soils	Hydric soils are found within the study reach.	Hydric soils are not found within the study reach.
	Present = 3	**Absent = (0)**

1.12. Sediment on Plants and Debris	Sediment found readily on plants and debris within the stream channel, on the streambank, and within the floodplain throughout the length of the stream.	Sediment found on plants or debris within the stream channel although it is not prevalent along the stream. Mostly accumulating in pools.	Sediment is isolated in small amounts along the stream.	No sediment is present on plants or debris.
	1.5	(1)	0.5	0
TOTAL POINTS (#1.1 – #1.12)				4.0

SUPPLEMENTAL INDICATORS: **The following indicators do not occur consistently throughout New Mexico but may be useful in the determination of perenniality. If the indicator is present record score below and tally with previous score to compute TOTAL.**

1.13. Seeps and Springs	Seeps and springs are found within the study reach.	Seeps and springs are not found within the study reach.
	Present = 1.5	**Absent = (0)**
1.14. Iron Oxidizing Bacteria/Fungi	Iron-oxidizing bacteria and/or fungi are found within the study reach.	Iron-oxidizing bacteria and/or fungi are not found within the study reach.
	Present = 1.5	**Absent = (0)**
TOTAL *plus* SUPPLEMENTAL POINTS (#1.1 – #1.14)		4.0

NMED Surface Water Quality Bureau – LEVEL 1 Hydrology Determination Field Sheet

Photo Descriptions and NOTES

Photo #	Description (US, DS, LB, RB, etc.)	Notes
	SEE APPENDIX K in UAA	

NOTES:

STREAM MODIFICATIONS! SEE UAA SECTION 3.10 & FIGURE 15
DISCHARGES! SEE SECTION 3.9 & FIGURE 12

LEVEL 1 Field Measurements

Pebble Count Tally Sheet

Site Name: Sub-reach 6 **Storet ID:** _____

Date: 6/18/19 **Crew:** J. Kay, M. Baca

Substrate Type	Diameter Range	In-Channel COUNT	In-Channel % Composition	Out of Channel COUNT	Out of Channel % Composition
Silt/Clay	< 0.06 mm	20	20	16	32
Sand	0.06 – 2.0 mm (gritty)	19	19	9	18
Gravel	2.0 – 64 mm	61	61	25	50
Cobble	64 – 256	0	0	0	0
Boulder	> 256 mm	0	0	0	0
Bedrock	---	0	0	0	0

****Please be sure to measure at least 50 pebbles (10 in 5 transects or 5 in 10 transects- depending on stream size) for accurate distributional representation****

INDICATOR #1.8 (*Floodplain and Channel Dimensions*) – MEASUREMENTS & CALCULATIONS**							
Max Depth (#1)	**Bankfull Stage (#2)**	**Maximum Depth Value (#3)**	**2x Maximum Depth Value (#3)**	**Flood-Prone Area Location (#4)**	**Flood-Prone Area Width (#5)**	**Bankfull Width (#6)**	**Floodplain to Active Channel Ratio** (FPA Width / Bankfull Width)
5365.23'	5365.94	0.707	1.414	5366.65'	33.63	28.64	1.17

****REFER to Figure 3 on page 19 for clarification**

Appendix I-7

A printed copy of this document may not be the official version. The official printed copy of this UAA is located in the office of the Environmental Compliance and monitoring (Org. 0641).

NMED Surface Water Quality Bureau – LEVEL 1 Hydrology Determination Field Sheet

Date: 6/27/19	**Stream Name:** TIJERAS ARROYO	**Latitude:** 35.043115
Evaluator(s): J. Kay, E. Fahey	**Site ID:** Sub-reach 7	**Longitude:** -106.528549
TOTAL POINTS: 7.0 *Stream is at least intermittent if ≥ 12*	**Assessment Unit:** NM-9000.A_070	**Drought Index (12-mo. SPI Value):** 0.65

	NOW:	PAST 48 HOURS:	Has there been a heavy rain in the last 48 hours?
WEATHER CONDITIONS	___ storm (heavy rain) ___ rain (steady rain) ___ showers (intermittent) ___ %cloud cover X clear/sunny	___ storm (heavy rain) ___ rain (steady rain) ___ showers (intermittent) ___ %cloud cover X clear/sunny	___ YES X NO **Field evaluations should be performed at least 48 hours after the last known major rainfall event.

OTHER:
Stream Modifications X YES ___ NO
Diversions ___ YES X NO
Discharges X YES ___ NO
**Explain in further detail in NOTES section

LEVEL 1 INDICATORS	STREAM CONDITION			
	Strong	**Moderate**	**Weak**	**Poor**
1.1. Water in Channel	Flow is evident throughout the reach. Moving water is seen in riffle areas but may not be as evident throughout the runs.	Water is present in the channel but flow is barely discernable in areas of greatest gradient change (i.e. riffles) or floating object is necessary to observe flow.	Dry channel with standing pools. There is some evidence of base flows (i.e. riparian vegetation growing along channel, saturated or moist sediment under rocks, etc)	Dry channel. No evidence of base flows was found.
	6	4	2	(0)
1.2. Fish	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Fish are not present.
	3	2	1	(0)
1.3. Benthic Macroinvertebrates	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Macroinvertebrates are not present.
	3	2	1	(0)
1.4. Filamentous Algae/Periphyton	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Filamentous algae and/or periphyton are not present.
	3	2	1	(0)
1.5. Differences in Vegetation	Dramatic compositional differences in vegetation are present between the stream banks and the adjacent uplands. A distict riparian vegetation corridor exists along the entire reach – riparian, aquatic, or wetland species dominate the length of the reach.	A distinct riparian vegetation corridor exists along part of the reach. Riparian vegetation is interspersed with upland vegetation along the length of the reach.	Vegetation growing along the reach may occur in greater densities or grow more vigorously than vegetation in the adjacent uplands, but there are no dramatic compositional differences between the two.	No compositional or density differences in vegetation are present between the streambanks and the adjacent uplands.
	3	2	(1)	0
1.6. Absence of Rooted Upland Plants in Streambed	Rooted upland plants are absent within the streambed/thalweg.	There are a few rooted upland plants present within the streambed/thalweg.	Rooted upland plants are consistently dispersed throughout the streambed/thalweg	Rooted upland plants are prevalent within the streambed/thalweg.
	3	2	(1)	0
			SUBTOTAL (#1.1 – #1.6)	2.0

If the stream being evaluated has a subtotal ≤ 2 at this juncture, the stream is determined to be EPHEMERAL.
If the stream being evaluated has a subtotal ≥ 18 at this point, the stream is determined to be PERENNIAL.
YOU MAY STOP THE EVALUATION AT THIS POINT. If the stream has a subtotal between 2 and 18 continue the Level 1 Evaluation.

LEVEL 1 INDICATORS	STREAM CONDITION			
	Strong	Moderate	Weak	Poor
1.7. Sinuosity	**Ratio > 1.4.** Stream has numerous, closely-spaced bends, few straight sections.	**Ratio < 1.4.** Stream has good sinuosity with some straight sections.	**Ratio < 1.2.** Stream has very few bends and mostly straight sections.	**Ratio = 1.0.** Stream is completely straight with no bends.
	3	2	(1)	0
1.8. Floodplain and Channel Dimensions	**Ratio > 2.5.** Stream is minimally confined with a wide, active floodplain.	**Ratio between 1.2 and 2.5.** Stream is moderately confined. Floodplain is present, but may only be active during larger floods.	**Ratio < 1.2.** Stream is incised with a noticeably confined channel. Floodplain is narrow or absent and typically disconnected from the channel.	
	(3)	1.5	0	
1.9. In-Channel Structure: Riffle-Pool Sequence	Demonstrated by a frequent number of riffles followed by pools along the entire reach. There is an obvious transition between riffles and pools.	Represented by a less frequent number of riffles and pools. Distinguishing the transition between riffles and pools is difficult.	Stream shows some flow but mostly has areas of pools or of riffles.	There is no sequence exhibited.
	3	2	1	0
SUBTOTAL (#1.1 – #1.9)				6.0
If the stream being evaluated has a subtotal ≤ 5 at this juncture, the stream is determined to be EPHEMERAL. If the stream being evaluated has a subtotal ≥ 21 at this point, the stream is determined to be PERENNIAL. YOU MAY STOP THE EVALUATION AT THIS POINT. If the stream has a subtotal between 5 and 21 continue the Level 1 Evaluation.				
1.10. Particle Size or Stream Substrate Sorting	Particle sizes in the channel are noticeably different from particle sizes in areas close to but not in the channel. There is a clear distribution of various sized substrates in the stream channel with finer particles accumulating in the pools, and larger particles accumulating in the riffles/runs.	Particle sizes in the channel are moderately similar to particle sizes in areas close to but not in the channel. Various sized substrates are present in the stream channel and are represented by a higher ratio of larger particles (gravel/cobble).	Particle sizes in the channel are similar or comparable to particle sizes in areas close to but not in the channel. Substrate sorting is not readily observed in the stream channel.	
	3	1.5	(0)	
1.11. Hydric Soils	Hydric soils are found within the study reach.		Hydric soils are not found within the study reach.	
	Present = 3		**Absent = (0)**	
1.12. Sediment on Plants and Debris	Sediment found readily on plants and debris within the stream channel, on the streambank, and within the floodplain throughout the length of the stream.	Sediment found on plants or debris within the stream channel although it is not prevalent along the stream. Mostly accumulating in pools.	Sediment is isolated in small amounts along the stream.	No sediment is present on plants or debris.
	1.5	(1)	0.5	0
TOTAL POINTS (#1.1 – #1.12)				7.0

SUPPLEMENTAL INDICATORS: **The following indicators do not occur consistently throughout New Mexico but may be useful in the determination of perenniality. If the indicator is present record score below and tally with previous score to compute TOTAL.**		
1.13. Seeps and Springs	Seeps and springs are found within the study reach.	Seeps and springs are not found within the study reach.
	Present = 1.5	**Absent = (0)**
1.14. Iron Oxidizing Bacteria/Fungi	Iron-oxidizing bacteria and/or fungi are found within the study reach.	Iron-oxidizing bacteria and/or fungi are not found within the study reach.
	Present = 1.5	**Absent = (0)**
TOTAL *plus* SUPPLEMENTAL POINTS (#1.1 – #1.14)		7.0

NMED Surface Water Quality Bureau – LEVEL 1 Hydrology Determination Field Sheet

Photo Descriptions and NOTES

Photo #	Description (US, DS, LB, RB, etc.)	Notes
	SEE APPENDIX K IN UAA	

NOTES:

STREAM MODIFICATIONS: SEE UAA SECTION 3.10 & FIGURE 15

DISCHARGES: SEE UAA SECTION 3.9 & FIGURE 12

LEVEL 1 Field Measurements

Pebble Count Tally Sheet

Site Name: Sub-reach 7 **Storet ID:** _____

Date: 6/27/19 **Crew:** J. Kay, M. Baca

Substrate Type	Diameter Range	In-Channel COUNT	In-Channel % Composition	Out of Channel COUNT	Out of Channel % Composition
Silt/Clay	< 0.06 mm	19	19	10	20
Sand	0.06 – 2.0 mm (gritty)	26	26	15	30
Gravel	2.0 – 64 mm	55	55	24	48
Cobble	64 – 256	0	0	1	2
Boulder	> 256 mm	0	0	0	0
Bedrock	---	0	0	0	0

****Please be sure to measure at least 50 pebbles (10 in 5 transects or 5 in 10 transects- depending on stream size) for accurate distributional representation****

INDICATOR #1.8 (*Floodplain and Channel Dimensions*) – MEASUREMENTS & CALCULATIONS**

Max Depth (#1)	Bankfull Stage (#2)	Maximum Depth Value (#3)	2x Maximum Depth Value (#3)	Flood-Prone Area Location (#4)	Flood-Prone Area Width (#5)	Bankfull Width (#6)	Floodplain to Active Channel Ratio (FPA Width / Bankfull Width)
5477.14'	5477.72'	0.503	1.01	5478.22	245.05	41.24	5.94

****REFER to Figure 3 on page 19 for clarification**

Appendix I-8

A printed copy of this document may not be the official version. The official printed copy of this UAA is located in the office of the Environmental Compliance and monitoring (Org. 0641).

NMED Surface Water Quality Bureau – LEVEL 1 Hydrology Determination Field Sheet

Date: 6/27/19	**Stream Name:** TIJERAS ARROYO	**Latitude:** 35.055735
Evaluator(s): J. Kay, J. Payne	**Site ID:** Sub-reach 8	**Longitude:** -106.515080
TOTAL POINTS: 6.5 *Stream is at least intermittent if ≥ 12*	**Assessment Unit:** NM-9000.A_070	**Drought Index (12-mo. SPI Value):** 0.65

	NOW:	PAST 48 HOURS:	Has there been a heavy rain in the last 48 hours?
WEATHER CONDITIONS	___ storm (heavy rain) ___ rain (steady rain) ___ showers (intermittent) ___ %cloud cover X clear/sunny	___ storm (heavy rain) ___ rain (steady rain) ___ showers (intermittent) ___ %cloud cover X clear/sunny	___ YES X NO **Field evaluations should be performed at least 48 hours after the last known major rainfall event. **OTHER:** Stream Modifications X YES ___ NO Diversions ___ YES X NO Discharges X YES ___ NO **Explain in further detail in NOTES section

LEVEL 1 INDICATORS	STREAM CONDITION			
	Strong	**Moderate**	**Weak**	**Poor**
1.1. Water in Channel	Flow is evident throughout the reach. Moving water is seen in riffle areas but may not be as evident throughout the runs.	Water is present in the channel but flow is barely discernable in areas of greatest gradient change (i.e. riffles) or floating object is necessary to observe flow.	Dry channel with standing pools. There is some evidence of base flows (i.e. riparian vegetation growing along channel, saturated or moist sediment under rocks, etc)	Dry channel. No evidence of base flows was found.
	6	4	2	(0)
1.2. Fish	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Fish are not present.
	3	2	1	(0)
1.3. Benthic Macroinvertebrates	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Macroinvertebrates are not present.
	3	2	1	(0)
1.4. Filamentous Algae/Periphyton	Found easily and consistently throughout the reach.	Found with little difficulty but not consistently throughout the reach.	Takes 10 or more minutes of extensive searching to find.	Filamentous algae and/or periphyton are not present.
	3	2	1	(0)
1.5. Differences in Vegetation	Dramatic compositional differences in vegetation are present between the stream banks and the adjacent uplands. A distict riparian vegetation corridor exists along the entire reach – riparian, aquatic, or wetland species dominate the length of the reach.	A distinct riparian vegetation corridor exists along part of the reach. Riparian vegetation is interspersed with upland vegetation along the length of the reach.	Vegetation growing along the reach may occur in greater densities or grow more vigorously than vegetation in the adjacent uplands, but there are no dramatic compositional differences between the two.	No compositional or density differences in vegetation are present between the streambanks and the adjacent uplands.
	3	2	(1)	0
1.6. Absence of Rooted Upland Plants in Streambed	Rooted upland plants are absent within the streambed/thalweg.	There are a few rooted upland plants present within the streambed/thalweg.	Rooted upland plants are consistently dispersed throughout the streambed/thalweg	Rooted upland plants are prevalent within the streambed/thalweg.
	3	2	(1)	0
			SUBTOTAL (#1.1 – #1.6)	2.0

If the stream being evaluated has a subtotal ≤ 2 at this juncture, the stream is determined to be EPHEMERAL.
If the stream being evaluated has a subtotal ≥ 18 at this point, the stream is determined to be PERENNIAL.
YOU MAY STOP THE EVALUATION AT THIS POINT. If the stream has a subtotal between 2 and 18 continue the Level 1 Evaluation.

LEVEL 1 INDICATORS	STREAM CONDITION			
	Strong	Moderate	Weak	Poor
1.7. Sinuosity	**Ratio > 1.4.** Stream has numerous, closely-spaced bends, few straight sections.	**Ratio < 1.4.** Stream has good sinuosity with some straight sections.	**Ratio < 1.2.** Stream has very few bends and mostly straight sections.	**Ratio = 1.0.** Stream is completely straight with no bends.
	3	2	(1)	0
1.8. Floodplain and Channel Dimensions	**Ratio > 2.5.** Stream is minimally confined with a wide, active floodplain.	**Ratio between 1.2 and 2.5.** Stream is moderately confined. Floodplain is present, but may only be active during larger floods.	**Ratio < 1.2.** Stream is incised with a noticeably confined channel. Floodplain is narrow or absent and typically disconnected from the channel.	
	3	1.5	(1.0)	0
1.9. In-Channel Structure: Riffle-Pool Sequence	Demonstrated by a frequent number of riffles followed by pools along the entire reach. There is an obvious transition between riffles and pools.	Represented by a less frequent number of riffles and pools. Distinguishing the transition between riffles and pools is difficult.	Stream shows some flow but mostly has areas of pools or of riffles.	There is no sequence exhibited.
	3	2	1	(0)
				SUBTOTAL (#1.1 – #1.9) 4.0

If the stream being evaluated has a subtotal ≤ 5 at this juncture, the stream is determined to be EPHEMERAL.
If the stream being evaluated has a subtotal ≥ 21 at this point, the stream is determined to be PERENNIAL.
YOU MAY STOP THE EVALUATION AT THIS POINT. If the stream has a subtotal between 5 and 21 continue the Level 1 Evaluation.

1.10. Particle Size or Stream Substrate Sorting	Particle sizes in the channel are noticeably different from particle sizes in areas close to but not in the channel. There is a clear distribution of various sized substrates in the stream channel with finer particles accumulating in the pools, and larger particles accumulating in the riffles/runs.	Particle sizes in the channel are moderately similar to particle sizes in areas close to but not in the channel. Various sized substrates are present in the stream channel and are represented by a higher ratio of larger particles (gravel/cobble).	Particle sizes in the channel are similar or comparable to particle sizes in areas close to but not in the channel. Substrate sorting is not readily observed in the stream channel.
	3	(1.5)	0

1.11. Hydric Soils	Hydric soils are found within the study reach.	Hydric soils are not found within the study reach.
	Present = 3	**Absent = 0**

1.12. Sediment on Plants and Debris	Sediment found readily on plants and debris within the stream channel, on the streambank, and within the floodplain throughout the length of the stream.	Sediment found on plants or debris within the stream channel although it is not prevalent along the stream. Mostly accumulating in pools.	Sediment is isolated in small amounts along the stream.	No sediment is present on plants or debris.
	1.5	(1)	0.5	0
				TOTAL POINTS (#1.1 – #1.12) 6.5

SUPPLEMENTAL INDICATORS: **The following indicators do not occur consistently throughout New Mexico but may be useful in the determination of perenniality. If the indicator is present record score below and tally with previous score to compute TOTAL.**

1.13. Seeps and Springs	Seeps and springs are found within the study reach.	Seeps and springs are not found within the study reach.
	Present = 1.5	**Absent = (0)**
1.14. Iron Oxidizing Bacteria/Fungi	Iron-oxidizing bacteria and/or fungi are found within the study reach.	Iron-oxidizing bacteria and/or fungi are not found within the study reach.
	Present = 1.5	**Absent = (0)**
		TOTAL *plus* SUPPLEMENTAL POINTS (#1.1 – #1.14) 6.5

NMED Surface Water Quality Bureau – LEVEL 1 Hydrology Determination Field Sheet

Photo Descriptions and NOTES

Photo #	Description (US, DS, LB, RB, etc.)	Notes
	SEE APPENDIX K IN UAA	

NOTES:

STREAM MODIFICATIONS: SEE UAA SECTION 3.10 & FIGURE 15
DISCHARGES: SEE UAA SECTION 3.9 & FIGURE 12

LEVEL 1 Field Measurements

Pebble Count Tally Sheet

Site Name: Sub-reach 8 **Storet ID:** _____

Date: 6/27/19 **Crew:** J. Kay, M. Daca

Substrate Type	Diameter Range	In-Channel COUNT	In-Channel % Composition	Out of Channel COUNT	Out of Channel % Composition
Silt/Clay	< 0.06 mm	4	4	30	60
Sand	0.06 – 2.0 mm (gritty)	18	18	4	8
Gravel	2.0 – 64 mm	71	71	16	32
Cobble	64 – 256	2	2	0	0
Boulder	> 256 mm	0	0	0	0
Bedrock	---	0	0	0	0

****Please be sure to measure at least 50 pebbles (10 in 5 transects or 5 in 10 transects- depending on stream size) for accurate distributional representation****

INDICATOR #1.8 (*Floodplain and Channel Dimensions*) – MEASUREMENTS & CALCULATIONS**							
Max Depth (#1)	**Bankfull Stage (#2)**	**Maximum Depth Value (#3)**	**2x Maximum Depth Value (#3)**	**Flood-Prone Area Location (#4)**	**Flood-Prone Area Width (#5)**	**Bankfull Width (#6)**	**Floodplain to Active Channel Ratio** (FPA Width / Bankfull Width)
5506.59'	5507.64'	1.05	2.10	5508.69	59.16	46.74	1.27

****REFER to Figure 3 on page 19 for clarification**

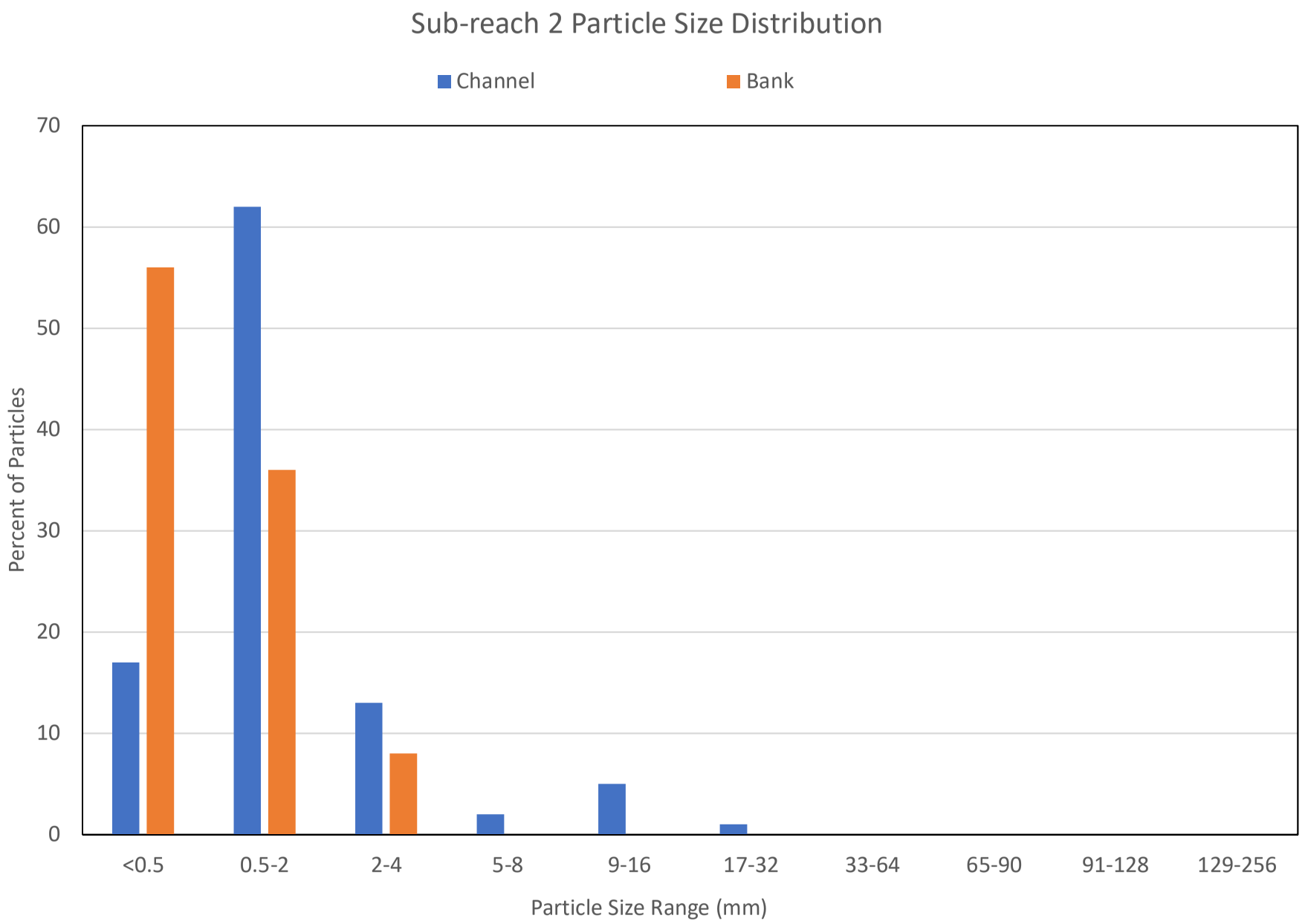
Appendix J – Sediment and Substrate Size

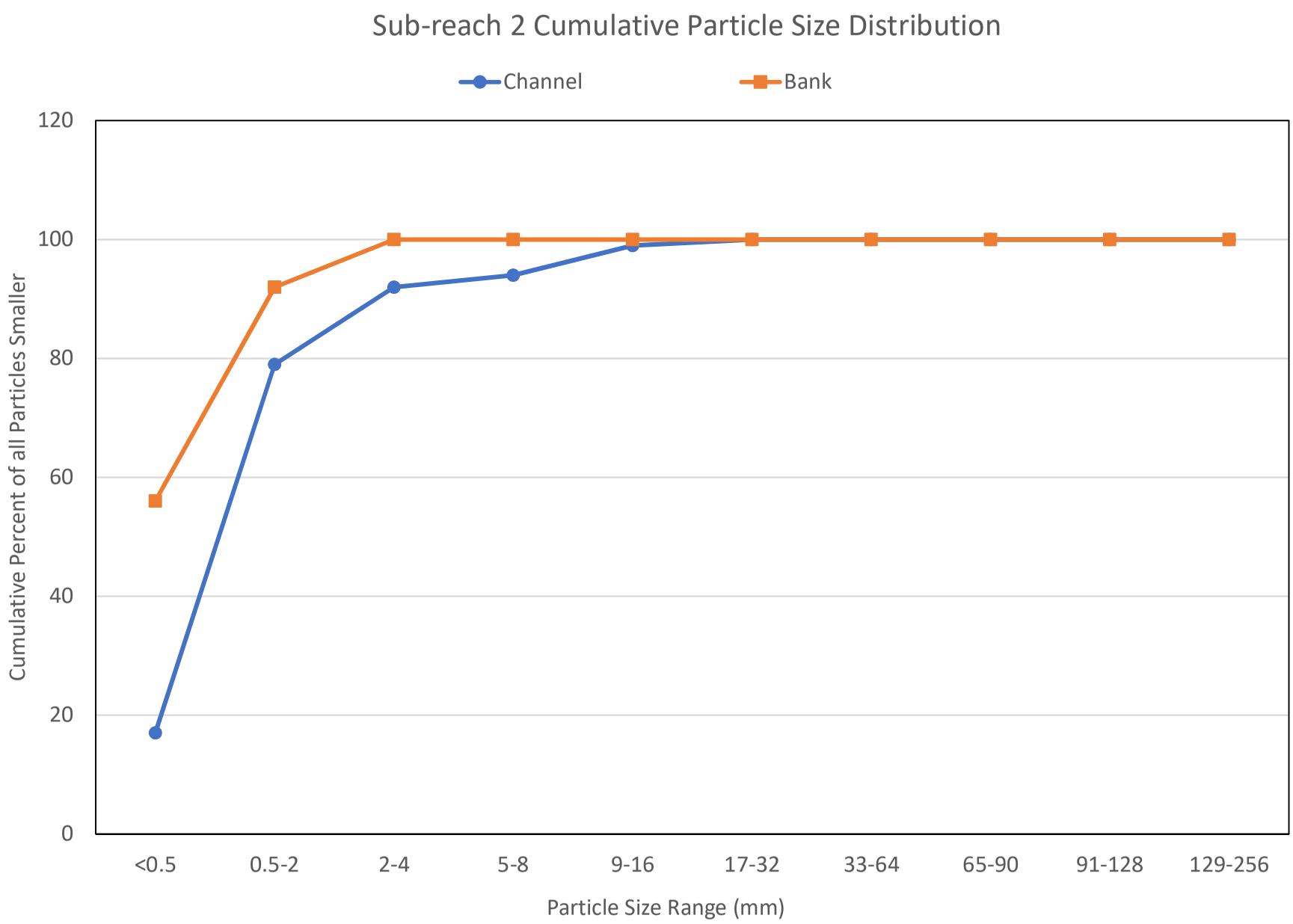
No.	Description
J-1	Graphs of Sediment and Substrate Size Distribution
J-2	Pebble Count Location Maps

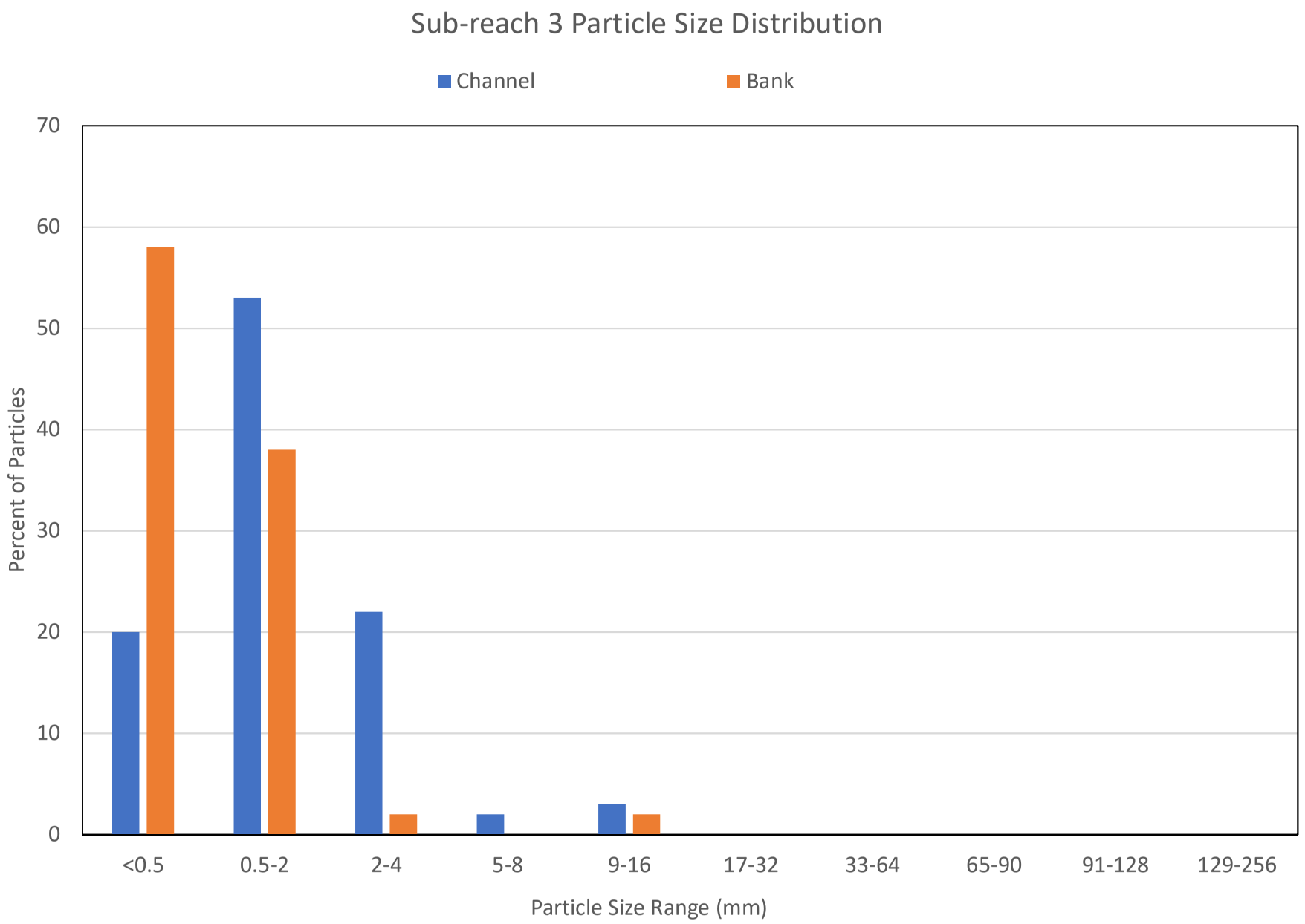
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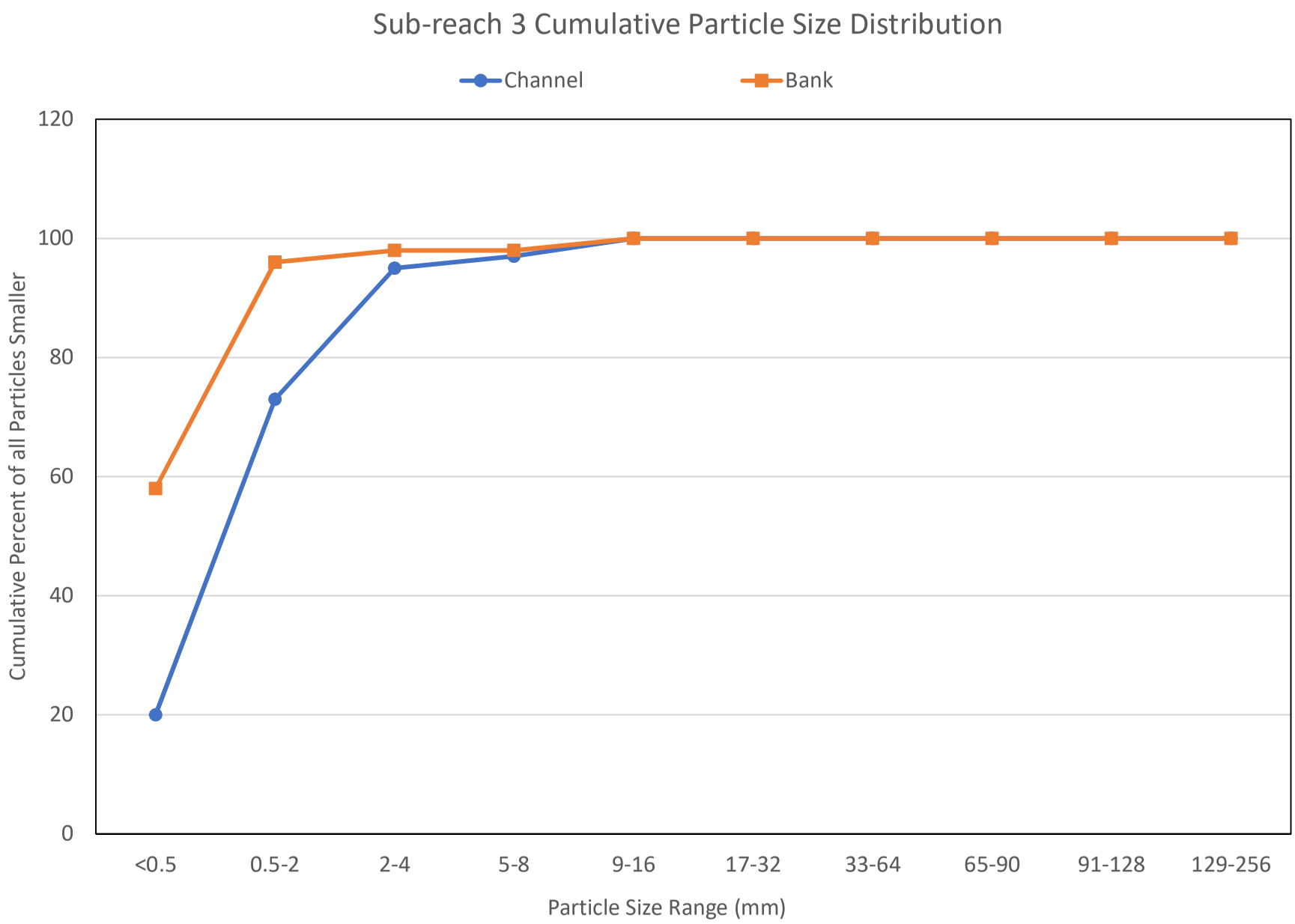
Appendix J-1

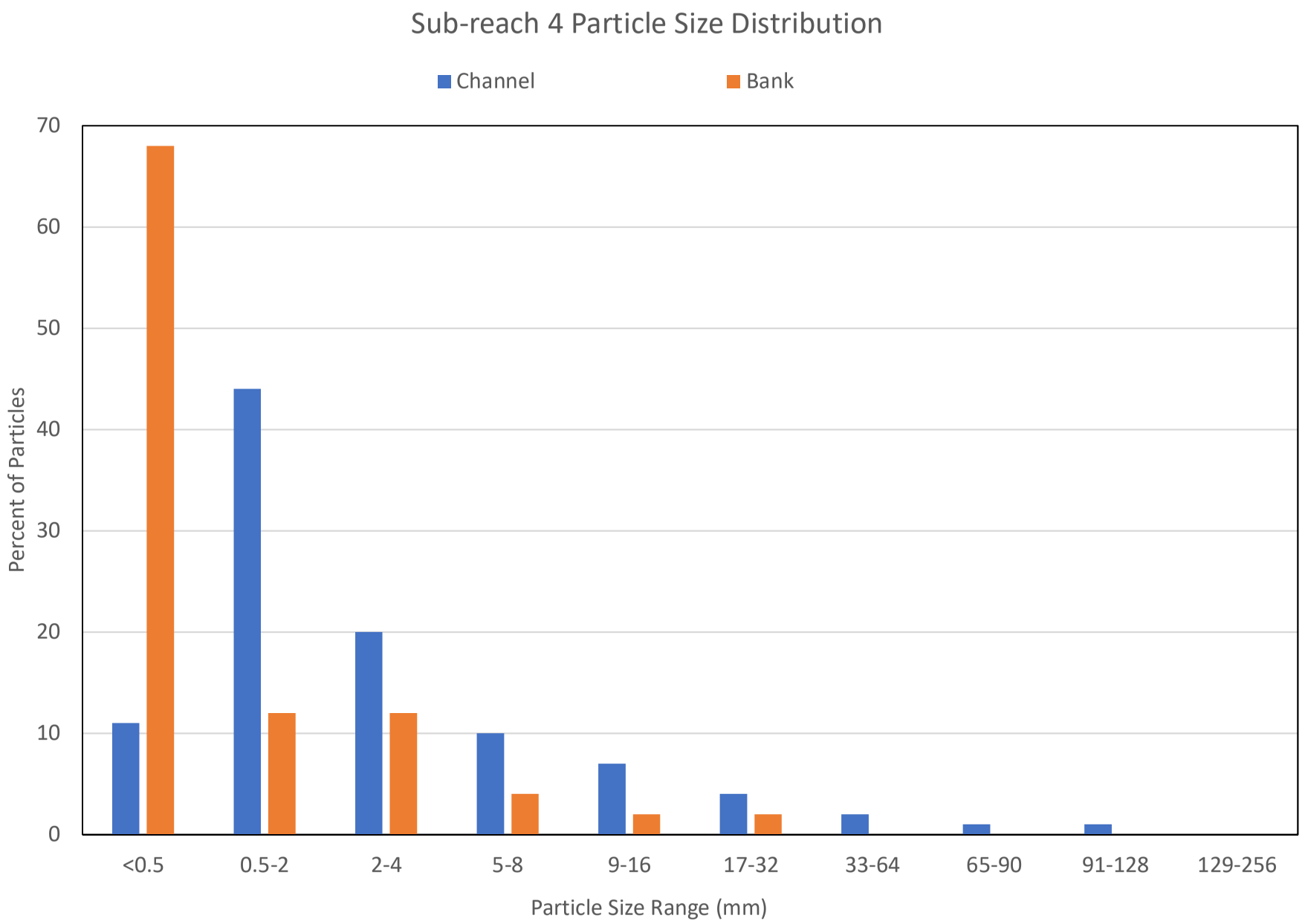
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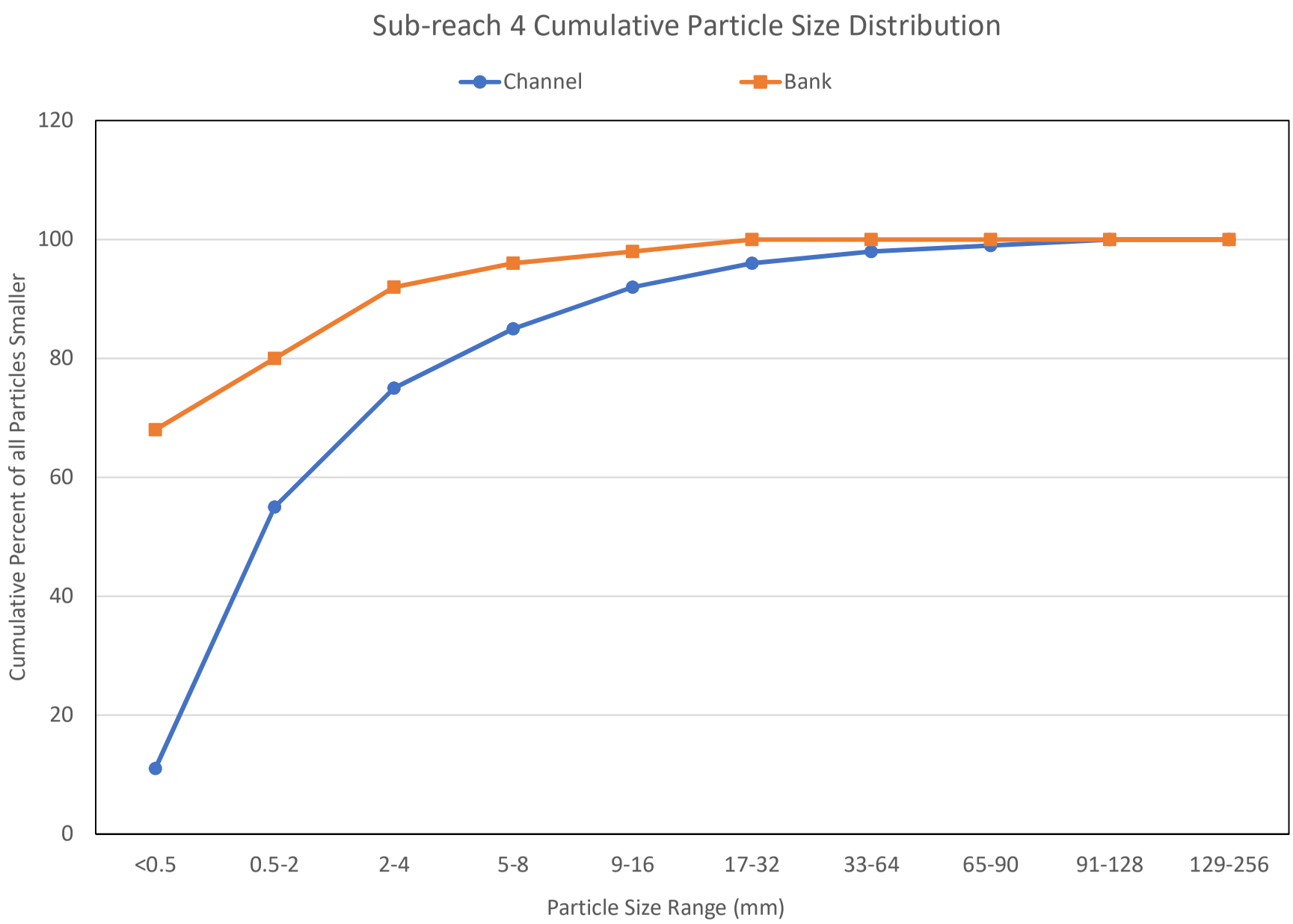

Sub-reach 2 Particle Size Distribution
Channel
Bank
70
60
50
40
30
20
10
0
Percent of Particles
<0.5
0.5-2
2-4
5-8
9-16
17-32
33-64
65-90
91-128
129-256
Particle Size Range (mm)

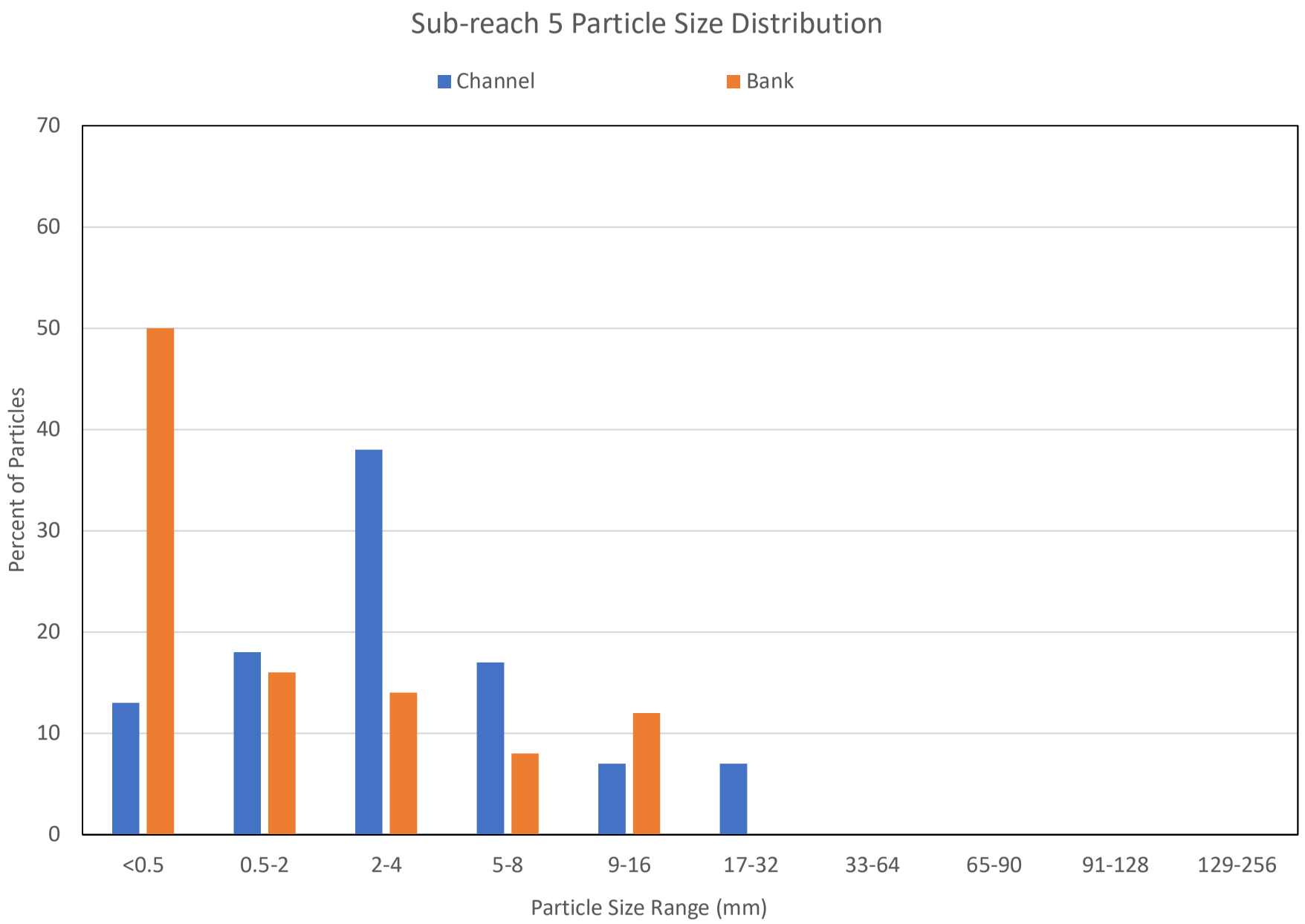

Sub-reach 2 Cumulative Particle Size Distribution
Channel
Bank
120
100
80
60
40
20
0
Cumulative Percent of all Particles Smaller
<0.5
0.5-2
2-4
5-8
9-16
17-32
33-64
65-90
91-128
129-256
Particle Size Range (mm)

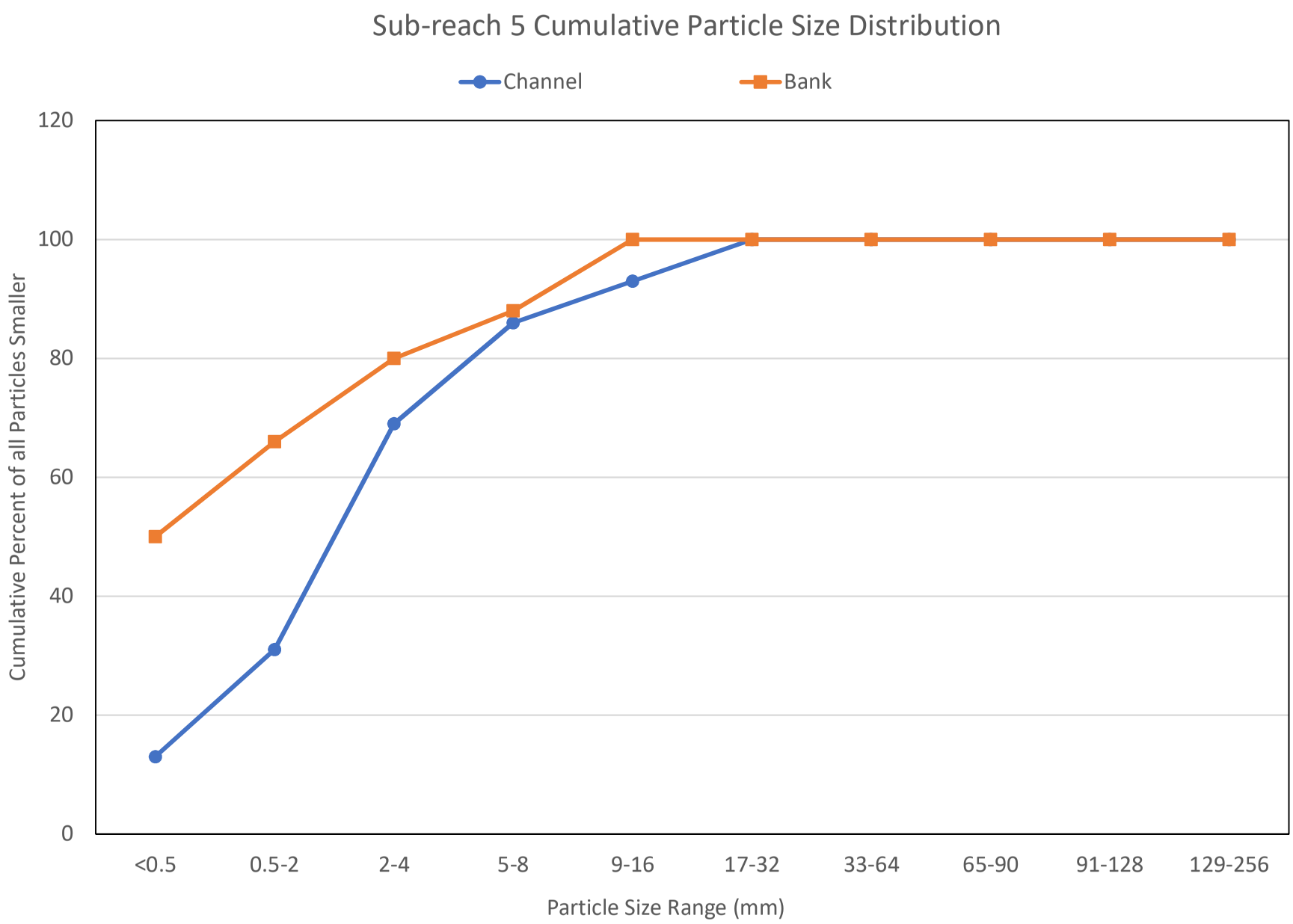

Sub-reach 3 Particle Size Distribution
Channel
Bank
70
60
50
40
30
20
10
0
Percent of Particles
<0.5
0.5-2
2-4
5-8
9-16
17-32
33-64
65-90
91-128
129-256
Particle Size Range (mm)

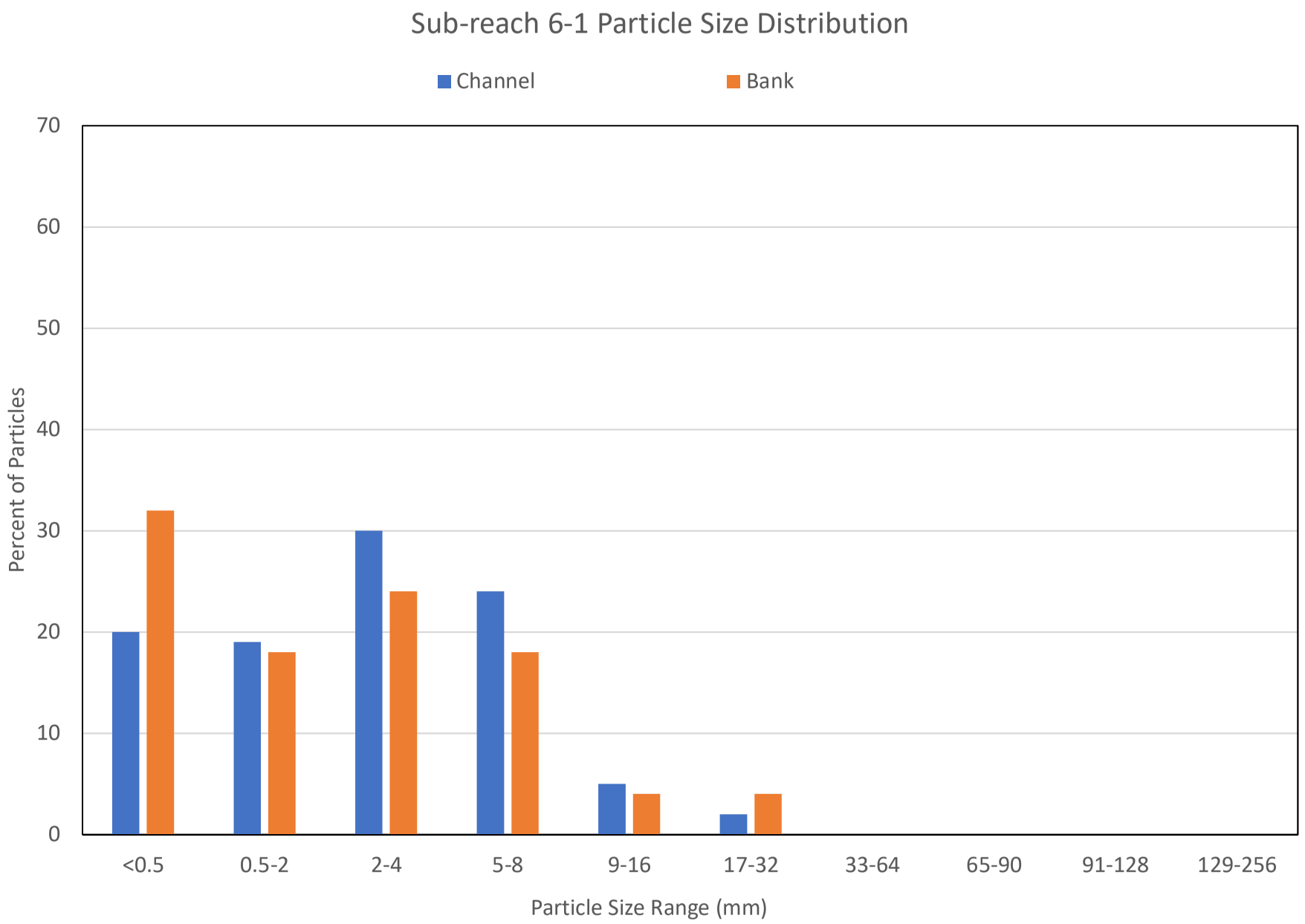

Sub-reach 3 Cumulative Particle Size Distribution
Channel
Bank
120
100
80
60
40
20
0
Cumulative Percent of all Particles Smaller
<0.5
0.5-2
2-4
5-8
9-16
17-32
33-64
65-90
91-128
129-256
Particle Size Range (mm)

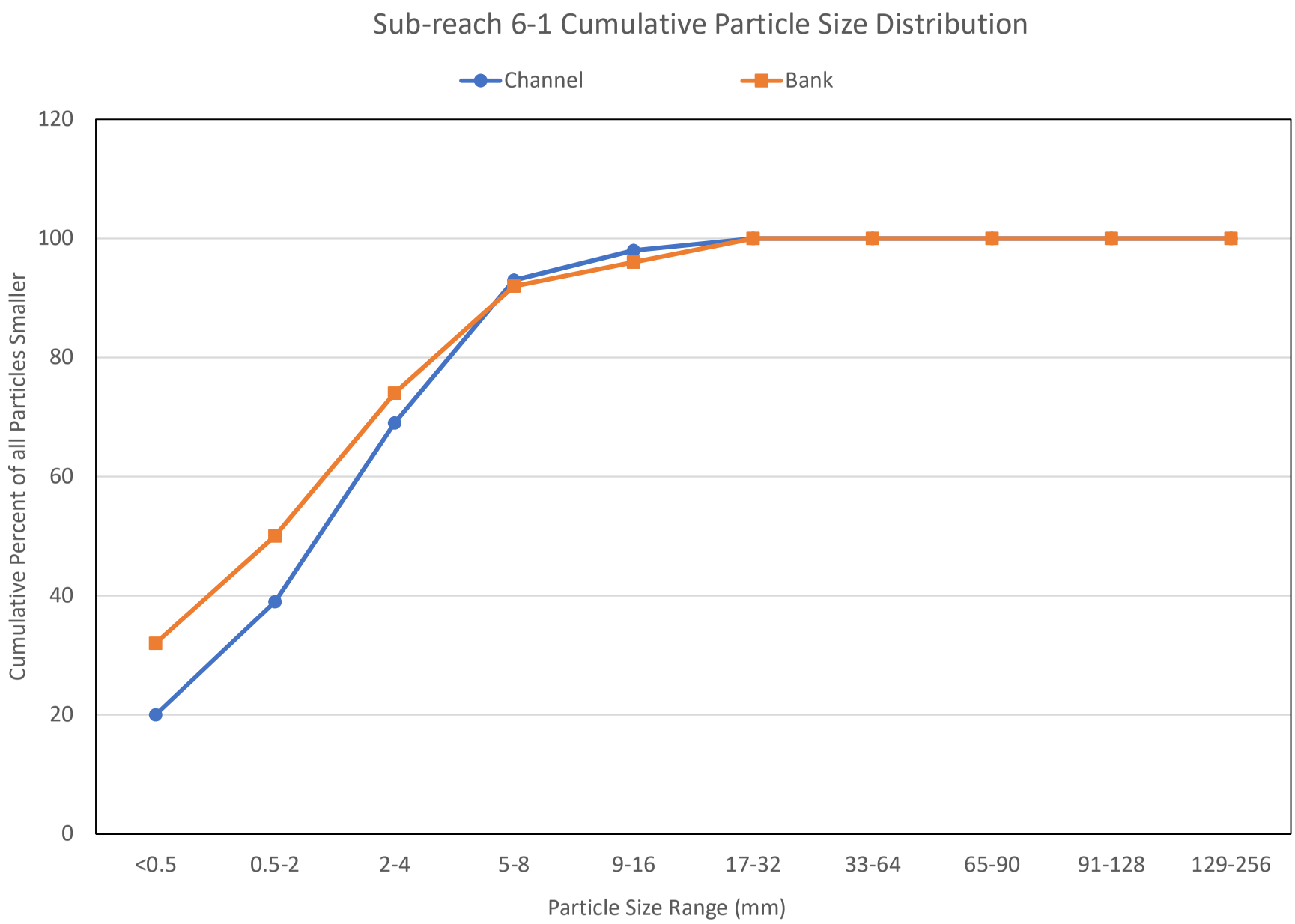

Sub-reach 4 Particle Size Distribution
Channel
Bank
70
60
50
40
30
20
10
0
Percent of Particles
<0.5
0.5-2
2-4
5-8
9-16
17-32
33-64
65-90
91-128
129-256
Particle Size Range (mm)

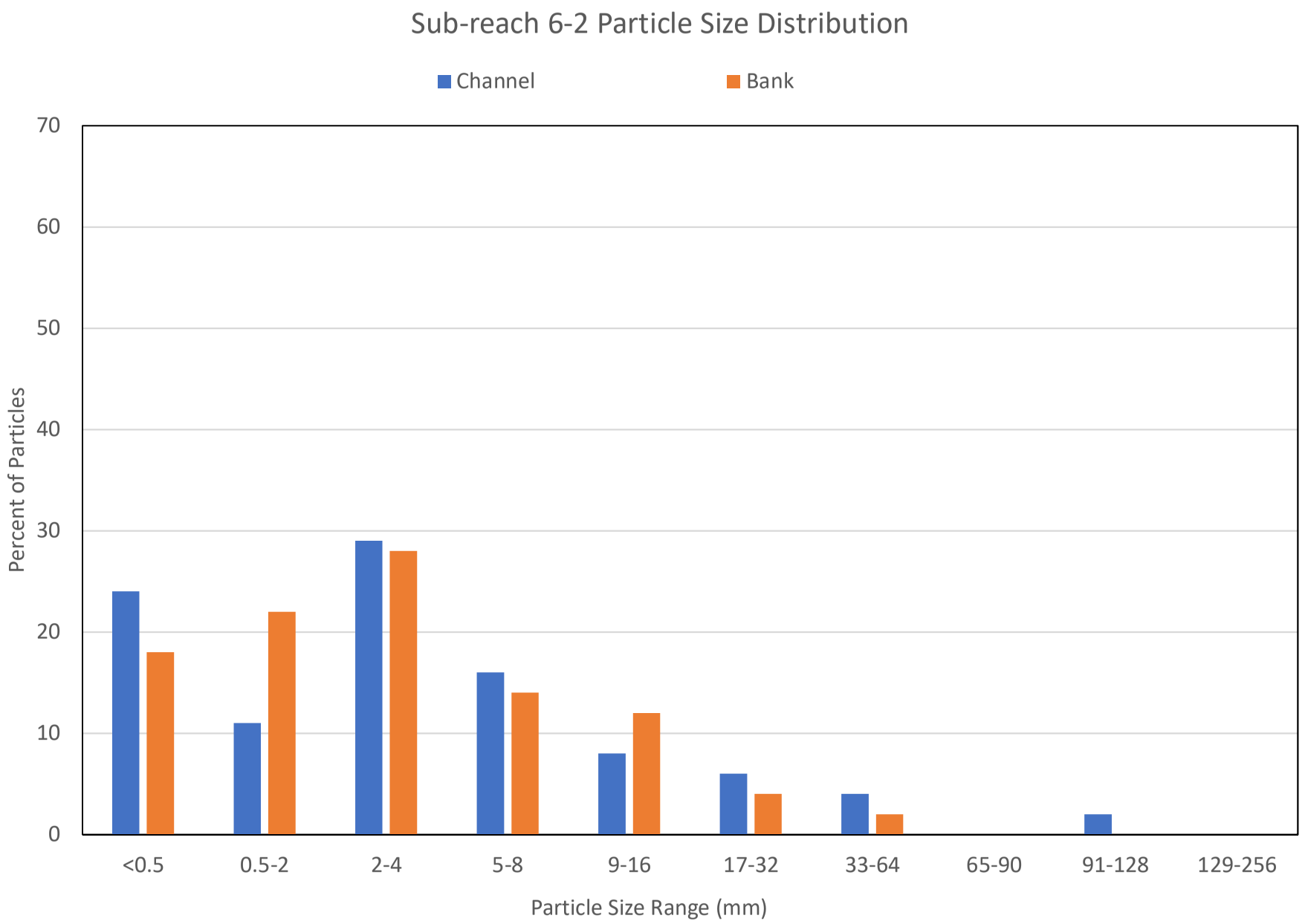

Sub-reach 4 Cumulative Particle Size Distribution
Channel
Bank
120
100
80
60
40
20
0
Cumulative Percent of all Particles Smaller
<0.5
0.5-2
2-4
5-8
9-16
17-32
33-64
65-90
91-128
129-256
Particle Size Range (mm)

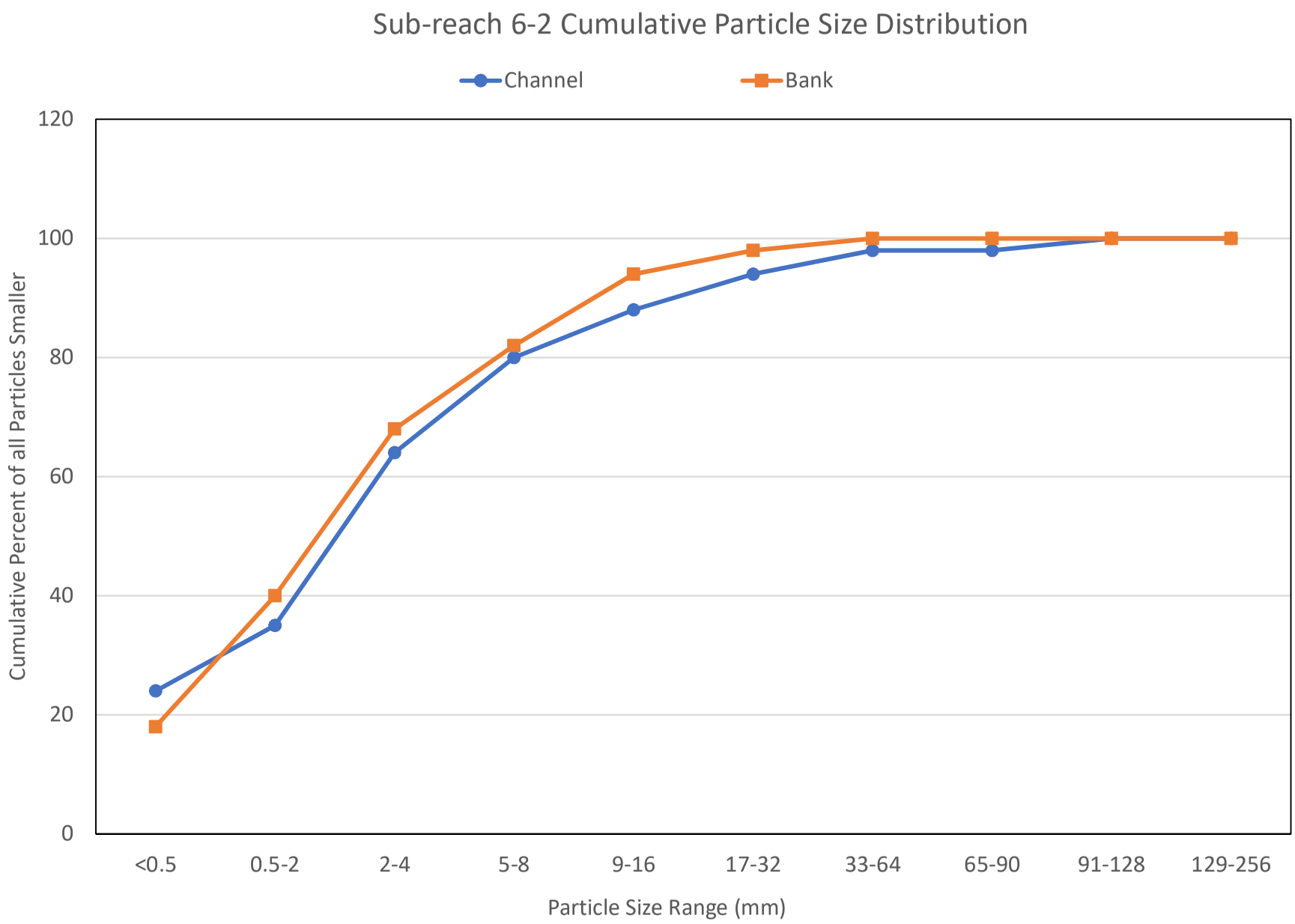

Sub-reach 5 Particle Size Distribution
Channel
Bank
70
60
50
40
30
20
10
0
Percent of Particles
<0.5
0.5-2
2-4
5-8
9-16
17-32
33-64
65-90
91-128
129-256
Particle Size Range (mm)

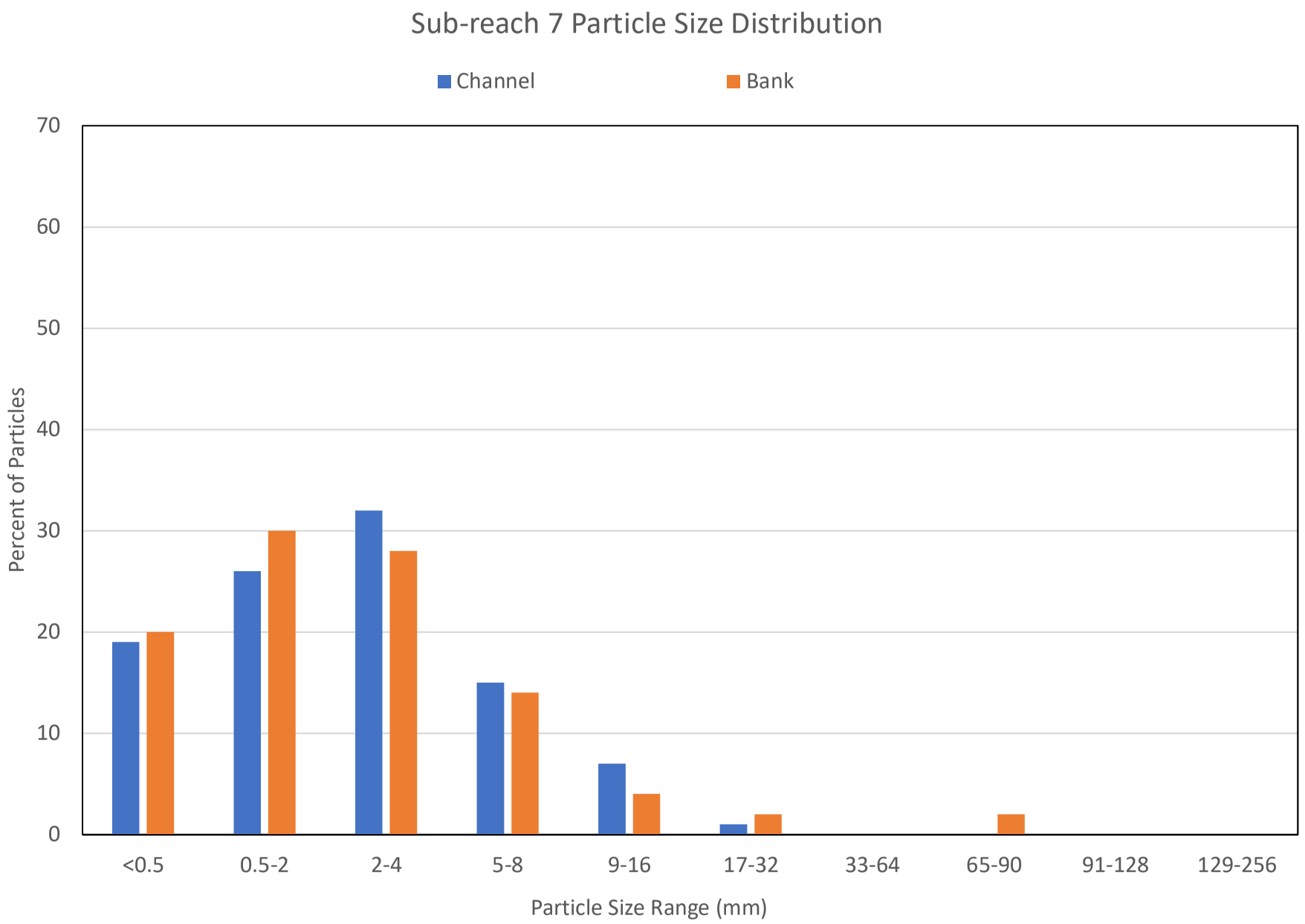

Sub-reach 5 Cumulative Particle Size Distribution
Channel
Bank
120
100
80
60
40
20
0
Cumulative Percent of all Particles Smaller
<0.5
0.5-2
2-4
5-8
9-16
17-32
33-64
65-90
91-128
129-256
Particle Size Range (mm)

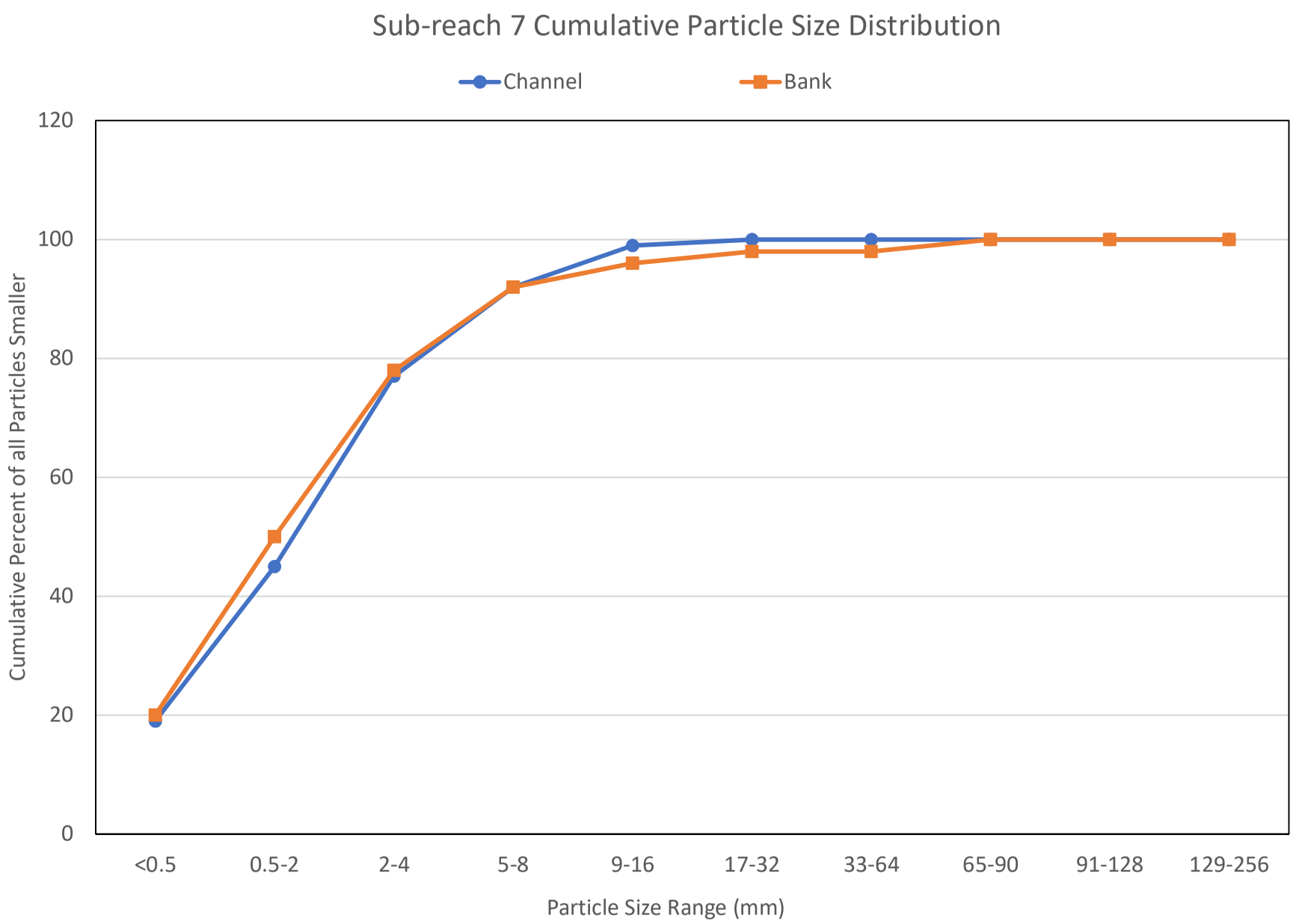

Sub-reach 6-1 Particle Size Distribution
Channel
Bank
70
60
50
40
30
20
10
0
Percent of Particles
<0.5
0.5-2
2-4
5-8
9-16
17-32
33-64
65-90
91-128
129-256
Particle Size Range (mm)

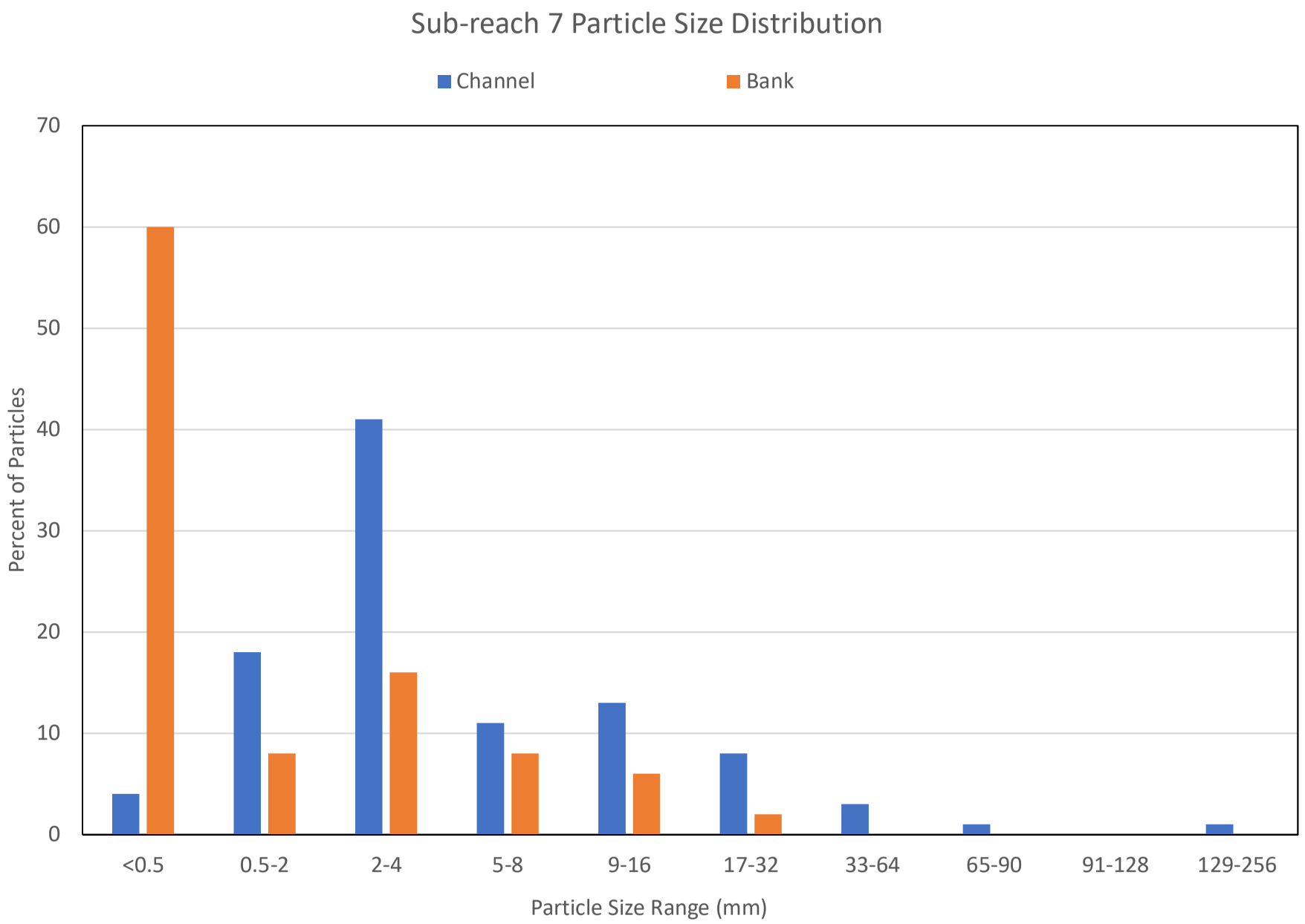

Sub-reach 6-1 Cumulative Particle Size Distribution
Channel
Bank
120
100
80
60
40
20
0
Cumulative Percent of all Particles Smaller
<0.5
0.5-2
2-4
5-8
9-16
17-32
33-64
65-90
91-128
129-256
Particle Size Range (mm)

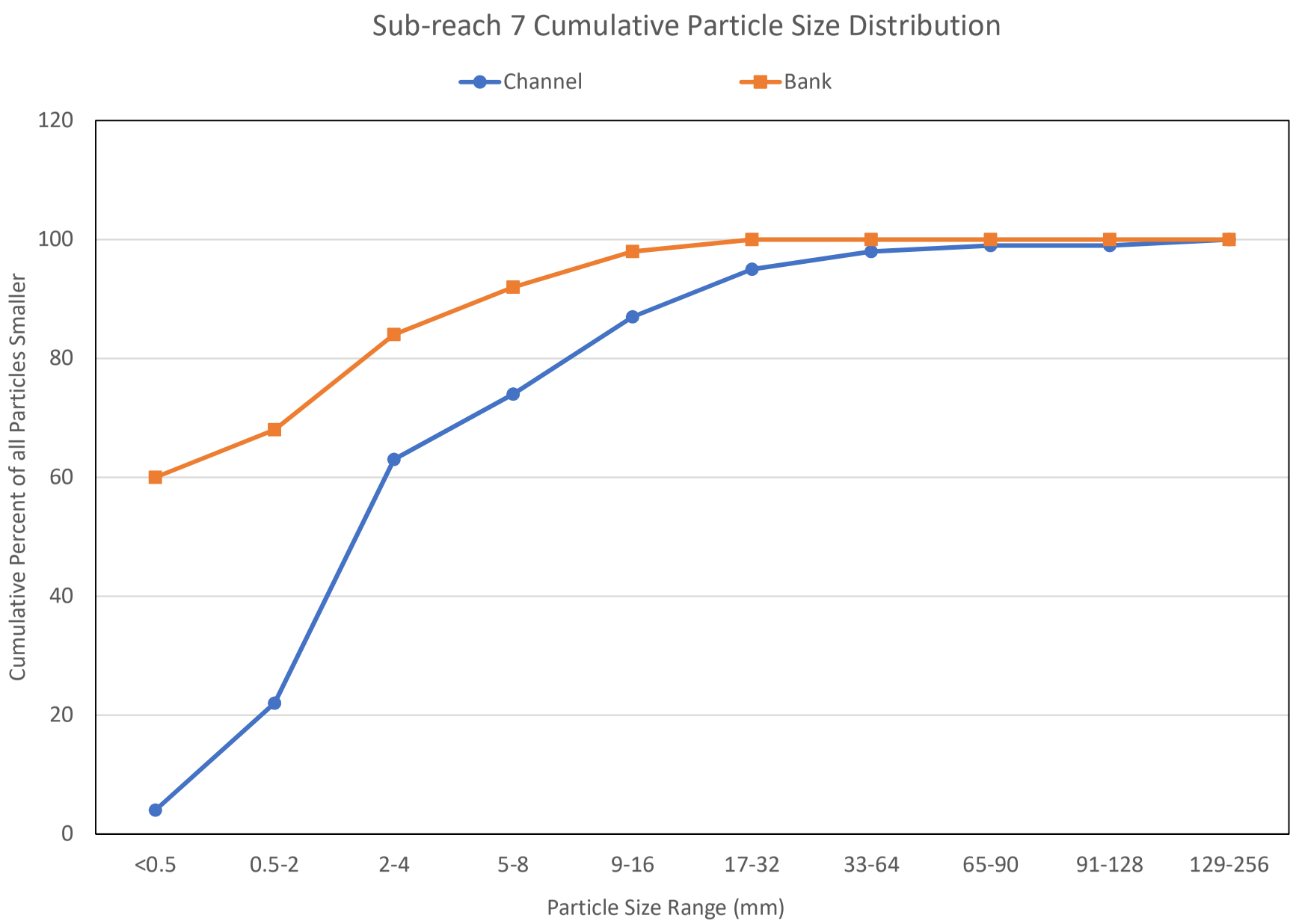

Sub-reach 6-2 Particle Size Distribution
Channel
Bank
70
60
50
40
30
20
10
0
Percent of Particles
<0.5
0.5-2
2-4
5-8
9-16
17-32
33-64
65-90
91-128
129-256
Particle Size Range (mm)

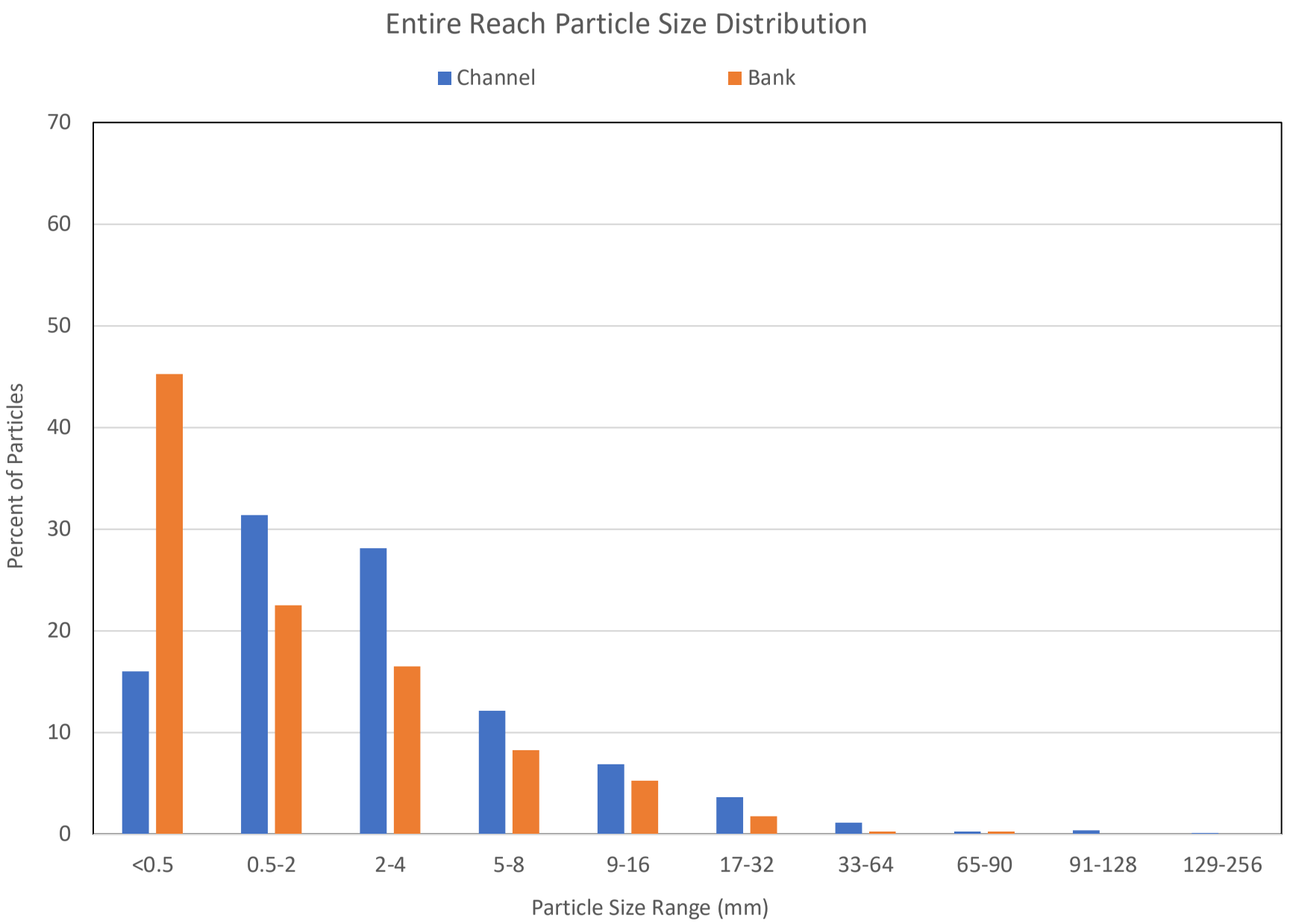

Sub-reach 6-2 Cumulative Particle Size Distribution
Channel
Bank
120
100
80
60
40
20
0
Cumulative Percent of all Particles Smaller
<0.5
0.5-2
2-4
5-8
9-16
17-32
33-64
65-90
91-128
129-256
Particle Size Range (mm)

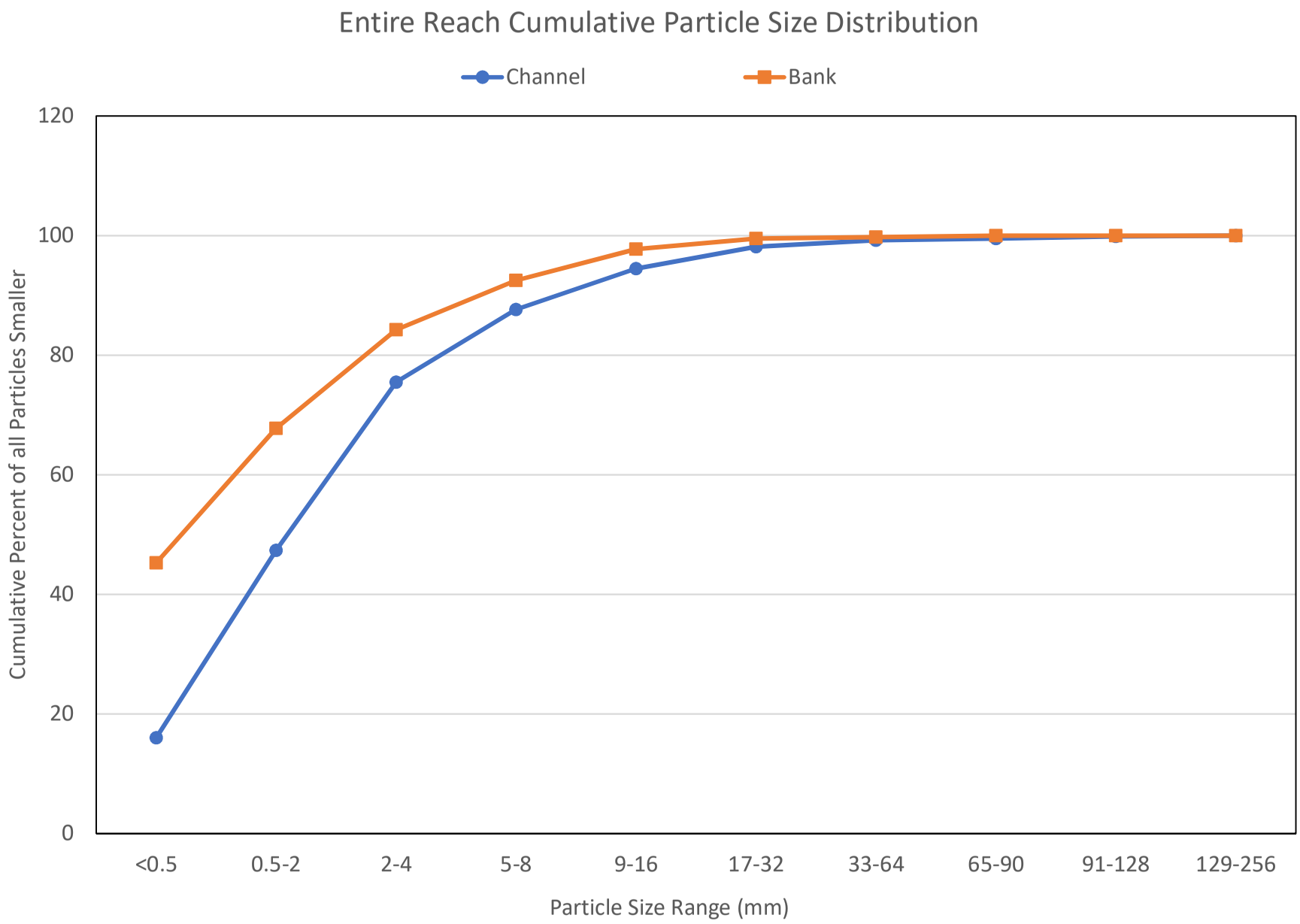

Sub-reach 7 Particle Size Distribution
Channel
Bank
70
60
50
40
30
20
10
0
Percent of Particles
<0.5
0.5-2
2-4
5-8
9-16
17-32
33-64
65-90
91-128
129-256
Particle Size Range (mm)


Sub-reach 7 Cumulative Particle Size Distribution
Channel
Bank
120
100
80
60
40
20
0
Cumulative Percent of all Particles Smaller
<0.5
0.5-2
2-4
5-8
9-16
17-32
33-64
65-90
91-128
129-256
Particle Size Range (mm)


Sub-reach 7 Particle Size Distribution
Channel
Bank
70
60
50
40
30
20
10
0
Percent of Particles
<0.5
0.5-2
2-4
5-8
9-16
17-32
33-64
65-90
91-128
129-256
Particle Size Range (mm)


Sub-reach 7 Cumulative Particle Size Distribution
Channel
Bank
120
100
80
60
40
20
0
Cumulative Percent of all Particles Smaller
<0.5
0.5-2
2-4
5-8
9-16
17-32
33-64
65-90
91-128
129-256
Particle Size Range (mm)


Entire Reach Particle Size Distribution
Channel
Bank
70
60
50
40
30
20
10
0
Percent of Particles
<0.5
0.5-2
2-4
5-8
9-16
17-32
33-64
65-90
91-128
129-256
Particle Size Range (mm)


Entire Reach Cumulative Particle Size Distribution
Channel
Bank
120
100
80
60
40
20
0
Cumulative Percent of all Particles Smaller
<0.5
0.5-2
2-4
5-8
9-16
17-32
33-64
65-90
91-128
129-256
Particle Size Range (mm)

Appendix J-2

Mapid = sc19235 08/27/19 SNL EGIS ORG. 0643



Legend

- Cross Section Locations
- PebbleCount Inside Channel
- PebbleCount Outside Channel
- Reach 2

Reach 2 Pebble Count Locations

Appendix J

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

0 125 250 500
Meters

0 0.125 0.25 0.5
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19234 08/23/19 SNL EGIS ORG. 0643



Legend

- Cross Section Locations
- PebbleCount Inside Channel
- PebbleCount Outside Channel
- Reach 3

Reach 3 Pebble Count Locations

Appendix J

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

0 87.5 175 350
Meters

0 0.075 0.15 0.3
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19233 08/27/19 SNL EGIS ORG. 0643



Legend

- Cross Section Locations
- PebbleCount Inside Channel
- PebbleCount Outside Channel
- Reach 4

Reach 4 Pebble Count Locations

Appendix J

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

0 50 100 200
Meters

0 0.05 0.1 0.2
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19232 08/23/19 SNL EGIS ORG. 0643



Legend

- Cross Section Locations
- PebbleCount Inside Channel
- PebbleCount Outside Channel
- Reach 5

Reach 5 Pebble Count Locations

Appendix J

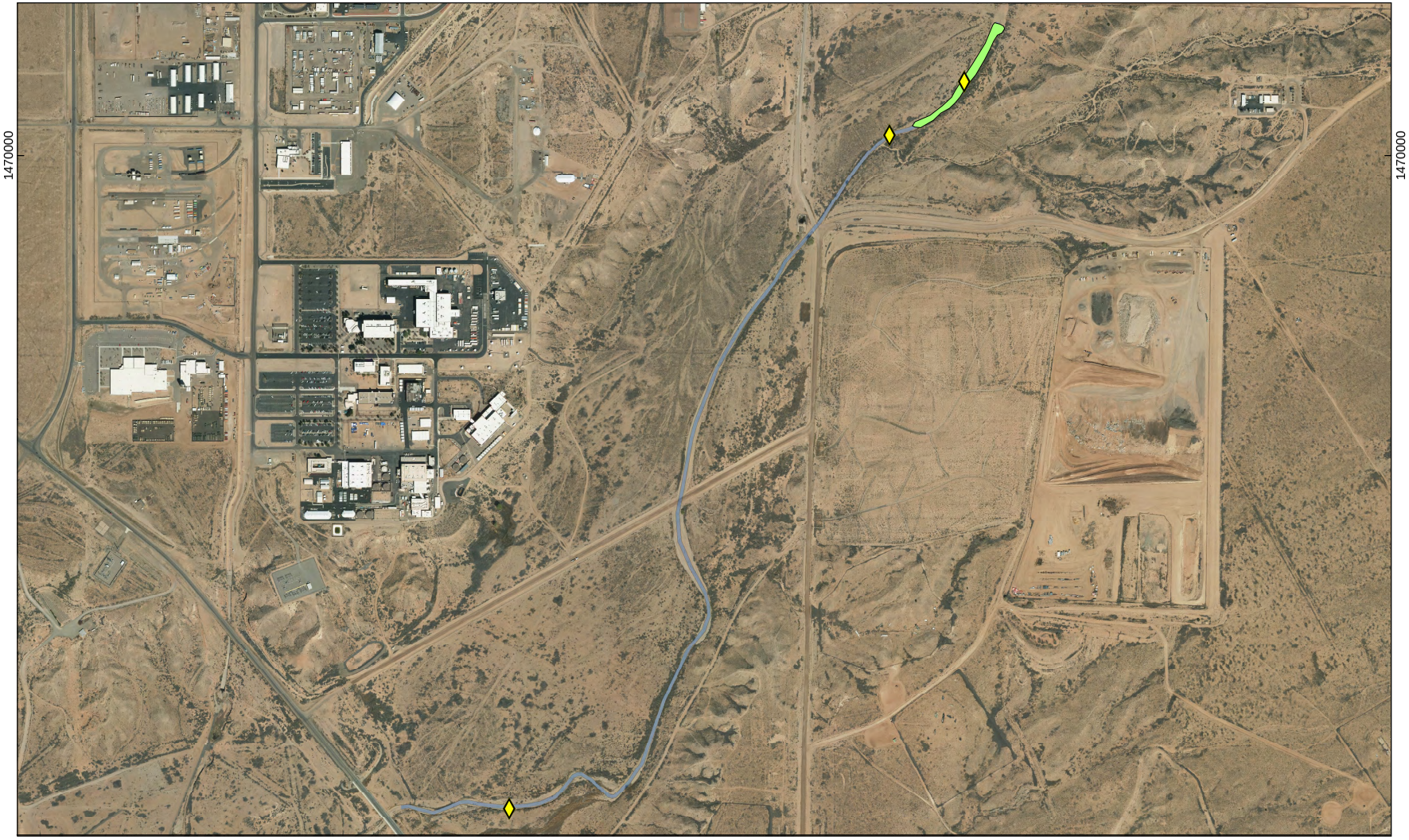
Sandia National Laboratories, New Mexico
Environmental Geographic Information System

0 112.5 225 450
Meters

0 0.1 0.2 0.4
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19231 08/27/19 SNL EGIS ORG. 0643



Legend

- Cross Section Locations
- PebbleCount Inside Channel
- PebbleCount Outside Channel
- Reach 6

Reach 6 Pebble Count Locations

Appendix J

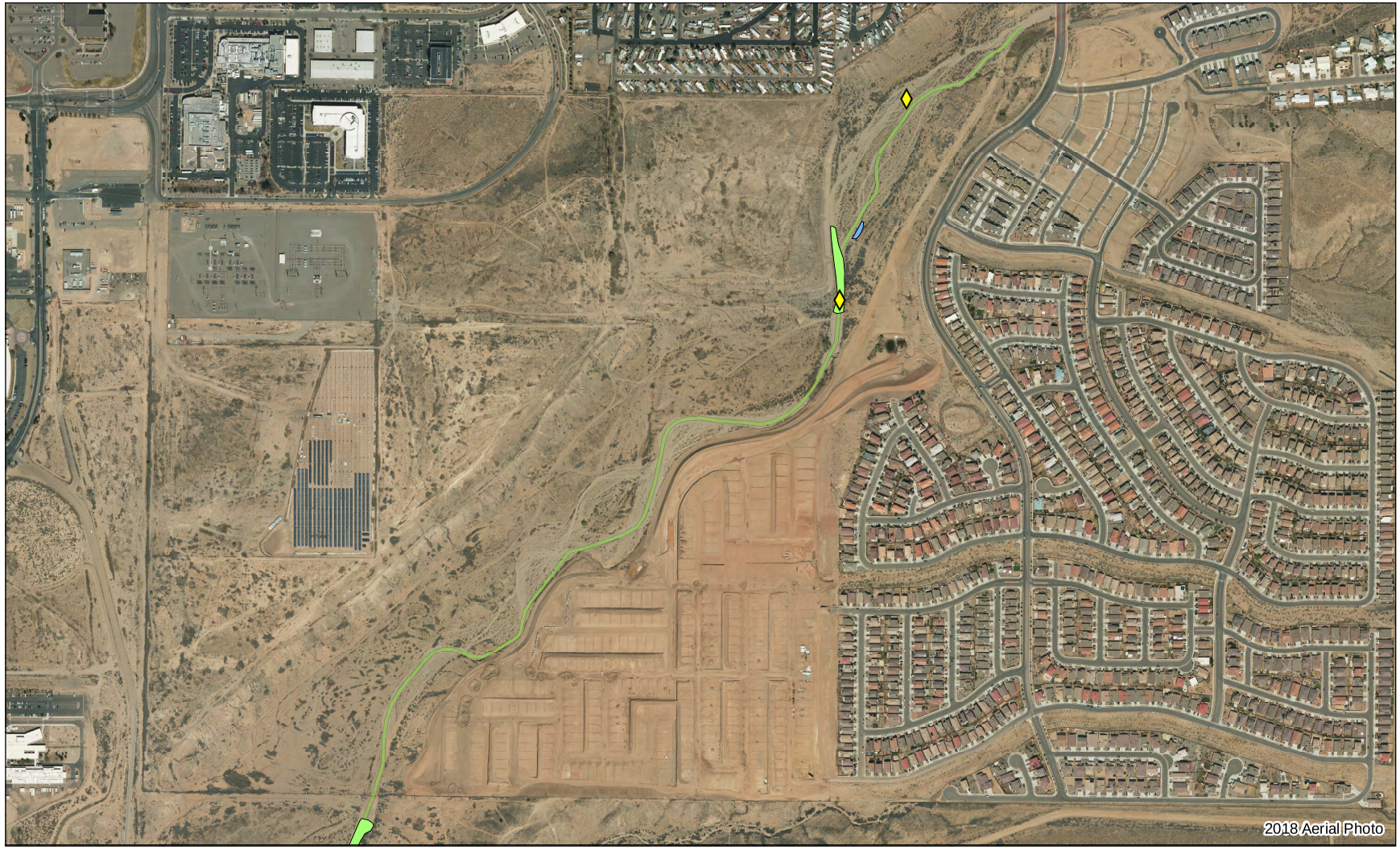
Sandia National Laboratories, New Mexico
Environmental Geographic Information System

0 112.5 225 450
Meters

0 0.1 0.2 0.4
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19230 08/23/19 SNL EGIS ORG. 0643



Legend

- Cross Section Locations
- PebbleCount Inside Channel
- PebbleCount Outside Channel
- Reach 7

Reach 7 Pebble Count Locations

Appendix J

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

0 87.5 175 350
Meters

0 0.075 0.15 0.3
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

Mapid = sc19229 08/23/19 SNL EGIS ORG. 0643



Legend

- Cross Section Locations
- PebbleCount Inside Channel
- PebbleCount Outside Channel
- Reach 8

Reach 8 Pebble Count Locations

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

0 75 150 300
Meters

0 0.05 0.1 0.2
Miles

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

N

EGIS

Appendix K – Field Photographs

No.	Description
K-1	Field Photographs

Appendix K-1

A printed copy of this document may not be the official version. The official printed copy of this UAA is located in the office of the Environmental Compliance and monitoring (Org. 0641).



Sub-reach 2: view of channel looking downstream (west) at the I-25 Bridge.



Sub-reach 2: view of channel looking upstream (east) from the I-25 Bridge.



Sub-reach 2: view of channel looking upstream (west) from the middle of the sub-reach.



Sub-reach 2: terrace walls, note the fine grained materials relative to channel.



Sub-reach 2: view of channel looking downstream (west) near top of the sub-reach.



Sub-reach 2: collapsed sanitary sewer from ca. 1980 due to terrace wall erosion.



Sub-reach 3: view of channel looking upstream at the bottom of the sub-reach.



Sub-reach 3: view of channel looking upstream near middle of the sub-reach.



Sub-reach 4: failed drop structure at bottom of reach (western boundary of KAFB).



Sub-reach 4: view of channel looking downstream near bottom of the sub-reach.



Sub-reach 4: marking transect location and bank full locations for survey team.



Sub-reach 4: example of a bank full survey point.



Sub-reach 4: looking downstream near top of reach.



Sub-reach 4: looking downstream near top of reach.



Sub-reach 5: looking upstream at Pennsylvania Road Bridge, top of reach.



Sub-reach 5: marking transect location for survey team near top of reach.



Sub-reach 6: looking upstream near bottom of reach.



Sub-reach 6: looking upstream near middle of the reach.



Sub-reach 6: looking upstream near top of reach.



Sub-reach 6: survey team measuring stream transect near top of reach.



Sub-reach 7: looking upstream near middle of reach.



Sub-reach 7: looking down stream near middle of reach at collapsed wastewater line from ca. 1980 and temporary sediment dam created to protect construction project.



Sub-reach 8: looking upstream from the south bank near bottom of reach.



Sub-reach 8: looking upstream near top of reach.



Sub-reach 8: looking downstream toward Juan Tabo Bridge. Note the persistent non-stormwater discharge from stormdrain leading to new development.



Sub-reach 8: looking upstream from Juan Tabo Bridge at vegetation related to persistent non-stormwater discharge from new development. The water does not reach the main channel of Tijeras Arroyo.