5-10-2011

Erosion potential of the main branch of the Piedras Marcadas Watershed, Petroglyph National Monument, New Mexico

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Submitted in partial fulfillment of the requirements for the degree of
Master of Water Resources Administration

To

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On:

March 29, 1999

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ACKNOWLEDGEMENTS

New Mexico State Highway and Transportation Department, Research Bureau.
Funding for this work is from the Research Bureau.

David Albright, Research Bureau Chief. I am indebted to David for his encouragement and observations concerning roads and equity for our New Mexican communities. Mr. Albright believes in and promotes strong research as the corner stone to understanding and resolving inequities in transportation. I am grateful for the gift of his vision.

Michelle Skrupskis, Planning Research Supervisor, for her research involvement, expertise, and friendship during my study.

ATR Institute
Judith M. Espinosa, Director, who worked out all the details so that I had the freedom to follow this path of study.

Fredrick Shean Jr., my field assistant, who was courteous and never complained of the heavy loads he was required to carry.

National Park Service, Petroglyph National Monument
Judith Cordova, Superintendent, who took a high interest in this study and then allowed many services in kind from her staff.

Michael Quijano, Chief Ranger, who opened his office for many conversations and suggestions.

Mike Medrano, Interpretation Specialist, who accompanied me on walks and performed the GPS mapping of my erosion pin and bridge stations.

Diane Souder, Assistant Superintendent, who briefed me on the historical aspects of the Monument and also roller-bladed my blues away.

Kerri Mich, GIS Specialist, of the NPS Intermountain GIS Support Center, for displaying my data in GIS format.

City of Albuquerque, Open Space Division
Dr. Matt Schmader, Assistant Superintendent, who was always available for discussions on the prehistoric to historic of this area.

United States Geological Survey

Dr. Allen Gellis, a geomorphologist who visited the study site and made practical suggestions and gave me great encouragement in collecting this information.

ABSTRACT

The Piedras Marcadas Watershed covers approximately 6 square miles west of the Rio Grande in Albuquerque, New Mexico. This watershed is semi-arid and has arroyos, ephemeral streams that empty into a retaining dam. During the fall of 1998, eleven erosion pins and bridges were placed to record the sediment eroded or aggraded. The erosion pins recorded erosion in a range of 0.05 to 4 mm erosion and aggradation of 2 to 10 mm. The erosion bridges recorded erosion in a range of 3 to 9 mm and 1.5 to 10.7 mm ranges of aggradation. Two modified universal soil loss equations were applied and contrasted to predict sediment loss for this watershed. The first equation values ranged from 0.5 to 17.5 and the second equation values ranged from 0.01 to 1.35 tons per acre per year. Sedimentation is a watershed management concern. Water and wind processes acting upon this area exhibit accelerated erosion.

The study site has a basalt escarpment rising 70 to 90 in as many feet. Four associated arroyos drain the watershed. Additionally, this area has 46 investigated gullies, four arroyo profiles, and one measured stratigraphic column.

The suggested erosion management plan is to monitor sediment loss in the main arroyo branch, eradicate non-native species, and plant black willows.

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Introduction

Why this project was chosen

I chose the Piedras Marcadas Watershed's southwestern escarpment as the study area because it combined issues I consider important in southwestern watershed management, namely arroyo erosion in culturally sensitive areas. The proposed Paseo del Norte transportation corridor, a four lane commuter highway that runs east-west in Albuquerque, New Mexico, is now allowed to extend through an area that previously was the National Park Service, Petrogylph National Monument's (Monument). This proposed transportation corridor would disturb a prehistoric to currently-used Native American sacred site. This proposed transportation corridor is also the northern boundary of the Atrisco Land Grant, marking the first Europeans, the Spanish colonists who settled in this area. This proposed transportation corridor also generally separates the cities of Paradise Hills and the West Side of Albuquerque, New Mexico. This road is a nexus of cultures, land use, and desires. Many people have strong feelings on the best use of this parcel of land.

The Piedras Marcadas is a small watershed located west of the Rio Grande (Map 1) in Bernalillo County, New Mexico that reflects this multiple ownership and authority dilemma. A federal authority is the Petroglyph National Monument. The Monument currently has authority over a large area of land that encompasses the basalt escarpment on the western edge of the City of Albuquerque. The Monument runs in a northeast to southwest direction and was a barrier to all roads that would run west of the natural landforms defining the City of Albuquerque. The Monument exists in the north from the city political boundary approximately five and a half miles south to just north of Interstate 40. A September 1998 U. S. Congressional vote [Public Law 105-174 (9-30-1998)] removed the federal portion of this proposed transportation corridor, allowing for the extension of the road past the Monument boundary and into undeveloped land. Paseo del Norte would run to the west and connect with the proposed Middle Unser Boulevard. These transportation corridors would allow the regional connection of the cities of Rio Rancho, Sandoval County, Paradise Hills, an unincorporated city in Bernalillo County, and Albuquerque, New Mexico.

The New Mexico State Highway and Transportation Department's Research Bureau (NMSHTD/RB) funded this research. The Alliance for Transportation Research (ATR) Institute, University of New Mexico, U.S. Geological Survey, Albuquerque Office, and the Petroglyph National Monument supported this research in kind.

<u>Watershed Perspective: Defined</u>

All the high points that allow water to flow downhill to a river, lake, or ocean define a watershed boundary. Dunne and Leopold (1978) defined a drainage basin or watershed as the area of land that drains water, sediment, and dissolved materials to a common outlet at some point along a stream channel. When a watershed includes an urban area, gullies, streams, groundwater bodies, urban storm drains, industrial-cooling systems, and irrigated fields are linked as components of the drainage basin. Many authors have described a watershed boundary (Potter, 1990; Tolisano, 1990; Fleming, 1983; Sheng, 1986). A watershed is not just a surface water system, but rather the complex web of life, landscape, and commingled groundwater. This life includes the human populations living within its boundaries as well.

The geology and geomorphology of an area such as a watershed can define and shape a culture. Human populations evolved and flourished on the banks of alluvial rivers such as the Nile and Euphrates. Our own Rio Grande is an alluvial stream, a stream that transports the sediment in which its channels lie. I suggest that water is more than a commodity; it has many significant cultural, religious, and legal aspects interwoven with its own riparian and groundwater complexity. My definition of a watershed includes these human aspects or values along with the scientific observations and methods used in the engineering, geological, and biological disciplines. The science and engineering aspects are required components in understanding the watershed. It is also important to understand and collect information on the land use patterns, cultural needs, and community assessments within the watershed. This information is now also required. Understanding the human component, that which has been more the domain of public policy rather than science, is important for present and future discussions with the community on the condition or changing conditions of their watershed. This research will address a small portion of a watershed assessment of the Piedras Marcadas Watershed, that of the erosion potential of the arroyos below the escarpment in southern portion of Unit 23 in the Petrogylph National Monument.

In summary, each generation of man leaves their mark on the hill. We now have bulldozers that within a day can destroy what geologic time has created. Luna Leopold (1962) suggested that a watershed network based on simple observations begin. This network, which he called the Vigil Network, would be a baseline of studies within a watershed to describe its soil, geology, topography, and vegetation. This is what I have investigated at this study site. I have compiled this information and used simple, but accurate, techniques to describe the arroyo and slope erosion potential.

Report Content

This report will discuss the Piedras Marcadas watershed with respect to the arroyo and slope erosion observed in the fall 1998 and the land use change through time as observed from aerial photography spanning from 1935 to 1996. The main body of investigation is the scientific and physical observations of the watershed with respect to erosion. This will include the disciplines of geology, soils, and hydrology. The second portion is the historical observations aerial photography affords.

Description of the Piedras Marcadas watershed

Geographic Setting

The Piedras Marcadas watershed is located west of the Rio Grande in Albuquerque, New Mexico. The watershed boundary is outlined on Map 1. This watershed covers approximately 6 square miles or 1320 hectares. The Arroyo de las Calabacillas bounds this small watershed to the north and the Boca Negra bounds it to the south. The headwaters are a high point to the west. The drainage is dendritic with some sense of a palmate pattern.

Previous authors (Simons, Li & Assoc., 1985; Molzen-Corbin & Assoc. et al., 1993) have described this watershed as approximately 5.6 square miles and as having a further western boundary (Map 2). The topography at the Albuquerque Corporate Boundary denotes the mesa as increasing in topography until it reaches a dip at the 5500-foot contour interval. I have placed the western edge of the watershed at the first 5500-foot contour line after field checking this location. Acreage west of this boundary drains to the Boca Negra Arroyo. The contractors have used a different shaped watershed to calculate the erosion and flood potential. I believe that these numbers are incorrect due to the boundary supplied or delineated. A comparison of these different shapes is provided as two boundary lines on Map 1.

The study area can be divided into three sections. The first section is the upper watershed that is currently undeveloped rangeland, but could be developed in the future. The second section is the escarpment area that is included within the Petroglyph National Monument. This section is currently in a conservation state, except for the narrow transportation corridor that is now legally allowed to traverse the Monument. The third section is the lower portion of the watershed and is the urban section that is predominantly zoned with residential single dwelling homes and light commercial establishments.

There are four main ephemeral streams within the Piedras Marcadas watershed. The north branch runs predominantly due north and is directly east of the current Golf Course Road. The middle branch drains the main Piedras Marcadas Canyon within the Petroglyph National Monument and drains from the west to a southeast direction. The main stem of the Piedras Marcadas is the area of study for this report. This arroyo drains from the northwest to the southeast and runoff will flow into the AMAFCA Piedras Marcadas Dam, built in the Spring of 1984. The south branch flowed from the south to the north and is now a developed drain within the Taylor Ranch subdivision of Albuquerque's West Side.

The branches of the Piedras Marcadas did at one time flow unhindered into the Rio Grande. The construction of the AMAFCA Corrales Main Canal in 1933 provided a new diversion path to the Rio Grande. The drainage, prior to the City of Albuquerque flood intervention, is projected to have flowed into the Rio Grande near the current Petroglyph National Monument lands east of Coors Boulevard (Map 1). This federal site is conserving an estimated 1000 room prehistoric Indian community. The cottonwood trees mark the last flood cycle of the Rio Grande, outlining an ancient oxbow. The prehistoric Indian community resided on the banks of the ancient oxbow and along side the Piedras Marcadas Arroyo. The Monument was created in 1990 to protect and conserve this cultural heritage site. In 1984 AMAFCA built the Piedras Marcadas Dam and the dam has become an artificial barrier to the Rio Grande. My outline of the watershed now has a second eastern limit of the dam as its boundary.

Boundary changes, 1954 to 1990

Comparison of the Los Griegos, New Mexico, 1954 United States Geological Survey (USGS) topographic map (Map 3) as compared to the updated 1990 Los Griegos (Map 4) topographic map shows changes to the watershed boundary, branches, and culture. The east boundary where the arroyo entered the Rio Grande has significantly changed with the installation of Corrales Main Canal in 1933 and with the installation of the Piedras Marcadas Dam in 1984. The ephemeral arroyo waters no longer naturally enter the Rio Grande, but are instead detained by the flood control dam. This in effect decreases the watershed to approximately 6 square miles.

A comparison of these two maps shows that the Main branch of the Piedras Marcadas is left off the 1990 map. The dashed blue line symbol does not exist in the 1990-updated version.

The cultural changes to the watershed are significant from the 1954 to the 1990 USGS maps. There were only two windmill symbols on the 1954 map signifying little to no cultural land use. The middle and south branch are not distinguishable within the development of West Side in the 1990 map. The 1990 map shows 40 percent (1,377 acres) of the watershed developed. The main residential development is single family homes and light commercial development. There are 396 acres protected by the Petroglyph National Monument within this watershed. This leaves 2,463 acres undeveloped in 1990.

In September 1998, the United States Congress removed a small width of the federal layer from the Petroglyph National Monument in order to allow for the proposed construction of the extension of Paseo del Norte, a four lane commuter highway, through the Monument. The proposed transportation corridor (City of Albuquerque, 1993) is in the south part of this study area (Map 5). The construction of a road would create additional sedimentation and drainage requirements. This one season collection of slope and arroyo sedimentation is offered as data to consider prior to designing any road through this Monument.

Geologic setting

This study area lies within the Middle Rio Grande Rift system. The rift basin is about 102 (164-km) miles long in the north-south direction and 25 to 40 miles wide in the east west direction (Kelly, 1977). The basin is filled, at maximum depth, with 12,000 feet of sandstone, mudstone, and gravel of the Santa Fe group of Miocene-Pliocene age (Map 6). The Albuquerque Basin is developed from the Rio Grande Rift. A series of two parallel down-dropped faults define the rift, which the present Rio Grande follows. The separation of the two sections of the North American Continental Plate caused a large segment of the Earth's crust to sink, creating the rift depression. The volcanism on the West Side is a response to the thinning of the crust at the rift system axis.

The modern topography of the Rio Grande Valley is largely a product of block faulting in late Tertiary time (King, 1977). The river is structurally controlled within the rift and has found and followed this pre-established rift trough (Chronic, 1987).

The study area also has a geologic feature called reverse topography. The fissure eruptions extruded lava that flowed into the lowest reaches of the topography, or the then current arroyos. Through geologic time, the resistant basalt flows are now on top, or reversed, as the cap rock to the Santa Fe group. The current flows outline the previous gullies. This is probably most clearly seen in the crescent shape of the eastern-most mesas in this study area. The eroding sediments under the basaltic cap are the prior arroyo's sediments. This explains the fine to medium-grained nature of the sand and the associated silts below the basalt cap. There is little to no clay associated with the current arroyo debris.

Stratigraphic section

The stratigraphic section was measure to define the study area's stratigraphy. The stratigraphic section (Figure 1) shows two stratigraphic units in this field area. The youngest unit is the Basalt mesa cap rock, extruded 110,000 years before present. This basalt flowed from a long crack in the earth that the five West Side volcanoes now mark. The multiple flows filled the low-lying drainage areas such as valleys and arroyos. This has produced a reverse topography, which allows geologists an insight into the previous drainage system.

The older unit is the Tertiary Santa Fe group (Chronic, 1987) and consists of arkosic and quartz-rich, unconsolidated silty sand. This sand is light tan in color. This lithology is friable or easily eroded to the touch. There are large amounts of blow sand in the area.

Soils

There are ten exploratory soil borings in the Piedras Marcadas Watershed conducted by Geo-Test (1993). Of these ten borings, one is in the field study area and five are proximate to the field study arroyos. These borings found that a thin layer of topsoil covering the volcanic material characterizes the mesa top above the escarpment. Secondly, the soil structure below the escarpment shows typical soil layering with no volcanic material within the borings. Third, the sampled arroyos showed typical silty sand material for the entire depth of the bore with no change in lithology encountered at depth (Molzen-Corbin & Associates et al., 1993). My field observations of these arroyos confirm the borings.

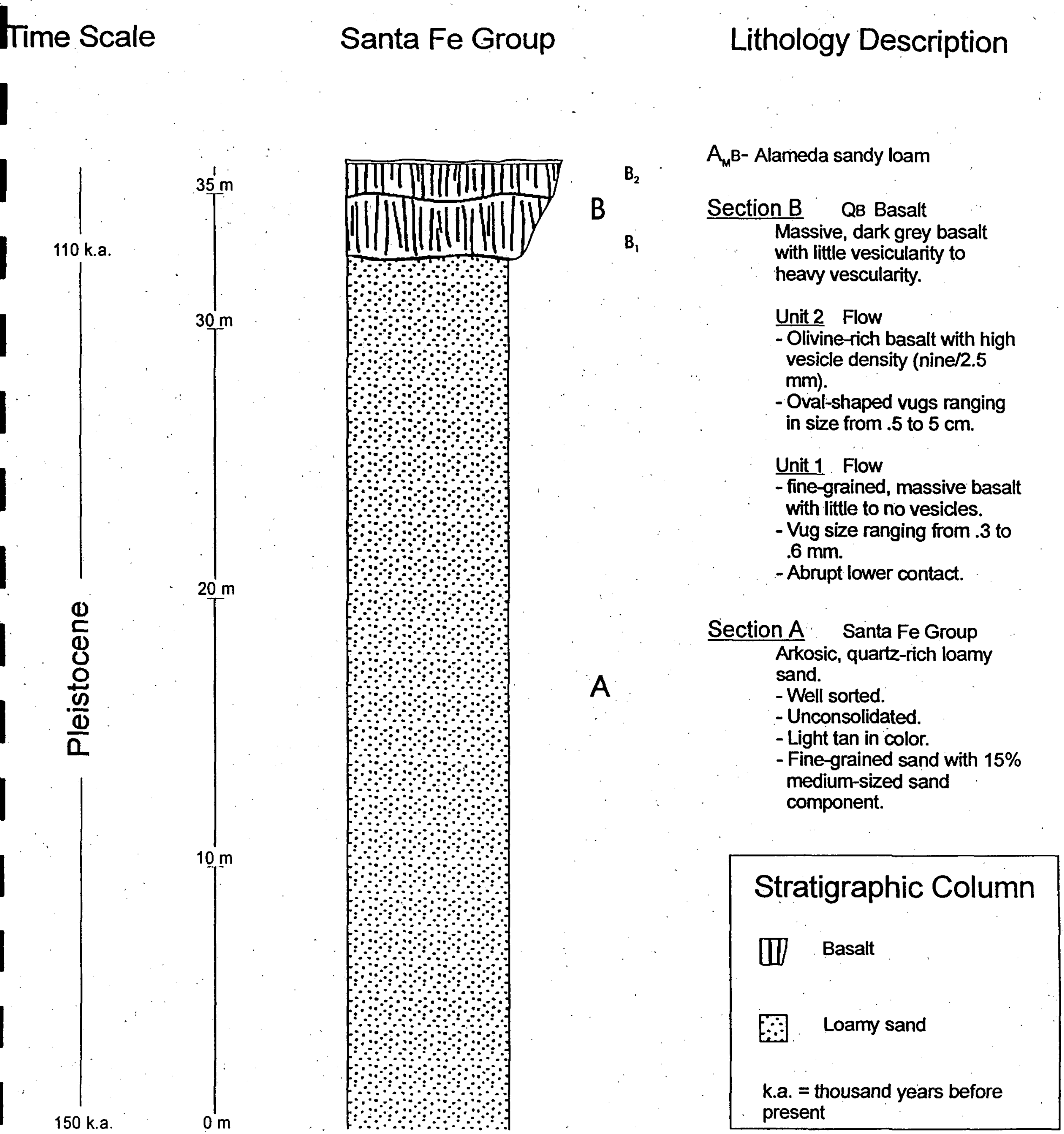


Figure 1. Stratigraphic Section

The soil types within the field area are: AmB (Alemeda sandy loam) [Note: Alameda is the correct Spanish spelling for a nearby town and for a cottonwood tree, however the Soil Conservation supplies a different spelling] on top of the West Mesa, KR (Kokan-Rock outcrop association) which is a thin line of top of the basaltic escarpment, BCC(Bluepoint loamy fine sand) in the arroyos to the west and the floor of this area, and BKD (Bluepoint-Kokan association) in the south within arroyo 1 (Map 7) (USDA Soil Conservation Service, 1977). The soil properties are displayed in

Table 1. The soil types within the study area and their associated water runoff, soil blowing capacity, soil permeability, and propensity for water erosion (USDA Soil Conservation Service, 1977).

Soil Type	AmB Alemeda sandy loam	KR Kokan-Rock outcrop association	BCC Bluepoint loamy fine sand	BKD Bluepoint-Kokan association
Runoff	Medium	Slow/rapid on basalt outcrop	Slow	Slow
Soil blowing	Moderate or severe		Severe	
Permeability	Moderate		Rapid	Rapid
Water erosion	Slight	Moderate/slight on basalt outcrop		Moderate to severe

The USDA Soil Conservation Service, 1977 describes these soil types as the following:

- **AmB** or Alemeda sand loam is found on 0 to 5 percent slopes. From 10 to 30 percent of this mapping unit is a basalt rock outcrop and Akela soils. The soil is used for range, wildlife habitat, watershed, and community development.

- **BCC** or Bluepoint loamy fine sand is found on 1 to 9 percent slopes. This soil series consists of deep, somewhat excessively drained soils that formed in sandy alluvial and eolian sediments on alluvial fans and terraces. The slopes are 1 to 15 percent. The soil is slightly calcareous and mildly or moderately alkaline.
- **BKD** or Bluepoint-Kokan association is approximately 50 percent a loamy fine sand on 5 to 15 percent slopes and approximately 40 percent a gravelly sand on steep slopes of 15 to 40 percent. In Bernalillo County it has been a major source for sand and gravel products.
- **KR** or Kokan-Rock outcrop association is approximately 75 percent a gravelly sand on 25 to 45 percent slopes and 10 percent nearly vertical basalt rock outcrop. This unit is at the edge of the basalt mesa breaks on the West Mesa.

Erosion Potential

Types of Erosion

The four types of rainfall erosion are: raindrop splash, sheet erosion, rilling, and gulling (Roberts, 1995). Rain splash erosion is an important overall element to semi-arid climates. A raindrop posses considerable kinetic energy, and falls at terminal velocity. In high-intensity rains, drops usually reach a maximum size of approximately 6mm and a terminal velocity of about 9m/sec (Ritter, 1978). This impact can directly displace a soil particle 10 mm in diameter downslope. The amount of soil moved by a splash is dependent on the kinetic energy of the raindrops, the type of soil, and the steepness of the slope. Free (1960) found that the kinetic energy (E) is $E^{1.46}$ for sand

and discovered that over a five-year period the total splash loss from a sandy surface is calculated at 1600 tons/acre. I suggest that rain splash erosion is a primary method of soil erosion on slopes and in arroyos in this field area in non-monsoon seasons. The data collected from the erosion bridges and pins demonstrate the high movement of soil despite little sustained precipitation.

Sheet erosion is the removal of soil from sloping land in thin sheets or layers (Roberts, 1995). Sheet erosion is the transport mechanism for soil dislodged by the raindrop splash. Sheet erosion is suggested as a one of the main mechanisms for transporting soil downslope.

Rill erosion occurs when rainfall and flow become intense, and small shallow channels may form. Rills form in fine-grained soils and display a set of well-defined sub-parallel channels (Ritter, 1987). Rills are commonly seen in construction zones where the land has been bulldozed and is exposed to runoff without vegetative cover, or natural topography or channels. Surprisingly, rills are not seen in this study area. There are rills immediately outside the study at the current construction locations and near the storm drain that conveys the Middle Branch arroyo.

Gully erosion is the result of a concentrated flow much greater than in rills (Roberts, 1995). In the southwest large gullies are termed arroyos and comprise the ephemeral drainage. There are four major arroyos in this study area.

Overgrazing of land has been shown to increase erosion, sedimentation, and encourage the development of arroyos (Thornthwaite et al., 1942; Antevs, 1952; Cooke and Reeves, 1976). War I and II intensified the need for wool and beef and New Mexican ranchers were offered incentives to overgraze their lands for the war effort

(Peña, 1997). This study area includes the historic grazing property of the Atrisco Land Grant. This study site may have been overgrazed in the past.

Geomorphology of Arroyos

Arroyos are ephemeral flow stream channels characterized by steeply sloping or vertical banks of fine sedimentary material and flat, generally sandy beds (Fairbridge, 1968). Gary et al. (1972) define an arroyo as "a term applied in the arid and semiarid regions of the southwestern U.S. to the deep, flat-floored channel or gully of an ephemeral stream or of an intermittent stream usually with vertical or steeply cut banks of unconsolidated material at least 60 centimeters high, that is usually dry, but may be transformed into a temporary water course or short lived torrent after heavy rains."

In the Albuquerque area, arroyos are the main conduit for the occasional thunderstorm induced runoff and the associated sediment derived from their watersheds. The Piedras Marcadas watershed is composed of highly erodible soils and flooding is normally caused by high-intensity thunderstorm events. This combination of soil and storms carries a high potential for significant erosion and or deposition of large quantities of sediment (Simons, Li & Assoc, Inc., 1985). This arroyo system discharges water only when the monsoon season produces heavy rains, a typically late summer event. The fall (August 26 through November 17, 1998) rains that this study sampled are of too low of an intensity to provide runoff. These rains also do not cover a basin wide area and therefore did not have enough input over the basin area to provide for runoff.

Cooke and Reeves (1976) reviewed arroyo development and concluded that the initial cause of erosion for many arroyos is the development of roads and trails or other activities that confine the flow and permit incision to occur. The other primary theories for historical arroyo incision and backfilling are due to climate change (Love, 1979), the exceedence of geomorphic thresholds (Schumm and Hadley, 1957; Schumm, 1973; 1977), and intrinsic arroyo geomorphic variables (Elliot et al., 1999; Patton and Schumm, 1975). Ironically, the link between roads and arroyos goes back to the 1600s. The American Geological Institute found a definition for a gully that described it as that feature which could not be crossed with the wheel of a wagon.

It is important for professionals in all aspects of development to understand how arroyos form and evolve within the Albuquerque basin. This knowledge will aid those professionals in better planning how to development of our community. Best practices in land and water use management requires planners and others to understand the basic science and engineering principles for competent infrastructure development. Geomorphologists suggest identifying which stage of evolution the arroyo in question has achieved prior to placing infrastructure or erosion control. The stages of arroyo development as defined by Gellis (1998) are incision, widening, and development of an incipient flood plain, complete filling or alternately re-incision of fine load to a wider channel. The study area's middle section arroyos are incised and without terraces or flood plains. There is little to no incision in the upper section of the watershed, that area on top of the mesa. The AMAFCA channels in the lower section are concrete lined and do not qualify as arroyos.

Study Area Arroyos

The Piedras Marcadas Basin morphology is a dendritic pattern that has two orders of streams using Horton's (1945) drainage composition method. The slope of this watershed demonstrates a typical arid slope profile in having a cliff with an abrupt vertical angle, a debris slope, and a desert plain (Ritter, 1978). The arroyos have a continuous gully system in the study area. The study area is below the escarpment and within the Petroglyph National Monument. The area is the southern portion of Unit 23 of the Monument. Arroyo 1 (Map 8) has a V shape or a broad inverted triangular shape, as Arroyos 2 and 3. Arroyo 4 has a very broad, flat-bottomed U shape.

Accelerated erosion in the West is a problem of great social and economic importance (Leopold and Miller, 1956). Arroyo development and incision can cause failure of bridge crossings and damage to utility crossings (Shen et al., 1981). Channel erosion can cause increased sediment delivery downstream that can lead to either increased flooding or a decrease in the reservoir capacity (Mussetter et al., 1994). Arroyo incision can also lead to a lowering of the water table and this in turn threatens the survival of floodplain vegetation. This vegetation usually increases the resistance of the channel to lateral erosion (Gellis et al., 1991). A watershed approach to maintaining the watershed is a proactive method to maintain both cultural developments and the integrity of the natural watershed environment.

Hydrology

Temperature

The study area has a semi-arid climate. The fall temperatures ranged from an average low of 25° F to an average high of 94° F (U.S. NOAA, 1998). The wind velocity is not available for this area.

Table 2. Petroglyph National Monument, New Mexico (station 6754) low and high average temperatures for the fall of 1998 (Appendix A).

1998 Month	Average Low (°F)	Average High (°F)
August	63°	94°
September	59°	91°
October	44°	74°
November	32°	62°
December	25°	56°

Precipitation

The average annual precipitation on this watershed is 7 to 10 inches (Simons, Li & Assoc. Inc., 1985). The year I have sampled is classified as an El Niño year that is also demonstrating the associated change into a La Niña weather year. The La Niña weather properties in New Mexico are traditionally years of less precipitation to extreme drought (Clifford Dahm, UNM, pers. comm., 1998). The Petroglyph National Monument rain gage, located approximately three miles south of the study area, provided the precipitation data used in this study area (Appendix A). For the study period of August 26 through November 17, 1998, 2.27 inches or approximately 60 mm of precipitation was recorded at the Monument Visitor's Center. This rain occurred in eighteen events.

Runoff

There was no runoff recorded during this investigation. No gage exists on this watershed. The developed portions of the watershed require drainage control. The drainage control in the Main branch has been developed into a concrete-lined trapezoidal channel that runs without meanders to the Piedras Marcadas Dam. The channel was walked on 2-14-99 and there was no sediment within the channel, except where a large concrete pylon was discarded, trapping sediment behind it. The area above the channel is concrete-lined and borders to mason walls of private houses.

Piedras Marcadas Dam

The Piedras Marcadas Dam is approximately one-half mile south and west of the Coors Boulevard and Paseo del Norte intersection. The Dam is approximately 1200 feet by 900 feet (Map 4) and was completed in June, 1984. The Piedras Marcadas Dam is an earthen structure 28 feet in height above the ground at the centerline. The bottom of the dam is also dirt.

AMAFCA controls the flow from the southeast portion of the dam to the Corrales Main Canal. Once in the Corrales Main Canal it flows south and intersects the Rio Grande just north of the current La Orilla Road. Floodwaters can be released from the dam when the floodwaters recede in the Corrales Main Canal.

The north branch empties into the main branch concrete-lined channel. The middle branch empties into the main branch just above the point where the concrete main channel begins. The south branch turns north and is channeled into the dam.

This facility has the following design parameters (Molzen-Corbin & Associates et al., 1993):

- a design storage capacity of 249 acre-feet (AF) at elevation 5032.0 feet
- dam crest elevation of 5043.5 feet
- a principal spillway capacity at elevation 5032.0 feet of 90 cubic feet per second (cfs)
- The 24-hour storm runoff volume table has the volume of sediment as: 40 AF of sediment with the existing condition with a 20% sediment load.

The dam is not designed for long-term accumulation, but rather to be cleaned when required. The maintenance records show the annual sediment accumulation to be 0.02 acre-ft/mi^2/year (Heggen, 1992).

This dam has adequate containment capacity for the 100-year, 6-hour storm event (Molzen-Corbin & Associates et al., 1993). Molzen-Corbin & Associates et al (1993) strongly suggest that with increased development within the watershed, the increased runoff will exceed the capacity of the Piedras Marcadas Dam. The 1993 peak discharge reaching the dam is approximately double the level from the historic condition (Ibid.).

Water quality

There are no water quality data for interpretations in this watershed.

Vegetation

The undeveloped portion of the watershed contains a diverse native and non-native flora. Common trees, shrubs and grasses of Petrogylph National Monument are:

- Cupressaceae (*Juniperus monosperma*), One-seed Juniper, "berries" are cones and are a food source
- Anacardiaceae (*Rhus trilobata*), Lemonade Bush, food source
- Asteraceae (*Gutierrizia spp.*), Snakeweed, indicator of overgrazing, medicinal herb
- Agavaceae (Yucca glauca), Soapweed yucca, fruit bearing
- Asteraceae (*Artemisia filifolia*), Sand Sage, indicator of deep sandy soils
- Cactaceae (*Opuntia imbricata*), Cane Cholla, fruit bearing
- Cactaceae (*Opuntia polyacantha*),Plains Prickly Pear, fruit bearing
- Chenopodiaceae (*Krascheninnikovia lanata*), Winterfat, high nutritional value
- Fabaceae (*Psorothamnus scoparius*), Broom Dalea, very aromatic
- Chenopodiaceae (*Atriplex canescens*), Four-Wing Saltbush, nutritionally important to browsers
- Globemallow (*Spheralcea angustifolio*)
- Jimsom Weed (*Daturo inoxia*)
- Threeawn Grass (*Aristida pansa*)
- Needle Grama (*Bouleloua aristoides*)
- Side-Oats Grama (*Bouteloua curtipendula*)
- Black Grama (*Bouteloua eriopoda*)
- Fluffgrass (*Erloneuron putchellum*)
- False Buffalograss (*Monroa squarrosa*)
- Indian Ricegrass (*Oryzopsis hymenoides*)
- Burrograss (*Scleropogon brevifolius*)

- Spike Dropseed (*Sporobolus contractus*)
- Sand Dropseed (*Sporebolus cryptandrus*)
- Mesa Dropseed (*Sporobolus giganteus*)
- Needle-and-Thread Grass (*Stipa neomexicana*)
- Porcupine Grass (*Stipa spartea*)
- Six Weeks Fescue (*Vulpia octoflora*)
- Ring Muhly (*Muhlenbergla pungens*)

The common mammal species present in the Monument are listed below. Coyotes and hawks are present in the upper and middle watershed and as predators are indicators of an adequate ecosystem web. It is assumed that these mammals may be present in the undeveloped upper and middle portion of the Piedras Marcadas watershed.

- Coyote (*Canis latrans*), common
- Whitetail Antelope Squirrel (*Ammospermophilus leucurus*), common
- Rock Squirrel (*Citellus variegatus*), near roads
- Spotted Ground Squirrel (*Citellus spilosoma*)
- Pronghorn Antelope (*Antilocapra americana*), rarely seen
- Kangaroo Rat (*Dipodomys spp.*), common
- Deer Mouse (*Peromyscus maniculatus*), Hanta virus carrier
- White-throated Wood Rat (*Neotoma albigula*), packrat
- Black-tailed Jackrabbit (*Lepus californicus*), common

- Desert Cottontail (*Sylvilagus audubon*i), common

Study Site Erosion Values

<u>Universal Soil Loss Equation</u>

I will be using two Universal Soil Loss Equations (USLE) for this study. The first will be a modified USLE equation used in watershed management, which gives the computed soil loss in tons per acre per year. The second equation is a USLE equation used in hydrologic engineering and calculates soil loss in tons per acre per storm event. Both will be presented and compared for this study.

The Universal Soil Loss Equation (USLE) was developed by the United States Department of Agriculture (USDA) Agricultural Research Service in 1965 in order to have a more widely applicable erosion prediction technique for agricultural plots under natural rainfall (Brooks et al, 1997). The basic USLE equation (Wischmeier and Smith, 1965; 1978) is:

$$A = RK(LS)CP \qquad \text{(Equation 1)}$$

where A is a computed soil loss in tons per acre; R is a rainfall erosivity factor for a specific area; K is a soil erodibility factor for a specific soil horizon; LS is a topographic factor; C is a dimensionless cropping management factor; and P is an erosion control practice factor. This field site is not under agriculture, but is a rangeland. The USLE is modified to be applicable in rangelands and forests. The cropping management (C) factor and the erosion control practice (P) factor are replaced with a vegetation management (VM) factor to form the Modified Soil Loss Equation (MSLE):

$$A = RK(LS)(VM) \qquad \text{(Equation 2)}$$

where VM is the vegetation management factor, the ratio of soil loss from land managed under specific conditions of vegetative cover. Within the VM factor, three effects are noted: the canopy cover; low-growing vegetative cover, mulch, and litter; and bare ground with fine roots. These three factors multiplied together create the VM factor. A visual inspection of the vegetation using a four feet square area in this field area provided the VM information.

<u>AMAFCA Preference</u>

The Modified Universal Soil Loss Equation (MUSLE) preferred by AMAFCA (Mussetter et al., 1994) and described by Williams and Berndt (1972) is

$$Y_s = \alpha(Vq_p)^\beta \text{ KLSCP} \qquad \text{(Equation 3)}$$

where the Y is the sediment yield for the storm in tons; V is the runoff volume for the storm in acre-feet; q_p is the peak discharge of the storm in cfs; K is the soil erodibility factor; LS is the topographic factor representing the combination of slope length and slope gradient; C is the cover and management factor, and P is the erosion control practice factor. The values for α and β are dimensionless numbers derived from experimental watersheds in Texas and Nebraska (Mussetter et al., 1994). The α value is modified for the Albuquerque area to be 285 and the β value of 0.56 is taken from the out-of-state experimental watersheds.

In both equations the topography coefficient, denoted by LS, is measured at the nail and bridge sites for the slope up to the top of the mesa. This measurement is not expanded to the entire watershed. The calculated number represents the study site in the second section of the watershed

Engineered flood control of our arroyos is the city's public policy. The AMAFCA Board and staff are recently allowing aesthetics, joint use, and wetlands protection as the evolving engineering of flood control (John Kelly, Chief Engineer, AMAFCA, pers. comm., 1999).

Sediment Erosion - Field Collection Method

Eleven erosion pins and eleven erosion bridges were constructed in this field site. The erosion pins were placed within the arroyos and the bridges were placed on the slopes. Map 9 shows the location of the bridges and pins. At each station the vegetative cover percentage is noted. The grain size of the sand or soil was determined using a common field identification grain size folder (Gamma Zeta Chapter, 1968). A comparison between the pins and bridges is then a comparison between arroyo erosion and slope erosion in the study site.

Erosion Pins

The erosion pins are of two types, the first is a galvanized nail 6.8 mm in length with an associated washer, and the second is a steel nail 10.6 mm in length with an associated washer. The galvanized pins have a higher variety of measurement as compared to the steel pins placed 6 cm apart. I choose to use the steel data for this investigation. The erosion pins were placed flush in the ground with the nail heads exposed. They were checked periodically (field data are in Appendix B) and measured and recorded for erosion or aggradation. Since this field site is in a National Monument and has an Open Space designation, the erosion pins were placed in the least visible locations. Hiding these pins meant placing them closer to grasses and bushes than was desired for erosion data collection. However, field visits to these pin sites that were not hidden did have human disturbance. People would pull the erosion pins completely out the ground and leave them at the site. People, pets or game stepped on the erosion pins. These disturbances resulted in a new placement. While some stations had data loss, there is still enough information to give a seasonal description of the erosion or aggradation.

A few weeks after placement of the erosion pins, it was discovered that several sites were buried, rather than eroded away. This resulted in a change of placement method. I decided to adjust several of the pins 2-cm out of the ground. This was only done with the steel pins because they are longer. This adjustment allowed for the collection of aggradation in a direct manner. I measured the galvanized nail by poking the measurement tool to the top of the nail head and adding the width of the nail head to provide the correct number.

The erosion for this site is high, in both the arroyos and slopes. The collected data highlight that one season of erosion or aggradation is higher than the suggested tolerance level (Rollins, 1981). Rollins (1981) suggested to the world community that 1 ton of soil loss per acre per year is sustainable soil loss. Further, 1 mm of soil loss per acre is equivalent to 1 ton per acre per year.

The following data has negative numbers for erosion and positive numbers for aggradation. The ranges of values are 1.0 to 4.0 mm-eroded soil loss and 2.0 to 10.0 mm for soil aggradation.

Table 3. Field data from the steel erosion pins, fall season 1998.

Erosion Pin Station	Steel (mm) Average erosion Fall 1999
EP-1	- 2.0
EP-2	- 1.0
EP-3	+ 2.0
EP-4	- 2.0
EP-5	+ 2.0
EP-6	+10.0
EP-7	- 1.0
EP-8	- 2.0
EP-9	- 1.0
EP-10	- 0.05
EP-11	- 4.0

Table 4. Comparison of the field data for fall season 1998 with the calculated Modified Universal Soil Loss Equations 1 and 2 applied.

Erosion Pin Station	MSLE Equation 1 tons/acre/year	MUSLE Equation 2 tons/acre/avg. event
EP-1	1.61	.28
EP-2	0.38	.06
EP-3	0.09	.02
EP-4	3.20	.57
EP-5	1.10	.19
EP-6	1.43	.25
EP-7	1.33	.23
EP-8	0.10	.02
EP-9	0.14	.03
EP-10	0.38	.07
EP-11	0.93	.16

The equation 1 values range from 0.09 to 3.2 tons per acre per year of sediment accumulation. Equation 2 calculations show no averaged storms producing the sediment that exceeds the recommended soil loss. Using Rollins's (1981) suggestions of tolerating only one ton per acre per year of rangeland soil loss, this study site has five sites that exceed Rollins's recommendation for a healthy rangeland. 1 mm of soil loss over an acre of rangeland is equivalent to one ton per acre of erosion (W. Fleming, UNM, pers. comm., 1998). The MSLE equations are calculated using observations from the field sites (Appendix B). The second USLE follows using field observations and using the recommended values for K for use in the Albuquerque area (Appendix B).

Erosion Bridges

Erosion bridges were constructed from two four-foot rebar pieces. A measurement tool was constructed from a 1"x48" aluminum hollow square tube, 1/16" thick purchased from a hardware store. This tube had a set of holes, one meter apart, drilled into the tube. These holes were drilled on one side only to accommodate the width of the rebar. This tool then had every five centimeters marked off in pen and cut in with a pocketknife.

To construct the bridge, the first rebar was pounded into the ground with a sledge. The measurement tool would then be placed on the initial rebar to find the second rebar placement. The rebar was then pounded into the ground until approximately 6 inches of rebar was left exposed. With rebar pieces in place parallel to the slope, the tool was placed on the rebar and a level was placed on the tool. Once the bridge was leveled, the tool was used to mark off every five centimeters of bridge and I would measure down to the slope in millimeters. I averaged the 20 numbers across the plane of the bridge to provide one number that defines the slope soil erosion. This information was recorded and statistical analysis was performed on the data (Appendix C). Erosion bridges are a simple, low cost and accurate method to determine the erosion potential of a watershed basin.

The field data for the erosion bridges show that from 1.5 to 10.7 mm of soil were lost from the stations on these slopes. Also, that 3 to 9.6 mm of additional soil was added at stations 2 and 3. It is not known if the soil aggraded at the site washed downhill or was wind blown to the site.

Table 5. The averaged erosion across the 1-meter bridge measured in the fall of 1998.

Erosion Bridge Station	Average Erosion in mm Fall Season, 1998
1	+1.5
2	- 9.6
3	- 3.0
4	+10.7
5	+2.2
6	+1.6
7	+6.2
8	+1.4
9	+6.3
10	+6.5
11	+7.0

The field data indicate that the measured slopes have a range of soil loss from 3 to 9.6 mm. The field data indicate that 1.4 to 10.7 mm of soil was added to the measurement site.

Table 6. Comparison of the field data for fall season 1998 with the calculated Modified Universal Soil Loss Equations 1 and 2 applied.

Erosion Bridge Station	MSLE Equation 1 tons/acre/year/study site	MUSLE Equation 2 ton/acre/avg. event/study site
EB-1:	4.08	.49
EB-2:	5.10	.93
EB-3:	2.77	.18
EB-4;	0.54	.07
EB-5:	13.77	.92
EB-6:	2.01	.20
EB-7:	0.21	.01
EB-8:	8.16	.81
EB-9:	3.83	.64
EB-10:	17.55	1.35
EB-11:	4.00	.44

The erosion bridge data echo the erosion pin data. The differences in the final sediment loss within the study site, based on the main branch of the watershed, are higher than considered tolerable by most sustainable rangeland standards. These equations apply to the middle section of the study area, which is the escarpment and associated arroyos below. Rollins (1981) suggests one ton per acre per year is the tolerance level for rangeland erosion. Based on field observations and equation 1, this tolerance level has been surpassed in all but one site.

Equation 2 does not surpass the suggested soil loss tolerance. This equation is an averaged storm event equation using the 100, 50, 25, 10, 5, 2 year storm events (Appendix C).

<u>Sediment Yield</u>

Heggen (1992) recommends for planning and reservoir maintenance, a sediment volume of 0.3 acre-ft/mi^2/yr is recommended for the historical basin and 0.2 acre-ft/mi^2/yr for the existing basin. This study demonstrates the smaller two and ten year storms have only a minor effect to transport sediment to the dam. Additional conclusions are that the basalt layer contributes to the general stability that is observed in this watershed along with the presence of playas. However, Gellis, (1996) has found that a two-year storm can instigate and create new gullies within the Petrogylph National Monument.

The study conducted by Heggen (1992) has a best practices estimate for this watershed as 1.0 acre-feet/mi^2/year. Using this estimate, the total basin sediment yield would be 6.0 acre-ft/year for the watershed boundary. My calculated yield for this watershed is averaged from the pin and bridge field collection sites as 4.9 tons per acre per year.

Arroyo Direction

The major cardinal direction the arroyo or slope faces has some significance for the level of erosion seen. The north facing slopes have the highest amount of erosion, closely followed by those facing south. The east facing arroyos have the highest amount of aggradation. There is only one west facing slope and six associated gullies in the field area. It was unknown at the time of this study that direction would be an important aspect of erosion or aggradation and hence no slope collection device was placed on the west facing arroyos.

The higher aggradation in the east facing arroyos may be due to the prevailing east to west winds. It is recommended that future studies include wind velocity as an aspect of investigation. The precipitation alone may not be the cause of this aggradation.

Table 7. Major cardinal direction of the erosion bridges and pins comparing high and low erosion values.

Arroyo direction	North	South	East	West
# of Bridges	1, 4, 5, 7	11,2,6,8	9	10
# of Pins	1,7	2,3,4,9,10,11	5,6,8	
High value (mm)	B: +10.7 P: -2	B: +9.6 P: -4	B: +6.3 P: +10	B: +6.5 P: no value
Low value (mm)	B: +1.5 P: -1.0	B: +1.4 P: -0.05	B: +6.3 P: -/+2.0	B: +6.5 P: no value

Wind velocity can be an important aspect of road design and development. A vegetative screening and enhanced construction design will be needed in mitigation of high velocity winds and the debris and snow that is carried with the wind.

Arroyo Profiles

Four baseline arroyo profiles were drawn (Map 8). Arroyo 1 had three profiles drawn (Figures 2, 3, 4) along the arroyo and Arroyo 3 had one profile (Figure 5). In order to measure the width of the arroyo two rebar stakes were pounded into the soil at the edges of the main portion of the arroyo. A foot tape was stretched between the rebar and at every foot a measurement to the bottom of the arroyo in centimeters was taken and recorded. This information is a baseline survey. I suggest that personnel at the Petroglyph National Monument perform this measurement every year to five years to gain insight into the morphology of this arroyo.

Arroyo 1, A is 58' 5" from the top of the mesa and profiles a main channel, the current pedestrian path, and a few high spots where four-wing salt bushes and sand sage bushes have stabilized the blow sand.

Arroyo 1, B is 115' 10" from the top of the mesa and profiles a main channel, the current pedestrian trail, and an additional arroyo channel that joins this main channel at a position 32 feet from the north side. This order 1 channel is from the southwest.

Arroyo 1, C is 230' 4" from the top of the mesa and profiles the arroyo as the morphology changes from an arroyo with a definite channel to an arroyo that is almost without a water pathway. This profile is across the current pedestrian trail.

Figure 2.
Arroyo 1: Profile A

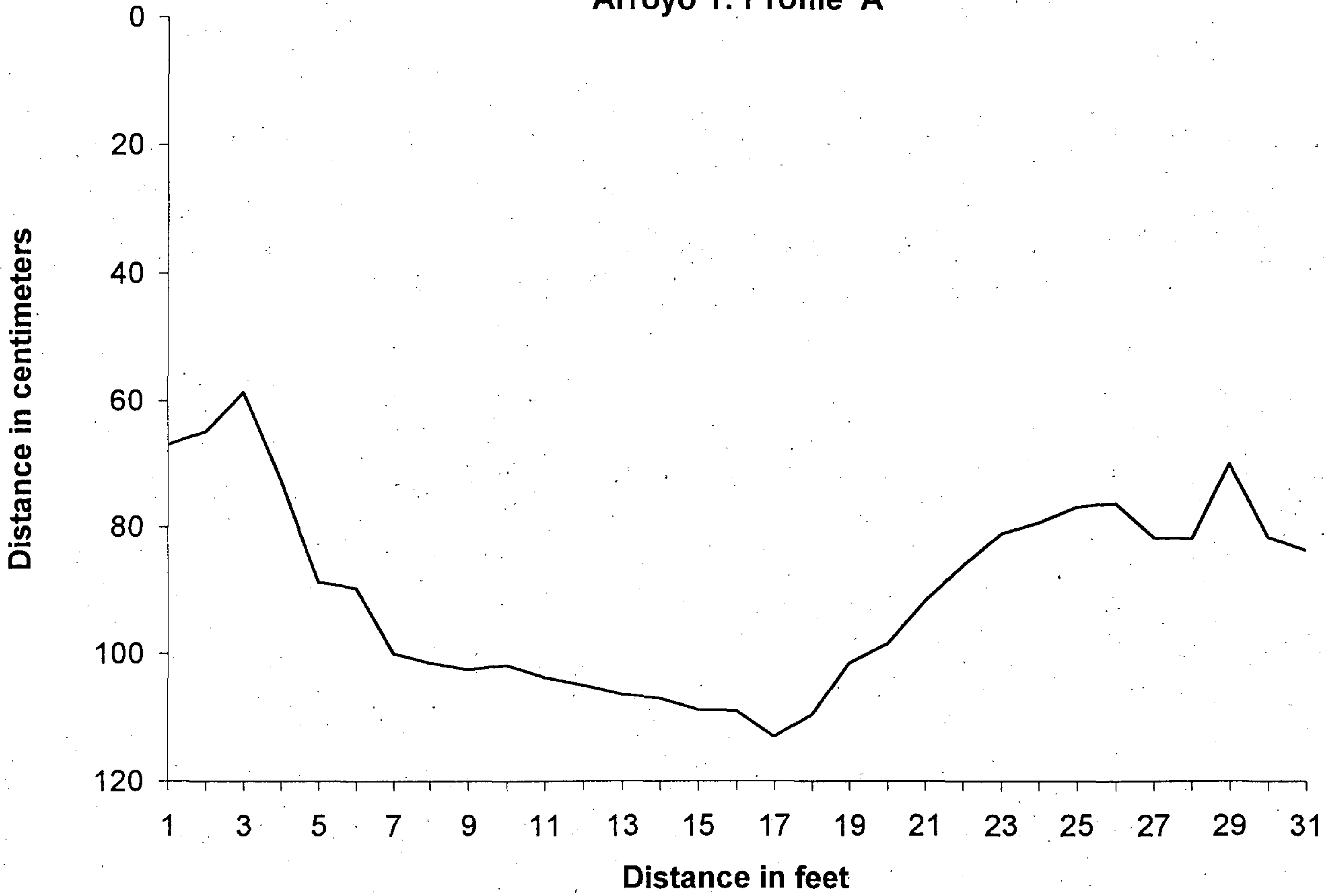


Figure 3.
Arroyo 1: Profile B

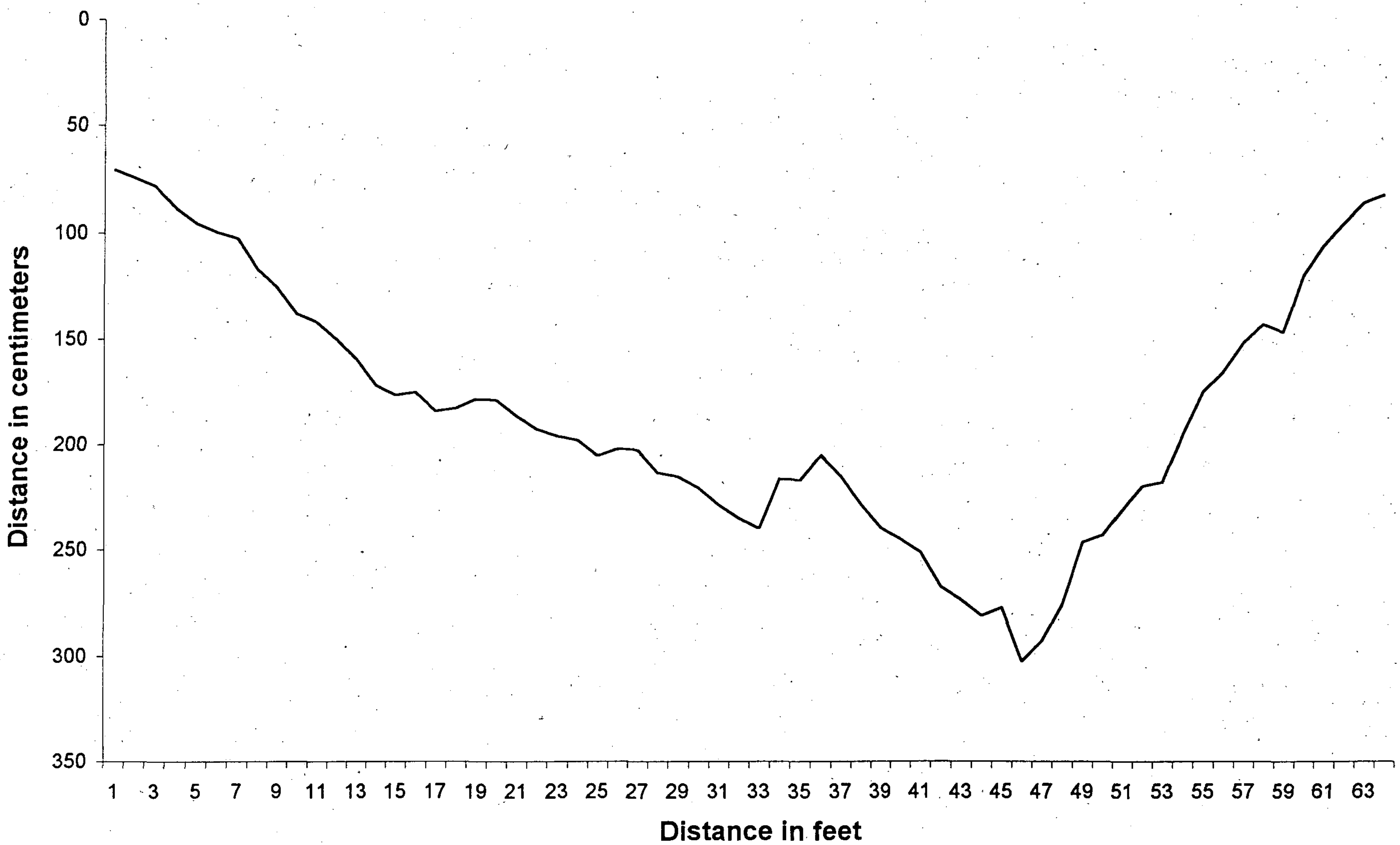


Figure 4.
Arroyo 1: Profile C

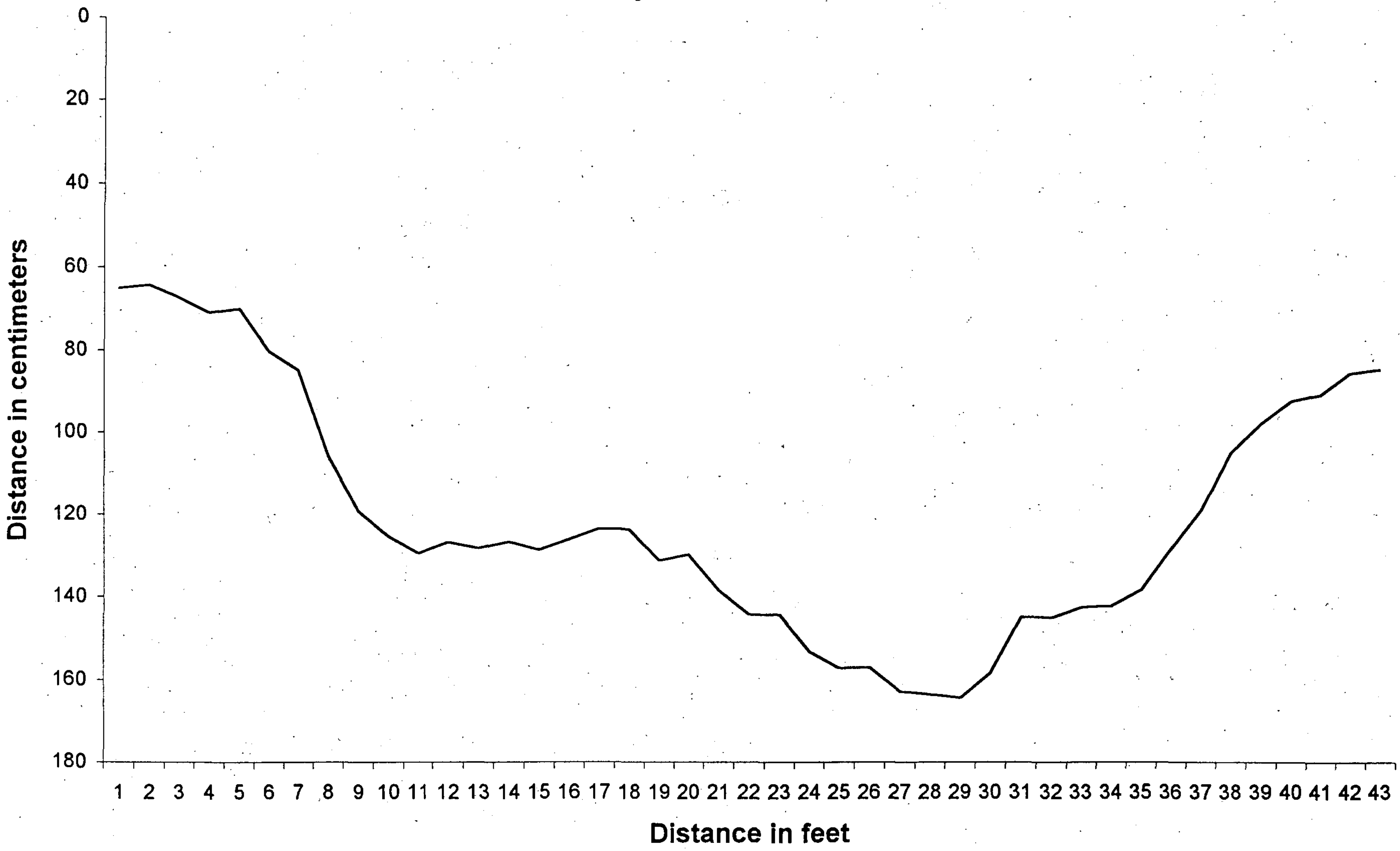
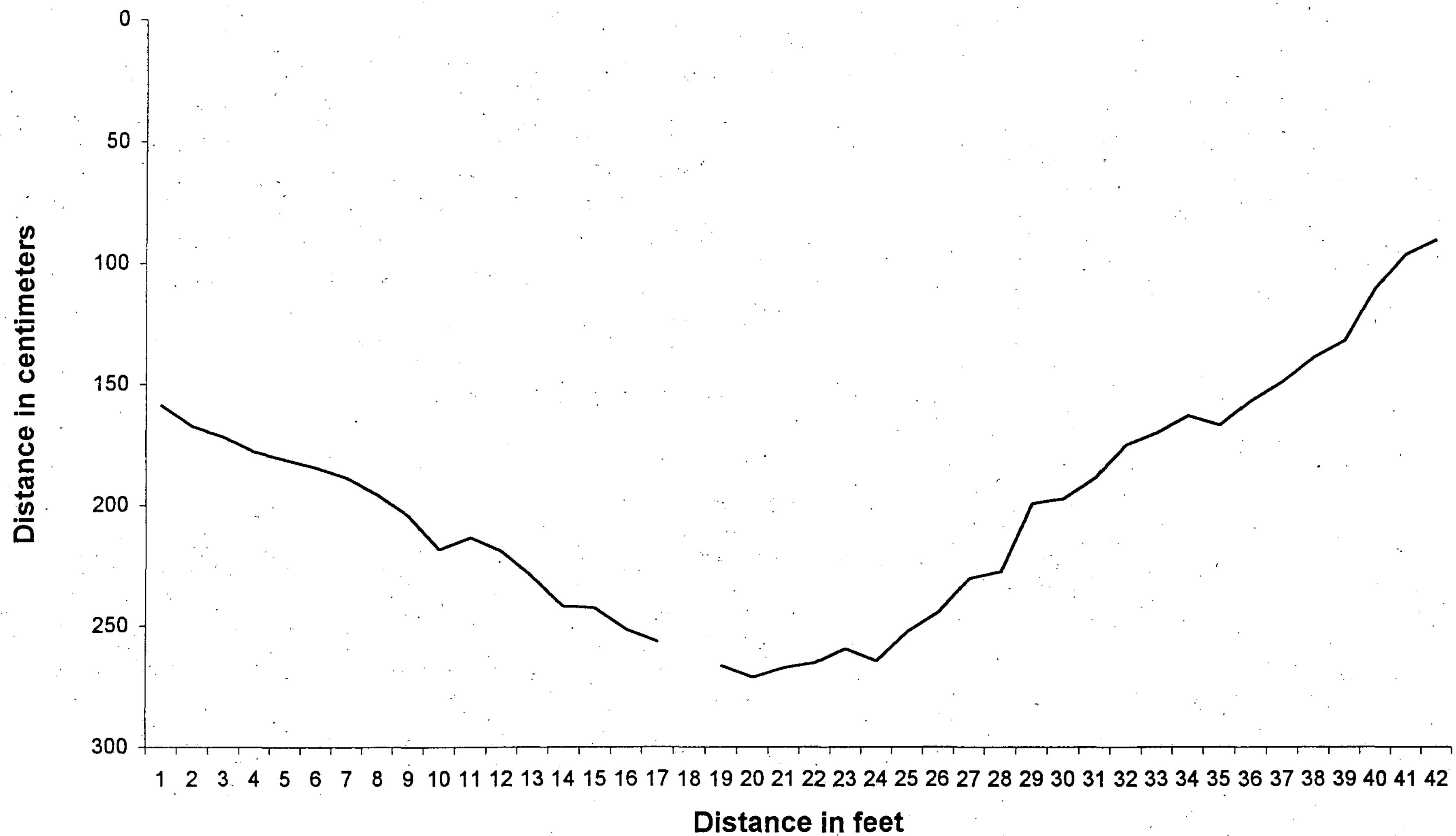


Figure 5.
Arroyo 3: Profile 1



The Arroyo 3 profile is observed at a nick point within this arroyo. The channel and slope narrows at this position. This arroyo is steep and has a main channel. The vegetation is bushes and grasses on this slope and within the channel.

Gully Inventory

There are four main arroyos and (Map 8) 46 mapped gullies in this field area. These gullies are mapped and their width at the mesa top is taped. The following table includes the collected data on these gullies. The distance from the gully to a dirt road, pedestrian path or game path was measured.

A dirt road, pedestrian, or game trail will become a preferred pathway for water runoff. This runoff may initiate gully development in this field site. Gellis (1996) notes gully development in the Monument with 30 of the 50 gullies (60%) connected by surface drainage to the mesa dirt roads. This suggested that the dirt roads were channeling surface runoff (Ibid.). The erosion in this field site may involve a relationship between gullying, dirt roads, low vegetation cover, and wind erosion. Vegetation was sampled in a four-foot radius with the erosion bridge or erosion pin as the center.

Dirt roads can channel surface flow from the roadbed and then increase the runoff over the basalt escarpment. Gellis (1996) compared aerial photographs from 1987 to 1981 and found that ten gullies may have formed in this time period. Six of these gullies were on roads or trails, indicating human activity (Ibid). The runoff from rainstorm in these ten years initiated gullies with recurrence intervals of not more than two years and the runoff events a recurrence interval of any more than five years.

Gellis (1996) concluded that gullying in the Petrogylph National Monument might not be the result of unusually high intensity rainfall or high runoff events.

Human activity may accelerate the natural gullying process. This recreation area is used extensively by the local community and city communities. This is a highly used dog exercise and running area. People still recreationally use the dirt roads on the top of the mesa. Native American and Hispanic *Penatente* religious activities still continue.

Table 8. List of described arroyos or gullies in this field location.

Arroyo Location Number	Width Tape Measurements	Strike	Dip	Distance to dirt road, pedestrian or game trail
1		N99E	8-25°	9'6"
2	14'	S0E	25°	No
3		N345E	17-21°	No
4	32'9"	N147E		No
5*	24'1"			
6*	64'8"	N85E		No
7	49'10"	N45E	16°	No
8	19'5'	N76E	16°	13'7" to ped path
9	2'10"	N74E	14°	Below basalt
10	12'9"	N54E	12°	Ped path
11	40'5"	N358E	2°	No
12	12'8"	N05E	10°	6'2" ped path
13	4'4"	N04E	12°	8' ped path
14	5'9"	N358E	20°	No
15	90'	N45E	10°	No
16	32'1"	N48E	10°	No
17	34'9"	N72E	2°	Game/ped
18	3'0"	N75E	10°	No
19	10'10"	N163E	16°	No
20	9'7"	N60E	16°	Game trail
21	10'10"	N163E	16°	Game/ped trail
22	30'2"	N143E	10°	Pedestrian trail
23	53'5"	N81E	10°	Pedestrian trail
24	21'4"	N340E	14°	Game trail

Arroyo Location Number	Width Tape Measurements	Strike	Dip	Distance to dirt road, pedestrian or game trail
25	35'2"	N51E	20°	9'8" from trails
26	19'1"	N92E	7°	See map
27	21'6"	N123E	13°	5'11"ped trail, se
28	31'6"	N150E	14°	Pedestrian trail
29	43'6"	N170E		Pedestrian trail
30	14'2"	N137E		Pedestrian trail
31	17'4"	N207E	27°	Pedestrian trail
32	25'5"	N173E	7°	Pedestrian trail
33	20'1"	N212E		Pedestrian trail
34	24'1"	N206E		Pedestrian trail
35	91'5"	N134E	12°	Pedestrian trail
36	26'0"	N134E	12°	Pedestrian trail
37	3'11"	N147E		Pedestrian trail
38	46'4"	N175E	14°	Pedestrian trail
39	22'10"	N166E	13°	Pedestrian trail
40	31'6"	N207E	11°	Pedestrian trail
41	9'0"	N260E	15°	Pedestrian trail
42	14'0"	N235E	13°	Pedestrian trail
43	42'9"	N237E	13°	No
44	47'7"	N215E	9°	No
45	52'0"	N238E	6°	No
46	12'0"	N173E	9°	No

Physical Improvements

The physical improvements to this watershed are divided into the three sections. The upper section is currently undeveloped. This section has a high variety of grasses, brushes and juniper trees. There are also many species that indicate over grazing and high erosion such as locoweed and snakeweed. The only improvement for a watershed recommendation would be to eradicate the non-native species and seed with native varieties. It will be important for the Petrogylph National Monument to monitor its western neighbors to ensure that development, with associated bulldozing of native vegetation, does not cause flooding within Unit 23 and endanger the cultural properties.

The middle section or escarpment section has the same indicator species of overgrazing or erosion. This is combined with many slope areas in a mono-culture status. A mono-culture status indicates the area is out of balance from its previous high diversity condition. This is particularly seen in entire, usually north-facing slopes covered in sand sage, devoid of grasses and other shrubs. A recommendation is to seed this area with native species to increase the grasses. Grasses have a high root to canopy ratio and will hold the soil in place when wind or runoff occurs. Grasses can stabilize the soil erosion for this reason. Additionally, the pedestrian paths and dirt roads on top of the escarpment are creating preferred pathways for water and hence erosion. Reclaiming these roads and paths will require construction practices such as discing and/or tilling and then seeding. Planting Black or Coyote willows in the channel will aid in stabilizing the channel.

In the lower section, the developed section, the arroyo channels are gone and replaced with concrete-lined straightened channels. The concrete continues to the adjacent home's mason walls. No dirt is exposed. The flood control measures are in place for protection of the human population. Since the arroyo is now not in its natural state, I would recommend keeping the Piedras Marcadas Dam a dirt detention basin. A stand of cottonwoods, native and non-native vegetation has begun to flourish and receives water from the proximate neighborhood's street runoff.

Socioeconomic Realities

The economic realities of applying improvements make them unlikely to be embraced. Eradicating small plants over several miles of the Monument or undeveloped land will be time consuming and costly from a personnel standpoint. Seeding will also cost money and personnel time. The Monument is established for visitors to explore and learn of our southwestern cultural heritage. The pedestrian trails allow visitors to view the petroglyphs and explore this federal and city land. Reclaiming these trails would disallow visitors to fully view this site. As it often happens, this area is on its way to being loved to death.

Historical Human use

Recent Past Land Use: Air Photo Comparison

As of 1990 the watershed is 44 percentage undeveloped land, in sections two and three of the watershed (Map 10). The Petrogylph National Monument is 396 acres within the watershed and remains undeveloped by federal mandate. 44 percent of the watershed is low to high density suburban land use as seen in the north with the community of Paradise Hills and the Double Eagle Golf course and in the southeast with the Subdivisions of Taylor Ranch, Volcano Cliffs, and Alban Hills. There is still undeveloped land in the southeast and infill development is anticipated in the future. The 1999 figures are approximately 39 percent undeveloped land and 49 percent developed, with the Monument making up the remaining land percentage.

The following air photographs are used for a land use comparison and the development of dirt roads within the study area. The following flight years are used for comparison: 1935, 1951, 1959, 1967, 1973, 1991, and 1996 (Appendix D). Tom R. Mann & Associates adjusted the scales to be 1 inch equals 2000 feet, the scale of a USGS 7.5 minute topographic map. The historical progression of the photos demonstrate an approximate 45 percent increase in development of the watershed, from dirt roads to suburban and light commercial development.

<u>1935</u>

The 1935 air photograph indicates few cultural developments within the watershed. A notable development is a barbed wire fence running east to west through the present day transportation corridor. This barbed wire fence is the northern Atrisco Land Grant boundary, a boundary that is still indicated on the 1990 USGS map. The second notable cultural feature in the then Lower Corrales Drain constructed in 1933 (Annabel Gallegos, MRGCD, pers. comm., 1999) and now called the Corrales Main Canal. The construction of this canal follows the pre-1800s *acequias,* or irrigation ditches. The north, middle, main, and south branches are visible in the air photo. A dirt road that runs from the agricultural land and to the northwest will in time become Paradise Boulevard. The arroyo drainage patterns are visible and show the natural Piedras Marcadas drainage to the cultivated lands proximate to the Rio Grande. There is a large, braided fan delta type drainage. The stands of cottonwoods indicate the historic flood plain. The ancient oxbow is the site of the Open Space Division Piedras Marcadas ruin. A prehistoric to historic Pueblo people lived at this location, until contact with the Spaniards (Dr. M. Schmader, Open Space Division, pers. comm., and M. Medrano, National Park Service, 1999). This settlement is hydrologically well located, with the Rio Grande and additional runoff from the arroyos to supply required water for domestic use.

1951

The 1951 air photograph more clearly shows the north, middle, main and southern branches of the Piedras Marcadas watershed. The north branch appears to have headcut 500 feet and is in contact with the dirt road that will become Paradise Boulevard.

This photo shows more clearly the main stem in the proposed transportation corridor. The incision is apparent. A south branch portion appears to be more incised with the advent of a dirt road that runs east to the west, and in places the arroyo may become the road.

The observable cultural features are the dirt roads and the Corrales Main Canal.

1959

The 1959 air photograph again shows little urban development of the watershed. A ranch appears in the southeastern and north central portion of the photo. The north and Middle Branches have vegetation on the arroyo bottom. There are now section line dirt roads in the southern section of the air photo.

The Atrisco Land Grant fence line still appears on this air photo. There are no dirt roads in the study area.

1967

The 1967 air photograph shows a marked increase in the urbanization of this watershed. The unincorporated town of Paradise Hills is present in the northern portion of the watershed. Paradise Hills was constructed in 1960 (Ed Boles, Albuquerque Historical Preservation, pers. comm., 1999). The development of the West Side of Albuquerque, starting with the Taylor Ranch subdivision began in 1967. Development in these two cities has been low to high-density housing, light commercial, parks, and a golf course.

A golf course, wastewater facility, and suburban houses are present. The north branch has headward gullying to the now paved Paradise Hills Boulevard and appears to drain the golf course. The water treatment facility appears to release water as evidenced by the new arroyo channel that leads from this facility to the north branch. There is also a new arroyo, or at least incised enough to show up on this photo, to the southeast of the water treatment facility. There are new dirt roads from Paradise Boulevard to the treatment facility. In this photograph the main stem and north branch appear to be more incised.

A dirt road loop is now present in the upper reaches of the middle branch of the arroyo. It also captures the increased road development to the southeast on the escarpment and within the southern portion of the watershed. There are more roads in the northwest sector, which corresponds to the middle branch of the watershed.

The main branch of the arroyo in the study area appears less incised. The appearance of the barbed wire fence marking the boundary of the Atrisco Land Grant is still present in this photograph.

A South Branch arroyo has increased by 400 feet due to a sand and gravel extraction operation south of the field site. This operation has increased the dirt roads in this area. There are more dirt roads in general in this southern area for four new housing or ranching complexes. Coors Boulevard is paved in this photo. There are approximately six residences present in this southern area of the photo.

1973

In general this photo shows again, increased urbanization to the north in Paradise Hills. The beginnings of the roads in the Taylor Ranch subdivision of the Albuquerque's West Side are present. The north branch appears to be stable, except for a new order gully. A northwestern trending arroyo in the north branch is approaching the curve in the middle branch, looking intent on stream capture. This may be due to the new dirt road in the Piedras Marcadas Canyon that is in alignment with this arroyo and may be the catalyst for its development. This arroyo is approximately 2000 feet in length. The dirt road is a catalyst for arroyo development.

The middle branch appears aggraded. There is less definition for the upper portion of this arroyo. The dirt road appears to become the arroyo by destroying the arroyo banks.

The main branch of the arroyo also appears aggraded. There is little definition of the arroyo. The Atrisco Land Grant Boundary fence line is still present. The fence line on top of the mesa is now a bulldozed dirt road, anticipating suburban development of top of the mesa. This is the Volcano Cliffs subdivision, which to this day (1999) has not been built. The individual plots within the present Monument are being acquired from the private landowners.

The southern branch has natural arroyo disruption from the sand and gravel extraction operation. A small branch of the main stem appears enhanced in this photo, another example of dirt roads being a catalyst for arroyo development. There now appear to be eight residences in the southern portion of the photo.

<u>1991</u>

In general there is overwhelming development of this watershed. The north branch is dislocated from the main stem due to bulldozing. The area north and south of Paseo del Norte is bulldozed for residential and light commercial development. There is a dirt road transportation corridor established to the west of the Paseo del Norte and Golf course road intersection. This area is within the proposed Paseo del Norte extension into the Monument.

The middle branch still is in confluence with the main branch. The middle branch headland is now shifted to the east, directly below a mesa top dirt road. There are now numerous pedestrian trails within the middle branch of the Canyon.

The main branch of the arroyo has one clear arroyo channel, but the previous arroyo channel is not clearly seen in this photo. The previous confluence with the north branch is bulldozed. There are now more dirt roads on top of the mesa, and the first trails in the arroyo bottom are present. The mesa top roads now connect north to the Paradise Hills community. The Volcano Cliffs subdivision dirt roads are less distinct now and probably have not recently been bladed.

The south branch is not visible from this photograph. The development of Taylor Ranch Subdivision has placed this arroyo in a defined channel amid the residential development. This photo shows the first presence of Taylor Ranch subdivision.

The Piedras Marcadas Dam has appeared, but the associated drainage channels are not yet in place. The establishment of the dam changes the boundary of the watershed. The runoff will progress no farther than the dam unless it is deemed necessary to allow flow into the Corrales Main Channel.

1996

In general this photograph has infill development in those areas previously bulldozed. The residential and light commercial development has been rapid from the previous 1991 photo. The dirt roads within the study area have increased on top of the mesa but not in the bottom of the arroyo. These dirt roads will become preferred pathways for water and will begin to change the drainage pattern of the watershed.

The North Branch appears slightly east of the now completed Golf Course Road between Paradise Boulevard and Golf Course Road. Development has occurred on each side of this road. West of Golf Course, north of Paseo del Norte, the suburban development engulfs the lower reach of the middle branch. This branch has been regulated to a storm drain. The upper reach of this branch appears aggraded and with less definition in this photo.

The main branch has lost its confluence with the middle and north Branches. The main branch now has runoff flows into the AMFCA concrete-lined ditches. These ditches have straightened the arroyo path en route to the Piedras Marcadas Dam. The previous dirt trail east from the intersection of Golf Course and Paseo del Norte is now widened and joins the construction of the Shenandoah Estates subdivision. The bulldozed land northwest of the same intersection is now a light commercial development of a fast food restaurant and video store. Most of the bulldozed areas have developments at present (1999).

The south branch of the arroyo is not visible in this photo. Development has replaced this arroyo with storm drains.

In summary, the air photographs, dated 1935 to the 1993, show the development of this watershed from two windmills to two well-established urban communities. This dramatic shift of land use has affected the arroyos by creating concrete-lined trapezoidal canals in portions of the south, middle, and north branches. The Piedras Marcadas dam site is 130 feet topographically higher than the Rio Grande. This topographic distance has taken the arroyo out of its previous balance to a new balance. The concrete-lined channels now carry runoff to the Piedras Marcadas Dam. The ephemeral runoff no longer reaches the Rio Grande except after a flood stage.

Recommendations

For Future Researchers

When comparing arroyo and slope erosion use both erosion pin and bridges at the same site. Place wind and rain gages at the sties in order to define which erosion process, wind or rain, is most prominent. Each cardinal direction should have a site to determine if direction plays a role in erosion or aggradation.

Additionally, the construction of straw bale dams may be a more exacting sediment loss tool. A straw bale dam is constructed by using multiple bales, usually two bales high across the entire stretch of a gully. The bales are secured with rebar, making sure that the bales dam the entire length of the gully. The location upslope of the bale is then surveyed and the topographic height is taken. This site is then re-surveyed to determine if additional sediment has collected at the straw bale site. Straw bales were not constructed at this site due to distance required to carry the bales (there is no motorized travel in this Monument area) and due to the cessation of the monsoon rainstorms.

For the Petrogylph National Monument

This study is the first within the Petrogylph National Monument to collect soil loss and erosion potential data. This data becomes more useful with a long-term collection. It is recommended that a monthly collection of this data be continued in the study area. This information is important due to the City Council's and federal government's allowance of a road through the southern portion of this site. It is suggested that the new erosion bridges or pins be equipped with rain and wind gages. The sites for the continued study should be placed on slopes near the proposed transportation corridor and display all cardinal directions in all soil types.

Arroyo profiles were drawn for four spots in the study area. I suggest additional profiles be preformed every one to five years to evaluate the development of the arroyos.

I suggest that the vegetation type and density continue to be monitored. My suggestion to the Monument is to choose a four-foot square site around all soils type plots and on each cardinal slope direction to conduct a yearly monitoring program. The sites need to be away from highly used pedestrian and game trails. I recommend having a control plot outside of the study site area and one in a denuded area that may be used for comparison.

I suggest that additional signs be placed in this area that suggesting visitors remain on the established trail. These signs will be education if the high erosion component of this area is discussed. I suggest that Native American and traditional Spanish religious practitioners be excluded from this suggestion. Local community use of Arroyo 1 and 2 has created denuded areas that hasten erosion downhill. Eroding the escarpment will hasten the headward cutting of the arroyo. The basalt cap will be undercut and eventually tumble, taking petroglyphs with the fall.

A stream gage in arroyo 3 is recommended along with one at the dam. This gage will record runoff data and will be informative to the Monument staff in monitoring the runoff for this watershed. This gage may prove valuable if development of headwaters begins.

For the Open Space Division:

Establish signs educating the visiting public on the fragile nature of this area. Suggest keeping to the established trails and keeping dogs on a lease. Dogs chase rabbits and Kangaroo rats, making these animals use their energy in flight instead of food gathering. These animals may die as a result of a dog's action. This also increases the erosion as the dogs traverse the slopes.

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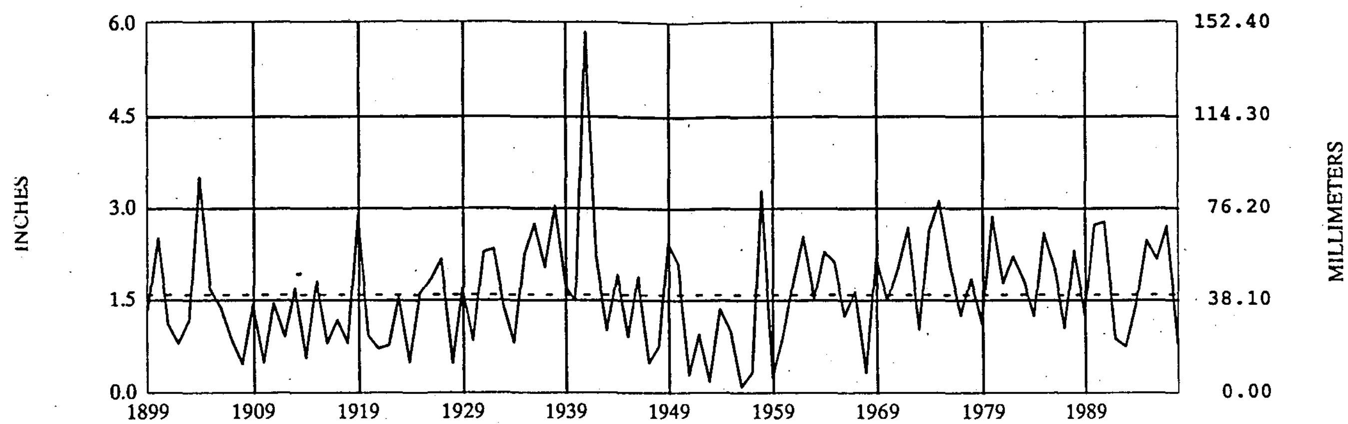
CLIMATOLOGICAL DATA

NEW MEXICO

SEPTEMBER 1998

VOLUME 102 NUMBER 09
ISSN 0364-5622



- - - - - - - - - - - Long-Term Average 1.57 inches

NEW MEXICO PRECIPITATION SEPTEMBER, 1899-1998

TEMPERATURE AND PRECIPITATION EXTREMES

HIGHEST TEMPERATURE	101	SEPTEMBER 20+	3 STATIONS
LOWEST TEMPERATURE	22	SEPTEMBER 27	EAGLE NEST
GREATEST TOTAL PRECIPITATION	2.78		EAGLE NEST
LEAST TOTAL PRECIPITATION	.00		CARLSBAD CAVERNS
GREATEST 1 DAY PRECIPITATION	1.97	SEPTEMBER 30	DILIA

"I certify that this is an official publication of the National Oceanic and Atmospheric Administration (NOAA). It is compiled using information from weather observing sites supervised by NOAA/National Weather Service and received at the National Climatic Data Center (NCDC), Asheville, North Carolina 28801."

Thomas R Karl

DIRECTOR
NATIONAL CLIMATIC DATA CENTER

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National Climatic Data Center Asheville, North Carolina

EVAPORATION AND WIND

STATION		DAY OF MONTH														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
EW MEXICO																
NORTHWESTERN																
PLATEAU 01																
ARMINGTON AG SCIENCE	WIND	125	74	63	61	73	47	47	47	70	64	63	39	44	50	53
	EVAP	28	23	30	35	26	32	37	26	43	39	29	35	11	38	29
	MAX	80	75	83	85	73	82	82	82	80	80	79	80	78	76	77
	MIN	54	54	55	55	55	52	55	55	53	53	54	54	53	52	51
AVAJO DAM	WIND	74	47	28	36	*	*	*	123	35	43	43	*	*	80	31
	EVAP	13	8	20	33	*	*	*	102	24	29	3	*	*	73	36
	MAX	102	85	100	100	-	-	-	99	97	89	-	-	-	115	98
	MIN	40	54	41	53	-	-	-	54	53	51	-	-	-	47	45
NORTHERN MOUNTAINS 02																
BIQUIU DAM	WIND	-	-	20	44	49	68	39	87	21	42	55	*	*	153	48
	EVAP	35	13	20	28	33	34	32	20	46	20	22	25	8	24	42
	MAX	90	75	83	82	82	82	84	85	83	81	82	84	83	82	83
	MIN	56	57	55	55	65	55	55	53	56	57	60	55	56	55	56
OCHITI DAM	WIND	97	94	55	59	74	65	40	53	60	65	55	61	69	72	55
	EVAP	25	40	33	40	43	39	88	30	47	37	26	51	38	41	36
	MAX	87	81	90	91	87	-	84	91	86	87	86	90	88	89	91
	MIN	60	60	58	57	55	-	52	55	56	62	59	56	53	54	57
AGLE NEST	WIND	20	9	6	17	12	10	10	9	10	12	10	15	17	26	20
	EVAP	15	21	17	24	21	22	23	24	17	14	15	17	24	28	19
	MAX	74	64	77	76	79	81	76	79	74	67	72	75	77	73	73
	MIN	40	44	45	41	41	43	45	45	41	40	41	43	46	38	38
L VADO DAM	WIND	18	8	9	18	*	44	*	30	20	27	10	*	*	63	12
	EVAP	15	7	20	24	25	25	26	26	21	19	16	21	21	21	16
	MAX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	MIN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NORTHEASTERN																
PLAINS 03																
LOVIS 13 N	WIND	41	51	50	35	*	*	268	27	28	58	97	*	*	25	*
	EVAP	32	73	20	20	-	-	-	16	23	11	8	*	*	101	*
	MAX	88	92	92	92	-	-	92	92	92	91	88	-	-	90	-
	MIN	62	61	61	62	-	-	61	59	59	60	57	-	-	56	-
ONCHAS DAM	WIND	37	40	25	17	28	37	40	21	37	52	32	33	26	38	50
	EVAP	37	26	28	30	37	52	17	26	33	35	19	-	22	26	31
	MAX	92	88	94	95	97	95	93	96	91	90	91	92	94	94	91
	MIN	61	66	61	60	62	61	59	52	58	58	61	58	61	60	59
UCUMCARI 4 NE	WIND	40	39	33	32	28	44	54	24	39	58	44	30	32	28	64
	EVAP	43	34	28	38	36	34	38	36	40	30	40	28	30	23	43
	MAX	88	88	87	89	90	87	87	90	86	85	87	86	89	90	86
	MIN	57	56	59	59	59	60	58	59	60	56	54	54	56	56	57
CENTRAL VALLEY 05																
OS LUNAS 3 SSW	WIND	16	6	3	5	3	8	7	4	4	5	9	6	3	9	8
	EVAP	30	26	24	29	21	31	29	30	25	27	27	27	26	29	28
	MAX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	MIN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OCORRO	WIND	18	12	5	12	13	6	7	12	11	11	9	15	11	15	27
	EVAP	45	18	23	23	52	16	31	30	43	31	27	22	-	14	44
	MAX	92	90	91	90	90	90	92	93	91	92	93	93	90	94	89
	MIN	60	59	57	65	64	61	57	56	59	62	57	56	57	59	64
CENTRAL HIGHLANDS 06																
STANCIA 7 NE	WIND	73	22	43	61	54	39	35	39	59	28	40	12	47	74	59
	EVAP	35	28	36	39	37	40	37	35	40	28	28	28	38	12	11
	MAX	75	73	80	80	71	68	76	79	78	67	70	64	76	69	73
	MIN	50	50	47	45	45	46	46	46	46	48	44	45	46	45	48
SOUTHEASTERN																
PLAINS 07																
ITTER LAKES WL REFUGE	WIND	38	34	40	46	46	59	37	31	38	49	28	38	30	25	80
	EVAP	39	32	36	39	38	37	23	37	41	30	30	27	38	26	39
	MAX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	MIN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RANTLEY DAM	WIND	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	EVAP	41	35	39	34	46	45	44	33	41	35	34	45	28	36	36
	MAX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	MIN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UMNER LAKE	WIND	42	78	30	31	35	44	49	35	53	71	46	43	30	37	83
	EVAP	32	41	35	34	36	30	37	37	43	36	30	22	41	33	28
	MAX	83	85	84	86	85	81	83	83	81	83	83	82	84	81	87
	MIN	53	56	57	55	55	58	56	54	55	52	55	54	53	54	54

Evaporation: Is measured in hundreths of inches
Wind: Is measured in miles
Max and Min: The maximum and minimum temperatures (Fahrenheit) of the water in the evaporation pan

EVAPORATION AND WIND

STATION	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTAL OR AVERAGE
' MEXICO																	
)RTHWESTERN																	
.ATEAU 01																	
'MINGTON AG SCIENCE	85	68	50	50	55	45	69	49	50	54	64	62	64	47	127		1859
	34	31	29	35	36	32	43	18	16	43	37	28	46	21	25		9.35
	79	80	80	80	80	80	72	72	71	77	76	75	74	75	75		77.9
	50	50	50	50	49	48	45	45	45	46	46	47	46	45	45		50.4
'AJO DAM	43	40	29	*	*	112	40	29	39	39	*	*	125	35	62		1133
	19	24	28	*	*	96	20	29	13	25	*	*	53	23	25		6.96
	96	95	95	-	-	94	88	85	98	92	-	-	91	84	80		M
	46	48	47	-	-	45	42	41	46	45	-	-	39	39	47		M
)RTHERN MOUNTAINS 02																	
:QUIU DAM	60	33	30	32	59	64	65	43	73	56	97	52	34	36	115		1580B
	24	24	33	26	34	32	21	28	24	34	38	35	27	23	15		8.20
	82	82	83	82	81	80	83	82	72	77	76	75	77	79	70		80.7
	54	53	52	51	50	52	48	45	50	49	46	45	45	45	52		52.8
:HITI DAM	58	59	48	50	58	46	52	67	47	57	77	65	59	51	86		1854
	30	31	30	30	30	30	35	41	30	33	44	40	46	21	39		11.24
	88	86	86	86	84	86	83	83	82	85	85	82	82	83	85		86.0
	57	56	55	53	51	51	51	54	55	55	52	51	45	49	59		54.8
;LE NEST	7	7	5	5	28	28	27	12	23	22	37	22	10	11	22		469
	13	12	10	20	20	4	27	10	31	11	20	34	24	10	-		5.66B
	66	67	67	71	73	70	70	68	72	72	72	72	72	73	62		72.1
	38	38	39	39	35	35	36	35	41	40	38	35	35	34	40		39.6
VADO DAM	*	33	15	*	*	76	38	19	25	21	*	*	69	15	10		580
	19	20	13	25	24	25	30	12	21	25	23	22	23	16	29		6.30
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		M
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		M
)RTHEASTERN																	
.AINS 03																	
)VIS 13 N	89	204	104	*	*	*	89	49	174	149	*	*	198	59	176		1971
	40	33	19	-	-	-	12	15	-	21	*	*	27	22	48		7.06B
	90	93	91	-	-	93	91	87	92	92	-	-	93	91	88		91.0
	57	60	60	-	-	62	60	51	64	61	-	-	60	60	59		59.6
'CHAS DAM	26	26	17	46	28	29	44	42	71	89	143	31	25	27	32		1189
	24	25	23	42	34	32	31	23	23	35	40	35	24	23	20		8.82B
	92	92	88	91	91	90	91	84	84	90	87	89	92	91	89		91.1
	60	60	60	60	57	58	58	55	56	60	63	55	55	60	62		59.2
:UMCARI 4 NE	40	24	28	68	54	43	97	50	141	152	153	61	49	36	64		1649
	23	22	38	30	43	40	34	20	39	50	49	39	36	23	23		10.30
	84	86	88	86	86	86	83	77	81	85	85	84	85	88	86		86.2
	55	55	57	57	54	54	51	49	51	59	59	55	56	59	59		56.3
:NTRAL VALLEY 05																	
; LUNAS 3 SSW	13	6	3	4	14	14	15	6	26	12	40	10	3	4	7		273
	25	21	22	25	22	26	30	25	28	27	39	27	21	22	13		7.82
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		M
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		M
:ORRO	11	8	10	5	14	14	22	36	26	28	*	33	13	9	16		429
	20	17	20	27	35	14	31	30	38	21	*	40	36	18	-		8.21B
	90	90	91	91	87	87	86	88	88	88	-	90	91	89	89		90.2
	61	61	59	63	60	57	55	58	57	59	-	49	52	56	56		58.5
:NTRAL HIGHLANDS 06																	
'ANCIA 7 NE	49	33	35	59	93	55	78	91	88	112	51	30	46	55	102		1662
	36	28	28	35	38	38	28	37	38	40	40	29	28	0	39		9.54
	78	73	67	63	64	76	68	75	63	74	63	61	59	69	65		70.6
	46	46	46	44	45	43	44	48	48	42	38	38	40	48	50		45.4
OUTHEASTERN																	
LAINS 07																	
'TER LAKES WL REFUGE	59	18	22	*	147	22	40	53	78	95	120	78	*	*	92		1443
	33	23	28	-	-	25	34	27	24	37	27	69	*	*	50		9.53B
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		M
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		M
ANTLEY DAM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		M
	37	16	36	36	41	44	69	37	41	53	47	30	43	33	40		11.75
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		M
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		M
MNER LAKE	45	38	41	72	49	89	86	63	99	103	116	53	34	46	67		1708
	31	35	30	39	35	42	50	28	32	42	34	38	29	25	45		10.50
	87	81	82	82	80	88	79	78	88	82	80	81	82	84	79		82.8
	54	55	55	53	52	53	53	49	51	56	57	53	53	56	56		54.2

Evaporation: Is measured in hundredths of inches
Wind: Is measured in miles
Max and Min: The maximum and minimum temperatures (Fahrenheit) of the water in the evaporation pan

STATION INDEX

STATION	INDEX NO.	DIVISION	COUNTY	LATITUDE	LONGITUDE	ELEVATION (IN FEET)	OBSERVATION TIME AND TABLES LOCAL STD TIME TEMP	PRECIP	EVAP	SPECIAL SEE (NOTES)	OBSERVER
FARMINGTON AG SCIENCE	3142	01	SAN JUAN	36 42	108 15W	5625	07	07	07	CGH	FARMINGTON AG SCI CENTER
FAYWOOD	3157	08	GRANT	32 38	107 52W	5191	18	18		H	REGIS MCSHERRY
FENCE LAKE	3180	01	VALENCIA	34 39	108 40W	7055	17	17		H	ELOISE MC DORMAN
FORT BAYARD	3265	04	GRANT	32 48	108 9W	6142	18	18		C H	FORT BAYARD HOSPITAL
FORT SUMNER	3294	07	DEBACA	34 28	104 15W	4025	08	08		GH	BETTY DUNLAP
FORT SUMNER 5 S	3296	07	DEBACA	34 22	104 15W	4050		18		H	C NEAL VAUGHN
FRUITLAND 3 E	3340	01	SAN JUAN	36 44	108 21W	5220	17	17		H	JOE DIDDE
GAGE 4 ESE	3368	08	LUNA	32 13	108 1W	4410	17	17		H	SHELBY C PHILLIPS III
GALLUP FAA AP	3422	01	MCKINLEY	35 31	108 47W	6466	MID	MID		H	MET TECH INCORPORATED
GASCON	3488	02	MORA	35 54	105 27W	8250	17	17		H	EDITHA BARTLEY
GHOST RANCH	3511	02	RIO ARRIBA	36 20	106 28W	6460		18		H	PRESBYTERIAN CHURCH
GILA HOT SPRINGS	3530	04	GRANT	33 12	108 13W	5600	18	18		H	DAWSON A CAMPBELL
GLENWOOD	3577	08	CATRON	33 19	108 53W	4752	17	17		H	BOBBIE D JOHNSTON
GLORIETA	3586	02	SANTA FE	35 35	105 46W	7518		16		H	ALICE LOBATO
GOLDEN	3592	06	SANTA FE	35 16	106 13W	6700		18		H	VERA HENDERSON
GRAN QUIVIRA NATL MON	3649	06	SOCORRO	34 16	106 6W	6600	17	17		H	NATIONAL PARK SERVICE
GRANTS AIRPORT	3682	04	CIBOLA	35 10	107 54W	6520	18	18		H	GRANTS MILAN AIRPORT
GRENVILLE	3706	03	UNION	36 36	103 37W	6002	17	17		H	KATHEREN SINK
HACHITA	3775	08	GRANT	31 56	108 19W	4507	18	18		H	VIRGINIA BEEN
HATCH 5 NW	3855	08	DONA ANA	32 43	107 13W	4040	09	09		H	INACTIVE 07/29/97
HILLSBORO	4009	08	SIERRA	32 56	107 34W	5270	19	19		C H	ROY F SCHOENRADT
HOBBS	4026	07	LEA	32 42	103 8W	3615	17	17		H	HOBBS GAS COMPANY
HOBBS 13 W	4030	07	LEA	32 43	103 21W	3805	19	19		C H	SOUTHWESTERN PUB SVC PL
HOUSE	4175	03	QUAY	34 38	103 54W	4850		07		H	LLOYD MORROW
JAL	4346	07	LEA	32 7	103 11W	3060	18	06		H	JAL POLICE DEPARTMENT
JEMEZ SPRINGS	4369	02	SANDOVAL	35 46	106 41W	6263	17	17		H	JEMEZ STATE MONUMENT
JOHNSON RANCH	4398	02	SANDOVAL	35 57	107 5W	7203		08		H	CLARA A JOHNSON
JORNADA EXP RANGE	4426	08	DONA ANA	32 37	106 44W	4266	08	08		C H	AGRICULTURAL RESRCH SRVC
KELLY RANCH	4461	04	SOCORRO	34 2	107 8W	6699		18		H	TOM E KELLY
LAGUNA	4719	05	CIBOLA	35 2	107 22W	5818	08	08		C H	BIA LAGUNA FORESTRY DIV
LAKE MALOYA	4742	02	COLFAX	36 59	104 22W	7400	07	07		H	NEW MEXICO STATE PARKS
LAS VEGAS FAA AIRPORT	4856	02	SAN MIGUEL	35 39	105 9W	6866	11	11		H	MET TECH INCORPORATED
LAS VEGAS SEWAGE PLANT	4862	02	SAN MIGUEL	35 32	105 12W	6349	08	08		C H	CITY OF LAS VEGAS
LINDRITH 1 WSW	4960	02	RIO ARRIBA	36 18	107 3W	7220	07	07		H	BETTY POST
LORDSBURG 4 SE	5079	08	HIDALGO	32 18	108 39W	4250	17	17		H	ROBERT LOWERY
LOS ALAMOS R	5084	02	LOS ALAMOS	35 52	106 19W	7424	MID	MID		H	UNIVERSITY OF CALIFORNIA
LOS LUNAS 3 SSW	5150	05	VALENCIA	34 46	106 45W	4840	07	07	07	GH	NEW MEXICO ST UNIVERSITY
LUNA R S	5273	04	CATRON	33 49	108 57W	7050	17	17		H	U S FOREST SERVICE
LYBROOK	5290	01	RIO ARRIBA	36 14	107 34W	7150	MID	MID		H	SUNTERRA GAS PRC COMPANY
MALJAMAR 4 SE	5370	07	LEA	32 49	103 42W	4000	18	18		C H	LEO R SUTTON
MAXWELL 3 NW	5490	03	COLFAX	36 34	104 34W	6019	08	08		H	MAXWELL NATL WLDLF REF
MC CARTY RANCH	5516	03	QUAY	35 36	103 22W	4411	08	08		H	JACK MCCARTY
MCGAFFEY 5 SE	5560	01	MCKINLEY	35 20	108 27W	8000	08	08		H	JOHN F JEKIELEK
MELROSE	5617	03	CURRY	34 26	103 37W	4598	17	17		H	GRADY A BRIGHT
MIMBRES RANGER STN	5754	04	GRANT	32 56	108 1W	6238	17	17		C H	US FOREST SERVICE
MORIARTY 1 NE	5908	06	TORRANCE	35 1	106 3W	6220	07	07		H	GLENN G OVERLANDER
MOSQUERO 1 NE	5937	03	HARDING	35 48	103 56W	5465	17	17		H	RICHARD D HAMMER
MOUNTAIN PARK	5960	06	OTERO	32 57	105 49W	6780	17	17		H	JAMES K CADWALLADER
MOUNTAINAIR	5965	06	TORRANCE	34 31	106 15W	6520	16	16		H	US FOREST SERVICE
NAVAJO DAM	6061	01	SAN JUAN	36 49	107 37W	5770	07	07	07	H	US BUREAU OF RECLAMATION
NEWKIRK	6115	03	GUADALUPE	35 4	104 15W	4563	17	17		H	DWAYNE WILKERSON
OCATE 2 NW	6275	02	MORA	36 12	105 4W	7655	17	17		C H	LOUIS MARES
OCHOA	6281	07	LEA	32 11	103 26W	3460	07	07		H	DEBBIE CERVANTES
OROGRANDE	6435	08	OTERO	32 23	106 6W	4182	18	18		C H	PATSY JOHNSON
OTIS	6465	01	SAN JUAN	36 19	107 52W	6880	17	17		H	BRETHERN IN CHRIST MISSI
PASAMONTE	6619	03	UNION	36 18	103 44W	5650	07	07		H	SAM BRITT
PECOS NATIONAL MONUMEN	6676	02	SAN MIGUEL	35 33	105 41W	6878	16	16		H	US NATIONAL PARK SERVICE
PECOS 11 SE	6678	02	SAN MIGUEL	35 26	105 34W	6800		07		H	ART MONTANA
PEDERNAL 4 E	6687	06	TORRANCE	34 38	105 34W	6200	08	08		H	LAHEETA HARVEY
PETROGLYPH NATL MON	6754	05	BERNALILLO	35 8	106 43W	5121	17	17		H	NATIONAL PARK SERVICE
PICACHO 2 WSW	6804	07	LINCOLN	33 20	105 10W	5042	17	17		H	LOIS CLEMENTS
PIETOWN 19 NE	6812	04	CATRON	34 30	107 54W	7961	18	18		C H	NANCY COON
PLACITAS 4 W	6911	05	SANDOVAL	35 18	106 30W	5515		18		H	MARLEN EASLEY
PORTALES	7008	03	ROOSEVELT	34 10	103 21W	4010	17	17		H	TELEVISION STATION KENW
PROGRESSO	7094	06	TORRANCE	34 25	105 53W	6297		18		C H	ALLEN BROWN
QUEMADO	7180	04	CATRON	34 20	108 31W	6860	17	17		H	JACQUE MCGUIRE
QUEMADO LAKE ESTATES	7195	04	CATRON	34 9	108 31W	7790	16	16		C H	INACTIVE 04/30/96
RAGLAND 3 SSW	7226	03	QUAY	34 47	103 45W	5060	18	18		H	DIANA RUSH
RAMON 8 SW	7254	07	LINCOLN	34 9	105 0W	5327	22	17		C H	RONALD L MERRITT
RATON FILTER PLANT	7279	02	COLFAX	36 55	104 26W	6932	07	07		C H	LONNIE BACON
RATON KRTN RADIO	7280	02	COLFAX	36 53	104 27W	6640	16	16		H	RADIO STATION KRTN
RED HILL 12 NW	7297	04	CATRON	34 19	109 2W	6840	18	18		H	INACTIVE 01/01/96

EW MEXICO
PTEMBER 1998

DAILY PRECIPITATION (INCHES)

STATION	TOTAL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		DAY OF MONTH														
WKIRK	.88															
SAMONTE	1.56			.25												
RTALES	.92									.78	.12					
GLAND 3 SSW	.70															
Y	.70														.10	.10
N JON	.67															
RINGER	M 2.19		.47	T									-		.07	
CUMCARI 4 NE	.61															
OUTHWESTERN MOUNTAINS 04																
GUSTINE 2 E	1.53	.30									.20					.23
AVERHEAD R S	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BERO	.35															
RT BAYARD	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LA HOT SPRINGS	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ANTS AIRPORT	M .40															
LLY RANCH	.82															.17
NA R S	.65		.03	.04	.36	.03					.02					.13
MBRES RANGER STN	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ETOWN 19 NE	.48	.01			.15						T				T	.15
EMADO	.58		T	.09						T			T	.11		
SERVE RANGER STN	.45		.09		.07				.03	.07	.03	.03				
OREAU 12 SE	1.45	.46			.03							.02	.18			.14
NSTON	M .36			T	.12					.04					-	-
ENTRAL VALLEY 05																
BUQUERQUE FOOTHILLS	.45	.07														.05
BUQUERQUE VALLEY	.24														T	T
BUQUERQUE WSFO AIRPO//R	.15														T	T
EMAN RANCH	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RNARDO	.16															
NGHAM 2 NE	.45															
SQUE DEL APACHE	.31															
RRIZOZO 1 SW	M .21													-		
RRALES	.36															
EPHANT BUTTE DAM	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GUNA	M .10															
S LUNAS 3 SSW	.28	.05														
TROGLYPH NATL MON	M .03													-		
ACITAS 4 W	.34															.07
ENHARDT RANCH	.44									.24						
CORRO	M .26															
ENTRAL HIGHLANDS 06																
PITAN	M	-	-	-	-	-	-	-			.16					T
INES CORNERS 7 SE	M					-	-	-				-	-		.02	-
OUDCROFT	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RONA 10 SW	1.86															
GEWOOD CEDAR GROVE	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TANCIA 7 NE	1.16														.10	.03
LDEN	.96										.22					.10
AN QUIVIRA NATL MON	2.19															.08
RIARTY 1 NE	.79															.29
UNTAIN PARK	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UNTAINAIR	1.32									.60			.01		T	
DERNAL 4 E	1.99															.41
OGRESSO	1.98															.17
IDOSO	1.00										.09	.01				.45
NDIA PARK	M .94				-	-										.06
ANLEY 1 NNE	1.36	.54										T				
OUTHEASTERN PLAINS 07																
TESIA 6 S	.44		.02								.42					T
TTER LAKES WL REFUGE	.52										.21	.04				.27
ANTLEY DAM	.31		.31													
NTON	1.27									T	.44					
RLSBAD	1.00	.07													.23	
RLSBAD FAA AIRPORT	.14									.05					.03	.06
RLSBAD CAVERNS	T .00		T													
OSSROADS 2	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ILIA	1.97															
K 2 E	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RT SUMNER	1.47									.15						
RT SUMNER 5 S	1.00										.35					
BBS	.98										.30					.22
BBS 13 W	1.39									T	.65					
AL	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ALJAMAR 4 SE	1.36									.10	.38					.80
CHOA	.79															.50
ICACHO 2 WSW	.90										T				.04	.17
AMON 8 SW	1.16														.05	.64

NEW MEXICO
SEPTEMBER 1998

DAILY PRECIPITATION (INCHES)

STATION		DAY OF MONTH															
		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
NEWKIRK			.15													.73	
PASAMONTE			.50									.77				.04	
PORTALES																.02	
RAGLAND 3 SSW			T													.70	
ROY									.50								
SAN JON															.38	.29	
SPRINGER									T							1.65	
TUCUMCARI 4 NE															.02	.59	
SOUTHWESTERN MOUNTAINS	04																
AUGUSTINE 2 E		.20	.14												.16	.30	
BEAVERHEAD R S		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CUBERO		.10	.05												.20		
FORT BAYARD		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
GILA HOT SPRINGS		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
GRANTS AIRPORT														-	.40		
KELLY RANCH						.07										.58	
LUNA R S			.03												.01		
MIMBRES RANGER STN		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
PIETOWN 19 NE		T												.10	.07		
QUEMADO		.38															
RESERVE RANGER STN		.09													.04		
THOREAU 12 SE		.24												.14	.24	T	
WINSTON			T												.20		
CENTRAL VALLEY	05																
ALBUQUERQUE FOOTHILLS		.12														.21	
ALBUQUERQUE VALLEY			T					T		T					.20	.04	
ALBUQUERQUE WSFO AIRPO//R			T			T									.12	.03	
ALEMAN RANCH		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
BERNARDO		.05														.11	
BINGHAM 2 NE		.09	.11												.23	.02	
BOSQUE DEL APACHE		.01					.11		.03							.16	
CARRIZOZO 1 SW																.21	
CORRALES															.36		
ELEPHANT BUTTE DAM		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
LAGUNA		.10													-	-	
LOS LUNAS 3 SSW		.09														.14	
PETROGLYPH NATL MON																.03	
PLACITAS 4 W														T	.27		
RIENHARDT RANCH															.20		
SOCORRO			.03									-			.18	.05	
CENTRAL HIGHLANDS	06																
CAPITAN		.54	.11								-	-	-		.69	.57	
CLINES CORNERS 7 SE		-	1.03	-	-	-		-	-	-	-	-	-	-	-	-	
CLOUDCROFT		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CORONA 10 SW		1.25														.61	
EDGEWOOD CEDAR GROVE		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
ESTANCIA 7 NE		.15						.09							.14	.65	
GOLDEN															.15	.49	
GRAN QUIVIRA NATL MON		.05	.28	.02			.03								.13	1.60	
MORIARTY 1 NE			.03	T					.02							.45	
MOUNTAIN PARK		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
MOUNTAINAIR			.34						.03							.34	
PEDERNAL 4 E		.01													.26	1.31	
PROGRESSO		1.00													.73	.08	
RUIDOSO		.12	.21	.01	.01				.01		.01			.01		.07	
SANDIA PARK		.48		-		-	-									.40	
STANLEY 1 NNE			.40							T						.42	
SOUTHEASTERN PLAINS	07																
ARTESIA 6 S														T			
BITTER LAKES WL REFUGE																	
BRANTLEY DAM																	
CANTON											T					.83	
CARLSBAD						.60										.10	
CARLSBAD FAA AIRPORT					T		T					T					
CARLSBAD CAVERNS																	
CROSSROADS 2		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
DILIA		T	T						T	T				T	T	1.97	
ELK 2 E		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
FORT SUMNER															.20	1.12	
FORT SUMNER 5 S			.08													.57	
HOBBS														.46			
HOBBS 13 W													.72	.02			
JAL		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
MALJAMAR 4 SE													.08				
OCHOA														.29			
PICACHO 2 WSW		.08							.16		.02				.16	.27	
RAMON 8 SW			.09												.38		

MONTHLY STATION AND DIVISION SUMMARY

STATION	PRECIPITATION (IN) TOTAL	DEPARTURE FROM NORMAL	GREATEST DAY	DATE	SLEET, SNOW TOTAL	MAX. DEPTH ON GROUND	DATE	NO. OF DAYS .10 OR MORE	.50 OR MORE	1.00 OR MORE
MOSQUERO 1 NE	.09	-1.99	.07	30	.0	0		0	0	0
NEWKIRK	.88	-.71	.73	30	.0	0		2	1	0
PASAMONTE	1.56	-.32	.77	26	.0	0		3	2	0
PORTALES	.92	-1.22	.78	9	.0	0		2	1	0
RAGLAND 3 SSW	.70	-1.66	.70	30	.0	0		1	1	0
ROY	.70	-1.20	.50	23	.0	0		3	1	0
SAN JON	.67	-1.40	.38	29	.0	0		2	0	0
SPRINGER	M 2.19		1.65	30	.0	0		2	1	1
TUCUMCARI 4 NE	.61	-1.14	.59	30	.0	0		1	1	0
--DIVISIONAL DATA------->	.75	-1.24			.0					
SOUTHWESTERN MOUNTAINS 04										
AUGUSTINE 2 E	1.53	-.21	.30	30+	.0	0		7	0	0
BEAVERHEAD R S					M	M				
CUBERO	.35	-1.19	.20	29	.0	0		2	0	0
FORT BAYARD					M	M				
GILA HOT SPRINGS					M	M				
GRANTS AIRPORT	M .40		.40	29	.0	0		1	0	0
LUNA R S	.65	-1.52	.36	4	.0	0		2	0	0
MIMBRES RANGER STN					M	M				
PIETOWN 19 NE	.48		.15	15+	.0	0		3	0	0
QUEMADO	.58	-.85	.38	16	.0	0		2	0	0
RESERVE RANGER STN	.45	-1.76	.09	16+	.0	0		0	0	0
THOREAU 12 SE	1.45		.46	1	.0	0		6	0	0
WINSTON	M .36		.20	29	.0	0		2	0	0
--DIVISIONAL DATA------->	.78	-1.19			.0					
CENTRAL VALLEY 05										
ALBUQUERQUE FOOTHILLS	.45		.21	30	.0	0		2	0	0
ALBUQUERQUE VALLEY	.24		.20	29	.0	0		1	0	0
ALBUQUERQUE WSFO AIRPO//R	.15	-.85	.12	29	.0	0		1	0	0
ALEMAN RANCH					M	M				
BERNARDO	.16	-1.11	.11	30	.0	0		1	0	0
BINGHAM 2 NE	.45	-1.19	.23	29	.0	0		2	0	0
BOSQUE DEL APACHE	.31	-1.20	.16	30	.0	0		2	0	0
CARRIZOZO 1 SW	M .21		.21	30	.0	0		1	0	0
CORRALES	.36		.36	29	.0	0		1	0	0
ELEPHANT BUTTE DAM					M	M				
LAGUNA	M .10		.10	16	.0	0		1	0	0
LOS LUNAS 3 SSW	.28	-1.02	.14	30	.0	0		1	0	0
PETROGLYPH NATL MON	M .03		.03	30	.0	0		0	0	0
SOCORRO	M .26		.18	29	.0	0		1	0	0
--DIVISIONAL DATA------->	.30	-1.15			.0					
CENTRAL HIGHLANDS 06										
CAPITAN			.69	29	M	0		5	3	0
CLINES CORNERS 7 SE			1.03	17	.0	0		1	1	1
CLOUDCROFT					M	M				
CORONA 10 SW	1.86		1.25	16	.0	0		2	2	1
EDGEWOOD CEDAR GROVE					M	M				
ESTANCIA 7 NE	1.16	-.50	.65	30	.0	0		4	1	0
GRAN QUIVIRA NATL MON	2.19	.24	1.60	30	.0	0		3	1	1
MORIARTY 1 NE	.79		.45	30	.0	0		2	0	0
MOUNTAIN PARK					M	M				
MOUNTAINAIR	1.32	-.68	.60	9	.0	0		3	1	0
PEDERNAL 4 E	1.99	.74	1.31	30	.0	0		3	1	1
RUIDOSO	1.00		.45	15	.0	0		3	0	0
SANDIA PARK	M .94		.48	16	.0	0		2	0	0
STANLEY 1 NNE	1.36	-.23	.54	1	.0	0		3	1	0
--DIVISIONAL DATA------->	1.46	-.74			.0					
SOUTHEASTERN PLAINS 07										
ARTESIA 6 S	.44	-1.95	.42	10	.0	0		1	0	0
BITTER LAKES WL REFUGE	.52	-1.44	.27	15	.0	0		2	0	0
BRANTLEY DAM	.31		.31	2	.0	0		1	0	0
CARLSBAD	1.00	-1.67	.60	20	.0	0		3	1	0
CARLSBAD FAA AIRPORT	.14	-2.61	.06	15	.0	0		0	0	0
CARLSBAD CAVERNS	T	-3.65	.00	30+	.0	0		0	0	0
CROSSROADS 2					M	M				
DILIA	1.97	.07	1.97	30	.0	0		1	1	1
ELK 2 E					M	M				
FORT SUMNER	1.47	-.48	1.12	30	.0	0		3	1	1

MONTHLY STATION AND DIVISION SUMMARY

STATION	TEMPERATURE (°F) AVERAGE MAXIMUM	AVERAGE MINIMUM	AVERAGE	DEPARTURE FROM NORMAL	HIGHEST	DATE	LOWEST	DATE	HEATING DEGREE DAYS	COOLING DEGREE DAYS	NO. OF DAYS MAX 90 OR ABOVE	MAX 32 OR BELOW	MIN 32 OR BELOW	MIN 0 OR BELOW
)UERO 1 NE	86.2	54.4	70.3	6.6	92	19	46	23	2	169	3	0	0	0
<IRK	90.5	56.3	73.4	4.3	95	27	48	23	0	260	19	0	0	0
\MONTE	84.3	51.3	67.8	5.3	89	5	44	27+	10	102	0	0	0	0
?ALES	89.4	59.2	74.3	4.9	93	26+	51	23+	0	286	17	0	0	0
LAND 3 SSW	87.4	55.6	71.5	5.3	93	5	48	22	0	201	12	0	0	0
	80.5	52.9	66.7	3.7	88	27	46	23	6	60	0	0	0	0
JON	90.4	60.3	75.4	5.0	96	27	50	22	0	320	19	0	0	0
INGER	85.0	48.3	66.7	4.4	92	24	39	27	7	62	3	0	0	0
UMCARI 4 NE	91.3	57.7	74.5	5.4	97	25+	47	23	4	296	22	0	0	0
IVISIONAL DATA------->			72.3	5.7										
UTHWESTERN														
UNTAINS 04														
USTINE 2 E	80.9	47.1	64.0	6.0	85	28+	36	27	39	19	0	0	0	0
VERHEAD R S	M	M	M											
ERO	84.7	50.4	67.6	4.8	89	24	35	26	11	95	0	0	0	0
T BAYARD	M	M	M											
A HOT SPRINGS	M	M	M											
NTS AIRPORT	86.2	46.6	66.4	4.8	90	27+	34	26	11	59	2	0	0	0
A R S	79.7	39.9	59.8	3.0	84	28+	30	27+	150	0	0	0	4	0
BRES RANGER STN	M	M	M											
TOWN 19 NE	77.0	48.4	62.7		84	23	35	26	70	9	0	0	0	0
MADO	79.2	39.0	59.1	-.8	81	22+	30	27+	168	0	0	0	4	0
ERVE RANGER STN	87.4	45.8	66.6	4.5	92	29+	34	28+	24	79	6	0	0	0
REAU 12 SE	77.9	44.5	61.2		82	28+	32	26	110	3	0	0	1	0
STON	83.3	48.8	66.1	4.0	89	13	42	26+	20	59	0	0	0	0
IVISIONAL DATA------->			63.7	2.7										
NTRAL VALLEY 05														
UQUERQUE FOOTHILLS	83.8	58.1	71.0		88	3	52	27+	0	186	0	0	0	0
UQUERQUE VALLEY	88.2	56.5	72.4		93	3	47	27+	0	224	11	0	0	0
UQUERQUE WSFO AIRPO//R	86.8	61.9	74.4	5.8	90	25+	52	26	0	288	3	0	0	0
MAN RANCH	M	M	M											
NARDO	95.9	55.3	75.6	8.8	101	3	42	27	0	326	30	0	0	0
GHAM 2 NE	87.8	53.5	70.7	4.1	91	17	48	26	0	177	3	0	0	0
QUE DEL APACHE	96.4	53.2	74.8	6.1	100	14	43	28+	0	301	30	0	0	0
RIZOZO 1 SW	89.9	56.6	73.3	6.1	94	28+	46	27	0	254	18	0	0	0
RALES	87.3	52.4	69.9		91	28+	41	27+	0	154	5	0	0	0
PHANT BUTTE DAM	M	M	M											
UNA	86.0	50.6	68.3	2.9	91	25	42	28	3	108	4	0	0	0
LUNAS 3 SSW	91.4	53.0	72.2	5.5	97	1	44	27	0	224	23	0	0	0
ROGLYPH NATL MON	91.1	58.6	74.9		94	3	51	27+	0	304	24	0	0	0
CORRO	92.2	53.5	72.9	5.1	95	28+	43	27	0	242	28	0	0	0
)IVISIONAL DATA------->			72.5	4.6										
ENTRAL HIGHLANDS 06														
PITAN	M	M	M		86	24+	43	12			0	0	0	0
INES CORNERS 7 SE	M	M	M		84	13	46	21+			0	0	0	0
)UDCROFT	M	M	M											
RONA 10 SW	78.6	52.4	65.5		85	28	46	12	14	37	0	0	0	0
GEWOOD CEDAR GROVE	M	M	M											
TANCIA 7 NE	84.6	44.2	64.4	2.2	88	28+	33	26	32	21	0	0	0	0
AN QUIVIRA NATL MON	85.1	51.2	68.2	4.2	89	28	46	24+	0	103	0	0	0	0
RIARTY 1 NE	84.4	46.3	65.4		88	29	37	27	15	33	0	0	0	0
UNTAIN PARK	M	M	M											
UNTAINAIR	86.8	48.8	67.8	5.7	89	28+	40	21	3	93	0	0	0	0
DERNAL 4 E	84.1	49.8	67.0	4.9	89	26+	42	12	7	72	0	0	0	0
IDOSO	78.9	45.5	62.2		88	24	40	27+	82	6	0	0	0	0
NDIA PARK	80.1	47.0	63.6	3.0	84	28+	40	27	47	12	0	0	0	0
ANLEY 1 NNE	83.3	47.2	65.3	4.4	88	29	37	27	25	37	0	0	0	0
DIVISIONAL DATA------->			65.5	5.2										
OUTHEASTERN														
LAINS 07														
TESIA 6 S	91.6	59.3	75.5	5.2	96	28+	56	11+	0	323	20	0	0	0
TTER LAKES WL REFUGE	94.6	58.5	76.6	6.7	99	28+	54	7	0	354	27	0	0	0
ANTLEY DAM	93.7	63.1	78.4		99	14	59	11	0	407	26	0	0	0
RLSBAD	94.0	63.7	78.9	6.3	101	14	60	11+	0	423	26	0	0	0
RLSBAD FAA AIRPORT	94.9	65.1	80.0	6.4	101	20+	59	11	0	459	28	0	0	0
RLSBAD CAVERNS	89.9	63.2	76.6	6.2	96	22	56	23	0	353	15	0	0	0
OSSROADS 2	M	M	M											
LIA	86.8	51.3	69.1	2.9	92	25	45	26	1	131	6	0	0	0
K 2 E	M	M	M											
)RT SUMNER	88.6	57.3	73.0	5.0	93	27	52	26	0	244	13	0	0	0

WS FORM B-91
(12-93)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

RECORD OF RIVER AND CLIMATOLOGICAL OBSERVATIONS

STATION (Climatological): PETROGLYPH NATIONAL MONUMENT
(River Station, if different):
MONTH: AUGUST 19 98
STATE: NEW MEXICO
COUNTY: BERNALILLO
RIVER:
TIME (local) OF OBSERVATION RIVER: TEMP.: PRECIPITATION:
STANDARD TIME IN USE: MST
TYPE OF RIVER GAGE:
ELEVATION OF RIVER GAGE ZERO: Ft.
FLOOD STAGE: Ft.
NORMAL POOL STAGE: Ft.

DATE	TEMPERATURE F. 24 HRS. ENDING AT OBSERVATION MAX.	MIN.	AT OBSN.	PRECIPITATION 24-HR AMOUNTS Rain, melted snow, etc. (Ins. and hundredths)	Snow, ice pellets, (ins. and tenths)	At Ob. Snow, ice pellets, hail, ice on ground (ins.)	Fog	Ice Pellets	Glaze	Thunder	Hail	Damaging Winds	REMARKS (Special observations, etc.)
1	87	65	82	.01						X			
2													
3	94	59	91										
4													
5	91	57	80	.13									
6													
7	97	56	94										
8	98	60	97										
9	99	63	94										
10	95	66	85										
11	92	66	85										
12	90	64	86										
13	92	59	90	.03									
14	93	59	90	.06									
15	93	61	92										
16	95	63	93										
17													
18	96	63	91	T									
19	95	66	89										
20	93	64	88	.05									
21	91	68	79	T									
22	95	68	94										
23	97	64	95										
24	99	66	94	T									
25	94	66	90	.02						X			
26	91	60	89	.15									
27	98	65	96										
28	92	69	90										
29	93	63	91										
30	95	62	93										
31	95	63	91										
SUM			SUM	.45									

PRECIPITATION: Draw a straight line (——) through hours precipitation was observed, and a waved line (~~~~) through hours precipitation probably occurred unobserved. A.M. 1 2 3 4 5 6 7 8 9 10 11 NOON P.M. 1 2 3 4 5 6 7 8 9 10 11

WEATHER (Calendar Day): Mark 'X' for all types occurring each day.

Time of observation if different from above

RIVER STAGE: CONDITION | GAGE READING AT ___ A.M. | TENDENCY

CHECK BAR (For wire-weight) NORMAL CK. BAR
READING | DATE

CONDITION OF RIVER AT GAGE

OBSERVER

STATION (Climatological) PETROGLYPH NATIONAL MONUMENT (River Station, if different)	MONTH SEPT	19 98
STATE NEW MEXICO / COUNTY BERNALILLO	RIVER	
TIME (local) OF OBSERVATION RIVER / TEMP. / PRECIPITATION	STANDARD TIME IN USE	
TYPE OF RIVER GAGE / ELEVATION OF RIVER GAGE ZERO Ft. / FLOOD STAGE Ft.	NORMAL POOL STAGE Ft.	

WS FORM B-91
(12-93)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

RECORD OF RIVER AND CLIMATOLOGICAL OBSERVATIONS

Precipitation: Draw a straight line (——) through hours precipitation was observed, and a waved line (~~~~) through hours precipitation probably occurred unobserved.

Weather (Calendar Day): Mark 'X' for all types occurring each day.

DATE	TEMPERATURE F. 24 HRS. ENDING AT OBSERVATION MAX.	MIN.	AT OBSN.	PRECIPITATION 24-HR AMOUNTS Rain, melted snow, etc. (ins. and hundredths)	Snow, ice pellets, (ins. and tenths)	At Ob. Snow, ice pellets, hail, ice on ground (ins.)	Hours (A.M. / NOON / P.M.)	Fog	Ice Pellets	Glaze	Thunder	Hail	Damaging Winds	Time of observation if different from above	RIVER STAGE CONDITION	GAGE READING AT A.M.	TENDENCY	REMARKS (Special observations, etc.)
1	92	65	88															
2	90	64	88															
3	94	63	92															
4	93	66	87															
5	93	61	91															
6	93	62	92															
7	93	58	90															
8	92	61	90															
9	91	65	90															
10	96	63	87															
11	92	61	89															
12	91	60	89															
13																		
14	92	61	89															
15	89	60	87															
16	87	54	86															
17	89	57	82															
18	91	52	89															
19	93	60	92															
20	92	52	89															
21	90	52	87															
22	88	55	86															
23	89	61	89															
24	92	54	90															
25	92	60	88															
26	91	51	63															Temps for 9-26 taken 0810 9-27
27	92	51	90															
28	93	55	91															
29	92	64	80				P.M. 6–11 ~~~~				X							
30	84	58	79	.03			A.M. 1–8 ~~~~				X							
31																		
SUM			SUM				CHECK BAR (For wire-weight) NORMAL CK. BAR	Fog	Ice Pel.	Glaze	Thund.	Hail	Dam. Winds					

CONDITION OF RIVER AT GAGE

CHECK BAR READING | DATE

OBSERVER PETROGLYPH NATIONAL MONUMENT

WS FORM B-91
(12-93)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

RECORD OF RIVER AND CLIMATOLOGICAL OBSERVATIONS

STATION (Climatological): PETROGLYPH NATIONAL MONUMENT (River Station, if different)
MONTH: OCT 19 98
STATE: NEW MEXICO
COUNTY: BERNALILLO
RIVER:
TIME (local) OF OBSERVATION RIVER: TEMP.: PRECIPITATION:
STANDARD TIME IN USE: MST
TYPE OF RIVER GAGE:
ELEVATION OF RIVER GAGE ZERO: Ft.
FLOOD STAGE: Ft.
NORMAL POOL STAGE: Ft.

DATE	TEMPERATURE F. 24 HRS. ENDING AT OBSERVATION MAX.	MIN.	AT OBSN.	PRECIPITATION 24-HR AMOUNTS Rain, melted snow, etc. (ins. and hundredths)	Snow, ice pellets, (ins. and tenths)	At Ob. Snow, ice pellets, hail, ice on ground (ins.)	WEATHER Fog	Ice Pellets	Glaze	Thunder	Hail	Damaging Winds	REMARKS (Special observations, etc..)
1	81	58	73	.04						X	X		
2	81	43	79	T									
3	83	41	81										
4	82		48										MIN. NOT RECORDED
5	66	46	62										
6	72	38	68										
7	77	42	74										
8	79	36	77										
9	83	40	82										
10	85	43	83										
11	85	38	80										
12	83	50	82										
13	82	52	82										
14	87	46	85										
15	86	41	81										WINDY
16	82	48	68										
17	70	31	57										
18	71	36	70										
19	71	43	67										
20	69	49	59	.67						X			
21	59	49	57	.11									
22	59	49	57										
23	69	53	67										
24	69	44	68	.01									
25	74	46	70										
26	71	50	57	.02						X			
27	59	45	49	.48						X			
28	64	36	60	.01									
29	67	34	65										
30	65	45	55	.03									
31	56	45	49	.21									
SUM			SUM	1.58									

CHECK BAR (For wire-weight) NORMAL CK. BAR
READING | DATE

CONDITION OF RIVER AT GAGE

OBSERVER: Petroglyph National Monument

WS FORM B-91
(12-93)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

RECORD OF RIVER AND CLIMATOLOGICAL OBSERVATIONS

STATION (Climatological): PETROGLYPH NAT'L MON (River Station, if different):
MONTH: NOV 19 98
STATE: NEW MEXICO
COUNTY: BERNALILLO
RIVER:
TIME (local) OF OBSERVATION RIVER: TEMP.: PRECIPITATION:
STANDARD TIME IN USE: M.S.T
TYPE OF RIVER GAGE:
ELEVATION OF RIVER GAGE ZERO: Ft.
FLOOD STAGE: Ft.
NORMAL POOL STAGE: Ft.

DATE	TEMPERATURE F. 24 HRS. ENDING AT OBSERVATION MAX.	MIN.	AT OBSN.	PRECIPITATION 24-HR AMOUNTS Rain, melted snow, etc. (Ins. and hundredths)	Snow, ice pellets (Ins. and tenths)	At Ob. Snow, ice pellets, hail, ice on ground (Ins.)	REMARKS (Special observations, etc.)
1	61	43	56	T			
2	61	37	56				
3	63	32	60				
4	61	35	58				
5	58	34	51				
6	63	32	58				
7	61	32	57				
8	64	39	59				
9	66	37	44	.14			
10	46	25	44				
11	47	27	45				
12	57	40	48	.07			
13	60	32	57	.17			
14	68	31	64				
15							NO RECORDING
16	69	32	66				
17	66	31	64				
18	64	36	62				
19	62	31	55				
20	56	28	51				
21	61	19	58				
22	65	23	62				
23	67	28	66				
24	69	31	61				
25	68	32	66				
26							NO RECORDING
27	69	28	65				
28	66	36	60				
29	61	43	51	.13			
30	58	32	53	T			
31							
SUM			SUM	.51			

PRECIPITATION: Draw a straight line (——) through hours precipitation was observed, and a waved line (~~~~) through hours precipitation probably occurred unobserved. A.M. 1 2 3 4 5 6 7 8 9 10 11 NOON P.M. 1 2 3 4 5 6 7 8 9 10 11

WEATHER (Calendar Day): Mark 'X' for all types occurring each day. Fog | Ice Pellets | Glaze | Thunder | Hail | Damaging Winds

Time of observation if different from above

RIVER STAGE: CONDITION | GAGE READING AT ___ A.M. | TENDENCY

CHECK BAR (For wire-weight) NORMAL CK. BAR — READING — DATE

CONDITION OF RIVER AT GAGE

OBSERVER

WS FORM B-91
(12-93)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

RECORD OF RIVER AND CLIMATOLOGICAL OBSERVATIONS

STATION (Climatological): PETROGLYPH NAT'L. MON. (River Station, if different):
MONTH: DEC. 19 98
STATE: NEW MEXICO
COUNTY: BERNALILLO
RIVER:
TIME (local) OF OBSERVATION RIVER: ~~[illegible]~~ TEMP.: PRECIPITATION:
STANDARD TIME IN USE: MST
TYPE OF RIVER GAGE:
ELEVATION OF RIVER GAGE ZERO: Ft.
FLOOD STAGE: Ft.
NORMAL POOL STAGE: Ft.

DATE	TEMPERATURE F. 24 HRS. ENDING AT OBSERVATION MAX.	MIN.	AT OBSN.	PRECIPITATION 24-HR AMOUNTS Rain, melted snow, etc. (Ins. and hundredths)	Snow, ice pellets (ins. and tenths)	At Ob. Snow, ice pellets, hail, ice on ground (Ins.)	WEATHER (Calendar Day) Fog	Ice Pellets	Glaze	Thunder	Hail	Damaging Winds	Time of observation if different from above	RIVER STAGE CONDITION	GAGE READING AT ___ A.M.	TENDENCY	REMARKS (Special observations, etc.)
1	62	35	57														
2	57	40	53														
3	67	42	60														
4	62	31	57														
5	61	31	57														
6																	NOT RECORDED
7	57	24	35		T	T											
8	42	13	37														
9	42	15	37														
10	40	31	38														
11	46	15	43														
12	51	16	45														
13	56	20	52														
14	55	19	51														
15	60	29	52														
16	59	22	53														
17	57	27	53														
18	61	22	58														
19	59	30	50														
20	64	33	59														
21	60	28	36														
22	37	14	34														
23																	NOT RECORDED
24	47	14	44														
25																	NOT RECORDED
26	55	19	50														
27	58	24	52														
28	61	24	56														
29	64	31	61														
30	66	28	63														
31	64	32	52														
SUM			SUM				Fog	Ice Pel.	Glaze	Thund.	Hail	Dam. Winds					

Precipitation: Draw a straight line (——) through hours precipitation was observed, and a waved line (~~~~) through hours precipitation probably occurred unobserved. A.M. NOON P.M.

CHECK BAR (For wire-weight) NORMAL CK. BAR
READING | DATE

CONDITION OF RIVER AT GAGE

OBSERVER: Petroglyph National Monument

Appendix B

Erosion Pin Data

Equation Descriptions

Equation 1

$$A = RK(LS)(VM)$$

A is soil loss, tons per acre per year
R is rainfall erosion index
K is soil erodibility Factor
LS is slope factor, steepness, and length
VM is vegetation factor.

2nd Equation:

$$Y_s = \alpha (V q_p)^{\beta} KLSCP$$

Y_s = sediment yield for the storm in tons
K = soil erodibility factor
LS = is the topographic factor representing the combination of slope length and slope gradient
C = cover and management factor
P = erosion control factor
V = runoff volume for the storm in acre-feet
q_p = peak discharge of the storm in cfs
α = 285 from an experimental watershed
β = .56

The V and q_p values for the 100 year storm are from Wilson & Assoc., 1983, figure 11.

Givens and estimations used:

acreage: 6 $miles^2$ x $\frac{640 \text{ acres}}{1 \text{ mile}^2}$ = 3,840 acres

runoff: Say 50% infiltration
10% Interception by plants

AHYMO runs: V ac-ft, cfs } taken from previous work of

Easterling & Assoc. 1988a, 1988b
Molzen-Corbin, 1993

- estimated V ac-f & cfs when no specific storm years were provided.

TABLE 7.5. *C* or *VM* factors for permanent pasture, rangeland, idle land, and grazed woodland

Type and height of raised canopy[a]	Canopy cover[b] (%)	Type[c]	Cover that contacts the surface (% ground cover) 0	20	40	60	80	95–100
No appreciable canopy		G	0.45	0.20	0.10	0.042	0.013	0.003
		W	0.45	0.24	0.15	0.090	0.043	0.011
Canopy of tall weeds or short brush (0.5 m fall height)	25	G	0.36	0.17	0.09	0.038	0.012	0.003
		W	0.36	0.20	0.13	0.082	0.041	0.011
	50	G	0.26	0.13	0.07	0.035	0.012	0.003
		W	0.26	0.16	0.11	0.075	0.039	0.011
	75	G	0.17	0.10	0.06	0.031	0.011	0.003
		W	0.17	0.12	0.09	0.067	0.038	0.011
Appreciable brush or bushes (2 m fall height)	25	G	0.40	0.18	0.09	0.040	0.013	0.003
		W	0.40	0.22	0.14	0.085	0.042	0.011
	50	G	0.34	0.16	0.085	0.038	0.012	0.003
		W	0.34	0.19	0.13	0.081	0.041	0.011
	75	G	0.28	0.14	0.08	0.036	0.012	0.003
		W	0.28	0.17	0.12	0.077	0.040	0.011
Trees but no appreciable low brush (4 m fall height)	25	G	0.42	0.19	0.10	0.041	0.013	0.003
		W	0.42	0.23	0.14	0.087	0.042	0.011
	50	G	0.39	0.18	0.09	0.040	0.013	0.003
		W	0.39	0.21	0.14	0.085	0.042	0.011
	75	G	0.36	0.17	0.09	0.039	0.012	0.003
		W	0.36	0.20	0.13	0.083	0.041	0.011

Source: USDA Soil Conservation Service 1977.

Note: All values assume (1) random distribution of mulch or vegetation and (2) mulch of appreciable depth where it exists. Idle land refers to land with undisturbed profiles for at least a period of 3 consecutive years. Also to be used for burned forest land and forest land that has been harvested less than 3 yr ago.

[a]Average fall height of water drops from canopy to soil surface.

[b]Portion of total area surface that would be hidden from view by canopy in a vertical projection (a bird's-eye view).

[c]G = cover at surface is grass, grasslike plants, decaying compacted duff, or litter at least 2 in. deep; W = cover at surface is mostly broadleaf herbaceous plants (as weeds with little lateral-root network near the surface) and/or undecayed residue.

effective root zone significantly, diminishing the potential of the soil to produce biomass over an extended period of time. The following criteria are used to assign T_e values to a soil series:

1. An adequate rooting depth must be maintained in the soil for plant growth. For shallow soils overlying rock or other restrictive layers, it is important to retain the remaining soil; little soil loss is tolerated. The T_e should be less on shallow soils or those with impervious layers than for soils with good soil depth or for soils with underlying soil materials that can be improved by management practices.

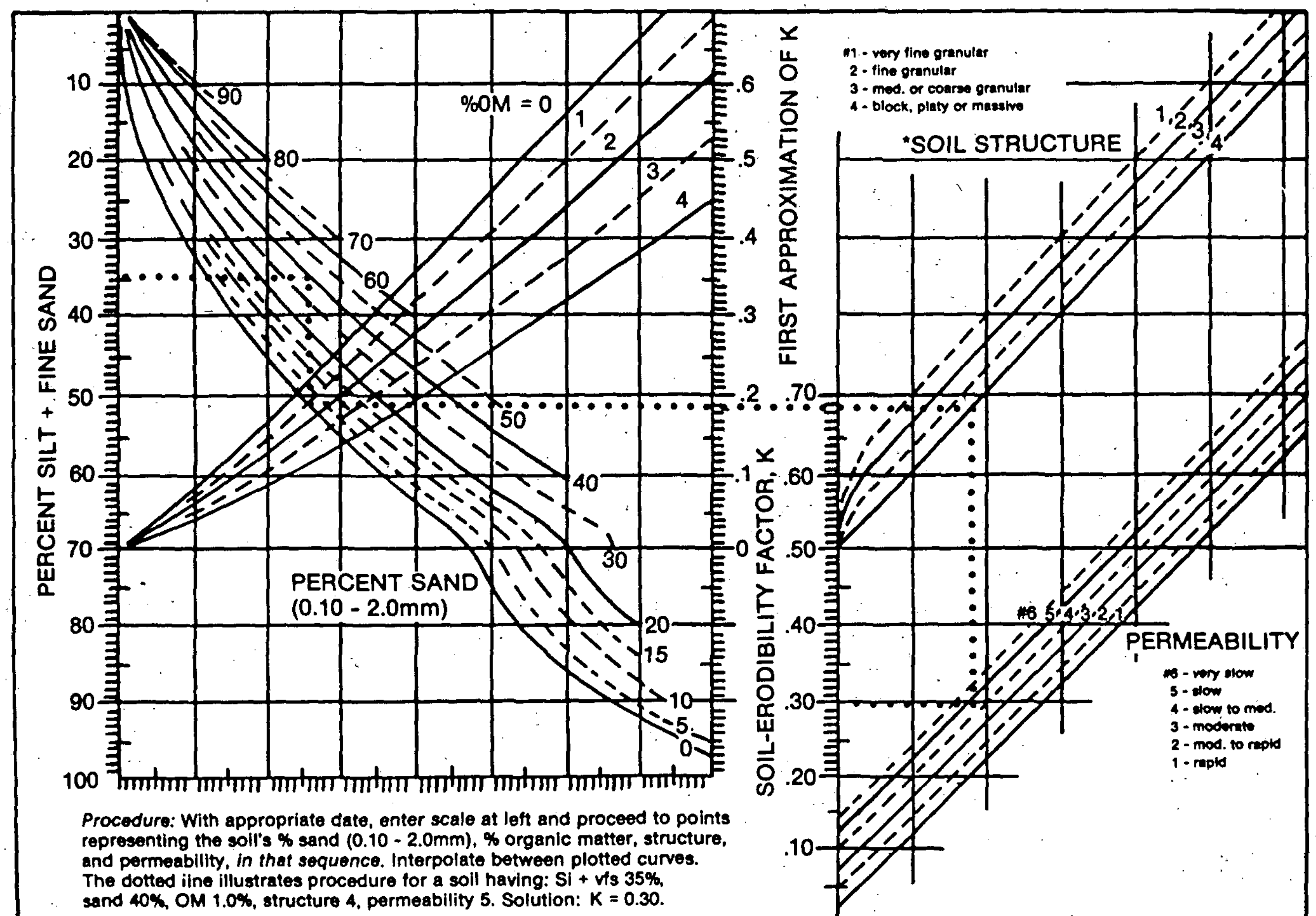


FIGURE 7.4. Nomograph for determining the soil erodibility factor (*K*) in English units (from U.S. Forest Service 1980, adapted from Wischmeier et al. 1971).

EP-1 Station

Date	Galvanized	Steel	Steel, Adjusted
9-12-1998	placed	placed	No
10-06-1998	-1 mm erosion	-1mm erosion	
10-08-1998	-2mm	-.5mm	
10-13-1998	-1mm	-1mm	
10-22-1998	-1mm	-.5mm	
11-03-1998	-1.5mm	-1mm	
11-10-1998	-1.5mm	-.5mm	
11-17-1998	-1.5mm	-2mm	

This station has a strike of N55E and 14° dip. This location is 51 cm to a pedestrian and game trail. It is 270cm to the center of a small natural arroyo that connects from the south into Arroyo 1. A large mature juniper tree is located upstream of this location, which is often the case. Junipers are placed at the headwaters of the arroyos and show a propensity for this location. Junipers have become indicator species for erosion processes in this field area. The vegetation ground cover is 15% and there is 0% rock cover*. The vegetation is black gamma grass, four-wing saltbush, snakeweed, Sand sage, locoweed, and side oats grass. In general the area has a good grass cover and medium sized boulders within the arroyo. The nails are placed directly downslope and sheltered by a clump of grass. Nails are located 6.4 cm apart.

*The rock and vegetation cover is assumed for a four-foot square area that contains the nails in the center.

Erosion Pin # 1
Sediment yield calculations
MUSLE equation 1 is A is equal to the values R * K * LS* VM

R	K	LS	VM	A
25	0.23	1.4	0.2	1.6

MUSLE equation 2 is Ys=alpha(Vqp)raised to Beta multiplied by K*LS*C*P

Storm	Alpha	V ac-ft	q in cfs	K	LS	C	P	Ys	Acreage	tons/acre	c:storm
100	285	113.5	256	0.23	1.4	0.2	1	5795.48	3840	1.509	0.015
50	285	80	224	0.23	1.4	0.2	1	4421.81	3840	0.851	0.015
25	285	60	179.2	0.23	1.4	0.2	1	3321.73	3840	0.865	0.04
10	285	26	480	0.23	1.4	0.2	1	3610.86	3840	0.940	0.08
5	285	12	220	0.23	1.4	0.2	1	1512.97	3840	0.394	0.2
2	285	3.24	125	0.23	1.4	0.2	1	529.55	3840	0.138	0.4

Calculations for the annual storm event load: 0.27919

EP-2 Station

Date	Galvanized	Steel	Steel, Adjusted
9-12-1998	Placed	Placed	No
9-29-1998	Disturbed & replaced	Disturbed & Not replaced	Yes, placed & adjusted +2cm
10-06-1998	-1mm erosion		-2mm erosion
10-08-1998	-.5mm		-2mm
10-13-1998	0mm		1.9cm
10-22-1998	-1mm		1.65cm
11-03-1998	-.5mm		1.8cm
11-10-1998	0mm		1.75cm*
11-17-1998	0mm		1.9cm (-1mm)

Description: Strike N75°E, dip 5° degree. The arroyo width is 14'0" feet. Site has low basalt cap rock exposed, with tumbled boulders to the slope base. The vegetation is rabbitbush, spectacle plant, black grama grass, mesquite, Sand sage, and four-wing Saltbush. The nails are placed in an area where they are hidden, due to the close proximity to the main pedestrian trail. Downslope to the pin site is a Sand sage, threeawn grass, and a snakeweed plant. The nails are 8.3cm apart. Vegetation cover is 45% and rock cover is 30%.

Note: these readings record the erosion at each pin at the point in time. This information is not additive or to be summed. The final number is the amount of erosion for that nail for this site. Showing the data through time is presented to show the reader the progress of the erosion or aggradation.

*washer is covered with sand/soil

Erosion Pin # 2
Sediment yield calculations
MUSLE equation 1 is A is equal to the values R * K * LS* VM

R	K	LS	VM	A
25	0.3	4.2	0.012	0.378

MUSLE equation is Ys=alpha(Vqp)raised to Beta multiplied by K*LS*C*P

Storm	Alpha	V ac-ft	q in cfs	K	LS	C	P	Ys	Acreage	tons/acre	c:storm
100	285	113.475	256	0.3	4.2	0.012	1	1360.68	3840	0.354	0.015
50	285	80	224	0.3	4.2	0.012	1	1038.16	3840	0.270	0.015
25	285	60	179.2	0.3	4.2	0.012	1	779.89	3840	0.203	0.04
10	285	26	480	0.3	4.2	0.012	1	847.77	3840	0.221	0.08
5	285	12	220	0.3	4.2	0.012	1	355.22	3840	0.093	0.2
2	285	3.24	125	0.3	4.2	0.012	1	124.33	3840	0.032	0.4

Calculations for the annual storm event load: 0.06129

EP-3 Station

Date	Galvanized	Steel	Steel, Adjusted
9-12-1998	Placed	Placed	No
9-17-1998	-1.15cm	-1.15cm	
9-29-1998	-5mm	-6mm	
10-08-1998	-7mm erosion Head exposed, no washer	-6mm Washer not exposed	
10-13-1998	Flush with head +1mm	-1.5mm	
10-22-1998	Surface flush w/ Bottom of head	Surface flush w/ Bottom of head	
11-03-1998	-2.0mm*	-1mm*	
11-10-1998	-2mm	-2.5mm	
11-17-1998	+1mm*	+2mm*	

Description: Strike N345ºE, dip 19°, length 68'. The vegetation at this site is Side-oats grama, Indian ricegrass, white puffy grass, snakeweed, and four wing saltbush. The overall vegetative cover is 50%. The rock cover is 15% and is basalt. The nails are 6.6cm apart.

*washer is buried

Erosion Pin # 3
Sediment yield calculations
MUSLE equation 1 is A is equal to the values R * K * LS* VM

R	K	LS	VM	A
25	0.23	0.4	0.038	0.0874

MUSLE equation 2 is Ys=alpha(Vqp)raised to Beta multiplied by K*LS*C*P

Storm	Alpha	V ac-ft	q in cfs	K	LS	C	P	Ys	Acreage	tons/acre	c:storm
100	285	113.475	256	0.23	0.4	0.038	1	314.61	3840	0.082	0.015
50	285	80	224	0.23	0.4	0.038	1	240.04	3840	0.063	0.015
25	285	60	179.2	0.23	0.4	0.038	1	180.32	3840	0.047	0.04
10	285	26	480	0.23	0.4	0.038	1	196.02	3840	0.051	0.08
5	285	12	220	0.23	0.4	0.038	1	82.13	3840	0.021	0.2
2	285	3.24	125	0.23	0.4	0.038	1	28.75	3840	0.007	0.4

Calculations for the annual storm event load: 0.015401

EP-4 Station

Date	Galvanized	Steel	Steel, Adjusted
9-12-1998	Placed	Placed	No
9-29-1998	-2mm		
10-08-1998	-3mm erosion	-1mm erosion	
10-13-1998	-5mm	-2mm	
10-22-1998	-4mm	-1mm	
11-03-1998	-4mm	-2mm	
11-10-1998	-3mm	-1.5mm	
11-17-1998	-4mm	-2mm	

Description: Strike N147°E with a 9° dip. The vegetation cover is good with 20% coverage. The following vegetation is found in this location: mesquite, snakeweed, Four-wing saltbush, Sand sage, Side-oats grama. In general this area is located in a broad arroyo with a juniper at the base. There are basalt boulders on each side of the arroyo, anchoring this position. There are also small to medium boulders strewn down the slope; the basalt rocks make up 15% of the ground coverage. No dirt roads, pedestrian trails or strong game trails are associated with this location on the mesa top. However, from the bottom of the escarpment, there is a pedestrian trail that comes within 21'4" feet of this nail site. The nails are placed 6 cm apart.

Erosion Pin # 4
Sediment yield calculations
MUSLE equation 1 is A is equal to the values R * K * LS* VM

R	K	LS	VM	A
25	0.34	4.2	0.09	3.213

MUSLE equation 2 is Ys=alpha(Vqp)raised to Beta multiplied by K*LS*C*P

Storm	Alpha	V ac-ft	q in cfs	K	LS	C	P	Ys	Acreage	tons/acre	c:storm
100	285	113.475	256	0.34	4.2	0.09	1	11565.76	3840	3.012	0.015
50	285	80	224	0.34	4.2	0.09	1	8824.39	3840	2.298	0.015
25	285	60	179.2	0.34	4.2	0.09	1	6629.02	3840	1.726	0.04
10	285	26	480	0.34	4.2	0.09	1	7206.02	3840	1.877	0.08
5	285	12	220	0.34	4.2	0.09	1	3019.35	3840	0.786	0.2
2	285	3.24	125	0.34	4.2	0.09	1	1056.79	3840	0.275	0.4

Calculations for the annual storm event load: 0.566168

EP-5 Station

Date	Galvanized	Steel	Steel, Adjusted Raised 2 cm up
9-12-1998	Placed	Placed	Yes
9-29-1998	+5mm buried		-4mm (1.6cm)
10-08-1998	-3.5mm Head only exposed		-4.5mm
10-13-1998	+2mm above head		-4mm
10-22-1998	+5mm buried head		-3mm
11-03-1998	+2.5mm Buried head		-3mm*
11-10-1998	+4mm head buried		+6mm head buried
11-17-1998	+4mm buried head		Head exposed only. 3mm to buried washer

* Denotes washer buried

Description: Strike N111°E, dip 20°, length 64'8". The unconsolidated sand is well-sorted and light tan in color. This site is located proximate to large boulders, with a steep sand slope vegetated with snakeweed, Sand sage, and Indian Ricegrass directly upslope of the nails. Vegetative cover downslope is Sand sage. The dirt road at the toe of the slope is 442 feet away. A game trail exists downslope of the nail site at 90cm to the east. Vegetative cover is 20% and rock cover is 30%. There appears to be creatures that live within the boulder areas. The nails are 5cm apart.

Erosion Pin # 5
Sediment yield calculations
MUSLE equation 1 is A is equal to the values R * K * LS* VM

R	K	LS	VM	A
25	0.35	1.4	0.09	1.1025

MUSLE equation 2 is Ys=alpha(Vqp)raised to Beta multiplied by K*LS*C*P

Storm	Alpha	V ac-ft	q in cfs	K	LS	C	P	Ys	Acreage	tons/acre	c:storm
100	285	113.475	256	0.35	1.4	0.09	1	3968.64	3840	1.034	0.015
50	285	80	224	0.35	1.4	0.09	1	3027.98	3840	0.789	0.015
25	285	60	179.2	0.35	1.4	0.09	1	2274.66	3840	0.592	0.04
10	285	26	480	0.35	1.4	0.09	1	2472.66	3840	0.644	0.08
5	285	12	220	0.35	1.4	0.09	1	1036.05	3840	0.270	0.2
2	285	3.24	125	0.35	1.4	0.09	1	362.63	3840	0.094	0.4

Calculations for the annual storm event load: 0.194273

EP-6 Station

Date	Galvanized	Steel	Steel, Adjusted
9-12-1998	Placed	Placed	Yes (2.0cm)
9-29-1998	-.5mm		+5mm (2.5cm)
10-08-1998	+1mm Head buried		+2.55cm
10-13-1998	+1mm above head		2.55cm
10-22-1998	-1mm		2.90cm
11-03-1998	-1mm		2.90cm
11-10-1998	-1mm*		2.90cm
11-17-1998	+1mm		3.0cm

Description: Strike N140ºE, dip 8°, length 49'10"". This site is within a broad, very sandy, arroyo with a U shape. The unconsolidated sand is well-sorted and light tan in color. There is a lack of a basalt cap in this area. There is less vegetative cover than the surrounding area, with 20%. The vegetation consists of: locoweed, Sand Sage, Broom dalea, mustard green, and snakeweed. The vegetation provides a strong anchor in this arroyo. Most bushes are tall (3.5'to 4.5') and are of similar height, hence also a probably the same age. There are no dirt roads at the mesa top, but game trails do exist. There is however, a pedestrian path at the slope terminus. This site is at a break in the slope, at a level spot, and downslope within a natural arroyo.

*indicates that washer is buried

Erosion Pin # 6
Sediment yield calculations
MUSLE equation 1 is A is equal to the values R * K * LS* VM

R	K	LS	VM	A
25	0.49	0.9	0.13	1.43

MUSLE equation 2 is Ys=alpha(Vqp)raised to Beta multiplied by K*LS*C*P

Storm	Alpha	V ac-ft	q in cfs	K	LS	C	P	Ys	Acreage	tons/acre	c:storm
100	285	113.475	256	0.49	0.9	0.13	1	5159.23	3840	1.344	0.015
50	285	80	224	0.49	0.9	0.13	1	3936.37	3840	1.025	0.015
25	285	60	179.2	0.49	0.9	0.13	1	2957.06	3840	0.770	0.04
10	285	26	480	0.49	0.9	0.13	1	3214.45	3840	0.837	0.08
5	285	12	220	0.49	0.9	0.13	1	1346.87	3840	0.351	0.2
2	285	3.24	125	0.49	0.9	0.13	1	471.41	3840	0.123	0.4

Calculations for the annual storm event load: 0.252555

EP-7 Station

Date	Galvanized	Steel	Steel, Adjusted
9-29-1998	Placed	Placed	Yes, +2cm
10-08-1998	0mm		+2.2cm
10-13-1998	-2mm		1.95cm
10-22-98	-.5mm		1.90cm
11-03-1998	-1mm		1.90cm
11-10-1998	-1mm		1.80cm
11-17-1998	-1mm		1.90cm*

Description: Strike N350ºE, 15°, 12'8" length. This arroyo is v-shaped with ledges below the nail location that contain concentrations of petroglyphs. The nail site is 6'2" to a game/pedestrian trail. The rock cover is 0%. The vegetation is 30%. The vegetation is snakeweed and rice grass. In general this area is rocky with basalt cap rock in ledges. The nails are 6.4cm apart.

*implies washer is buried

Erosion Pin # 7
Sediment yield calculations
MUSLE equation 1 is A is equal to the values R * K * LS* VM

R	K	LS	VM	A
25	0.38	1.4	0.1	1.3

MUSLE equation 2 is Ys=alpha(Vqp)raised to Beta multiplied by K*LS*C*P

Storm	Alpha	V ac-ft	q in cfs	K	LS	C	P	Ys	Acreage	tons/acre	c:storm
100	285	113.475	256	0.38	1.4	0.1	1	4787.57	3840	1.247	0.015
50	285	80	224	0.38	1.4	0.1	1	3652.80	3840	0.951	0.015
25	285	60	179.2	0.38	1.4	0.1	1	2744.04	3840	0.715	0.04
10	285	26	480	0.38	1.4	0.1	1	2982.89	3840	0.777	0.08
5	285	12	220	0.38	1.4	0.1	1	1249.84	3840	0.325	0.2
2	285	3.24	125	0.38	1.4	0.1	1	437.45	3840	0.114	0.4

Calculations for the annual storm event load: 0.234361

EP-8 Station

Date	Galvanized	Steel	Steel, Adjusted
9-12-1998	Placed	Placed	No
9-24-1998	-1.0mm	-4.5mm	
9-29-1998	-1.0mm	-0.5mm	
10-08-1998	-1.5mm	-4.0mm	
10-13-1998	-2.5mm	-4.0mm	
10-13-1998	-2.5mm	-4.0mm	
10-22-1998	-1.5mm	-3.0mm	
11-03-1998	-1.0mm	-2.0mm	
11-10-1998	2.5mm	-2.0mm	
11-17-1998	-2.0mm	-2.0mm	

Description: Strike N135ºE, dip 3°, arroyo length across is 36'1". This site is in a protected area within a decided water pathway. This arroyo has V-shaped morphology. The basaltic cap rock is at ground level, and the ground cover of rock is 60%. The vegetation cover is 15% and consists of Sand sage, snakeweed, and puffy grass. This site is 2'9" to a pedestrian trail. It is also 100'22" feet to a fence with an associated pedestrian trail and one of the few dirt roads of this area. The site in general is at the headwaters of the southern arroyo joining arroyo 2. The nails are 11.4cm apart.

Erosion Pin # 8
Sediment yield calculations
MUSLE equation 1 is A is equal to the values R * K * LS* VM

R	K	LS	VM	A
25	0.46	0.7	0.013	0.105

MUSLE equation 2 is Ys=alpha(Vqp)raised to Beta multiplied by K*LS*C*P

Storm	Alpha	V ac-ft	q in cfs	K	LS	C	P	Ys	Acreage	tons/acre	c:storm
100	285	113.475	256	0.46	0.7	0.013	1	376.71	3840	0.098	0.015
50	285	80	224	0.46	0.7	0.013	1	287.42	3840	0.075	0.015
25	285	60	179.2	0.46	0.7	0.013	1	215.91	3840	0.056	0.04
10	285	26	480	0.46	0.7	0.013	1	234.71	3840	0.061	0.08
5	285	12	220	0.46	0.7	0.013	1	98.34	3840	0.026	0.2
2	285	3.24	125	0.46	0.7	0.013	1	34.42	3840	0.009	0.4

Calculations for the annual storm event load: 0.018441

EP-9 Station

Date	Galvanized	Steel	Steel, Adjusted
9-12-1998	Placed	Placed	No
9-24-1998	Adjusted up 2cm	-4.0mm	
9-29-1998	2.1cm	-6.5mm	
10-08-1998	1.9cm	-5.0mm	
10-13-1998	1.95cm	-6.0mm	
10-22-1998	-1.7cm	-6.3mm	
11-03-1998	Buried head 1mm	-1.5mm	
11-10-1998	Head buried 4mm	0mm	
11-17-1998	Buried +5mm	-1.0mm	

Description: Strike N137°E, dip 9.5°, length 14'2". This location is 50'10" to the edge of the basalt cap rock; the nails are 12' down from the measured length of the arroyo. This nail site is within a game trail. There is the question that the game trail could be effecting the erosion or aggradation at this site. The nails are 4.6cm apart. This site is on a flat spot in the arroyo and debris is probably aggrading at this spot. This site is within the thalweg, somewhat v-shaped below and u-shaped above the nail site, which was chosen for its nickpoint location. The vegetation consists of Sand sage, mesquite, abundant Indian Ricegrass, and snakeweed. This area is generally grassy with very small (1-11/2 foot) Sand sage. The vegetation cover is 40%. The basalt rock cover is also 40%.

Erosion Pin # 9
Sediment yield calculations
MUSLE equation 1 is A is equal to the values R * K * LS* VM

R	K	LS	VM	A
25	0.32	1.4	0.013	0.146

MUSLE equation 2 is Ys=alpha(Vqp)raised to Beta multiplied by K*LS*C*P

Storm	Alpha	V ac-ft	q in cfs	K	LS	C	P	Ys	Acreage	tons/acre	c:storm
100	285	113.475	256	0.32	1.4	0.013	1	524.11	3840	0.136	0.015
50	285	80	224	0.32	1.4	0.013	1	399.89	3840	0.104	0.015
25	285	60	179.2	0.32	1.4	0.013	1	300.40	3840	0.078	0.04
10	285	26	480	0.32	1.4	0.013	1	326.55	3840	0.085	0.08
5	285	12	220	0.32	1.4	0.013	1	136.82	3840	0.036	0.2
2	285	3.24	125	0.32	1.4	0.013	1	47.89	3840	0.012	0.4

Calculations for the annual storm event load: 0.025656

EP-10 Station

Date	Galvanized	Steel	Steel, Adjusted
9-12-1998	Placed	Placed	No
9-29-1998	Re-placed		Placed
10-08-1998	-1mm		2.2cm
10-13-1998	N/A		N/A
10-22-1998	-2mm		2.2cm
11-03-1998	-1.5mm		2.0cm
11-10-1998	-2.5mm		2.0cm*
11-17-1998	-2mm		1.95cm

This site has a strike of N189E and 3° dip. These nails are placed upslope from a small four-wing saltbush, grasses, snakeweed, Side-oat grama. In general this area is a broad U-shaped arroyo with vegetation cover of 30%. The basalt is small cobble size to small boulders of basalt debris. This rock coverage is 15%. This site is downslope from the basalt foundation. The nails are 7.2 cm apart. This site is 97'5" from a pedestrian trail and 59'6" to a paleo (?) or historic constructed basalt wall.

Erosion Pin # 10

Sediment yield calculations

MUSLE equation 1 is A is equal to the values R * K * LS* VM

R	K	LS	VM	A
25	0.38	0.4	0.1	0.38

MUSLE equation 2 is Ys=alpha(Vqp)raised to Beta multiplied by K*LS*C*P

Storm	Alpha	V ac-ft	q in cfs	K	LS	C	P	Ys	Acreage	tons/acre	c:storm
100	285	113.475	256	0.38	0.4	0.1	1	1367.88	3840	0.356	0.015
50	285	80	224	0.38	0.4	0.1	1	1043.66	3840	0.272	0.015
25	285	60	179.2	0.38	0.4	0.1	1	784.01	3840	0.204	0.04
10	285	26	480	0.38	0.4	0.1	1	852.25	3840	0.222	0.08
5	285	12	220	0.38	0.4	0.1	1	357.10	3840	0.093	0.2
2	285	3.24	125	0.38	0.4	0.1	1	124.99	3840	0.033	0.4

Calculations for the annual storm event load: 0.06696

EP-11 Station

Date	Galvanized	Steel	Steel, Adjusted
9-12-1998	Placed	Placed	No
9-29-1998	+3.5mm (+2.5 above head)	-2.5mm	
10-08-1998	+1.5mm above head	Buried 3mm above head	
10-13-1998	N/A	N/A	
10-22-1998	-6.0mm	-4.5mm	
11-03-1998	-8.0mm	-3.0mm	
11-10-1998	-7.0mm	3.5mm	
11-17-1998	-6.0mm	-4.0mm	

This site has a strike of N191 E and a dip of 12 . This site is in general barren with 10% vegetation cover. The vegetation consists of spring mustard, Indian rice grass, locoweed, sand sage, snakeweed, and Side-oats grama. This arroyo is has a broad shape with basalt ledges to the west and east. This site lies along the ridge that separates this arroyo system with the Piedras Marcadas arroyo system to the north. The nails are 9.5cm apart. It is 26'10" to the north for a popular pedestrian and game trail.

Erosion Pin # 11

Sediment yield calculations

MUSLE equation 1 is A is equal to the values R * K * LS* VM

R	K	LS	VM	A
25	0.38	0.3	0.325	0.926

MUSLE equation 2 is Ys=alpha(Vqp)raised to Beta multiplied by K*LS*C*P

Storm	Alpha	V ac-ft	q in cfs	K	LS	C	P	Ys	Acreage	tons/acre	c:storm
100	285	113.475	256	0.38	0.3	0.325	1	3334.20	3840	0.868	0.015
50	285	80	224	0.38	0.3	0.325	1	2543.91	3840	0.662	0.015
25	285	60	179.2	0.38	0.3	0.325	1	1911.03	3840	0.498	0.04
10	285	26	480	0.38	0.3	0.325	1	2077.37	3840	0.541	0.08
5	285	12	220	0.38	0.3	0.325	1	870.42	3840	0.227	0.2
2	285	3.24	125	0.38	0.3	0.325	1	304.65	3840	0.079	0.4

Calculations for the annual storm event load: 0.16322

Appendix C

Erosion Bridge Data, measured in millimeters

Givens and estimations used:

acreage: $6 \text{ miles}^2 \times \frac{640 \text{ acres}}{1 \text{ mile}^2} = 3,840$ acres.

runoff: Say 50% infiltration
10% interception by plants

AHYMO runs: V ac-ft, cfs } taken from previous work of

Easterling & Assoc. 1988a, 1988b
Molzen-Corbin, 1993

- estimated V ac-ft & cfs when no specific storm years were provided.

AMAFCA preference K factors.

Table B.1. Soil Erodibility Factor K Based on USDA Texture.				
	Estimated K Factor[1]			
USDA Texture	Normal[2]	Gravelly[2]	Very Gravelly[2]	Extremely Gravelly[2]
Coarse Sand	0.10	0.05	0.02	0.02
Sand	0.10	0.05	0.02	0.02
Fine Sand	0.17	0.10	0.05	0.02
Very Coarse Sand	0.10	0.05	0.02	0.02
Loamy Coarse Sand	0.15	0.10	0.05	0.02
Loamy Sand	0.17	0.10	0.05	0.02
Loamy Fine Sand	0.20	0.10	0.05	0.02
Loamy Very Fine Sand	0.49	0.28	0.15	0.05
Coarse Sandy Loam	0.20	0.10	0.05	0.02
Sandy Loam	0.24	0.15	0.10	0.05
Fine Sandy Loam	0.28	0.15	0.10	0.05
Very Fine Sandy Loam	0.55	0.28	0.17	0.10
Loam	0.37	0.20	0.10	0.05
Silt Loam	0.43	0.24	0.15	0.05
Silt	0.64	0.37	0.20	0.10
Sandy Clay Loam	0.32	0.15	0.10	0.05
Clay Loam	0.32	0.15	0.10	0.05
Silty Clay Loam	0.37	0.20	0.10	0.05
Sandy Clay	0.32	0.15	0.10	0.05
Silty Clay	0.24	0.15	0.10	0.05
Clay	0.20	0.10	0.05	0.02

[1]Where a Soils Survey Interpretation Sheet, SOILS-5, is available for a soil, the K Factor listed will be more accurate than the factor provided by this table.

[2]Total rock fragments are included in these figures, not just gravel. Normal = 0-15 percent, gravelly = 15-35 percent, very gravelly = 35-60 percent, and extremely gravelly = over 60 percent.

EROSION BRIDGE STATION No. 1

N56ºE, 13º

Date	0-5cm	10cm	15cm	20cm	25cm	30cm	35cm	40cm	45cm	50cm	55cm	60cm	65cm	70cm	75cm	80cm	85cm	90cm	95cm	100cm	SUM	AVG
10/6/98	11.50	11.10	10.60	10.70	10.50	11.20	11.30	11.00	10.80	10.50	10.40	10.50	10.20	10.70	10.90	10.20	9.80	10.60	10.60	11.60	214.70	10.735
10/22/98	12.10	11.60	11.05	10.90	10.80	11.20	11.20	11.00	10.65	10.30	10.20	10.50	10.20	10.50	10.95	10.35	10.00	10.60	10.90	11.00	216.00	10.8
11/3/98	11.40	11.20	10.90	10.80	10.50	11.00	10.90	10.80	10.40	10.20	10.20	10.10	9.90	10.40	10.80	10.00	9.70	10.40	10.50	10.90	211.00	10.55
11/10/98	11.10	11.00	10.60	10.50	10.30	10.70	10.80	10.50	10.20	10.00	9.80	9.90	9.80	10.20	10.20	10.00	9.70	10.30	10.40	11.00	207.00	10.35
11/22/98	11.20	11.30	10.90	10.70	10.50	11.00	10.90	10.70	10.50	10.20	10.00	10.20	10.00	10.40	10.80	10.50	9.90	10.50	10.60	10.90	211.70	10.585
Δ	0.30	-0.20	-0.30	0.00	0.00	0.20	0.40	0.30	0.30	0.30	0.40	0.30	0.20	0.30	0.10	-0.30	-0.10	0.10	0.00	0.70	3.00	0.15
AVG	11.46	11.24	10.81	10.72	10.52	11.02	11.02	10.80	10.51	10.24	10.12	10.24	10.02	10.44	10.73	10.21	9.82	10.48	10.60	11.08		
AVG DEV	0.272	0.168	0.168	0.104	0.112	0.144	0.184	0.16	0.172	0.128	0.176	0.208	0.144	0.128	0.212	0.172	0.104	0.104	0.12	0.208		

Erosion Bridge # 1
Sediment yield calculations
MUSLE equation 1 is A is equal to the values R * K * LS* VM

R	K	LS	VM	A
25	0.24	4	0.17	4.1

MUSLE equation 2 is Ys=alpha(Vqp)raised to Beta multiplied by K*LS*C*P

Storm	Alpha	V ac-ft	q in cfs	K	LS	C	P	Ys	Acreage	tons/acre	c:storm
100	285	113.5	256	0.17	4	0.17	1	10403.06	3840	2.709	0.015
50	285	80	224	0.17	4	0.17	1	7937.29	3840	0.851	0.015
25	285	60	179.2	0.17	4	0.17	1	5962.61	3840	1.553	0.04
10	285	26	480	0.17	4	0.17	1	6481.61	3840	1.688	0.08
5	285	12	220	0.17	4	0.17	1	2715.82	3840	0.707	0.2
2	285	3.24	125	0.17	4	0.17	1	950.56	3840	0.248	0.4

Calculations for the annual storm event load: 0.49101

EROSION BRIDGE STATION No. 2
*N149°E, 17°

Date	0-5cm	10cm	15cm	20cm	25cm	30cm	35cm	40cm	45cm	50cm	55cm	60cm	65cm	70cm	75cm	80cm	85cm	90cm	95cm	100cm	SUM	AVG
10/6/98	32.00	31.30	30.90	30.90	30.20	30.60	32.40	33.30	34.10	34.90	36.40	37.00	37.10	37.00	36.90	38.10	38.70	38.80	38.60	39.40	698.60	34.93
10/22/98	32.00	31.80	31.70	31.60	31.10	32.00	33.00	33.70	34.30	35.70	36.30	37.10	36.80	37.20	37.50	38.50	38.70	38.30	38.60	39.20	705.10	35.255
11/3/98	31.80	31.90	31.10	32.30	31.20	32.30	33.10	33.70	34.10	35.70	36.80	37.50	37.70	38.30	38.70	38.40	39.00	39.60	39.10	40.00	712.30	35.615
11/10/98	31.20	31.00	31.40	32.10	30.90	32.40	33.10	33.80	34.30	35.70	37.00	37.30	37.80	38.00	37.80	38.30	38.80	39.10	39.00	39.40	708.40	35.42
11/17/98	31.60	31.90	31.70	32.10	31.10	32.70	33.50	38.80	34.60	35.90	36.90	37.40	37.90	38.30	38.50	38.40	39.10	39.30	39.20	39.70	718.60	35.93
Δ	0.40	-0.60	-0.80	-1.20	-0.90	-2.10	-1.10	-5.50	-0.50	-1.00	-0.50	-0.40	-0.80	-1.30	-1.60	-0.30	-0.40	-0.50	-0.60	-0.30	-20.00	-1
AVG	31.72	31.58	31.36	31.80	30.90	32.00	33.02	34.66	34.28	35.58	36.68	37.26	37.46	37.76	37.88	38.34	38.86	39.02	38.90	39.54	708.60	
AVG DEV	0.256	0.344	0.288	0.44	0.28	0.56	0.256	1.656	0.144	0.272	0.264	0.168	0.408	0.528	0.576	0.112	0.152	0.376	0.24	0.248	7.57	

Highlighted areas correspond to dog or coyote paw imprints

Erosion Bridge # 2
Sediment yield calculations
MUSLE equation 1 is A is equal to the values R * K * LS* VM

R	K	LS	VM	A
25	0.15	6.8	0.2	5.1

MUSLE equation 2 is Ys=alpha(Vqp)raised to Beta multiplied by K*LS*C*P

Storm	Alpha	V ac-ft	q in cfs	K	LS	C	P	Ys	Acreage	tons/acre	c:storm
100	285	113.475	256	0.17	6.8	0.2	1	20806.12	3840	5.418	0.015
50	285	80	224	0.17	6.8	0.2	1	15874.57	3840	4.134	0.015
25	285	60	179.2	0.17	6.8	0.2	1	11925.23	3840	3.106	0.04
10	285	26	480	0.17	6.8	0.2	1	12963.22	3840	3.376	0.08
5	285	12	220	0.17	6.8	0.2	1	5431.64	3840	1.414	0.2
2	285	3.24	125	0.17	6.8	0.2	1	1901.11	3840	0.495	0.4

Calculations for the annual storm event load: 0.93723

EROSION BRIDGE STATION No. 3
N109°E, 16°

Date	0-5cm	10cm	15cm	20cm	25cm	30cm	35cm	40cm	45cm	50cm	55cm	60cm	65cm	70cm	75cm	80cm	85cm	90cm	95cm	100cm	SUM	AVG
10/6/98	24.50	23.40	23.90	24.00	22.40	22.60	22.60	21.60	20.80	18.20	18.30	16.40	17.30	17.70	17.70	17.00	16.60	16.40	16.00	16.60	7.90	0.395
10/22/98	24.10	24.20	24.30	23.40	23.60	23.40	22.80	22.00	21.20	19.20	18.30	19.00	18.80	18.40	17.50	16.80	16.50	15.90	16.10	16.30	7.80	0.39
11/3/98	24.10	24.00	24.30	22.90	22.70	22.30	21.90	21.60	19.10	17.90	17.40	17.80	18.20	17.90	17.40	16.80	16.40	16.00	16.00	16.20	7.90	0.395
11/10/98	24.40	24.50	24.50	23.40	23.40	22.80	22.40	22.20	20.40	19.10	17.40	17.90	18.30	18.30	17.50	16.90	16.70	15.90	16.20	16.30	8.10	0.405
11/17/98	24.40	24.20	24.40	23.50	23.30	22.70	22.30	22.30	20.50	19.20	17.60	18.10	18.60	18.40	17.50	17.10	16.70	16.20	16.60	16.40	8.00	0.4
Δ	0.10	-0.80	-0.50	0.50	-0.90	-0.10	0.30	-0.70	0.30	-1.00	0.70	-1.70	-1.30	-0.70	0.20	-0.10	-0.10	0.20	-0.60	0.20	-0.10	-0.01
AVG	24.30	24.06	24.28	23.44	23.08	22.76	22.40	21.94	20.40	18.72	17.80	17.84	18.24	18.14	17.52	16.92	16.58	16.08	16.18	16.36	7.94	
AVG DEV	0.16	0.288	0.152	0.248	0.424	0.272	0.24	0.272	0.52	0.536	0.4	0.592	0.392	0.272	0.072	0.104	0.104	0.176	0.176	0.112	0.05	

highlighted areas indicates dead Indian Rice grass mound

Erosion Bridge # 3
Sediment yield calculations
MUSLE equation 1 is A is equal to the values R * K * LS* VM

R	K	LS	VM	A
25	0.45	1.9	0.13	2.77875

MUSLE equation 2 is Ys=alpha(Vqp)raised to Beta multiplied by K*LS*C*P

Storm	Alpha	V ac-ft	q in cfs	K	LS	C	P	Ys	Acreage	tons/acre	c:storm
100	285	113.475	256	0.17	1.9	0.13	1	3778.76	3840	0.984	0.015
50	285	80	224	0.17	1.9	0.13	1	2883.10	3840	0.751	0.015
25	285	60	179.2	0.17	1.9	0.13	1	2165.83	3840	0.564	0.04
10	285	26	480	0.17	1.9	0.13	1	2354.35	3840	0.613	0.08
5	285	12	220	0.17	1.9	0.13	1	986.48	3840	0.257	0.2
2	285	3.24	125	0.17	1.9	0.13	1	345.28	3840	0.090	0.4

Calculations for the annual storm event load: 0.184978

EROSION BRIDGE STATION No. 4
N340°E, 14°

Date	0-5cm	10cm	15cm	20cm	25cm	30cm	35cm	40cm	45cm	50cm	55cm	60cm	65cm	70cm	75cm	80cm	85cm	90cm	95cm	100cm	SUM	AVG
10/6/98	26.20	25.60	23.90	22.50	21.60	21.10	19.90	18.40	17.70	17.90	18.20	18.00	17.50	17.20	16.50	14.90	13.70	13.10	9.60	9.00	362.50	0.45
10/22/98	25.80	24.50	23.55	22.00	21.40	20.15	18.00	17.90	17.65	17.60	17.35	17.20	16.85	16.35	15.00	14.20	12.70	9.90	8.20	7.60	343.90	0.38
11/3/98	24.70	24.00	22.70	22.00	21.10	19.50	18.10	17.80	17.60	18.10	17.30	16.90	16.30	16.20	15.10	13.90	12.40	9.80	8.10	7.70	339.30	0.385
11/10/98	25.00	23.30	22.00	21.60	20.30	19.10	17.40	17.10	17.10	16.70	16.80	16.40	15.70	15.30	14.60	13.50	12.20	9.70	8.80	7.60	330.20	0.38
11/17/98	25.50	23.60	22.40	22.00	21.10	20.30	18.20	17.70	17.70	17.80	17.50	17.00	16.50	15.90	15.40	14.00	12.50	10.00	8.20	7.80	341.10	0.39
Δ	0.70	2.00	1.50	0.50	0.50	0.80	1.70	0.70	0.00	0.10	0.70	1.00	1.00	1.30	1.10	0.90	1.20	3.10	1.40	1.20	21.40	0.06
AVG	25.44	24.20	22.91	22.02	21.10	20.03	18.32	17.78	17.55	17.62	17.43	17.10	16.57	16.19	15.32	14.10	12.70	10.50	8.58	7.94	343.40	
AVG DEV	0.472	0.68	0.652	0.192	0.32	0.584	0.632	0.304	0.18	0.376	0.336	0.4	0.484	0.472	0.504	0.36	0.4	1.04	0.496	0.424	9.31	

Erosion Pin # 4
Sediment yield calculations
MUSLE equation 1 is A is equal to the values R * K * LS* VM

R	K	LS	VM	A
25	0.12	0.9	0.1	0.27

MUSLE equation 2 is Ys=alpha(Vqp)raised to Beta multiplied by K*LS*C*P

Storm	Alpha	V ac-ft	q in cfs	K	LS	C	P	Ys	Acreage	tons/acre	c:storm
100	285	113.475	256	0.17	0.9	0.1	1	1376.88	3840	0.359	0.015
50	285	80	224	0.17	0.9	0.1	1	1050.52	3840	0.274	0.015
25	285	60	179.2	0.17	0.9	0.1	1	789.17	3840	0.206	0.04
10	285	26	480	0.17	0.9	0.1	1	857.86	3840	0.223	0.08
5	285	12	220	0.17	0.9	0.1	1	359.45	3840	0.094	0.2
2	285	3.24	125	0.17	0.9	0.1	1	125.81	3840	0.033	0.4

Calculations for the annual storm event load: 0.067401

REBAR BRIDGE STATION No. 5
N14°E, 19°

Date	0-5cm	10cm	15cm	20cm	25cm	30cm	35cm	40cm	45cm	50cm	55cm	60cm	65cm	70cm	75cm	80cm	85cm	90cm	95cm	100cm	SUM	AVG
10/6/98	13.00	13.10	12.90	12.80	13.20	12.60	12.40	11.70	11.75	11.90	11.90	11.90	12.20	12.10	11.90	11.30	11.00	10.30	10.10	9.70	237.75	11.888
10/22/98	12.60	13.00	13.00	13.00	13.20	12.60	11.90	11.80	11.90	11.90	11.80	11.90	12.20	12.20	11.90	11.60	10.90	10.50	9.80	9.50	237.20	11.86
11/3/98	13.10	13.60	13.20	13.50	13.40	12.70	12.80	11.70	11.70	11.60	11.90	11.90	12.30	12.10	11.80	11.40	11.80	10.60	9.90	9.50	240.50	12.025
11/10/98	12.80	12.70	12.90	12.90	13.10	12.40	11.50	11.50	11.60	11.20	11.60	11.70	12.10	12.10	11.80	11.30	10.60	9.90	9.40	9.40	232.50	11.625
11/17/98	12.90	12.80	12.70	12.80	13.00	12.30	11.50	11.60	11.70	11.40	11.70	11.80	12.10	11.90	11.80	11.20	10.70	10.20	9.80	9.40	233.30	11.665
Δ	0.10	0.30	0.20	0.00	0.20	0.30	0.90	0.10	0.05	0.50	0.20	0.10	0.10	0.20	0.10	0.10	0.30	0.10	0.30	0.30	4.45	0.2225
AVG	12.88	13.04	12.94	13.00	13.18	12.52	12.02	11.66	11.73	11.60	11.78	11.84	12.18	12.08	11.84	11.36	11.00	10.30	9.80	9.50	236.25	
AVG DEV	0.144	0.248	0.128	0.2	0.104	0.136	0.464	0.088	0.076	0.24	0.104	0.072	0.064	0.072	0.048	0.112	0.32	0.2	0.16	0.08	3.06	

Erosion bridge # 5
Sediment yield calculations
MUSLE equation 1 is A is equal to the values R * K * LS* VM

R	K	LS	VM	A
25	0.45	7.2	0.17	13.77

MUSLE equation 2 is Ys=alpha(Vqp)raised to Beta multiplied by K*LS*C*P

Storm	Alpha	V ac-ft	q in cfs	K	LS	C	P	Ys	Acreage	tons/acre	c:storm
100	285	113.475	256	0.17	7.2	0.17	1	18725.51	3840	4.876	0.015
50	285	80	224	0.17	7.2	0.17	1	14287.11	3840	3.721	0.015
25	285	60	179.2	0.17	7.2	0.17	1	10732.70	3840	2.795	0.04
10	285	26	480	0.17	7.2	0.17	1	11666.90	3840	3.038	0.08
5	285	12	220	0.17	7.2	0.17	1	4888.47	3840	1.273	0.2
2	285	3.24	125	0.17	7.2	0.17	1	1711.00	3840	0.446	0.4

Calculations for the annual storm event load: 0.916652

REBAR BRIDGE STATION No. 6
N182°E, 8°

Date	0-5cm	10cm	15cm	20cm	25cm	30cm	35cm	40cm	45cm	50cm	55cm	60cm	65cm	70cm	75cm	80cm	85cm	90cm	95cm	100cm	SUM	AVG
10/6/98	11.60	12.70	13.70	14.00	15.10	15.10	14.65	15.40	14.15	16.70	17.20	17.30	18.20	19.80	21.00	20.90	21.05	19.55	21.50	22.90	342.5	17.125
10/22/98	11.50	12.80	14.00	14.60	15.20	15.10	15.30	15.40	16.50	16.90	17.00	17.70	18.40	19.70	20.70	20.40	20.80	19.60	21.10	21.40	344.1	17.205
11/3/98	11.50	11.60	13.80	13.90	15.10	15.10	14.80	15.30	13.90	16.90	16.80	17.70	18.40	20.70	20.80	20.50	20.90	19.50	21.00	21.90	340.1	17.005
11/10/98	11.80	11.90	13.90	14.00	15.00	15.20	15.20	15.40	14.60	16.70	16.90	17.30	18.00	19.70	20.50	20.90	20.80	19.40	21.00	21.30	339.5	16.975
11/17/98	11.50	12.40	13.80	14.10	15.00	15.00	14.60	15.20	14.60	16.70	16.90	17.30	17.80	19.60	20.80	20.80	20.80	19.50	20.80	22.00	339.2	16.96
Δ	0.10	0.30	-0.10	-0.10	0.10	0.10	0.05	0.20	-0.45	0.00	0.30	0.00	0.40	0.20	0.20	0.10	0.25	0.05	0.70	0.90	3.3	0.165
AVG	11.58	12.28	13.84	14.12	15.08	15.10	14.91	15.34	14.75	16.78	16.96	17.46	18.16	19.90	20.76	20.70	20.87	19.51	21.08	21.90	341.1	
AVG DEV	0.096	0.424	0.088	0.192	0.064	0.04	0.272	0.072	0.7	0.096	0.112	0.192	0.208	0.32	0.128	0.2	0.084	0.052	0.176	0.44	4.0	

Highlighted area denotes readings on boulder or rocks.

Erosion Bridge # 6
Sediment yield calculations
MUSLE equation 1 is A is equal to the values R * K * LS* VM

R	K	LS	VM	A
25	0.3	6.4	0.042	2.02

MUSLE equation 2 is Ys=alpha(Vqp)raised to Beta multiplied by K*LS*C*P

Storm	Alpha	V ac-ft	q in cfs	K	LS	C	P	Ys	Acreage	tons/acre	c:storm
100	285	113.475	256	0.17	6.4	0.042	1	4112.27	3840	1.071	0.015
50	285	80	224	0.17	6.4	0.042	1	3137.56	3840	0.817	0.015
25	285	60	179.2	0.17	6.4	0.042	1	2356.99	3840	0.614	0.04
10	285	26	480	0.17	6.4	0.042	1	2562.14	3840	0.667	0.08
5	285	12	220	0.17	6.4	0.042	1	1073.55	3840	0.280	0.2
2	285	3.24	125	0.17	6.4	0.042	1	375.75	3840	0.098	0.4

Calculations for the annual storm event load: 0.201304

REBAR BRIDGE STATION No. 7
N338ºE, 15º

Date	0-5cm	10cm	15cm	20cm	25cm	30cm	35cm	40cm	45cm	50cm	55cm	60cm	65cm	70cm	75cm	80cm	85cm	90cm	95cm	100cm	SUM	AVG
10/6/98	22.90	23.20	24.00	24.30	25.40	25.90	26.05	25.10	24.95	24.40	23.60	22.80	20.65	18.40	15.70	10.60	10.40	10.60	11.55	12.00	402.50	20.125
10/22/98	25.10	22.80	24.40	23.60	25.50	25.60	25.60	24.40	24.20	23.00	22.90	21.30	20.20	18.00	15.20	10.30	9.20	9.40	10.80	11.35	392.85	19.6425
11/3/98	21.60	24.30	24.20	23.80	25.50	25.80	25.70	24.80	24.10	23.30	23.10	21.40	19.80	17.90	15.50	11.00	9.30	9.50	10.80	11.60	393.00	19.65
11/10/98	21.50	24.20	24.50	24.90	25.00	25.40	25.50	24.30	24.00	24.00	23.30	21.60	20.30	16.90	15.20	10.80	9.10	9.20	10.50	11.40	391.60	19.58
11/17/98	21.30	24.30	24.50	23.40	25.40	25.50	25.40	24.70	24.00	23.40	22.80	21.40	20.00	17.40	15.30	10.80	9.30	9.40	10.50	11.40	390.20	19.51
Δ	1.60	-1.10	-0.50	0.90	0.00	0.40	0.65	0.40	0.95	1.00	0.80	1.40	0.65	1.00	0.40	-0.20	1.10	1.20	1.05	0.60	12.30	0.615
AVG	22.48	23.76	24.32	24.00	25.36	25.64	25.65	24.66	24.25	23.62	23.14	21.70	20.19	17.72	15.38	10.70	9.46	9.62	10.83	11.55	394.03	
AVG DEV	1.216	0.608	0.176	0.48	0.144	0.168	0.18	0.248	0.28	0.464	0.248	0.44	0.232	0.456	0.176	0.2	0.376	0.392	0.288	0.2	6.97	

Highlighted areas denote Indian Rice grass roots

Erosion Bridge # 7
Sediment yield calculations
MUSLE equation 1 is A is equal to the values R * K * LS* VM

R	K	LS	VM	A
25	0.44	6.4	0.003	0.2

MUSLE equation 2 is Ys=alpha(Vqp)raised to Beta multiplied by K*LS*C*P

Storm	Alpha	V ac-ft	q in cfs	K	LS	C	P	Ys	Acreage	tons/acre	c:storm
100	285	113.475	256	0.17	6.4	0.003	1	293.73	3840	0.076	0.015
50	285	80	224	0.17	6.4	0.003	1	224.11	3840	0.058	0.015
25	285	60	179.2	0.17	6.4	0.003	1	168.36	3840	0.044	0.04
10	285	26	480	0.17	6.4	0.003	1	183.01	3840	0.048	0.08
5	285	12	220	0.17	6.4	0.003	1	76.68	3840	0.020	0.2
2	285	3.24	125	0.17	6.4	0.003	1	26.84	3840	0.007	0.4

Calculations for the annual storm event load: 0.014379

REBAR BRIDGE STATION No. 8

N190°, 10°

Date	0-5cm	10cm	15cm	20cm	25cm	30cm	35cm	40cm	45cm	50cm	55cm	60cm	65cm	70cm	75cm	80cm	85cm	90cm	95cm	100cm	SUM	AVG
10/6/98	21.30	20.80	20.70	20.80	21.10	21.30	20.55	20.40	20.00	19.60	19.40	19.50	19.55	19.40	19.20	18.90	18.90	19.50	19.70	19.55	400.15	20.01
10/22/98	23.70	21.40	20.95	20.80	21.00	21.20	21.80	21.50	20.10	19.50	19.30	19.40	19.40	19.40	19.10	18.90	19.00	19.30	19.40	19.00	404.15	20.21
11/3/98	21.20	20.50	20.30	20.60	20.90	21.40	20.50	20.20	19.80	19.40	19.10	19.10	19.00	19.10	19.00	18.90	19.00	19.20	19.40	18.80	395.40	19.77
11/10/98	21.40	20.80	20.70	20.80	21.00	21.50	20.70	20.40	20.10	19.40	19.30	19.10	19.10	19.20	19.00	19.00	19.10	19.30	19.30	18.90	398.10	19.91
11/17/98	21.40	20.60	20.80	21.00	21.00	21.30	20.50	20.40	19.60	19.40	19.10	19.00	19.10	19.20	19.10	18.90	19.10	19.30	19.30	18.90	397.00	19.85
Δ	-0.10	0.20	-0.10	-0.20	0.10	0.00	0.05	0.00	0.40	0.20	0.30	0.50	0.45	0.20	0.10	0.00	-0.20	0.20	0.40	0.65	3.15	0.16
AVG	21.80	20.82	20.69	20.80	21.00	21.34	20.81	20.58	19.92	19.46	19.24	19.22	19.23	19.26	19.08	18.92	19.02	19.32	19.42	19.03	398.96	
AVG DEV	0.76	0.23	0.16	0.08	0.04	0.09	0.40	0.37	0.18	0.07	0.11	0.18	0.20	0.11	0.06	0.03	0.06	0.07	0.11	0.21	3.52	

Highlighted areas denote rocks.

Erosion Bridge # 8
Sediment yield calculations
MUSLE equation 1 is A is equal to the values R * K * LS* VM

R	K	LS	VM	A
25	0.3	6.4	0.17	8.16

MUSLE equation 2 is Ys=alpha(Vqp)raised to Beta multiplied by K*LS*C*P

Storm	Alpha	V ac-ft	q in cfs	K	LS	C	P	Ys	Acreage	tons/acre	c:storm
100	285	113.475	256	0.17	6.4	0.17	1	16644.90	3840	4.335	0.015
50	285	80	224	0.17	6.4	0.17	1	12699.66	3840	3.307	0.015
25	285	60	179.2	0.17	6.4	0.17	1	9540.18	3840	2.484	0.04
10	285	26	480	0.17	6.4	0.17	1	10370.58	3840	2.701	0.08
5	285	12	220	0.17	6.4	0.17	1	4345.31	3840	1.132	0.2
2	285	3.24	125	0.17	6.4	0.17	1	1520.89	3840	0.396	0.4

Calculations for the annual storm event load: 0.814802

REBAR BRIDGE STATION No. 9
N82°E, 12°

Date	0-5cm	10cm	15cm	20cm	25cm	30cm	35cm	40cm	45cm	50cm	55cm	60cm	65cm	70cm	75cm	80cm	85cm	90cm	95cm	100cm	SUM	AVG
10/6/98	20.95	21.40	21.60	22.60	22.80	24.40	26.20	26.10	25.60	26.20	25.40	24.70	24.70	24.70	25.40	25.30	25.10	24.50	23.80	24.40	485.85	24.2925
10/22/98	21.60	20.80	21.70	21.50	22.80	22.70	24.10	26.00	25.70	25.10	24.70	24.60	24.50	24.60	25.30	24.80	24.50	24.30	23.60	24.00	476.90	23.845
11/3/98	20.90	21.60	21.90	23.00	23.00	24.30	26.00	26.10	25.50	25.70	25.10	24.50	24.50	24.70	25.60	25.00	24.50	24.40	23.60	24.20	484.10	24.205
11/10/98	20.70	21.10	21.40	22.30	22.70	23.90	25.40	25.90	25.50	25.50	24.90	24.50	24.50	24.40	24.60	24.40	24.20	24.40	23.50	24.10	477.90	23.895
11/17/98	20.60	21.10	21.30	21.80	21.70	23.30	25.50	25.50	25.50	25.70	24.80	24.40	24.30	24.20	24.10	24.30	23.90	23.90	23.40	23.90	473.20	23.66
Δ	0.35	0.30	0.30	0.80	1.10	1.10	0.70	0.60	0.10	0.50	0.60	0.30	0.40	0.50	1.30	1.00	1.20	0.60	0.40	0.50	12.65	0.6325
AVG	20.95	21.20	21.58	22.24	22.60	23.72	25.44	25.92	25.56	25.64	24.98	24.54	24.50	24.52	25.00	24.76	24.44	24.30	23.58	24.12	479.59	
AVG DEV	0.26	0.24	0.18	0.47	0.36	0.58	0.55	0.18	0.07	0.27	0.22	0.09	0.08	0.18	0.52	0.33	0.31	0.16	0.10	0.14	5.29	

Erosion bridge # 9
Sediment yield calculations
MUSLE equation 1 is A is equal to the values R * K * LS* VM

R	K	LS	VM	A
25	0.18	5	0.17	3.825

MUSLE equation 2 is Ys=alpha(Vqp)raised to Beta multiplied by K*LS*C*P

Storm	Alpha	V ac-ft	q in cfs	K	LS	C	P	Ys	Acreage	tons/acre	c:storm
100	285	113.475	256	0.17	5	0.17	1	13003.83	3840	3.386	0.015
50	285	80	224	0.17	5	0.17	1	9921.61	3840	2.584	0.015
25	285	60	179.2	0.17	5	0.17	1	7453.27	3840	1.941	0.04
10	285	26	480	0.17	5	0.17	1	8102.01	3840	2.110	0.08
5	285	12	220	0.17	5	0.17	1	3394.77	3840	0.884	0.2
2	285	3.24	125	0.17	5	0.17	1	1188.19	3840	0.309	0.4

Calculations for the annual storm event load: 0.636564

REBAR BRIDGE STATION No. 10
N248°E, 21°

Date	0-5cm	10cm	15cm	20cm	25cm	30cm	35cm	40cm	45cm	50cm	55cm	60cm	65cm	70cm	75cm	80cm	85cm	90cm	95cm	100cm	SUM	AVG
10/6/98	38.20	37.80	37.80	37.40	37.35	37.40	36.50	36.80	36.20	36.10	35.70	35.50	34.90	33.50	33.40	33.10	32.80	32.30	31.60	31.70	706.05	1.585
10/22/98	37.50	37.30	37.10	36.40	35.80	35.60	35.40	35.90	35.80	35.50	35.30	34.30	34.50	33.30	33.30	32.30	31.80	30.60	29.90	29.50	687.10	1.475
11/3/98	37.00	36.70	36.40	35.80	35.90	35.80	35.80	35.80	36.00	35.70	34.70	34.00	34.10	33.20	32.90	32.20	31.80	31.10	30.40	30.80	686.10	1.54
11/10/98	37.00	36.60	36.80	35.40	35.70	35.70	35.80	35.70	35.40	35.10	35.00	34.60	34.00	33.30	33.00	32.40	31.70	31.30	31.60	30.50	686.60	1.525
11/17/98	37.50	37.50	37.30	36.80	36.20	35.60	35.90	36.00	36.00	35.90	35.10	34.70	35.10	34.00	32.90	32.50	31.70	31.20	30.40	30.80	693.10	1.54
Δ	0.70	0.30	0.50	0.60	1.15	1.80	0.60	0.80	0.20	0.20	0.60	0.80	-0.20	-0.50	0.50	0.60	1.10	1.10	1.20	0.90	12.95	0.045
AVG	37.44	37.18	37.08	36.36	36.19	36.02	35.88	36.04	35.88	35.66	35.16	34.62	34.52	33.46	33.10	32.50	31.96	31.30	30.78	30.66	691.79	
AVG DEV	0.35	0.42	0.38	0.61	0.47	0.55	0.26	0.30	0.22	0.29	0.27	0.38	0.38	0.23	0.20	0.24	0.34	0.40	0.66	0.53	7.49	

Erosion Bridge # 10
Sediment yield calculations
MUSLE equation 1 is A is equal to the values R * K * LS* VM

R	K	LS	VM	A
25	0.39	5	0.36	17.55

MUSLE equation 2 is Ys=alpha(Vqp)raised to Beta multiplied by K*LS*C*P

Storm	Alpha	V ac-ft	q in cfs	K	LS	C	P	Ys	Acreage	tons/acre	c:storm
100	285	113.475	256	0.17	5	0.36	1	27537.52	3840	7.171	0.015
50	285	80	224	0.17	5	0.36	1	21010.46	3840	5.471	0.015
25	285	60	179.2	0.17	5	0.36	1	15783.39	3840	4.110	0.04
10	285	26	480	0.17	5	0.36	1	17157.20	3840	4.468	0.08
5	285	12	220	0.17	5	0.36	1	7188.93	3840	1.872	0.2
2	285	3.24	125	0.17	5	0.36	1	2516.18	3840	0.655	0.4

Calculations for the annual storm event load: 1.34802

REBAR BRIDGE STATION No. 11
N173°E, 18°

Date	0-5cm	10cm	15cm	20cm	25cm	30cm	35cm	40cm	45cm	50cm	55cm	60cm	65cm	70cm	75cm	80cm	85cm	90cm	95cm	100cm	SUM	AVG
10/6/98	26.60	26.70	25.80	25.60	25.40	25.50	25.50	25.40	24.80	24.80	24.50	24.20	23.80	23.30	23.60	22.40	22.10	23.00	22.90	23.90	489.80	24.49
10/22/98	25.60	25.60	25.20	24.80	24.30	24.70	24.65	24.65	23.90	23.60	23.60	23.40	22.90	22.70	22.50	*21.7	*21.6	21.05	22.90	22.70	428.75	21.4375
11/3/98	25.80	25.60	25.40	25.00	24.60	24.50	24.90	24.60	23.80	23.60	23.80	23.10	23.10	22.80	22.40	21.70	21.60	22.20	22.40	23.00	473.90	23.695
11/10/98	25.50	25.40	25.10	24.80	24.10	24.20	24.50	24.30	23.80	23.30	23.20	23.00	22.90	22.60	22.20	21.60	21.50	21.50	22.30	23.10	468.90	23.445
11/17/98	25.70	25.40	25.20	24.10	24.50	24.70	24.70	24.90	24.60	24.30	24.20	24.00	23.10	22.70	22.70	21.6*	21.8*	22.20	22.50	23.00	432.50	21.625
Δ	0.90	1.30	0.60	1.50	0.90	0.80	0.80	0.50	0.20	0.50	0.30	0.20	0.70	0.60	0.90	0.80	0.30	0.80	0.40	0.90	13.90	0.695
AVG	25.84	25.74	25.34	24.86	24.58	24.72	24.85	24.77	24.18	23.92	23.86	23.54	23.16	22.82	22.68	21.90	21.73	21.99	22.60	23.14	476.22	
AVG DEV	0.304	0.384	0.208	0.352	0.336	0.312	0.28	0.304	0.416	0.504	0.392	0.448	0.256	0.192	0.376	0.333	0.244	0.572	0.24	0.304	6.76	

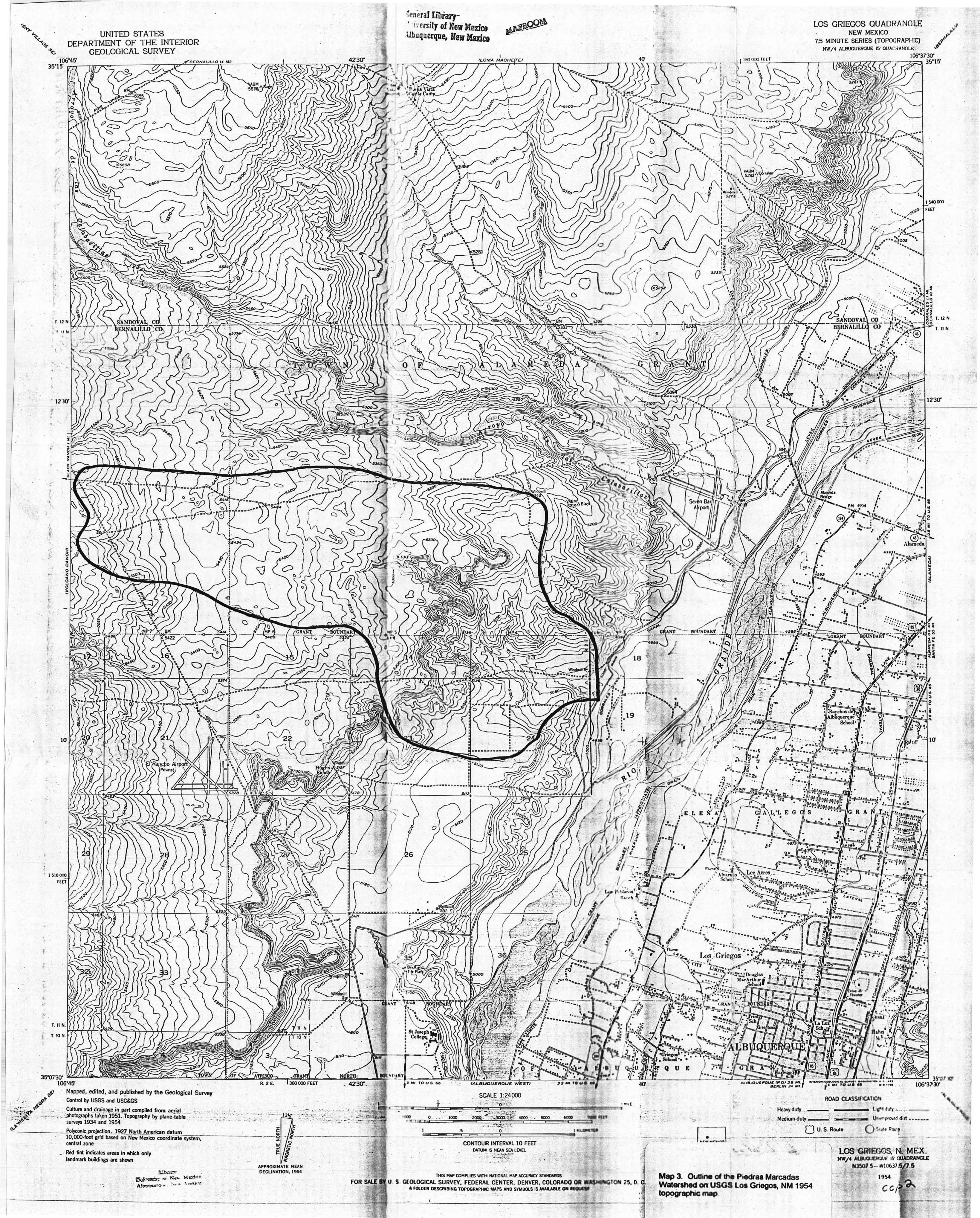
Erosion Bridge # 11
Sediment yield calculations
MUSLE equation 1 is A is equal to the values R * K * LS* VM

R	K	LS	VM	A
25	0.16	5	0.2	4

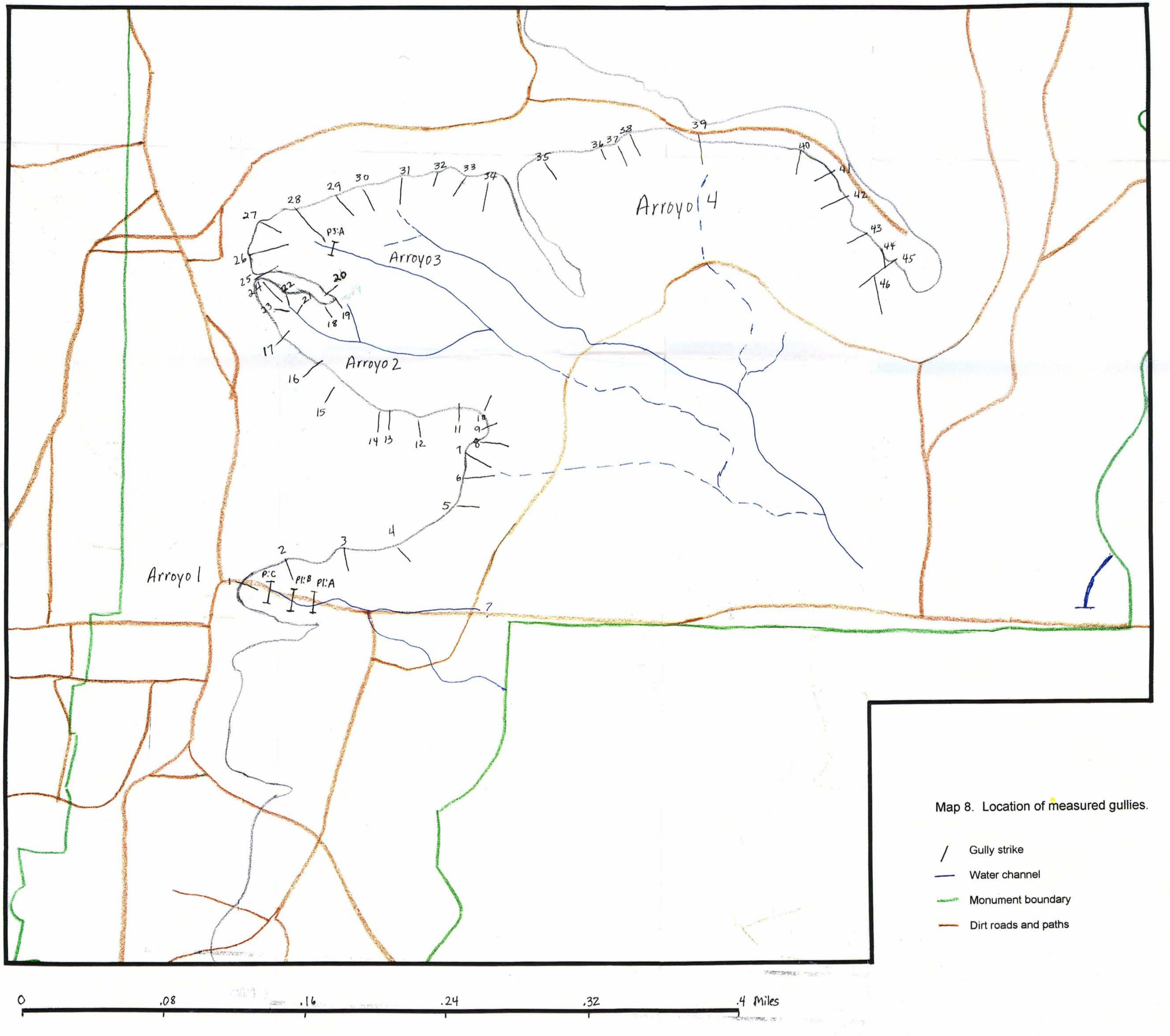
MUSLE equation 2 is Ys=alpha(Vqp)raised to Beta multiplied by K*LS*C*P

Storm	Alpha	V ac-ft	q in cfs	K	LS	C	P	Ys	Acreage	tons/acre	c:storm
100	285	113.475	256	0.1	5	0.2	1	8999.19	3840	2.344	0.015
50	285	80	224	0.1	5	0.2	1	6866.16	3840	1.788	0.015
25	285	60	179.2	0.1	5	0.2	1	5157.97	3840	1.343	0.04
10	285	26	480	0.1	5	0.2	1	5606.93	3840	1.460	0.08
5	285	12	220	0.1	5	0.2	1	2349.32	3840	0.612	0.2
2	285	3.24	125	0.1	5	0.2	1	822.28	3840	0.214	0.4

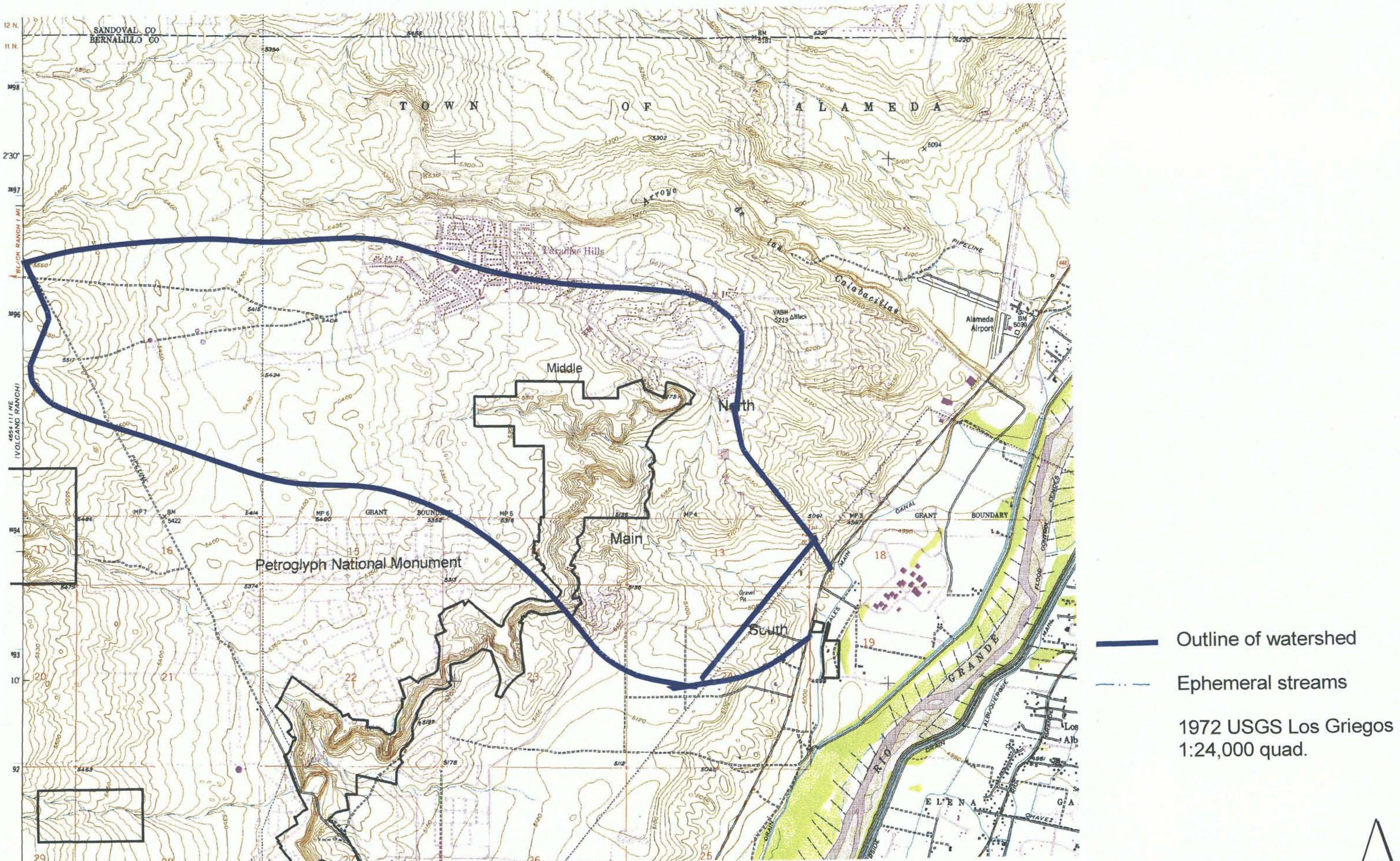
Calculations for the annual storm event load: 0.44053



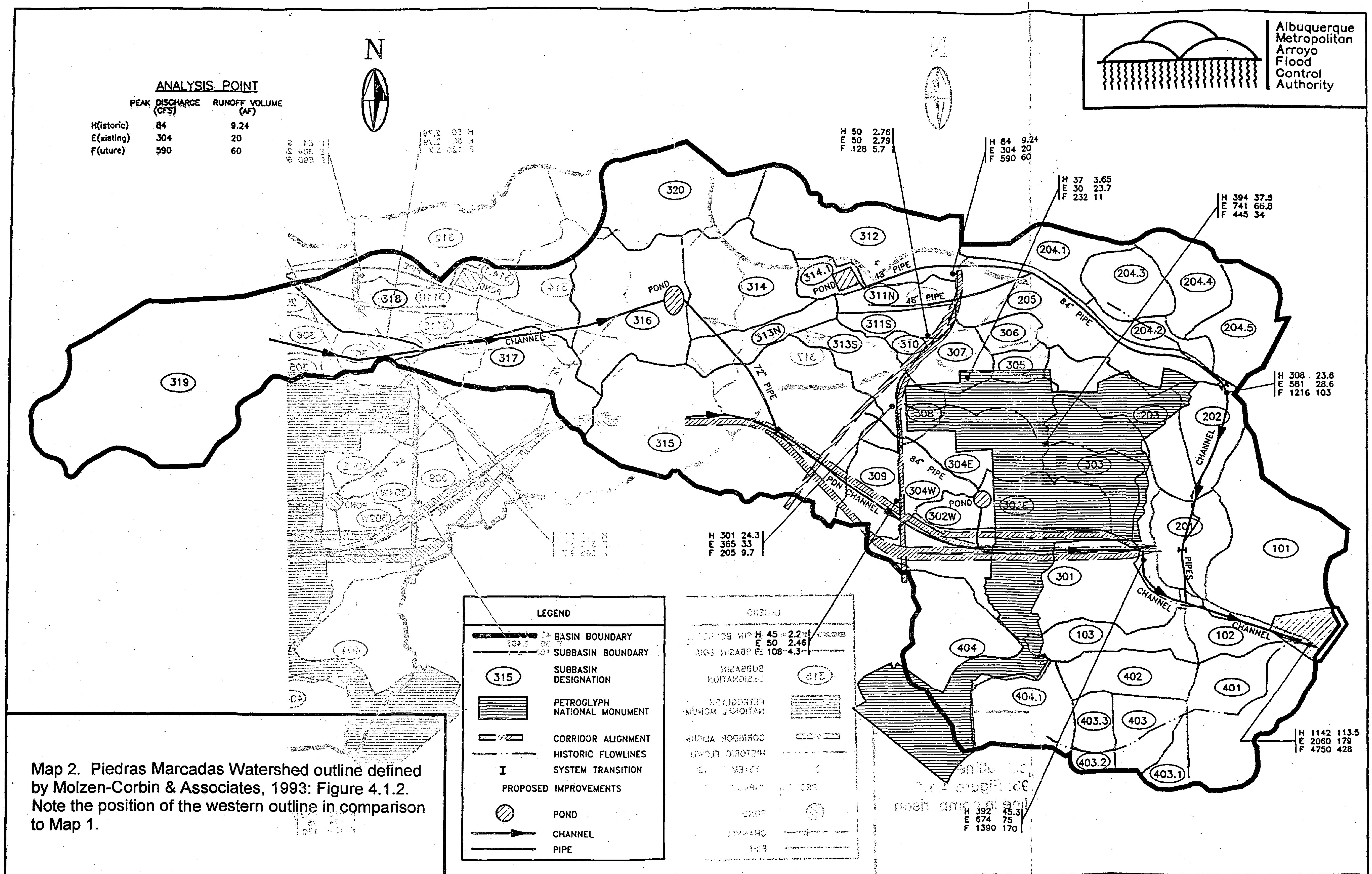
Map 3. Outline of the Piedras Marcadas Watershed on USGS Los Griegos, NM 1954 topographic map



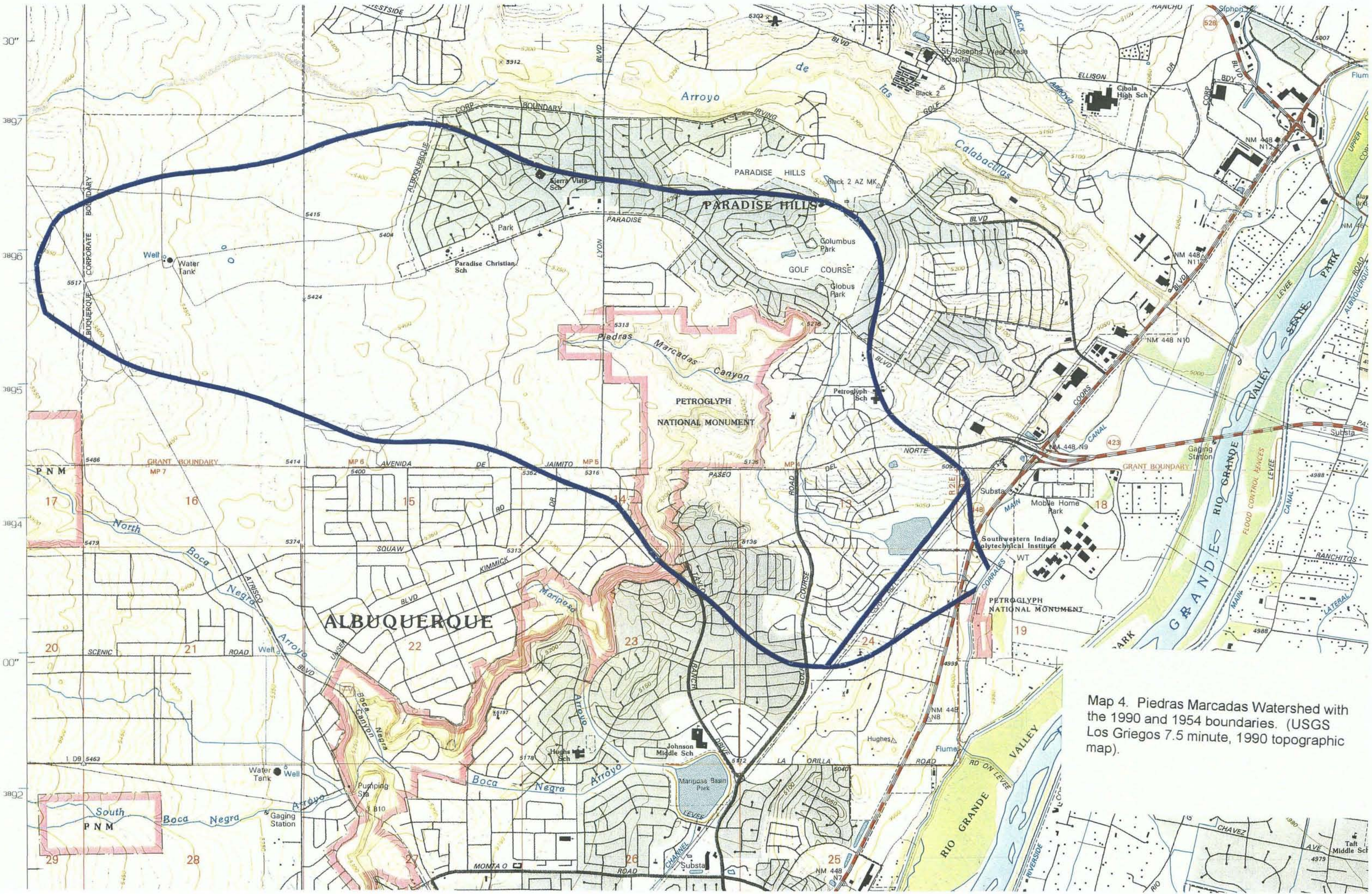
Map 8. Location of measured gullies.



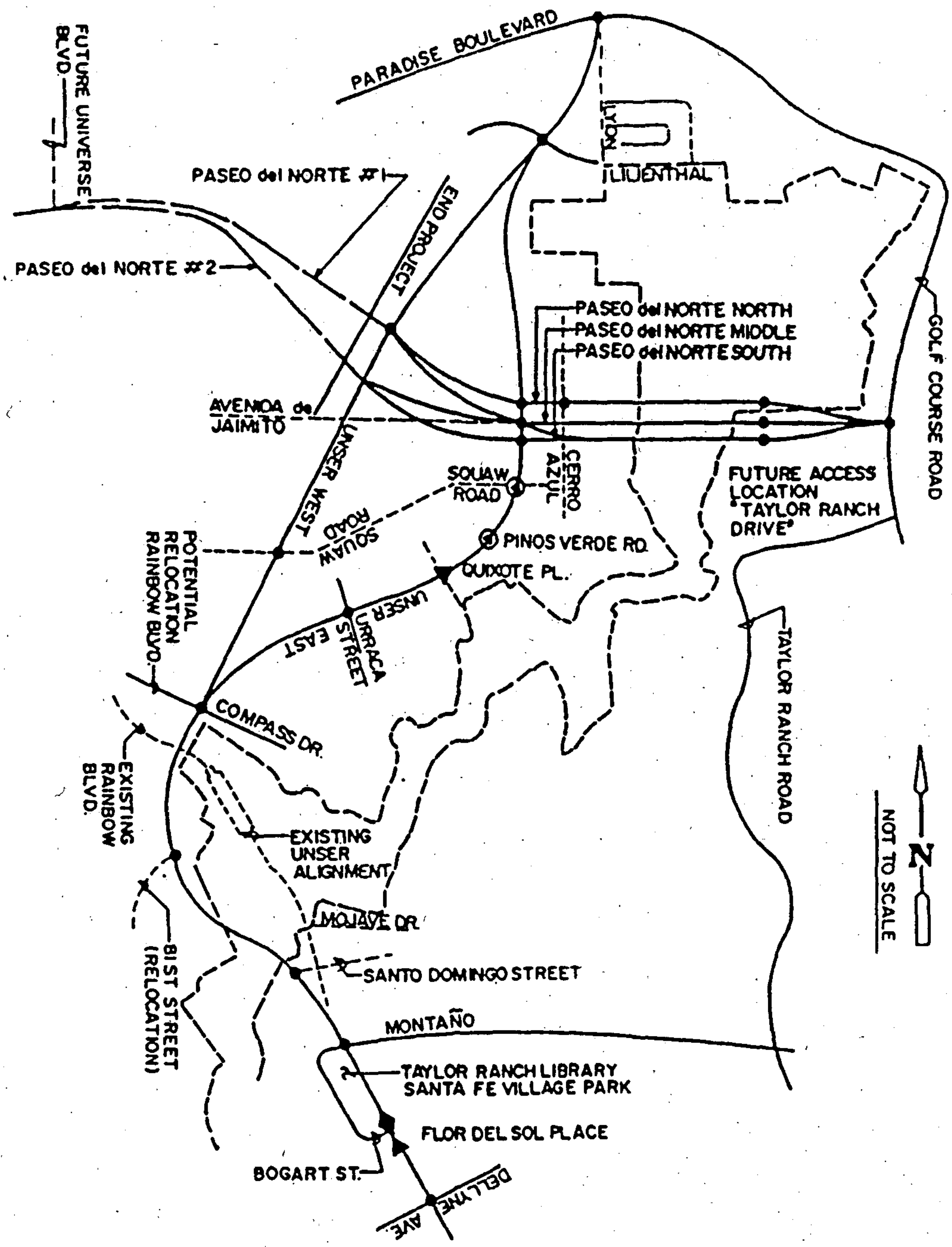
Map 1. Piedras Marcadas Watershed, Albuquerque, New Mexico. The North, Middle, Main and South branches of the arroyo are highlighted in blue.



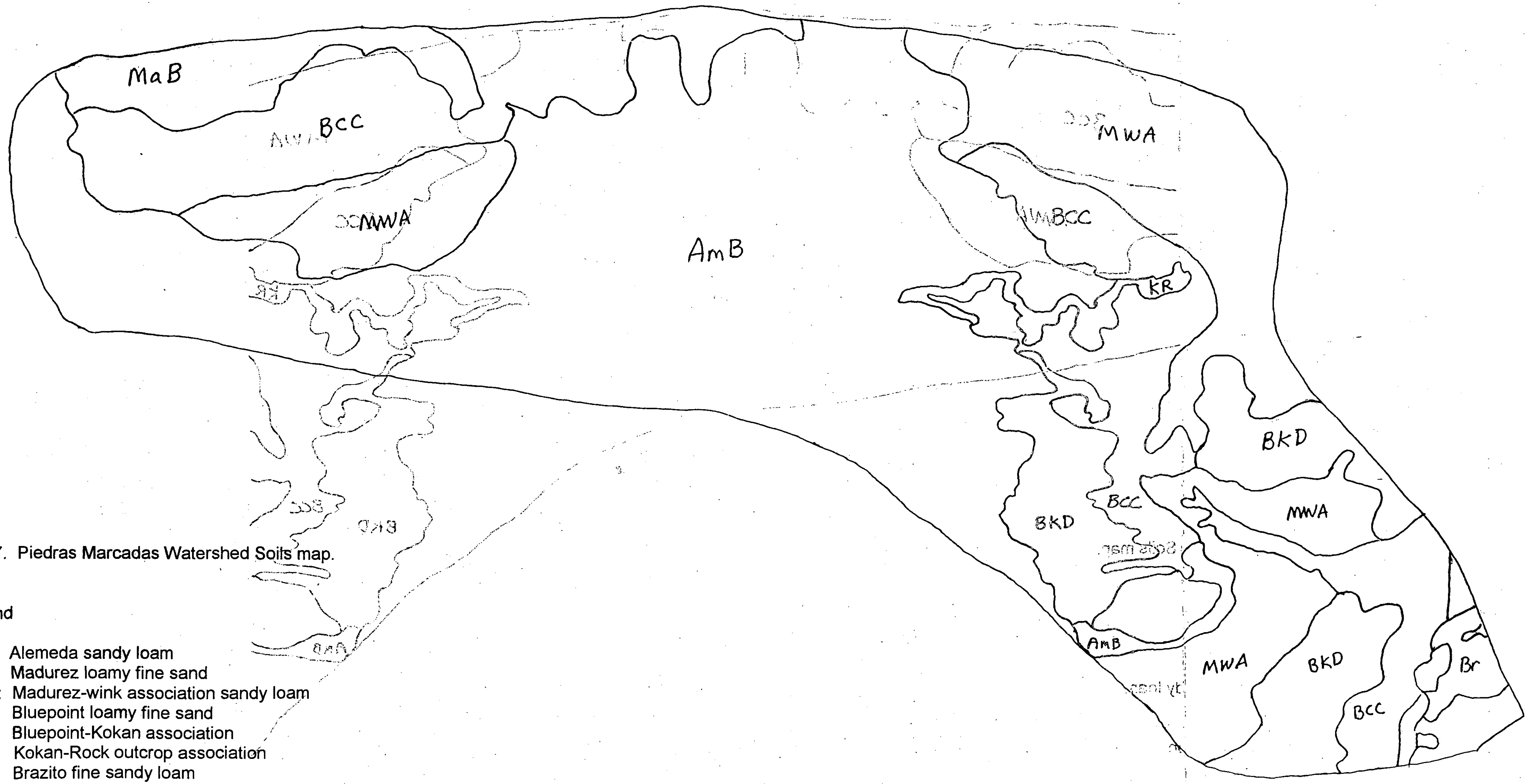
Map 2. Piedras Marcadas Watershed outline defined by Molzen-Corbin & Associates, 1993: Figure 4.1.2. Note the position of the western outline in comparison to Map 1.



Map 4. Piedras Marcadas Watershed with the 1990 and 1954 boundaries. (USGS Los Griegos 7.5 minute, 1990 topographic map).



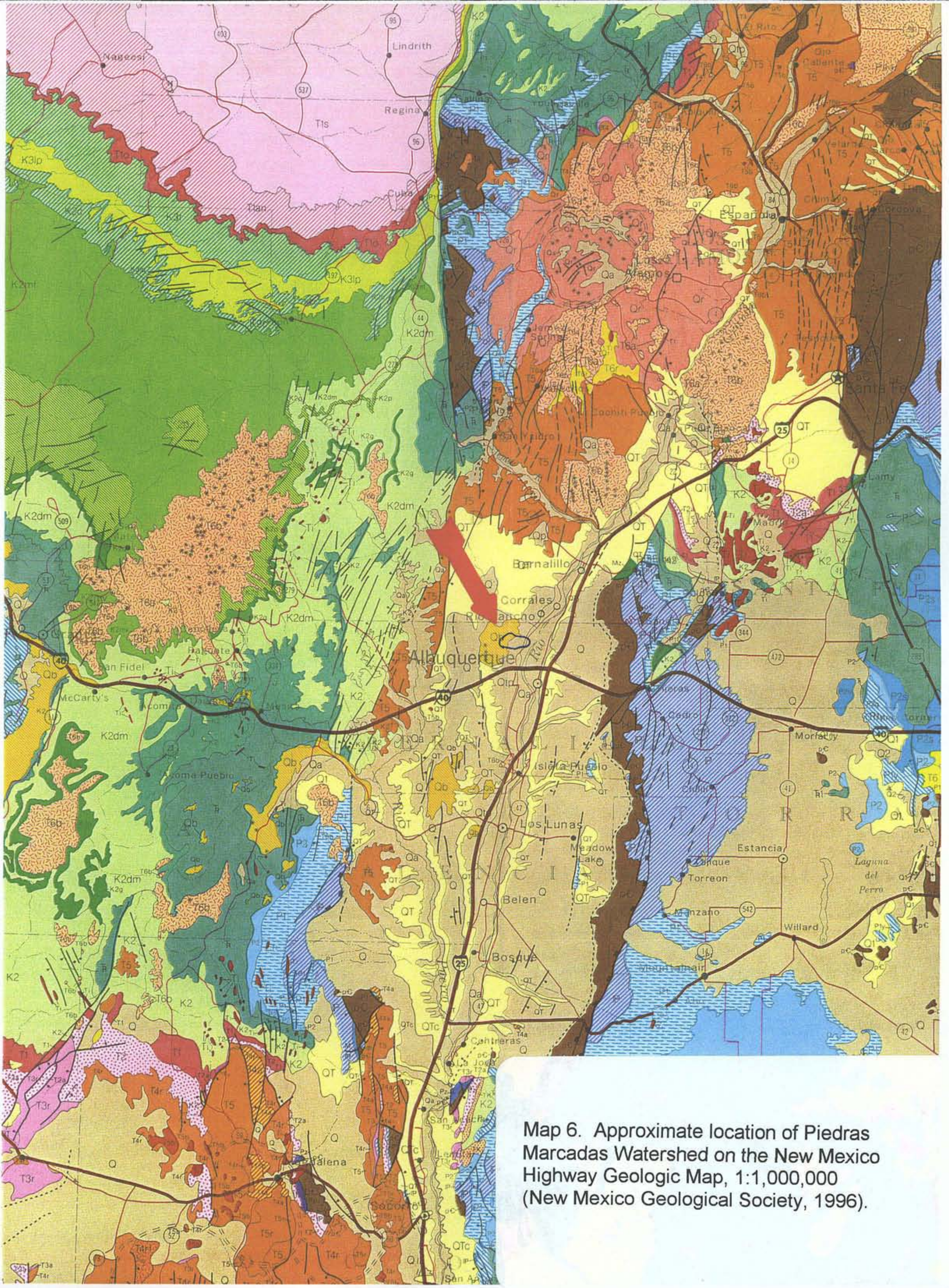
Map 5. Proposed transportation corridors Paseo del Norte and Middle Unser Boulevard, modified from Leedshill-Herkenhoff, Inc., 1993: 25.



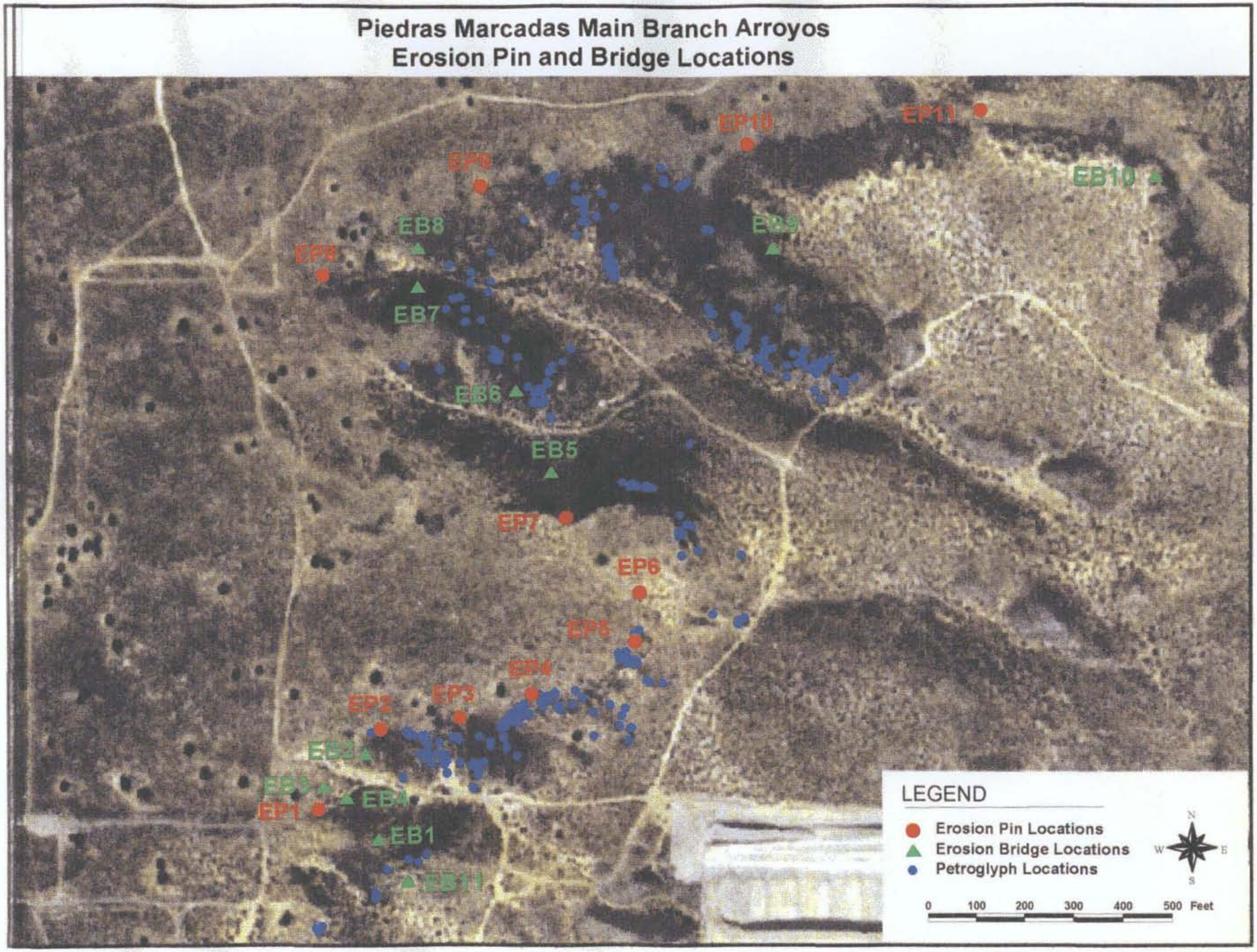
Map 7. Piedras Marcadas Watershed Soils map.

Legend

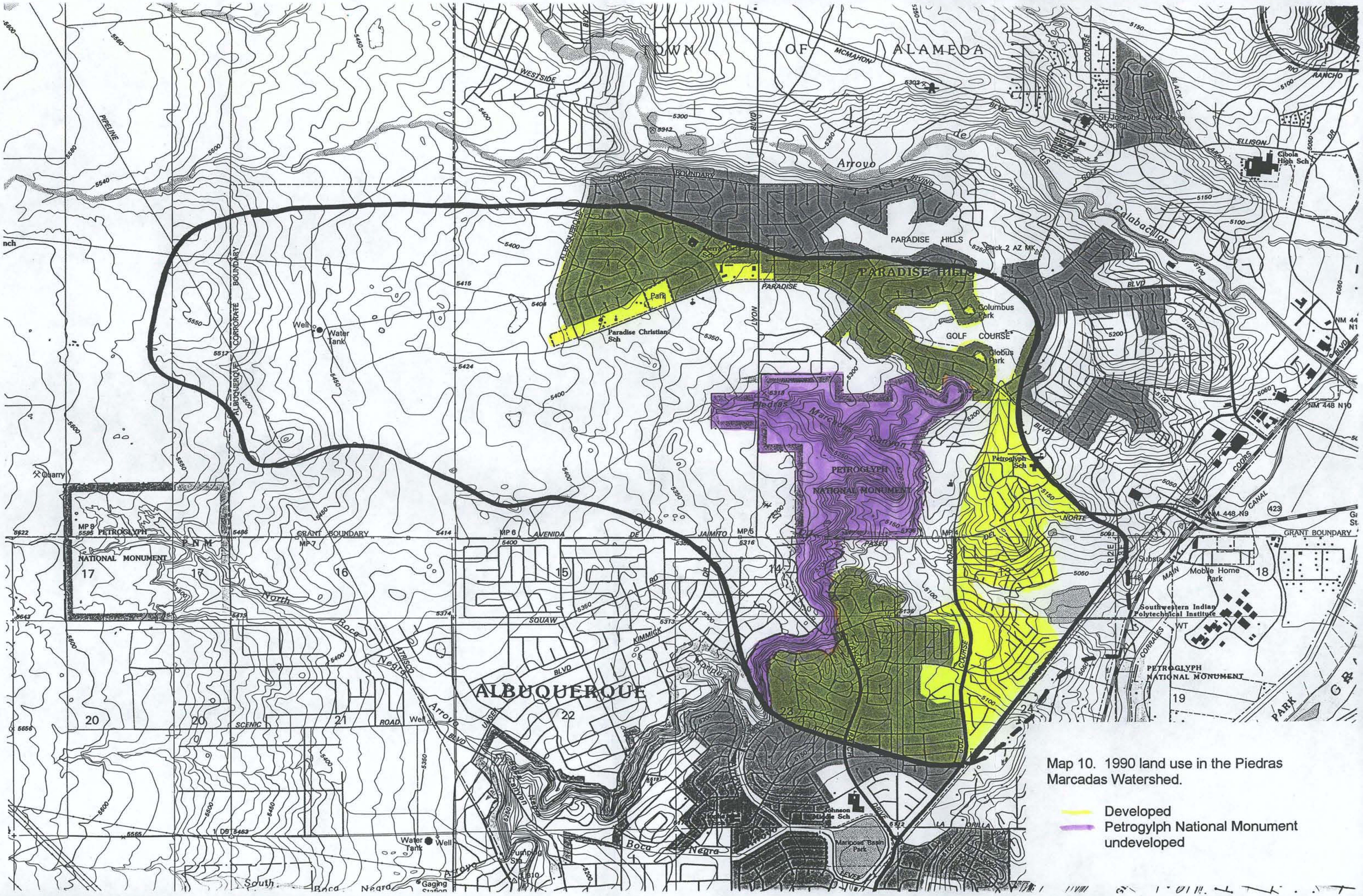
AmB: Alemeda sandy loam
MaB: Madurez loamy fine sand
MWA: Madurez-wink association sandy loam
BCC: Bluepoint loamy fine sand
BKD: Bluepoint-Kokan association
KR: Kokan-Rock outcrop association
Br: Brazito fine sandy loam



Map 6. Approximate location of Piedras Marcadas Watershed on the New Mexico Highway Geologic Map, 1:1,000,000 (New Mexico Geological Society, 1996).


Piedras Marcadas Main Branch Arroyos
Erosion Pin and Bridge Locations
EP1
EP2
EP3
EP4
EP5
EP6
EP7
EP8
EP9
EP10
EP11
EB1
EB2
EB3
EB4
EB5
EB6
EB7
EB8
EB9
EB10
EB11
LEGEND
Erosion Pin Locations
Erosion Bridge Locations
Petroglyph Locations
N
W
E
S
0 100 200 300 400 500 Feet

Map 9.



Map 10. 1990 land use in the Piedras Marcadas Watershed.

Developed

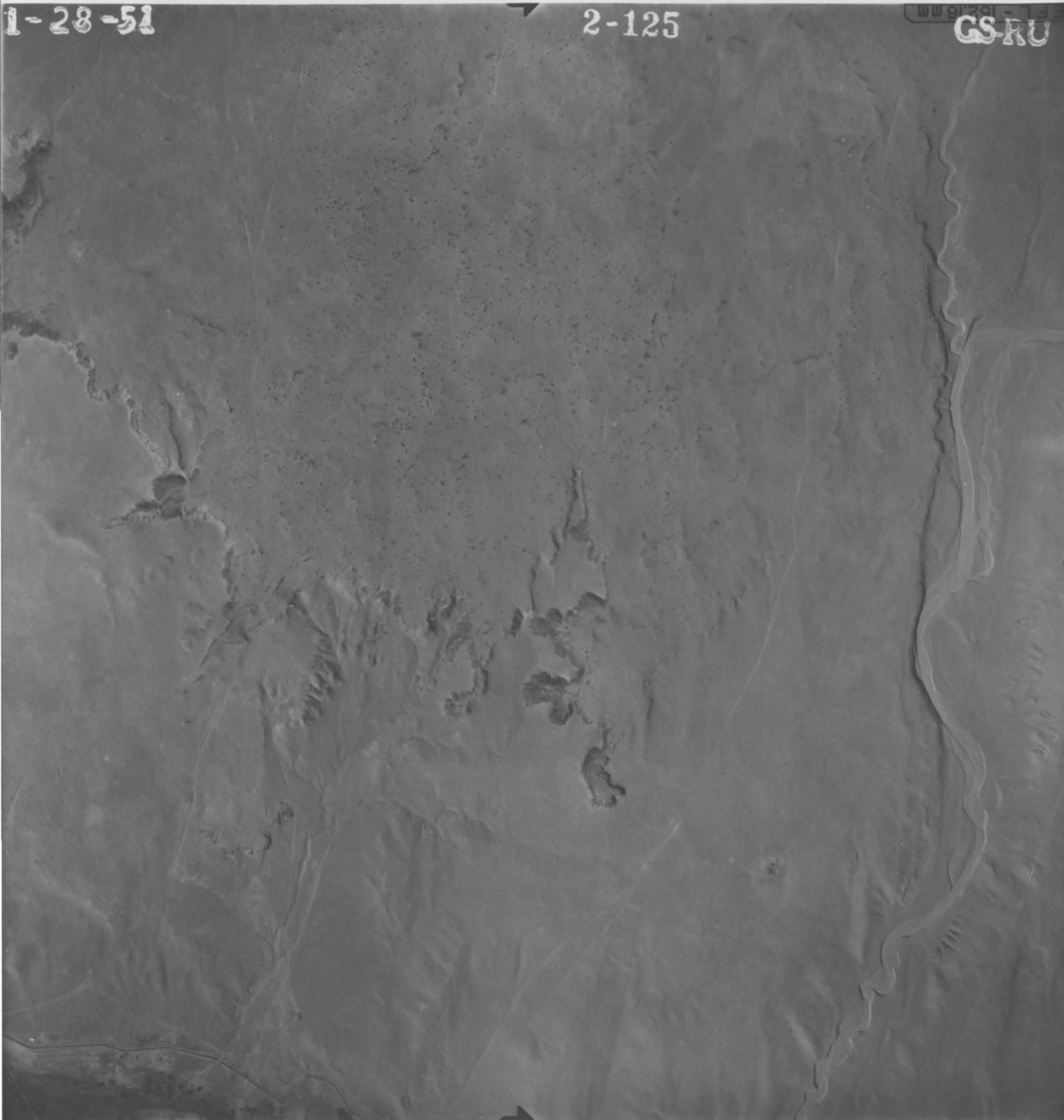
Petrogylph National Monument undeveloped

Appendix A

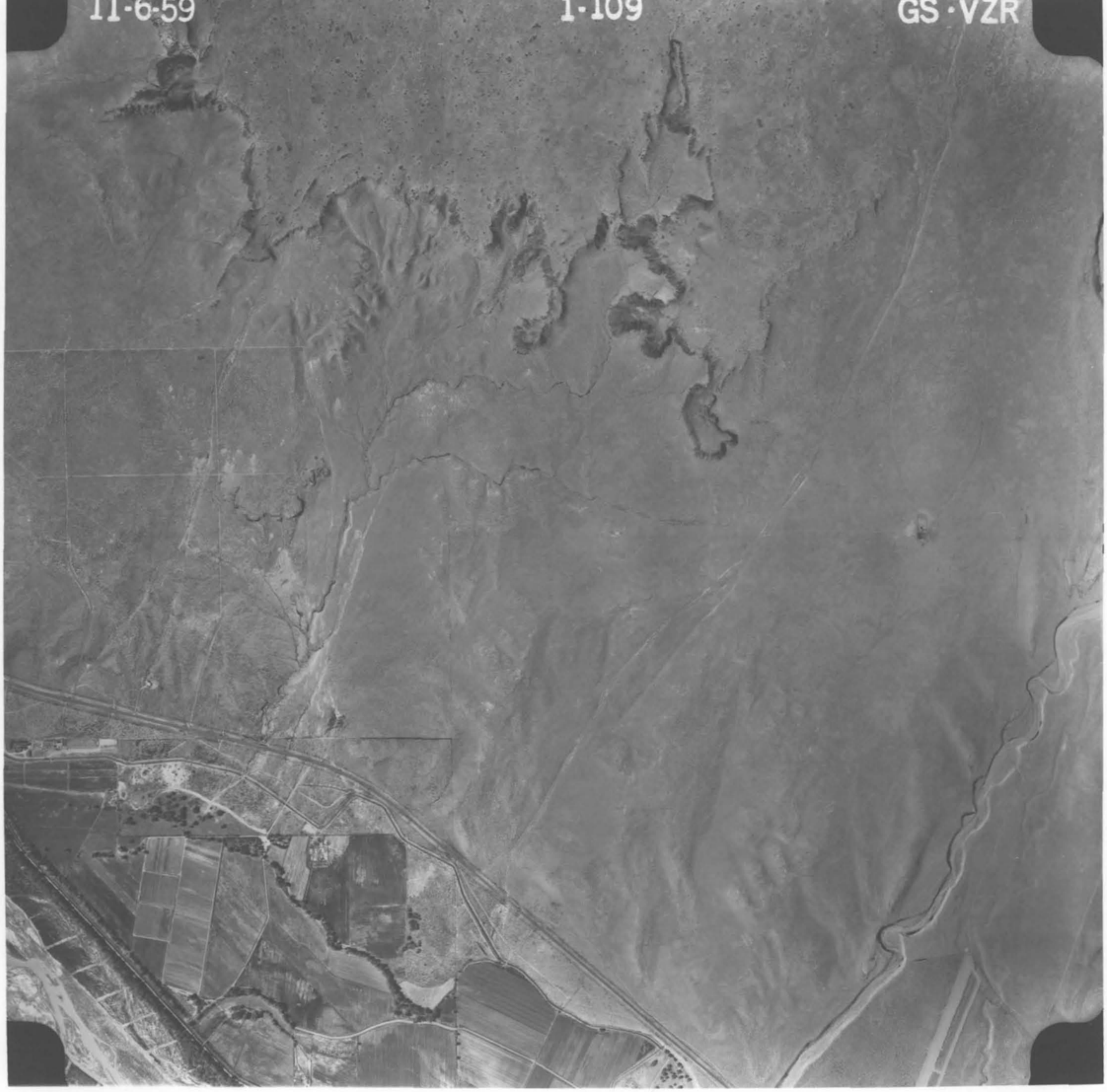
Climate Data

1996
Scale 1:24,000
Piedras Marcadas Watershed

1935
Scale 1:24,000
Piedras Marcadas Watershed


1-28-51
2-125
GS-RU

1951
Scale 1:24,000
Piedras Marcadas Watershed


11-6-59
1-109
GS-VZR

1959
Scale 1:24,000
Piedras Marcadas Watershed

10-8-67
2-16
GS-VBUG

1967
Scale 1:24,000
Piedras Marcadas Watershed


5-29-73
A 20
35001 273-114

1973
Scale 1:24,000
Piedras Marcadas Watershed

1991
Scale 1:24,000
Piedras Marcadas Watershed

Appendix D

Aerial Photographs, 1:24,000 scale from years:

1935
1951
1959
1967
1973
1991
1996