Las Huertas Canyon
Watershed Restoration Action Strategy (WRAS)

Version 2.0

September 30, 2005

Prepared by the Las Huertas Watershed Project, Placitas, New Mexico

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Acronyms and Abbreviation

BLM	U.S. Bureau of Land Management
BMP	Best Management Practice
CWA	Clean Water Act
EPA	U.S. Environmental Protection Agency
GPS	Global Positioning System
HQCWAL	High Quality Cold Water Aquatic Life
HUC	Hydrologic Unit Code
LHWP	Las Huertas Watershed Project
LPA	Las Placitas Association
MAPL	Mid-America Pipeline Company
mL	milliliters
msl	mean sea level
NMED	New Mexico Environment Department
NOAA	National Oceanic and Atmospheric Administration
ntu	turbidity units
ORV	Off-Road Vehicle
OSD	Open Space Division (City of Albuquerque)
POS	Placitas Open Space
QAP	Quality Assurance Plan
SABs	Suspended and Bedded Sediments
STORET	STOrage and RETrieval (EPA database)
TDS	Total Dissolved Solids
TMDL	Total Maximum Daily Load
UNM	University of New Mexico
USFS	United States Forest Service
USGS	United States Geological Survey
VTF	Volunteer Task Force
WQS	Water Quality Standards
WRAS	Watershed Restoration Action Strategy

Background

The Las Huertas Watershed Project (LHWP) is a regional group based in Placitas, New Mexico dedicated to conserving and enhancing the ecological health of the Las Huertas watershed. The LHWP membership is comprised of local citizens, university students, technical professionals and various public agency representatives. The LHWP undertakes various studies, public educational forums and workshops in addition to active restoration projects to involve the Las Huertas community in the stewardship of the watershed.

This Watershed Restoration Action Strategy (WRAS) has been prepared in conjunction with LHWP's work under a Clean Water Act (CWA) Section 319(h) grant for watershed group formation. The CWA 319(h) program was formed to address non-point-source (NPS) pollution issues in the U.S. One objective of the program is the preparation of a WRAS for each priority watershed. Las Huertas Creek is tributary to the Rio Grande, and both are included on the CWA Section 303(d) list of impaired waters.

This initial draft of the WRAS for Las Huertas Watershed is a first step in formulating specific effective measures in support of the long-term ecological health of the watershed, and will undergo periodic revision in response to public comment, internal reviews, and feedback from projects.

This report is organized in two major sections: 1). Watershed Assessment, including background information, water quality, and current watershed outreach, monitoring and assessment activities; and 2). Implementation Opportunities, which detail specific plans for restoration projects in conjunction with monitoring, assessment, and outreach activities. Finally, the section includes an implementation schedule, management targets and success measures, along with potential funding sources.

Las Huertas Watershed Restoration Action Strategy (WRAS)

1.0 WATERSHED ASSESSMENT

1.1 Overview of the Las Huertas Watershed

Location. The Las Huertas Creek watershed is located in central New Mexico, mostly in southeastern Sandoval County. The watershed extends approximately to Sandia Crest on the west, to the Sandia Peak ski area to the south, includes the subwatersheds of Palo Duro, Apache and Perdiz Canyons on the east. The watershed's northern boundary generally occurs within a mile of the channel of Las Huertas Creek or its northerly tributary arroyos (Figure 1). The headwaters begin in the northerly portion of the Sandia Mountains, flow north to and through the village of Placitas and then head northwest under Interstate 25 and west to meet the Rio Grande near the town of Bernalillo. The watershed is approximately 19,704 acres in area, and the Creek is approximately 16 miles in length from the source to where it joins the Rio Grande north of the town of Bernalillo (Figure 1). Las Huertas Creek is in the Rio Grande-Santa Fe watershed U.S. Geological Survey (USGS) Hydrologic Unit Code (HUC) 13020201.

Topography. Topography in the Las Huertas watershed varies from the mixed conifer forest of the northern flank of the Sandia Mountains at the headwaters to the rolling pinon-juniper scrub and grassland hills of the Placitas area, before joining the flatter topography of the Middle Rio Grande valley north of Bernalillo. Elevations range from approximately 8,100 feet above mean sea level (msl) at the Las Huertas Creek source in the Canon Media, to approximately 5,100 feet above msl where it joins the Rio Grande. Elevations through the majority of the Placitas area range between 5,400 feet to 6,400 feet above msl.

Geology/Hydrology. The Las Huertas Creek watershed is comprised of three primary hydrogeologic zones, or hydrologic systems: A). Mountain Zone; B). Mesozoic Ramp; and C). Albuquerque Basin (Johnson, 2000). These hydrologic systems are defined by geologic faults and stratigraphic contacts which hydrogeologic boundaries. Each of these systems is characterized by unique groundwater flow and occurrence and water quality. A generalized geologic map of the watershed study area is provided in Figure 2.

The Las Huertas Creek headwaters begin in the Mountain Hydrologic System within the Madera Limestone Formation, which forms a fractured carbonate aquifer in upper Las Huertas Canyon.

The lower part of Las Huertas Canyon is characterized by the Abo Formation, a mainly fine-grained sedimentary unit. Las Huertas Creek originates in Canon Media at a series of springs located on private land that originate out of faults in the Madera Formation. The water from these springs is of a calcium bicarbonate type with low total dissolved solids (TDS), and is generally considered very high quality as a drinking water source.

The next region in the downstream direction is comprised of the Mesozoic Ramp system, which covers the foothills between the north slope of the Sandia Mountains and the Albuquerque Basin (Johnson, 2000). The Mesozoic Ramp is generally characterized by an assortment of shales, siltstones, mudstones and sandstones with varying degrees of fracturing and permeability. Aquifer yield is highly variable in this area, with ground water occurring in compartmentalized thin strip aquifers bounded by low permeability aquitard units. Water quality in this system is also highly variable, but is generally considered poor.

The third major hydrologic system is the Albuquerque Basin, which generally comprises the portion of Las Huertas Creek watershed north of Highway 165. The Albuquerque Basin is comprised of thick sedimentary sequences of the alluvial deposits of the Santa Fe Formation. These sediments range from very coarse-grained cobble and boulder conglomerates to fine-grained mudstones associated with alluvial fan and river channel deposits (Johnson, 2000). Ground water within the Albuquerque Basin aquifer is generally considered of good quality, and extensive in supply. Recharge here is due to subsurface flow from the Sandia mountains, various stream systems, and the Espanola Basin to the north.

Surface Water. Las Huertas Creek drains most of the northern end of the Sandia Mountains (Johnson, 2000). The Creek is mostly intermittent, but is perennial through spring-fed reaches in Upper Las Huertas Canyon and below the Rosa de Castilla Spring west of Tecolote (Figure 3). The Arroyo del Ojo del Orno is a large system of tributary drainageways that primarily drains the Mesozoic Ramp hydrologic zone, and is also fed by perennial springs. Arroyo Agua Sarca comprises a separate small (approximately 6 square miles) watershed in the area that drains a section of the west face of the Sandia Mountains, but is not tributary to Las Huertas Creek.

Las Huertas Creek originates from a series of springs located in Canon Media to the northwest of Capulin Peak. The Creek flows perennially from the source to north of the Sandia Man Cave area. The perennial Creek flow diminishes downstream of the Sandia Man Cave as a result of

crossing a series of faults, including an extensive fault that follows the Palo Duro Canyon into the Las Huertas Creek channel in this area (Titus, 1980). The ditch diversion for the Las Huertas community ditch, located between the Sandia Man Cave parking lot and Palo Duro canyon. Studies have reported that Las Huertas flow at the ditch diversion is lower than flows measured upstream at the Las Huertas Picnic ground, possibly as a result of the same effect (UNM, 1991).

A second perennial reach begins at the Rosa de Castilla Springs located approximately 1 mile west of Tecolote along the Creek. Johnson (2000) estimated discharge of these springs at approximately 100 gallons per minute in January 1998, a time of no snowmelt or rain runoff. The same study indicated that 82% of stream base flow in las Huertas Creek in this reach was lost in crossing the Escala Fault, approximately 0.4 miles west of the Spring. Johnson (2000) has indicated that infiltration of Las Huertas Creek water into Santa Fe Group sediments in this reach is an important source of recharge for this portion of the Albuquerque ground water basin. A series of springs located on private property in the vicinity of the historic Tecolote settlement intermittently reaches Las Huertas Creek.

Creek flow in the intervening reaches upstream of Rosa de Castilla Spring to Lower las Huertas Canyon, and below the Escala fault, generally only occurs during spring snowmelt runoff and storm water runoff events.

Arroyo del Ojo del Orno, fed by the two major tributaries Arroyo del Oso and Arroyo Suela, also carry some perennial flow that originates from five major springs in the vicinity of the Placitas Village. These springs discharge ground water from the Madera Limestone aquifer. These springs and associated surface water flow serve as the source of irrigation and domestic water supply for Las Acequias de Placitas, a community water distribution system that serves the Village (Johnson, 2000). Overflow and return flow from the domestic and irrigation systems supply perennial stream flow in Arroyo del Oso and Arroyo Suela. This spring-fed perennial flow is maintained in Arroyo del Ojo del Orno until the stream crosses the Lomos fault (Figure 2). During periods of normal or below normal flow, the Creek surface flows are lost to channel-bed infiltration within a few hundred feet of crossing the Lomos fault. During periods of runoff and stormwater events, the stream continues all the way to its confluence with lower Las Huertas Creek (Johnson, 2000).

Climate. Mean annual precipitation measured in Bernalillo was measured at 8.7 (22.1 centimeters) inches over the period of record 1889-1982. Mean annual precipitation at Sandia Crest was 23 inches, (58.4 centimeters) over the period 1953-1979, based on National Oceanic and Atmospheric Administration (NOAA) data. A private party located in the northern section of the Placitas village measured average annual precipitation in Placitas at 14.6 inches between 1991 - 1999 (Johnson, 2000). These data reflect a trend of increasing precipitation with elevation, consistent with mountain environments in general. The private Placitas records indicated an annual maximum of approximately 18 inches in 1994, and a minimum of about 9.5 inches in 1995 during this ten-year period of record. These data reflect the extreme variability in precipitation patterns year-to-year that characterizes this high desert environment. Seasonal dry periods are common in the watershed, as indicated by the drought extending from summer of 1995 through winter of 1996 within this relatively short period of record.

Soils. Soils distributions in the Las Huertas Watershed were compiled from two separate soil surveys conducted by the Natural Resources Conservation Service (Figure 5). Separate surveys were conducted north and south of the Forest Service boundary in Las Huertas canyon, which resulted in different nomenclature associated with each study. A soil type of La Fonda loam prevails in the bulk of the lower Las Huertas watershed, complemented by Zia sandy loam in the lowermost portion traversing Interstate 25 (Figure 5). Steeper slopes and higher erodibility prevail in the upper portion of the Canyon.

Vegetation. A simplified schematic of prevailing vegetation types reveals a predominant Pinon-Juniper woodland/savannah vegetation classification in the majority of the lower Las Huertas watershed (Figure 6). Ponderosa pine woodland is the prevailing type in the upper canyon, with mixed conifer forest/woodland the dominant type in the uppermost reaches. Riparian woodland/shrubland characterizes lands adjacent to perennial Creek reaches. A patch of oak shrubland apparent along the western edge of the upper watershed is apparently associated with a burn event in that area. Semi-arid shrubland and grassland predominate in the lowest reach of the watershed traversing I-25. A more detailed analysis of vegetation communities in the lower watershed on the Placitas Open Space may be found in a report by botanist W. Dunmire (Dunmire, 1997).

Fauna. A general survey of prevailing mammalian fauna for the Las Huertas watershed includes approximately 40 species ranging from rodents to large herbivores (mule deer); and carnivores

(mountain lion, bobcat and black bear). Although the study completed by Dunmire (1997) focuses on the lower watershed, many of its listed species are shared in common with the upper watershed. The Dunmire (1997) study also listed 8 amphibian species, 13 lizard species and 17 snake species. A detailed survey of bird species completed by Schwarz (1998) documented 75 species in the vicinity of the open space alone, two of which (the Gray Vireo and the Loggerhead Shrike) appear on the federal "threatened and endangered" species list. Schwarz (1998) also noted the overlap of many of the observed Open Space species with the rest of the Las Huertas watershed.

Land Ownership/Land Use. A variety of entities own land with in the Las Huertas Creek Watershed (Figure 7). Land uses associated with land ownership vary. The United States Forest Service (USFS), Bureau of Land Management (BLM), City of Albuquerque, Sandia and Santa Ana Pueblos manage areas in the watershed (Nelson, 2005). USFS manages the largest amount of acres within the watershed, which begin at the headwaters. Private property owners hold approximately 30% of land in the watershed. Placitas Open Space (POS) is part of the City of Albuquerque's Open Space holdings, and is located approximately three miles northwest of the village of Placitas.

Table 1
Las Huertas Creek Watershed Land Ownership
Source: 2003 BLM Map data, courtesy LHWP

	Acres	Percent
Bureau of Land Management	1382	7
US Forest Service (including T'uf Shur Bien Preservation Trust)	11389	58
Santa Ana Pueblo	431	2
City of Albuquerque	560	3
Conservation Easements	1	less than .01%
Private Lands	5942	30
Total	19,704	100

Figure 8 provides Township, Range and Section reference information, and illustrates historic land grant tracts in the area.

US Forest Service

The USFS owns and manages the largest amount of land in the watershed at 11,389 acres. The Cibola Forest Ranger station manages the headwaters of the watershed in the Sandia Mountains. A small portion of the watershed lies to the south in Bernalillo County (see map Johnson figure 7). The majority of the watershed managed by the USFS lies within the Cibola National Forest in Sandoval County. Allowable activities on USFS land include; firewood cutting, livestock grazing, off-road vehicle (ORV) use, snow mobiling, and non-motorized recreation. State Road 165 is a dirt and gravel-surfaced road which serves as a route to the Sandia Man Cave and the Las Huertas Creek Picnic Area. The road is managed by the NM Department of Transportation.

Livestock grazing does not currently take place, though historic cattle, goat and sheep grazing have taken place. Recreational activities often take place in the creek bed, such as ORV use, and mountain biking and hiking, which directly affect the creek and watershed health.

T'uf Shur Bien Preservation Trust (Sandia Pueblo)

The T'uf Bien Shur Preservation Trust (the Trust) comprises a portion of the lands in the Sandia Mountains and near vicinity that are managed by the Cibola National Forest (Figure 7). The lands are held in trust by the Department of Interior for the benefit of Sandia Pueblo, which collaboratively manages the tract with the Forest Service. The Trust was established by the T'uf Bien Shur Preservation Trust Act of 2003, via Bill H.R. 222). The purpose of the creation of the Trust is to recognize the Pueblo's claims to the lands; and to make allowances for traditional and cultural tribal uses of the lands (within the constraints of existing wilderness and wildlife laws), while protecting existing improvements on the lands. The total area of the Trust includes 9,890 acres within the Cibola National Forest, only the easternmost extent of which lies within the Las Huertas watershed (Figure 7).

Bureau of Land Management

Activities allowed on BLM lands include: grazing, ORV use, mining, and non-motorized recreation. These activities impact and harm the watershed. Grazing is allowed on this public land and may be leased to private ranchers/cattle owners. Grazing may deplete ground vegetation if not properly managed, leading to erosion, incising of drainages, and associated increased siltation/sedimentation in the Creek. ORV and non-motorized recreation may also contribute to erosion by establishing trails that become drainage pathways that erode during runoff events.

Mining Operations

Another allowable use of BLM land is leasing for mining. Lafarge North America Inc. conducts gravel mining at the northern end of the watershed. Lafarge operates the Placitas Sand and Gravel operation on 800 acres leased from BLM that are closely surrounded by several Placitas area subdivisions (DeMello, 2005). Lafarge additionally operates the Santa Ana pit and Santa Ana asphalt plant, both on and abutting the Santa Ana Reservation and BLM land. Lafarge may expand mining operations on the Santa Ana pit eastward onto an additional 275 acres of BLM lease land (DeMello, 2005).

Petroleum Product Pipelines

Several petroleum product pipelines traverse the northern portion of the Las Huertas Watershed. These pipelines are contained in two corridors that enter the east side of the watershed and merge within the Placitas Open Space (Figure 7). A major pipeline corridor operated by the Mid-America Pipeline Company (MAPL) borders Las Huertas Creek on private land, the POS, BLM and finally Santa Ana Pueblo land. An Environmental Assessment was recently published proposing the construction of an additional natural gas liquids pipeline within the Placitas watershed pipeline section, calling for the expansion of the existing pipeline right of way by 25 feet (Diven, 2005). Recent local product leak and release incidents, together with recent spectacular pipeline explosion accidents involving human fatalities near Carlsbad, New Mexico, and Bellingham, Washington continue to make the Placitas pipeline corridors a major environmental and human health and safety concern of local residents (LPA, 2005a).

Private Property Owners

Land use by private property holders in the watershed is primarily residential. The creek flows through private properties, and most of the lower perennial reach of the Creek is on private property (Figures 3 and 7). Private land uses in the lower canyon include limited livestock and equestrian grazing, and small-scale agriculture.

Most small-scale agriculture in the Placitas area operates through one of three membership acequias: 1). Las Acequias de Placitas; 2). Rosa de Castilla; and 3). Las Huertas Community Ditch. Acequias are community water-sharing organizations that date back to the time of the New Mexico territory prior to statehood (Rivera, 1998). These associations administer surface water diversions collectively for the mutual benefit of all members. Water rights declarations and licenses associated with agricultural diversions in the Placitas area that are on file at the New

Mexico Office of the State Engineer collectively account for total declared irrigated acreage of approximately 465 acres (Sweetman and Bandeen, 2002). The priority dates associated with these declarations range from 1963 to 1920. These Placitas area acequias depend on surface flows from springs and the Las Huertas Creek, and are generally viewed as a vital part of the historical and current culture of the Las Huertas watershed, based on public feedback at recent workshops (LPA, 2005b).

Placitas Open Space

Placitas Open Space (POS) is located approximately three miles northwest of the village of Placitas. It is currently 560 acres and managed by the City of Albuquerque, Open Space Division (OSD). The Las Placitas Association grew out of concerns residents had about preserving the undeveloped natural and low-impact recreational site. The residents consider it to be a pocket of natural beauty and cultural history that provides wildlife habitat and outdoor enjoyment for the community. A Master Plan defining the protocols for OSD's management of the POS was prepared in February 2002, but is still waiting final formal adoption (Sites Southwest, 2002).

Santa Ana Pueblo

The Santa Ana Reservation lies near where the creek merges with the Rio Grande. Las Huertas Creek actually flows all the way to the Rio Grande infrequently. High flows associated with the 2005 spring runoff resulted in the Creek reaching the Rio Grande for over 4 weeks based on LHWP observations. Existing land uses include the Lafarge gravel mining operation, agricultural and cultural uses (Linderoth, 1998).

1.2 Watershed Assessment Process

Surface Water Quality Criteria. New Mexico's Surface Water Quality Standards (WQS) define water quality goals by designating uses for various water bodies, setting criteria to protect those uses, and establishing provisions to preserve water quality. To meet the requirements of Section 303 (d) of the federal Clean Water Act, the WQS are examined for changes on a 3-year rotating basis in a process known as the Triennial Review (NMED, 2005a). General WQS are listed at the web link:
http://www.nmenv.state.nm.us/swqb/standards/20.6.4NMAC.pdf

The Triennial Review convening in 2003 resolved to upgrade the use criterion for Las Huertas Creek from a "cold water fishery" designation to a "high quality cold water aquatic life" (HQCWAL) designation, based on monitoring data demonstrating historical and current compliance with the HQCWAL standards. In practice, the difference in water quality standards between the two use designations is relatively minor (Appendix A). General water quality criteria of pH and temperature are largely the same, though there is a refinement on the bacteria standard from general fecal coliform to specific limits on *Escherichia coli* (E. Coli) bacteria. These specify a limit of monthly geometric mean of not more than 126 colony forming units (cfu) per 100 mL, and a single sample maximum of 410 cfu/100mL (Appendix A).

The E. coli bacteria standard relates to the Total Maximum Daily Load (TMDL) standard set for the Middle Rio Grande. Middle Rio Grande reaches directly affected by runoff from Las Huertas Creek include Reach 20.6.4.106 (Alameda Bridge in Corrales to the Angostura Diversion works), and Sandia Pueblo tribal waters (applicable within exterior boundaries of tribal lands). The applicable E. coli standards for these reaches is summarized in Table 2. The Middle Rio Grande Fecal Coliform TMDL report may be accessed at the following web link: http://www.nmenv.state.nm.us/swqb/Middle_Rio_Grande-Fecal_Coliform_TMDL-May2002.pdf Sandia Tribal standards for fecal coliform are more stringent than the state TMDL or the HQCWAL use standard. Depending on concentrations of fecal coliform above the confluence of Las Huertas Creek and the Rio Grande, upholding a HQCWAL standard in Las Huertas may or may not ensure compliance with water quality standards in the Middle Rio Grande (Table 2).

Table 2. Applicable E. Coli and Total Coliform bacteria standards for Middle Rio Grande TMDL and Las Huertas Creek Use Criteria (NMED, 2002; 2005a)

Reach	Use Designation	Monthly Geometric Mean E. Coli, cfu per 100mL	Single Sample Maximum Monthly Geometric Mean E. Coli, cfu per 100mL
Rio Grande Segment 20.6.4.106 - Angostura Diversion to Alameda Bridge	Irrigation, marginal warm water aquatic life, livestock watering, wildlife habitat, secondary contact.	126	410
Las Huertas Creek	High Quality Cold Water Aquatic Life, irrigation, livestock watering, wildlife habitat, secondary contact.	126	410

Table 2 (continued). Applicable E. Coli and Total Coliform bacteria standards for Middle Rio Grande TMDL and Las Huertas Creek Use Criteria (NMED, 2002; 2005a)			
Sandia Pueblo Tribal Waters		**Monthly Geometric Mean (a) Fecal coliform Colonies per 100mL**	**Single Sample Maximum Fecal Coliform (colonies per 100 mL)**
	Primary contact ceremonial	100	200
	Primary contact recreation (b)	100	200
	Secondary Contact recreation	200	400
	Agricultural Water Supply	1000	2000
	Warmwater Fishery	100	200
(a) taken as mean of 5 samples analyzed over maximum of 30 days	(b) Applies April 1 - Sept. 30, outside of which Secondary Contact standards apply		

Public Input. Public outreach activities have included inviting anecdotal input from watershed stakeholders regarding potential water quality concerns in Las Huertas Creek and its tributaries. This input was noted for future reference as NMED and LHWP supplemental monitoring activities were planned. Examples of such anecdotal input from citizen stakeholders include:

- Observation of septic leachate seeping from inadequately constructed septic systems into area arroyos;
- Observation of effluent associated with water well drilling activity being discharged into area arroyos;
- Observation of inadequate and non-compliant site stormwater erosion control on active construction sites in new area subdivisions.

Previous Work/Available Data. Various government, educational, and private non-profit agencies and groups have been involved with collecting water quality data on Las Huertas Creek in recent years. The U.S. Environmental Protection Agency (EPA) maintains an on-line database of historical water quality data nationwide. This database may be accessed at the web address:

http://www.epa.gov/storet/

This "STORET" (for STOrage and RETrieval) database includes results of limited field parameters testing and inorganic constituents analysis in 1975 in Las Huertas Canyon (Appendix B). Classes at the Bosque Preparatory School in Albuquerque have been conducting monitoring activities in Las Huertas Creek since September of 1995. A table summarizing water quality data from their field monitoring program for the period September 1995 through May 2002 is included as Appendix C.

The New Mexico Bureau of Geology report on the Hydrogeology of the Placitas area (Johnson, 2000) compiled extensive monitoring data during the period 1998 - 2000.

Las Huertas Creek Water Quality. Available water quality data supports the HQCWAL standard for the perennial upper Las Huertas Canyon reach (Appendix B, Appendix C). Johnson (2000) analyzed water samples for general organic chemistry parameters and trace elements at two locations in close proximity to the lower perennial reach of Las Huertas Creek (Figure 3). The first is identified as PS-7, which is the spring located on private property near Tecolote. The second is the Rosa de Castilla spring, identified as PS-8, once during May of 1996 (Johnson, 2000, Appendices F, G and H). These data are attached as Appendix D for reference. Although these data indicate compliance with the HQCWAL designation, they were collected during the spring runoff period, directly from spring sources. Temperature levels further downstream may exceed the 20 degrees C limit, especially during the summer months.

Water quality monitoring performed by LHWP staff in May 2005 also resulted in measurements that indicate compliance with the HQCWAL standard (Table 3).

Table 3. Water Quality Monitoring Results - LHWP staff - May 25, 2005

Upper Las Huertas Creek near Sandia Man Cave Parking Lot

Parameter	Result	Parameter	Result
Temperature	12 degrees Celsius	General weather	Partly cloudy
Electrical Conductivity	323 micromhos	Air Temperature	81.3 degrees F
Dissolved Oxygen	9.5 milligrams per liter	Elevation	7060 feet msl

Table 3 (continued). Water Quality Monitoring Results - LHWP staff - May 25, 2005 Upper Las Huertas Creek near Sandia Man Cave Parking Lot			
Turbidity	7.26 ntu's	Wind	Less than 5 mph
pH	6.75		

The current NMED Middle Rio Grande water quality study investigation will add substantially to the available water quality database for Las Huertas Creek.

1.3 Issues Affecting Water Quality

The New Mexico CWA Section 303(d) list of impaired waters for 2004-2006 includes Las Huertas Creek as an impaired water way due to sedimentation/siltation (NMED, 2005b). NMED cites this as one of the most pervasive water quality problems in the state. NMED is currently planning to develop a TMDL document for sedimentation/siltation in Las Huertas Creek in 2007.

The EPA writes that " Suspended and bedded sediments (SABS) are defined by EPA as particulate organic and inorganic matter that suspend in or are carried by the water, and/or accumulate in a loose, unconsolidated form on the bottom of natural water bodies. This includes the frequently used terms of clean sediment, suspended sediment, total suspended solids, bedload, turbidity, or in common terms, dirt, soils or eroded materials." The rationale for SABS being classified as a contaminant is that "an increased sediment load is often the most important adverse effect of … activities on streams." This impact is largely a mechanical action that severely reduces the available habitat for macroinvertebrates and fish species that utilize the streambed in various life stages. An increase in suspended sediment concentration will reduce the penetration of light, decreases the ability of fish or fingerlings to capture prey, and reduce primary production (NMED, 2004). Other effects include aggradation and destabilization of stream channels, scouring and removal of riparian and pool habitat, subsidence and disappearance of wetlands, lowering of the water table and accelerated in-fill of water bodies (EPA, 2003).

Loss of riparian vegetation may indirectly contribute to SABS. Channel incising and locally lowered riparian channel water tables may cause diebacks of naturally occurring riparian vegetative cover. As a result of the loss of shade, ambient water temperatures may increase,

leading to increased algae growth in the stream bottom. As such, temperature is an important monitoring criterion in the ongoing water quality assessment.

Factors that may be contributing to SABS in the Las Huertas watershed include:

- Road bed runoff in Las Huertas Canyon
- Unregulated discharge of borehole drilling fluids in area arroyos
- Poor storm water control practices on construction sites
- Loss of riparian vegetation

Ongoing monitoring by NMED will determine whether elevated E. Coli levels in Las Huertas creek are a significant water quality issue. As indicated in the Middle Rio Grande Water Quality study, only a portion of E. coli levels are usually traceable to human origins, the primary contribution being made by wildlife and pets (NMED, 2005c). Improperly constructed septic systems could be a contributing factor to elevated E. coli levels, and two other indicators of septic leachate: nitrate and ammonia.

1.4 Historical and Current Watershed Restoration Activities

LPA has undertaken restoration activities in recent years on the Placitas Open Space (POS) property. Both riparian vegetation restoration and induced channel meandering projects were undertaken under the leadership of watershed hydrologist Bill Zeedyk and watershed ecologist Dr. Ellie Trotter (LPA, 2005b).

Some private landowners have undertaken systematic watershed restoration projects on their properties. One private citizen owning property below Rosa de Castilla Spring along Las Huertas Creek is currently conducting induced meandering work under a grant from U.S. Fish & Wildlife. Although not considered part of the Las Huertas Watershed, the Diamondtail subdivision in the San Francisco Creek watershed has undertaken substantial erosion control and arroyo stabilization projects on its property. With arroyo incising and bank subsidence being widespread and highly visible problems in the Placitas area, numerous private landowners undertake ad hoc bank and hillside stabilization measures which make significant contributions to drainageway sediment reduction.

The U.S. Forest Service, Sandia Ranger District, the New Mexico Department of Transportation (DOT), and the LHWP are undertaking a pilot road-runoff detention/sediment filtration project in Las Huertas Canyon (U.S. Forest Service, 2005a). The project involves direction of stormwater runoff from NM 165 below the Las Huertas Picnic ground into a relatively level meadow adjacent to the Creek where the water will be allowed to filter through meadow sediments and a rock detention structure before seeping back into the Creek. The detention utilizes a former ditch channel historically used for the same purpose (U.S. Forest Service, 2005b). This may prove to be an economical and effective means of reducing Creek sediment load. The project was implemented during September 2005

1.5 Current Watershed Monitoring and Assessment Activities

The NMED is currently conducting regular sampling and analysis of Las Huertas Creek waters in conjunction with its Middle Rio Grande Water Quality Study. The program will provide data that will be used in establishing and refining TMDLs for the Middle Rio Grande, and depending on analytical results, in developing TMDLs for Las Huertas Creek proper. The NMED program targets two locations, each near the lower end of the two perennial reaches of Las Huertas Creek (Figure 3). The planned sampling and analysis schedule is summarized in Appendix E. The water quality data compiled by NMED will be subject to the state Quality Assurance Project Plan (QAPP), which will allow its inclusion in the official state database. Data collected by other entities outside of the governance of the QAPP are generally not included in this database.

The LHWP is undertaking supplementary flow level and water quality monitoring in Las Huertas Creek. The sampling plan outlining the supplementary water quality monitoring program is included as Appendix F. Monitoring for Creek flow level, dissolved oxygen, turbidity, temperature, salinity, pH and electrical conductance will be conducted at a minimum quarterly, and at additional events opportunistically, with particular emphasis on storm water runoff events. Scheduled monitoring will be conducted at the same two primary locations as the NMED program, and will opportunistically target additional locations, including lower Arroyo del Ojo del Orno.

Riparian Survey

A riparian survey was conducted of the upper Las Huertas Creek during May 2003 along upper Las Huertas Creek near the Sandia Man Cave site at 35.249 N and 106.415 W by UNM graduate students Laura Lindenmayer and Jennifer Nelson. This survey followed the outline of

the New Mexico Watershed Watch Riparian Survey. Parameters and the conditions of each characteristic are shown below.

- *Riparian Vegetation and Structural Diversity* was excellent with more than three height classes of grasses, shrubs, and trees.
- *Bank Stability* was good, but some erosion and unstable areas are present.
- *Bank Cover* was fair with about 50% vegetated.
- *Vegetation Buffer Width* was very poor. The primitive road which climbs into the Sandia Mountains is only a few meters away.
- *Vegetation Diversity* was fair with about seven species in the immediate vicinity.
- *Embeddedness* was ranked good. The vertical depth of rock buried in sediment was about 40-50%.
- *Flow* above 7,000 feet was ranked poorly with only 0.14 cubic feet per second.
- *Canopy* was excellent with a mix of sun and shade over the water.
- *Benthic Insect Diversity* was excellent with dominant mayflies, stoneflies, and caddisflies. There were some leeches but very few.
- *Width to Depth* of the frequently flooded channel was excellent with a 3 foot depth to 20 foot width.
- *Pools and Riffles* were excellent because of a variety of habitats.
- *Streambed Geology* was poor with less than 20% diversity of boulders, logs, cobbles, and gravel.

The reach was given a score of 2.2. Turbidity in this reach was at 5.4 ntu undisturbed and at 187 ntu when disturbed. At 7.8 ^{o}C, the pH was determined to be about 8.0. Total dissolved solids were 240 mg/L of mostly calcium and carbonate.

LHWP performed similar riparian survey monitoring along a privately owned stretch of Las Huertas Creek bosque west of Tecolote during May 2005 (Figure 1). A general "watershed health" index was developed based on methods published by Fleming (1999). On a scale of 1 to 4, with 4 being optimal, the monitored riparian zone ranked a 2.5.

The United States Geological Survey (USGS) is currently conducting monitoring of Placitas area ground water levels and selected surface water body flows (Lutz, 2005). These data are intended to provide follow-up data of selected wells and surface water monitoring stations published in Johnson (2000) report. Monitoring was initiated in spring of 2005 and no data have as yet been released.

1.6 Outreach Activities

The LHWP accomplishes public outreach and stakeholder engagement via conducting workshops and seminars, publishing newspaper articles on watershed topics, and inviting public participation in active restoration projects.

Workshops/Seminars

Beginning in 2003, the LHWP has conducted numerous educational seminars and participatory workshops. LHWP-sponsored activities include:

- Las Huertas Creek Watershed tours, conducted June 2003 and September 2004. These tours were led by Rich Schrader, Watershed Specialist with River Source, Inc. The tours included a general watershed geomorphology, hydrology and ecology presentation; stream biota sampling and assessment; and visits to ongoing private restoration projects.
- Placitas town meetings and stakeholder's workshops conducted July 2003 and January 2005. Sessions of technical presentations were offered along with group input exercises compiling stakeholder input regarding priority watershed restoration issues. An agenda and summary group input from the January 2005 workshop is available on the LPA web site (LPA, 2005b).
- 2004 Workshops including an acequia tour/workshop; Stormwater management; Well and Septic tanks; Drought gardening; Grey water systems and rainwater harvesting. An informational seminar in December 2004 addressed historical road paving issues in Las Huertas Canyon.
- 2005 Workshops to date have included Drought gardening (March) led by horticulturalist Joran Viers; Placitas Acequias (April) led by San Antonio de Las Huertas Land Grant President Tony Lucero; Rapid Watershed Health Assessment techniques (May) led by UNM Regional Planning Graduate Student and Middle Rio Grande Watershed Coordinator Jennifer Nelson; Septic Tank design and water quality testing, featuring Jerzy Kulis and other NMED staff (July).
- Additional planned 2005 LHWP workshops include: Diamondtail Stormwater management and Town of Tejon tour (August); and a Community Las Huertas Creek cleanup (September).
- Additional workshops will be conducted during 2006, though a specific schedule is not in place at this time.

As of this writing, approximately 150 people have attended LPA/LHWP watershed-related workshops and seminars in 2005.

Newspaper Articles

LHWP regularly reports on watershed-related topics in the regional community newspaper, the Sandoval Signpost. Most of these articles relate to LHWP's workshop program, either introducing a topic of interest to be featured in an upcoming workshop, or reporting on the results of a recent workshop. LHWP has also published articles on topics of stakeholder interest, such as wildland/urban interface fire management (April 2005).

Watershed Library

A shelf in the Placitas Community library has been dedicated to the LHWP, and currently features 15 volumes of watershed-related documents. These are comprised of general hydrology, hydrogeology, ecology and resource-planning documents. Current titles are summarized on the LHWP link under the Las Placitas web site (www.lasplacitas.org). A special map rack for storage of large-format maps, such as those included in the Johnson (2000) report, forms part of the LHWP section. The LHWP library section will be updated in an ongoing manner as documents of interest are acquired. Quarterly reports on the CWA 319 grant are included as part of the library.

Focused Outreach

Meetings and telephone conversations have been held with specific groups and individuals in the community that have expressed concerns regarding the potential side-effects of restoration activities, usually with regards to potential impacts on downstream irrigation water rights. A meeting was held with approximately 20 members of the Las Huertas Community Ditch, who expressed such concerns related to potential sediment-reduction strategies that have been suggested for the upper Canyon. Local acequia members and private landowners have been assured that no projects will be undertaken in the upper Canyon (above the irrigation diversion) without their full participation in screening and feasibility analysis. Findings of current technical research on the long-term enhancement effects of riparian restoration activities that increase alluvial bank storage, creek base flow, and ultimately the amount of water available for irrigation diversion have been presented to these concerned irrigators. The Las Huertas Community Ditch president has become a regular attendant at LHWP monthly planning meetings. Ongoing communication and participation of this group is an integral part of pursuing active restoration projects in this reach of Las Huertas Creek.

Volunteer Task Force

In addition to regular planning meeting participants, workshop/seminar participants and interested individuals who have been accumulated in the LHWP contact database, the LHWP is forming a Volunteer Task Force (VTF) of individual stakeholders who have indicated an interest in performing active volunteer work associated with field and project activities. So far VTF participation has been limited to a few people assisting in field monitoring activities. A focused effort at increasing the VTF numbers will coincide with developing volunteer labor for the construction of the USFS pilot infiltration project in upper Las Huertas Canyon during the summer of 2005. The VTF will be developed on an ongoing basis as a labor and planning resource for future on-the-ground projects.

2.0 IMPLEMENTATION OPPORTUNITIES

2.1 Overview

The LHWP's strategy is to work with Sandoval County, the U.S. Forest Service, the Bureau of Land Management, the New Mexico Department of Transportation, the New Mexico Environment Department and the City of Albuquerque Open Space Division to develop BMPs to reduce storm water runoff, enhance vegetative cover in both riparian and upland areas, and implement channel treatments to reduce flow velocities, stabilize banks and hillsides, and increase overall watershed retention. LHWP plans to initiate on-the-ground restoration efforts high in the watershed, and generally work in a progressively downstream direction. The LHWP also plans to work with NMED to enforce existing regulations to curb illicit dumping of drilling fluids in area arroyos and remedy discharges of septic leachate into surface water drainages.

Load Reductions

Given that load reductions of target constituents is a major goal of watershed restoration in the model of the EPA's CWA Section 319 Program, restoration strategies with demonstrated track records for reducing the target constituent of sedimentation and siltation are presented. Though specific measurements of sedimentation/siltation are not yet available from the NMED Middle Rio Grande water quality study, these proven strategies serve the overall reduction of these constituents, and address the current designation of Las Huertas Creek on the CWA Section 303 (d) list of impaired waters for these constituents.

Load reductions will be traced via the proposed monitoring program (see page 24), which will begin with a baseline survey against which project-related effects will be measured. Project-specific success measures, including load reductions where appropriate, are included in Table 4, Section 2.6.

Project Milestones pertaining to proposed projects that target load are summarized in Table 5, Section 2.6.

Implementation Strategy

These implementation measures collectively are designed to minimize erosion and sediment/pollutant transport in upland areas, and control, alleviate and disseminate peak storm water flows in primary tributaries and the mainstem of Las Huertas Creek. Public outreach, education and involvement will be incorporated into all phases of these initiatives. By successfully implementing these strategies, introduction of anthropogenic contaminants and transport of sediment can be significantly reduced, and both riparian and upland areas stabilized. Implementation of restoration projects can be pursued via LHWP-led projects, and via broader coalitions involving LHWP acting in partnership or support of agencies working in the Las Huertas watershed.

Potential actions that would advance these strategies include:

1. Runoff and erosion control for roads, construction sites, and lots post-construction;
2. Riparian, stream bank and hillside stabilization;
    - Channel modification/induced meandering
    - Riparian zone revegetation/exotics removal
    - Slope stabilization measures
    - Drainage source area channel stabilization
3. Upland area revegetation and re-establishment of native grasses to establish vegetative buffer zones between sediment sources and drainageways;
4. Promote establishment of healthy forest tree density, control of ladder fuels and establishment of healthy ground cover in forested areas of upper Las Huertas Canyon;
    - tree thinning programs
    - controlled burn programs
5. Rainwater retention for tree watering and other irrigation;
6. Enforcement of existing storm water and waste water regulations.

7. Repair of existing culvert drainage system in Las Huertas Canyon as a primary means of runoff control in the upper watershed.

2.2 Proposed Projects

Selected projects that could be led by the LHWP are proposed to address target restoration issues as follows.

2.2.1. Stormwater Management

Task 1. Perform Watershed Survey and Ranking of Sediment Sources

LHWP proposes to conduct a watershed-wide survey to assess sources of runoff and eroded sediments in the individual drainages of the watershed. Document current conditions in each major drainage area, and quantitatively rank these areas regarding their contribution to geomorphic and hydraulic degradation of the drainage, and degradation of habitat and ecosystem health. The survey should include a baseline study of the stream profile and gradient.

Task 2. Develop a Best Management Practices Handbook for the Las Huertas Watershed

Anticipating continued development within the watershed, this task involves preparing a guidance document for private landowners, public lands managers and property developers in the watershed with the overall goal of reducing the rate of surface runoff, reducing peak runoff flows and associated soil erosion and sediment transport. The BMP Handbook will be designed to be a useful reference tool for these entities, and could be incorporated into Sandoval County regulations on stormwater management for the area of the Las Huertas Watershed.

2.2.2. On-the-Ground Stormwater and Erosion Control Projects

Based on the watershed survey and drainage area rankings, and BMP manual developed in Task 2.2.1, selected high-priority problem areas will be targeted for specific BMP implementation projects. These will both address specific problems of immediate need, and serve as pilot projects for BMP demonstrations for the watershed stakeholder body.

Task 1. Restore and Enhance Culvert Drainage at Road Crossings in Las Huertas Canyon

Reduction in sediment load in upper Las Huertas Canyon is the first priority for the project. As stream-borne sediments propagate downstream, control of sedimentation/siltation must begin high in the watershed. The first step in controlling sedimentation in the upper watershed is to restore culvert drainages at road crossings in Las Huertas canyon, all of which are either partially, or totally clogged. Deprived of the controlled drainage that the culverts provide, Las Huertas

Creek flows are finding alternative, and highly erosive, flow paths around the road crossings. Without restoration of culvert drainages, implementation of other BMPs will be undermined by this persistent problem.

Task 2. Upper Las Huertas Canyon Stream Channel Improvements

Additional installations of temporary wet meadow infiltration and detention of Las Huertas Creek storm flows, patterned after the pilot project near Sandia Man Cave that re-directs road runoff to temporary wet meadow infiltration, are recommended for upper Las Huertas Canyon. Given LHWP's plan of initiating restoration projects in the upper Canyon, this restoration measure is well-suited to this reach of the Creek. LHWP conducted GPS surveys of natural floodplain overflow areas during periods of high Creek flows during Spring 2005. LHWP has targeted three locations well-suited to implementation of additional wet meadow infiltration projects in the reach between Las Huertas picnic ground and the lower extent of perennial flow in the upper Canyon.

LHWP will also undertake stream channel modifications in upper Las Huertas Canyon to enhance the natural scouring of step pools that have become filled in with sediment. The step pools that form as part of the natural pool-drop morphology of upper Las Huertas Creek form a natural energy-dissipation structure. Selectively removing and replacing large rocks within the Creek channel, and selective removal of accumulated brush piles, can restore flow patterns within the Creek channel that naturally scour accumulated sediment from the Creek's step pools, restoring these natural energy dissipating features (Zeedyk, 2005).

Task 3. Conduct vegetation restoration projects

Select three perennial reaches of Las Huertas Creek and/or Arroyo del Orno del Oso totaling 5 miles in length in which to conduct riparian vegetation restoration, including removal of exotic phreatophyte species, planting of native tree species, and revegetation of eroded upland and bank areas with native grasses and shrubs. LHWP proposes removal of tamarisk and elm trees, and restorative planting of native plant species. These may include wild roses in the upper Las Huertas Canyon area, and willows and cottonwoods in the vicinity of the perennial reach near Rosa de Castilla. This project will improve wildlife habitat and stabilize perennial riparian channels while increasing water retention and reducing evapotranspiration.

Task 4. Hillslope Stabilization

LHWP proposes to construct 200 erosion control structures on upland slopes within the watershed. LHWP envisions implementation of low-tech structures applied in other New Mexico watersheds including one rock dams, vegetative strip buffers, wicker weirs, brush dams, log mats and straw bale dams as detailed in Zeedyk and Jansens (2004). These structures will be widely dispersed in the headland areas of priority erosion problem areas to begin to arrest and reverse rill and gully formation.

Included under this task, LHWP proposes to provide follow-on support to individual resident landowners and homeowners associations to implement erosion control measures detailed in the BMP handbook (Task 1 - Stormwater Management). LHWP will conduct public outreach to landowners, and provide technical expertise, project coordination, and volunteer labor assistance to landowners wishing to implement BMPs on their property. Such support is intended to help address widespread erosion on private property in the Placitas area.

BMPs likely to be employed under this task include catchment and/or detention of runoff from non-infiltrating surfaces such as rooftops, driveways, landscaping improvements, and subdivision roads, including application of detained flows for outdoor landscaping and watering native vegetation. These BMPs will interrupt the current direct flow path from non-infiltrating surfaces to the Creek, which contribute to the deleterious effects of sudden stormwater flows.

Widespread implementation of BMPs detailed in the BMP Handbook will contribute to general reductions in peak storm flows in Las Huertas Creek, reduce overland flow and associated erosion during stormwater events, and contribute to overall soil stability by enhancing upland watershed vegetation. This task will be ongoing during the life of the project.

Task 5. Design and implement induced meandering and channel detention measures in selected reaches of middle and lower Las Huertas Creek.

In addition to the work proposed for upper Las Huertas Canyon (Task 2), two other reaches of Las Huertas Creek will be selected, based on the erosion source survey, for implementation of induced meandering and streambank reinforcement structures. These structures are designed to arrest channel straightening/incising, direct flows away from eroding banks, and restore a meandering channel morphology to the Creek. Induced meandering will be accomplished

primarily via the use of strategically placed rock structures and post-vane structures to induce the desired channel morphology.

Target reaches for in-stream flow control measures include: a) privately-owned tracts in the Rosa de Castilla area; b) private lands governed by homeowner's association in the vicinity of the Las Huertas Creek/Arroyo del Oso del Orno confluence (Figure 1, middle reach); and c) the downstream reach in the vicinity of the Placitas Open Space (Figure 1; Lower Reach).

As with the other proposed projects, this task is expected to have its own marginal contribution to reducing sedimentation/siltation in Las Huertas Creek, mainly as a result of decreasing the hydraulic energy of the stream flow. This decreased hydraulic energy in turn results in less scouring of the stream channel and banks, and higher seepage rates and alluvial storage, with a net effect of lowering peak discharges, and increasing stream baseflow (McCord, 2005). This has the secondary effect of providing a more stable environment for riparian vegetation, which in turn provides wildlife habitat and cools the stream via shading.

In-stream flow control measures will be implemented in one reach for each year of the project, beginning with the uppermost reach (Task 2) and progressing to the lower reach in the third year. The middle and lower reach projects will target approximately 1 mile of stream channel each. Implementation of in-stream flow control measures will be completed by October of each project year.

2.2.3 Open Space Preservation

The LHWP advocates land conservation and open space preservation as a means to promote the overall ecological health of the watershed. The LHWP plans to pursue the land ownership survey described in the following text in order to begin outreach and education on land conservation strategies to interested parties. This effort will be funded outside of the CWA Section 319 (h) program.

Task 6. Perform Riparian Land Ownership Survey

Based on public feedback received during community outreach sessions, preservation of open space within the watershed ranks high in watershed stakeholders' priorities. Preserving existing open space and bringing new sensitive lands into open space is one of the most direct enhancements of the ecological quality of a watershed. Such preserved land receives the double

benefit of maintaining the land's natural habitat, and precluding additional water quality impairments that come with residential development, including stormwater runoff issues and potential septic contamination. Citizen's stakeholders have suggested that private landowners along Las Huertas Creek be involved in preserving their land in an undeveloped state for posterity.

Preliminary conversations with some such landowners indicates a preliminary interest on the part of several individuals in participating in such a plan. Preservation measures may include selling or donating a conservation easement on the land, or selling the land to a publicly held parks and open space program.

The LHWP proposes to conduct research into land ownership along the perennial reach of Las Huertas Creek near Rosa de Castilla, and approach selected landowners with respect to the possibility of participating in such a program. Three landowners along this reach owning land of approximately 20 acres each are either already engaged in preserving and restoring their riparian land, or have expressed an interest in doing so. LHWP plans to partner with Sandoval County and the private landowners to prepare a plan for open space preservation in this area, providing sufficient landowner interest can be generated.

2.3 Proposed Monitoring and Assessment Activities

Documentation of baseline and post-restoration conditions in a variety of categories will be documented by project participants. Monitoring work will be accomplished primarily by VTF members assisted by LHWP project staff, and may involve local school students and workshop participants. A QAPP document will be prepared prior to any monitoring work under the guidance of NMED, in order to ensure appropriate methods and repeatability of monitoring activities, and the accuracy of data and results documented via the monitoring program.

a. Repeat Photography Photographic observation points will be established at optimal locations for all on-the-ground projects. Project impacts for wet meadow infiltration, vegetation restoration, hillslope stabilization and channel enhancements will be documented annually.

b. Ground cover VTF members will accomplish monitoring the effects of vegetation restoration efforts. Selected representative areas will be established for documenting per cent cover and vegetation type for wet meadow infiltration, riparian and upland restoration and hillslope stabilization projects.

c. Rill density VTF members will accomplish baseline and follow-up rill density measurements on representative hillslopes along Las Huertas Creek and its major tributary drainages in the watershed. Density measured as rills per mile and cumulative rill cross-sectional area per mile will be recorded. This monitoring will operate in conjunction with the initial watershed survey and hillslope stabilization projects. Initially high rill density areas will be given priority for hillslope stabilization and erosion control measures (Task 3). Rill density measurements will be repeated at annual intervals following treatment.

d. Stream channel cross sections Monitoring locations will be established both upstream and downstream of the four wet meadow infiltration sites, vegetation restoration sites and induced meandering sites to monitor changes in stream channel morphology. Stream channel morphology and cross-sectional area, stream bank morphology and vegetation and sediment transport will be monitored annually at each location. The stream channel monitoring will be conducted by the VTF.

e. Seedling Survival Survival rates of riparian and upland plantings will be documented by surveying representative areas at 6 months, one year and two years after initial planting. Percent survival will be computed and general site cover and plant health will be recorded as measures of the effectiveness of vegetation restoration efforts.

f. Storm water quality The VTF will continue selective monitoring of Las Huertas Creek water quality parameters during storm water and snowmelt runoff events. Stream flow, turbidity, temperature, pH, salinity and dissolved oxygen will be measured and recorded in LHWP's water quality data base.

2.4 Proposed Outreach Activities

Working in conjunction with LPA's active public outreach agenda, the LHWP regularly conducts field workshops, public speaker events, and public education activities in the Placitas area. These activities are planned to continue in coming years. Specific goals for the LHWP include:

a. Workshop series Continue to conduct educational and participatory public workshops relevant to the LHWP and watershed restoration. Past programs that have produced valuable results or enjoyed high levels of public participation include watershed monitoring, water quality testing, acequia agriculture, watershed tours, xeriscaping, water harvesting and gray water management, and stream-channel modifications. Additional workshops may include vegetation

restoration and upland erosion control. Depending on LHWP's continued success in procuring project funding, this workshop program is planned to continue.

b. Speaker Series The LHWP has sponsored an educational speaker series, covering subjects such as acequia culture, transportation management issues of Las Huertas Canyon, watershed hydrology, and general watershed restoration. Additional topics of interest that could be included in future events include watershed restoration as a means to increased alluvial water storage, the Middle Rio Grande water quality survey, and Conservation Easements as a means of watershed preservation. Again, LHWP plans to continue with these programs to the extent appropriate project funding can be obtained.

c. Web site The LHWP maintains a web page link under LPA's general web page. The web page is periodically updated to reflect current LHWP activities and project progress, events calendar, and additional links to key watershed project-related documents. The web page also includes an up-to-date listing of watershed project documents and maps held at the Placitas Community library watershed section. Additional upgrades are planned for the web site, including a link to the draft WRAS, updated accomplishments section, improved graphics and user interface, and additional informational links.

d. Volunteer Task Force (VTF)

As described in Section 1, VTF formation is still underway, and the LHWP plans to expand the volunteer body as the project progresses. Every LHWP regular meeting, workshop or speaker event is used to recruit additional VTF members. As the LHWP now moves from the Watershed Group Formation phase into a more active project implementation mode, VTF participation opportunities will increase.

2.5 Proposed Agency Partner Initiatives

The following projects are recommended for implementation with LHWP in a support role to another partner agency assuming a lead role.

A. Fire Risk Management in Las Huertas Canyon Management of the risk of forest fire or a catastrophic wildfire in Las Huertas Canyon ranks high on the list of priorities for the community, based on feedback at LHWP public workshops. Currently, the USFS doesn't have a program in place to manage fire risk in Las Huertas Canyon. Elements of a risk management program often include controlled burns and tree thinning. Due to staff and program funding cutbacks at the

USFS as a result of the current U.S. administration's budget priorities, a funded program for Las Huertas canyon is not a priority at this time (De Gruyter, 2005). However, the Cibola National Forest Sandia District is about to undertake a Forest Plan Revision, and community fire prevention plan programs are funded by USFS. LHWP will assist in facilitation of group formation seeking community fire protection planning and active fire risk management in Las Huertas Canyon by the Sandia Ranger District. The LHWP will lend support from the VTF where appropriate at the request of the USFS.

B. Stormwater Drainage Improvements in Las Huertas Canyon

USFS and NMDOT representatives have indicated a need for maintenance activities to restore flow in existing culverts and drainage ditches along NM 165 in Las Huertas canyon. The LHWP has offered assistance from the VTF at such time as the NMDOT and USFS undertakes these maintenance projects.

C. Establish TMDL standards for Las Huertas Creek

The EPA/NMED 2004-2006 303(d) Impairment Listings include Las Huertas Creek as being impaired with respect to Sedimentation and Siltation. A TMDL document addressing these parameters is scheduled to be drafted in 2007 (Nelson, 2005). The LHWP plans to lend public outreach assistance and provide additional water quality data to NMED in support of this effort.

D. Lower Las Huertas Road and Stream Improvements

The Albuquerque office of BLM has indicated plans to repair dirt roads washed out by storm events in lower Las Huertas Canyon downstream of the Placitas Open Space (Randall, 2005). LHWP has suggested implementing water harvesting berms on these roads to disperse road runoff into the grasslands adjoining the Creek in this reach. In workshops offered by Bill Zeedyk and the Quivira Coalition, this technique has demonstrated convincing results of reduced road erosion and improved upland vegetation growth. LHWP seeks to support BLM as a partner to implement similar measures on BLM lands of the lower Las Huertas Creek watershed.

LHWP will also seek the partnership of BLM and the City of Albuquerque Open Space Division in pursuing the channel modifications and bank stabilization measures for lower Las Huertas Creek as described in Section 2.2.2, Task 4.

2.6 Proposed Implementation Schedule Table 4 summarizes target implementation dates and management goals for the project tasks summarized in Sections 2.2 and 2.3. Implementation target dates assume initiation of on-the-ground projects in July 2006, and a 3-year schedule.

Table 4. Las Huertas Watershed Proposed Project Implementation			
Project	**Management Goal**	**Success Measures**	**Target Delivery Date/Approx. Cost**
Stormwater Management			
Task 1. Watershed Survey	Ranked listing of all significant sediment sources in watershed	Completed document	January 2007 $10,000.
Task 2. BMP Handbook	Catalog of Best Management Practices for Stormwater control	Use of Handbook by local developers, landowners and land managers; incorporation into County regulations	January 2007 $5,000.
Stormwater/Erosion Control Projects			
Task 1. Restore Culvert Drainages	Measurable reductions in sediment loading in Las Huertas Creek	Measurable improvement in Las Huertas water quality	May 2007 $17,000
Task 2. Upper canyon stream channel improvements	Measurable reductions in sediment loading in Las Huertas Creek	Measurable improvement in Las Huertas water quality	October 2007 $16,000.
Task 3. Vegetation restoration projects	Tree planting along three stream reaches	50% increase in ground cover and 60% seedling survival rate	May 2009 $105,000.
Task 4. Hillslope Stabilization & landowner erosion control	Placement of 200 erosion control structures in upland slope areas	Measurable increase in ground cover and decrease in rill density	May 2009 $100,000.
Task 5. Middle and lower canyon channel improvements	Measurable improvement in stream profile and sediment load reductions	>40% decrease in sediment load measured through monitoring.	September 2008 $65,000.
Task 6. Land ownership survey	Documentation of riparian land ownership along Creek	60% of riparian land owners participating in riparian restoration projects and/or land preservation	December 2006 $2,500.
Monitoring and Assessment	Provide documentation of watershed conditions	Create database of monitoring parameters	March 2009 $27,000.
Outreach and Education	Watershed community informed and educated about the benefits of watershed restoration, and how property owners can assist.	1,000 hours of volunteer time participating in LHWP educational events and projects.	May 2009 $40,000.
Agency Partnering Activities	Provide public outreach and volunteer support to agency initiatives	Agency projects ongoing with active volunteer participation	May 2009 $4,000.

Project Milestones

Projected milestones, including project-specific load reductions where appropriate, are summarized in Table 5.

Table 5. Proposed Project Implementation Milestones

Project	Milestone #1/Date	Milestone #2/Date	Target Delivery / Completion Date
Stormwater Management			
Task 1. Watershed Survey	Field technician hired, trained by September 2006.	Field work completed by October 2006.	January 2007
Task 2. BMP Handbook	BMP research completed by November 2006.		January 2007
Stormwater/Erosion Control Projects			
Task 1. Restore Culvert Drainages	Permits and clearances complete by August 2006.	Work begins September 2006.	May 2007
Task 2. Upper canyon stream channel improvements	Permits and clearances complete by March 2007.	Work begins April 2007.	October 2007
Task 3. Vegetation restoration projects	Year 1 program implemented May 2007.	Year 2 program implemented May 2008.	May 2009
Task 4. Hillslope Stabilization & landowner erosion control	Placement of 70+ erosion control structures by November 2006.	Placement of 140+ erosion control structures by November 2007.	May 2009
Task 5. Middle and lower canyon channel improvements	Reach 1 work completed by September 2007.	>40% decrease in sediment load below Reach 1 by May 2008.	September 2008
Task 6. Land ownership survey	Riparian landowners identified and contacted by October 2006.	Outreach event regarding conservation easements by November 2006.	December 2006
Monitoring and Assessment	Database format created by September 2006.	Database updated quarterly at minimum.	March 2009
Outreach and Education	300 volunteer hours by May 2007	700 volunteer hours by May 2008	May 2009
Agency Partnering Activities	Group involved in Community Fire Protection Plan by May 2007.	Upper canyon drainage restoration by May 2007.	May 2009

2.7 Funding Opportunities

LHWP plans to seek funding from several government and private foundation grant agencies to finance the implementation measures outlined in this WRAS. Different funding agents will be sought for Education/Outreach and Watershed Restoration/Water Quality Improvement. Examples include:

Education and Outreach:

- Environmental Protection Agency Environmental Education Grant Program
- Resources for Community Collaboration

Watershed Restoration/Water Quality Improvement

- U.S. Fish & Wildlife
- U.S. Environmental Protection Agency Section 319 Water Quality Grant Program
- Patagonia, Inc. Environmental Fund

LHWP is ongoingly seeking project funding. Most recently, LHWP applied to the Goldman Fund in May 2005 for support in monitoring and restoration activities.

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APPENDIX A

NEW MEXICO WATER QUALITY CONTROL COMMISSION

WATER QUALITY REGULATIONS FOR

COLD WATER AND HIGH QUALITY COLD WATER AQUATIC LIFE

DESIGNATED USE STANDARDS

20.6.4.111 RIO GRANDE BASIN - Perennial reaches of Las Huertas creek.

A. Designated Uses: high quality coldwater aquatic life, irrigation, livestock watering, wildlife habitat and secondary contact.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 8.8 and temperature 25°C (77°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.111 NMAC - Rp 20 NMAC 6.1.2108.5, 10-12-00; A, 7-25-01; A, 05-23-05]

[**NOTE: The segment covered by this section was divided effective 05-23-05. The standards for the additional segment are under 20.6.4.125 NMAC.**]

20.6.4.900 STANDARDS APPLICABLE TO ATTAINABLE OR DESIGNATED USES UNLESS OTHERWISE SPECIFIED IN 20.6.4.101 THROUGH 20.6.4.899 NMAC.

A. Coldwater Fishery: Dissolved oxygen shall not be less than 6.0 mg/L, temperature shall not exceed 20°C (68°F), and pH shall be within the range of 6.6 to 8.8. The acute and chronic aquatic life standards set out in subsections J and M of this section are applicable to this use. The total ammonia standards set out in Subsection O of this section and the human health standards listed in Subsection M of this section are applicable to this use.

B. Domestic Water Supply: Surface waters of the state designated for use as domestic water supplies shall not contain substances in concentrations that create a lifetime cancer risk of more than one cancer per 100,000 exposed persons. The following numeric standards and those standards listed under domestic water supply in Subsection M of this section shall not be exceeded:

(1) dissolved nitrate (as N)	10.	mg/L
(2) radium-226 + radium-228	5.	pCi/L
(3) strontium-90	8	pCi/L
(4) tritium	20,000	pCi/L
(5) gross alpha (including radium-266, but excluding radon and uranium)	15	pCi/L

C. High Quality Coldwater Fishery: Dissolved oxygen shall not be less than 6.0 mg/L, temperature shall not exceed 20°C (68°F), pH shall be within the range of 6.6 to 8.8, turbidity shall not exceed 10 NTU (25 NTU in certain reaches where natural background prevents attainment of lower turbidity), and conductivity (at 25°C) shall not exceed a limit varying between 300 mmhos/cm and 1,500 mmhos/cm depending on the natural background in particular surface waters of the state (the intent of this standard is to prevent excessive increases in dissolved solids which would result in changes in community structure). The acute and chronic aquatic life standards set out in subsections J and M of this section are applicable to this use. The total ammonia standards set out in Subsection O of this section and the human health standards for pollutants listed in Subsection M of this section are applicable to this use.

APPENDIX B

LAS HUERTAS CREEK WATER QUALITY DATA
EPA STORET DATABASE
MAY 20, 1975

STORET LDC - Detailed Data Report

Organization Code: **21NMEX** Organization Name: **N.MEXICO DEPT HLTH & ENV** Station ID: **HT50** Station Alias:
Station Name: **LAS HUERTAS CR MILE S OF N BDRY** State: **New Mexico** County: **Sandoval** Latitude: **35deg. 16min. 48sec. N** Longitude: **106deg. 24min. 40sec. W** Hydrologic Unit Code (HUC): **13020201** Station Type Indicator Description: **Surface Water** Legacy STORET Station Type: **/TYPA/AMBNT/STREAM**

Start Date: **05-20-1975** Start Time: **1140** End Date: End Time: **0** Sample Depth: **feet** Effluent Monitoring Code: UMK:
Replicate Number: Composite Method Code: Pipe ID: Composite/Grab Number: Primary/Secondary Activity Category:
Composite Statistic Code
Parameter Code
Parameter Long Name Result Value
Remark Code
00010 TEMPERATURE, WATER (DEGREES CENTIGRADE) 7.50 D 00060 FLOW, STREAM, MEAN DAILY CFS 28.40 D 00095 SPECIFIC CONDUCTANCE (UMHOS/CM @ 25C) 550.00 D 00610 NITROGEN, AMMONIA, TOTAL (MG/L AS N) 0.045 D 00620 NITRATE NITROGEN, TOTAL (MG/L AS N) 0.30 D 00665 PHOSPHORUS, TOTAL (MG/L AS P) 0.02 K D

Date Created: Sep 24, 2003

STORET LDC - Detailed Data Report

Organization Code: **21NMEX** Organization Name: **N.MEXICO DEPT HLTH & ENV** Station ID: **HT60**
Station Alias: Station Name: **LAS HUERTAS CR N OF COOPER RANCH** State: **New Mexico** County:
Sandoval Latitude: **35deg. 14min. 5sec. N** Longitude: **106deg. 24min. 43sec. W** Hydrologic Unit Code (HUC):
13020201 Station Type Indicator Description: **Surface Water** Legacy STORET Station Type:
/TYPA/AMBNT/STREAM

Start Date: **05-20-1975** Start Time: **1045** End Date: End Time: **0** Sample Depth: **feet** Effluent Monitoring Code:
UMK: Replicate Number: Composite Method Code: Pipe ID: Composite/Grab Number: Primary/Secondary Activity
Category: Composite Statistic Code
Parameter Code
Parameter Long Name Result Value
Remark Code
00010 TEMPERATURE, WATER (DEGREES CENTIGRADE) 7.50 D 00060 FLOW, STREAM, MEAN DAILY CFS 48.00 D 00095 SPECIFIC CONDUCTANCE (UMHOS/CM @ 25C) 600.00 D 00610 NITROGEN, AMMONIA, TOTAL (MG/L AS N) 0.038 D 00620 NITRATE NITROGEN, TOTAL (MG/L AS N) 0.408 D 00665 PHOSPHORUS, TOTAL (MG/L AS P) 0.02 D

Date Created: Sep 24, 2003

APPENDIX C

LAS HUERTAS CREEK WATER QUALITY DATA

BOSQUE PREPARATORY SCHOOL MONITORING PROGRAM

Las Huertas Watershed data
Bosque School, contact: Dan Shaw
site: Beanfield on west side of creek in Cibola National Forest

date	9/26/95	10/27/95	11/10/95	12/14/95	1/12/96	2/9/96	3/8/96	4/5/96	5/3/96	6/9/96	7/15/96
streamflow in CFS	0.80	0.60	1.00	0.50	1.10	0.50	0.30	0.20	0.20	0.10	0.60
pH	8.5	8.7	7.6	7.7	7.5	7.7	8.1	8.3	8.2	8.2	8.6
water temp in °C.	11	8	12	4	0	1	2	9	14	14	13
TDS	140	130	170	150	150	160	130	160	140	140	160
Turbidity in NTU	1.99	1.02	0.70	0.60	0.30	0.60	1.30	4.34	1.42	1.60	1.15
Nitrate in mg/l	0.20	n/a	0.10	0.10	3.10	1.10	1.70	0.30	<0.1		0.10
Ammonia in mg/l	0.01	n/a	0.00	0.00							0.00
Total Phosphorus in mg/l	0.02	n/a	0.01			0.90	0.19	1.12	0.12	0.07	0.07
Copper in mg/l						0.0100	0.0600		0.1600	0.0700	0.0100
Zinc in mg/l	0.02			0.02							
air temp (dry bulb) °C.										26.0	21.0
relative humidity in %			85	41	15	21	40	54		18	68
wind speed gusts to in kph											
wind speed sustained in kph											2.0
wind direction										ne	ne
current precipitation	none										none
cloud cover %											
cloud cover type											
collector code	7D	7D	7D	7D	7D	7D	7D	7D	7D		
teacher	Shaw	Shaw	Shaw	Shaw	Shaw	Shaw	Shaw	Shaw	Shaw	Shaw	Shaw

Las Huertas Watershed data
Bosque School, contact: Dan Shaw
site: Beanfield on west side of creek in Cibola National Forest

date	10/15/97	11/10/97	12/15/97	2/11/98	3/2/98	4/8/98	5/6/98	6/9/98	7/20/98	8/13/98	9/14/98	10/14/98
streamflow in CFS	0.60	3.50	3.20	1.00	4.30	1.90	30.10	9.80	2.80	2.50	1.40	1.00
pH	8.1	8.0	8.0	8.0	7.9	8.5	8.0	8.0	8.0	8.0	8.0	8.0
water temp in °C.	7	3	1	0	0	3	8	9	12	14	11	13
TDS	160	180	150		190	170	144	130	150	150	140	150
Turbidity in NTU	1.49	2.78	5.04	2.00	7.33	4.36	15.50	2.55	1.84	1.84		3.00
Nitrate in mg/l	0.00		0.20		0.01	0.20	0.30	0.10	0.10	1.00	0.00	0.30
Ammonia in mg/l			0.04		0.40	0.27	0.00	0.01	0.01	0.01		0.00
Total Phosphorus in mg/l		0.56	0.17	0.13	0.07		5.36	2.69	5.32	0.50		0.01
Copper in mg/l	0.0900	0.0600	0.0500	0.2000	2.5100	0.0100	0.0800	0.0500	0.0800	0.0400	1.5000	0.1100
Zinc in mg/l												
air temp (dry bulb) °C.	13.0	-1.0	7.0	3.0	2.0	18.0	11.0	21.0	18.0	21.0	21.0	21.0
relative humidity in %												
wind speed gusts to in kph			0.0	0.0				10.0	2.0	2.0	2.0	10.0
wind speed sustained in kph	2.0	0.0	0.0	12.0	2.0	5.0	2.0	6.0	2.0	2.0	3.0	2.0
wind direction	ne	none	none	sse	n	n	s	s	s	ssw	SE	sw
current precipitation	none	snow	none	none	none	none	none	none	none	none	none	none
cloud cover %	0	100	none	none	63	55	0		5	25	95	63
cloud cover type	none	nimbus	none	none	cirrus	cumulus	none		cumulus	cumulus		cumulus and stratus
collector code	7E	7F	7F	7K	7L	7E	7K				7E	7E
teacher	Shaw	Ruhl	Ruhl	Shaw	Ruhl	Shaw	Shaw	Shaw	Shaw	Shaw	Shaw	Shaw

Las Huertas Watershed data
Bosque School, contact: Dan Shaw
site: Beanfield on west side of creek in Cibola National Forest

date	11/12/98	12/4/98	1/1/99	2/10/99	3/4/99	4/9/99	5/10/99	6/14/99	7/16/99	8/11/99	9/8/99	10/25/99
streamflow in CFS	0.80	1.00	0.70	0.40	0.90	1.90	4.20	1.60	0.80	7.60	1.20	6.80
pH	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
water temp in °C.	4	1	1	3	3	4	6	9	12	13	13	10
TDS			162	130	165	174		171	133		166	147
Turbidity in NTU	6.00	2.00	0.30	2.40		3.05	6.00	1.90	1.80	5.50		6.54
Nitrate in mg/l	0.10	0.30	0.08	1.60	0.04	0.10		0.20	0.10	0.20	0.40	0.10
Ammonia in mg/l			0.06	0.42	0.03		0.05	0.04	0.04			
Total Phosphorus in mg/l			0.05	5.88			0.79	0.17	0.20	0.07		1.30
Copper in mg/l		0.2000		0.1700	0.0800	0.0900	0.1000	0.0700	0.0900	0.0300	0.0400	0.0500
Zinc in mg/l												
air temp (dry bulb) °C.	11.0	12.0	9.0		11.0	14.0	14.0	19.0	18.0	18.0	20.0	12.5
relative humidity in %												
wind speed gusts to in kph	9.0	8.0	8.0		30.0	6.0	9.0	8.0	<2	8.0	21.0	4.0
wind speed sustained in kph	5.0	0.0	3.0		8.0	10.0	3.0	<2	<2	4.0	14.0	5.0
wind direction	nw	nne	n	.	s	sw	s	ne	sw	n	W	n
current precipitation	none	none	none	none	none	none	none	none	none	light rain	none	none
cloud cover %			40	50		82	0	0	0	75	25	5
cloud cover type			cumulus							cumulus		
collector code	7F	7G	7D	7E	7F	7G	7D				7F	7E
teacher	McCormick	McCormick	Shaw	Shaw	McCormick	McCormick	Shaw	Shaw	Shaw	Shaw	McCormick	Shaw

Las Huertas Watershed data
Bosque School, contact: Dan Shaw
site: Beanfield on west side of creek in Cibola National Forest

date	11/3/99	12/2/99	1/10/00	2/9/00	3/9/00	4/3/00	5/5/00	6/2/00	7/10/00	8/ /2000	9/6/00	10/11/00	11/1/00
streamflow in CFS	1.50	6.70	0.50	1.10	1.01	0.50	2.50	0.70	0.40	0.20	0.38	0.12	1.19
pH	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
water temp in °C.	5	15	3	5	3	3	9	11	11	11	17	4	4
TDS	190	198	196	179	185	183	170	201	196	177	166	150	197
Turbidity in NTU	3.70	2.60	1.10	5.90	1.80	1.70	2.10	1.80	5.40	1.80	6.10	3.40	4.60
Nitrate in mg/l	0.20	0.69	0.20	0.10	0.40	0.10	0.10	0.20	0.20	0.30	0.40	0.30	0.56
Ammonia in mg/l	0.03		0.07		0.06	0.03	0.05	0.02	0.03	0.01	0.02	0.02	0.05
Total Phosphorus in mg/l	0.10	0.90	8.01			0.45		0.87	0.07	0.07	0.82	0.50	1.74
Copper in mg/l	0.0300	0.8000	0.2200	0.2300	0.3300	0.0000	0.1200	0.0700	0.1400	0.0400	0.1200	0.0120	0.0350
Zinc in mg/l								18	15	19	29	15	7
air temp (dry bulb) °C.	8.0	3.5	6.0	12.0	8.6	7.0	23.0						
relative humidity in %					24	29	22	40	57	58	26	56	29
wind speed gusts to in kph	6.0	16.0	13.0	7.7	35.3	7.3	15.0	14.0	0.0	2.0	12.0	8.0	4.0
wind speed sustained in kph	2.0	8.0	11.0	3.7	25.1	16.0	9.0	5.0	0.0	2.0	6.0	16.0	13.0
wind direction	w	sw	sw	n	e	se	W	sw	sw	w	none	Nw	Nw
current precipitation	none	none	none	none	none	none	none	none	none	none	none	none	none
cloud cover %	20	21	0	34	75	17.5	0	0	20	25	58	40	15
cloud cover type													
collector code	7F	7G	7E	7F	7G	7E	7G	none	none	none	7d	7d	7d
teacher	McCormick	McCormick	Shaw	McCormick	McCormick	Shaw	McCormick	Shaw	Shaw	Shaw	McC	McC	McC

Las Huertas Watershed data
Bosque School, contact: Dan Shaw
site: Beanfield on west side of creek in Cibola National Forest

date	12/14/00	1/8/01	2/9/01	3/3/01	4/2/01	5/3/01	6/19/01	7/15/01	8/25/01	9/25/01	10/3/01
streamflow in CFS	0.88	14.26	1.10	0.75	1.82	22.07	1.10	0.84	0.82	0.78	0.66
pH	8.0	8.0	8.0	8.0	8.0	8.0	8.0		8.0	8.0	8.0
water temp in °C.	1	1	5	4	2	9			13	14	11
TDS	182	130	179	63	119	145	145	150	144	166	158
Turbidity in NTU	5.10	5.40	5.90	7.30	9.00	5.50	9.00	10.20	4.30	7.50	3.30
Nitrate in mg/l	0.42	0.02	0.30	0.35	0.30	0.35		0.30	0.40	0.60	0.50
Ammonia in mg/l	0.04	0.02	0.00	0.02	0.09	0.06			0.03	0.05	0.02
Total Phosphorus in mg/l	1.20	2.08	0.23	0.38	0.90	0.60			0.11	0.08	0.15
Copper in mg/l	0.2000	0.0650	0.1770	0.0540	0.0500	0.0175			0.0100	0.0180	0.0500
Zinc in mg/l		6	12	5	15	15					
air temp (dry bulb) °C.							22.5		22.0	25.5	21.0
relative humidity in %	36	37		68	35	27	23		16	20	25
wind speed gusts to in kph	3.0	3.0	8.0	4.0	5.0	6.0	1.6		5.8	3.9	3.3
wind speed sustained in kph	3.0	2.0	4.0	2.0	2.0	3.0	0.8		3.2	1.7	1.4
wind direction	Nw	Sw	n	e	s	sw			sw	s	nw
current precipitation	none	none	none	none	none	none	s	n	none	none	none
cloud cover %	5	8	34	100	97	10	none		0	10	15
cloud cover type							0	10			
collector code	7d	7b	7F	7a	7b	7D			7B	7B	7C
teacher	McC	McC	McC	McC	McC	McC	Shaw	Shaw	McC	McC	McC

Las Huertas Watershed data
Bosque School, contact: Dan Shaw
site: Beanfield on west side of creek in Cibola National Forest

date	11/14/01	12/15/01	1/17/02	2/6/02	3/4/02	4/11/02	5/2/02
streamflow in CFS	0.48	0.43	0.61	0.47	0.51	0.61	0.28
pH	8.0	8.0	8.0	8.0	8.0	8.0	8.0
water temp in °C.	5	2	3	1	5	13	8
TDS	169	160	171	177	165	98	153
Turbidity in NTU	4.66	3.85	3.70	5.40	4.80	8.30	5.36
Nitrate in mg/l	0.30	0.25	0.30	0.10	0.15	0.20	0.05
Ammonia in mg/l	0.04	0.10	0.50	0.05	0.12	0.32	0.15
Total Phosphorus in mg/l	0.09		0.02	0.04		0.08	0.06
Copper in mg/l	0.0033	0.0182	0.0007	0.0039	0.0020	0.0064	0.0044
Zinc in mg/l							
air temp (dry bulb) °C.	7.0	5.5	3.3	1.6	8.2	20.0	15.3
relative humidity in %	35	23	40	21	15	14	13
wind speed gusts to in kph	15.0	7.2	9.0	7.0	7.1	17.0	18.2
wind speed sustained in kph	2.0	1.1	2.0	1.8	2.0	4.0	5.7
wind direction	nw	s	nw	nw	s	se	sw
current precipitation	drizzle	none	none	none	none	none	none
cloud cover %	0	12	0	0	5	9	80
cloud cover type							
collector code	7C		7B	7C	7B	7D	7C
teacher	McC	McC	McC	McC	McC	McC	McC

APPENDIX D

SELECTED WATER QUALITY DATA

LOWER LAS HUERTAS AREA SPRINGS

From Johnson (2000)

Appendix F. General chemistry of ground- and surface-water samples. Page 1 of 6.

Site ID	Sample Date	Ca^{2+} ppm	Mg^{2+} ppm	Na^{+} ppm	K^{+} ppm	HCO_3^{-} ppm	CO_3^{2-} ppm	Cl^{-} ppm	SO_4^{2-} ppm	NO_3^{-} ppm	SiO_2 ppm
PS-01	4/26/96	88	6.1	5	1	270	0	11	16	2	12
PS-02	4/26/96	83	5.5	4	0.85	260	0	13	13	1.4	12
PS-03	4/26/96	88	5.9	5	0.9	260	0	17	19	1.8	11
PS-03	4/26/96	87	5.9	5.1	0.85	260	0	17	21	1.5	11
PS-04	4/26/96	96	7	7.5	0.75	270	0	23	27	2	11
PS-05	5/28/96	96	5.6	3.3	0.77	280	0	12	21	1.4	10
PS-05#	6/18/96	106	5.66	3.5	0.9	326		2.22	19.5	0.33	10.6
PS-05#	6/18/96	108	5.68	3.5	0.9	325		2.22	19.5	0.33	10.7
PS-06	5/29/96	76	8.4	8.6	1.3	242	0	7	29	0	13
PS-07	5/30/96	58	8.4	32	1.8	260	0	7.6	32	1.1	13
PS-08	5/30/96	75	9	19	0.67	246	0	16	38	2.8	13
PS-09	5/15/98	85	6.2	3.1	0.6	278		2.4	18	1.1	15
PS-10	7/17/97	82	9.6	40	2.8	332		14	41	1.2	15
PS-11	7/23/97	77	11	32	2.2	318		12	34	0.9	14
PS-17	9/10/97	73	9	32	1.9	300		7.6	32	0.96	16
PS-19	2/13/98	200	46	110	1.8	340		55	585	1	21
PSW-01	3/11/97	121	28	45	5.1	237		43	252	0	15
PSW-02	5/6/97	53	5.4	4	0.7	175		2	20	0	12
PSW-03	9/ 1/97	70	5	7	0.72	228		13	10	1.2	11
PSW-04	9/13/97	91	8.1	13	0.8	290		21	27	0	14
PSW-05	9/13/97	37	8.2	20	1	137		22	30	0.2	16
PSW-06	1/ 1/98	70	17	50	2.4	335		12	70	0.51	15
PSW-07	1/ 1/98	92	10	21	0.9	315		18	38	0.72	12
PW-001	4/26/96	150	39	30	2	400	0	25	220	0.8	27
PW-002	5/28/96	85	17	12	3.8	280	0	15.5	46	0	14
PW-003	5/28/96	75	6.8	6.8	0.93	220	0	19	16	3.6	10.7

Data sources are (*) analyses conducted at the request of the owner by independent labs, (#) the US Geological Survey (N. Plummer, unpubl., 1997), (+) US dept. Health and Human Services, OEH&E, Indian Health Service, unmarked samples collected by the New Mexico Bureau of Mines and Mineral Resources for this study.

Appendix G. Stable isotope and field parameters. Page 1 of 6.

Site ID	Sample Date	δ^2H °/oo	$\delta^{18}O$ °/oo	Temp °C (field)	DO ppm (field)	pH (field)	Sp. Cond µS/cm @ 25°C (field)	pH (lab)	Cond µS/cm (lab)	TDS ppm	Hardness ppm
PS-01	4/26/96	-95	-11.9					7.3	420	276	245
PS-02	4/26/96	-89	-12.0					7.3	400	263	230
PS-03	4/26/96	-92	-12.1					7.3	430	279	244
PS-03	4/26/96							7.3	420	280	242
PS-04	4/26/96	-90	-12.1					7.5	460	310	269
PS-05	5/28/96	-93	-12.1					7.41	430	291	263
PS-05#	6/18/96			12.9	6.20	7.5	381				
PS-05#	6/18/96			12.9	5.20	7.4	407				
PS-06	5/29/96	-80	-11.3					7.4	400	264	224
PS-07	5/30/96	-93	-11.9					8.26	450	285	179
PS-08	5/30/96	-95	-12.1	17.3		8.1		8.06	500	297	224
PS-09	5/15/98	-93	-12.2	16.7	5.17	7.79	417			260	238
PS-10	5/ 1/98	-90	-11.8	23.4	2.45	7.2	582				
PS-11	7/23/97	-90	-11.8	21.1	1.8	7.2	559		440	330	238
PS-17	9/10/97	-90	-11.5		2.83	7.17	559			320	219
PS-19	2/13/98	-83	-11.7	13.2	5.43	6.92	1740	6.9	1740	1170	689
PSW-01	3/11/97	-92	-11.5					8.0	800	630	417
PSW-02	5/6/97	-87	-11.8					7.9	270	170	155
PSW-03	9/ 1/97	-93	-11.7	13.9	6.13	8.43	419		350	230	195
PSW-04	9/13/97	-90	-12.0	20.9	4.66	7.93	560			310	261
PSW-05	9/13/97	-83	-10.4	28.8	5.56	8.58	352			190	126
PSW-06	1/ 1/98	-89	-11.7	2.6	8.55	8.32	696	7.7	620	410	245
PSW-07	1/ 1/98	-93	-12.1	10.2	5.40	7.35	607	7.3	550	340	271
PW-001	4/26/96	-90	-11.3					7.1	990	695	535
PW-002	5/28/96	-89	-11.9					7.16	550	334	282
PW-003	5/28/96	-93	-11.8					7.34	410	249	215

Data sources are (*) analyses conducted at the request of the owner by independent labs, (#) the US Geological Survey (N. Plummer, unpubl., 1997), (+) US dept. Health and Human Services, OEH&E, Indian Health Service, unmarked samples collected by the New Mexico Bureau of Mines and Mineral Resources for this study.

Appendix H. Trace constituents. Page 1 of 6.

Site ID	Sample Date	As ppb	Cu ppb	F ppm	Fe ppm	Mn ppb	Zn ppb	Al ppm	Ba ppb	Be ppb	Cd ppb	Cr ppb	Co ppb	Pb ppb	Mo ppb	Ni ppb	Se ppb	Ag ppb
PS-01	4/26/96	0	0	0.3	0.022	0	0	0	0	0	0	0		0	0	0	0	0
PS-02	4/26/96	0	0	0.3	0.015	0	0	0	0	0	0	0	15	0	0	0	0	0
PS-03	4/26/96	0	0	0.3	0.026	0	0	0	0	0	0	0		0	0	0	0	0
PS-03	4/26/96	0	0	0.3	0.02	0	0	0	0	0	0	0		0	0	0	0	0
PS-04	4/26/96	0	0	0.35	0.023	0	0	0	0	0	0				0	0	0	0
PS-05	5/28/96	0	0	0.45	0	0	0	0			0	0	0	0	0	0	0	0
PS-05#	6/18/96	0	0	0.41	0.051	6		0.004	215			0		1.7	0			
PS-05#	6/18/96	0	4	0.41	0.06	7		0.004	219			0		1.7	0			
PS-06	5/29/96	0	0	0	0.004	0	0	0			0	0	0	0	0	0	0	0
PS-07	5/30/96	0	0	0.82	0.019	0	0	0			0	0	0	0	0	0	0	0
PS-08	5/30/96	0	1	0.33	0.008	0	0	0			0	0	0	0	0	0	0	0
PS-09	5/15/98	12	7	0.4	0.083	240	0											
PS-10	7/17/87	0	1.6	1	0	0	0											
PS-11	7/23/97	0	3	0.8	0	7	90											
PS-17	9/10/97	3.5	0	0.65	0.102		0											
PS-19	2/13/98	0	0	0.36	0.049	9	0											
PSW-01	3/11/97	0	0	0.25	0.066	9.9	0									0		
PSW-02	5/6/97	0	0	0.32	0	0	0							0				
PSW-03	9/ 1/97	0	4.2	0.3	0	9	0											
PSW-04	9/13/97	0	0	0.32	0.018	17	0											
PSW-05	9/13/97	0	3.6	0.38	0.05	3.3	0											
PSW-06	1/ 1/98	0	0	0.9	0.057	62	0											
PSW-07	1/ 1/98	0	0	0.34	0.1	54	0											
PW-001	4/26/96	0	0	1.00	0.029	0	120	0	0	0	0	0		0	0	0	0	0
PW-002	5/28/96	0	0	0.65	2.8	68	200	0			0	0	0	0	0	0	0	0
PW-003	5/28/96	0	0	0.39	0.003	0	0	0			0	0	0	0	0	0	0	0

Data sources are (*) analyses conducted at the request of the owner by independent labs, (#) the US Geological Survey (N. Plummer, unpubl., 1997), (+) US dept. Health and Human Services, OEH&E, Indian Health Service, unmarked samples collected by the New Mexico Bureau of Mines and Mineral Resources for this study.

APPENDIX E

TARGET LAS HUERTAS WATER QUALITY PARAMETERS

NMED MIDDLE RIO GRANDE WATER QUALITY STUDY

Las Huertas Watershed Project
Water Quality Parameters - NMED Middle Rio Grande Study

Location	Analyte	Frequency / Dates	EPA / NMED TMDL for MRG	Geomorph and other targets
Upper Canyon	Temperature	Quarterly		3-month plus thermographs (water and air)
	Dissolved Oxygen	Quarterly		Pebble counts
	pH	Quarterly		width/depth ratio
	Conductivity	Quarterly		Flow/discharge
	Turbidity	Quarterly		Riparian habitat
	Common Ions	Quarterly		Fish sampling
	Nutrients	Quarterly		Macroinvertebrates
	Total heavy metals	Quarterly		periphyton
	Dissolved heavy metals	Quarterly		
	Fecal Coliform	Quarterly	X	
	E. Coli bacteria	Quarterly		
	Organics	1		
	Radionuclides	1		
Lower Reach	Same as Above	Monthly (March - October 2005)		
	Organics	1		
	Radionuclides	1		

APPENDIX F

LAS HUERTAS WATERSHED PROJECT

LAS HUERTAS CREEK SUPPLEMENTARY

WATER QUALITY SAMPLING PLAN

Las Huertas Watershed Project
Las Huertas Creek Water Quality Sampling Plan
May 17, 2005

The Las Huertas Watershed Project (LHWP), operating under an EPA Clean Water Act Section 319 Grant, is conducting a limited volunteer-based water quality monitoring effort. These activities are meant to supplement the New Mexico Environment Department (NMED) water quality monitoring activites currently being conducted as part of its Middle Rio Grande Water Quality Study.

Analytes

NMED has provided selected field water quality parameters analytical equipment on a temporary loan basis to the LHWP. This equipment includes 1). A Hach Model 2100P Turbidimeter; 2). A Yellow Springs Instrument Co. (YSI) Model 57 Dissolved Oxygen Meter; and 3). A YSI Model 33 S-C-T (Salinity, Conductivity, Temperature) Meter. LHWP will acquire pH test paper to allow for approximate gauging of pH. LHWP's supplementary sampling program will be limited to these analytes.

Location

LHWP plans to target the two sampling locations currently under use by NMED in its sampling program. These two locations coincide with the two primary perennial flow reaches of Las Huertas Creek. The first location is where Tres Amigo Road crosses the Creek, and the second is within Las Huertas Canyon near the parking lot for Sandia Man Cave. Additional locations may be sampled opportunistically for additional data coverage.

Schedule

LHWP plans to collect samples and conduct analyses on a quarterly basis at a minimum during May, July, October and January. Additional sampling and analyses may be performed opportunistically and with particular attention to runoff events. LHWP plans to continue these monitoring activities until May 2006 at a minimum.

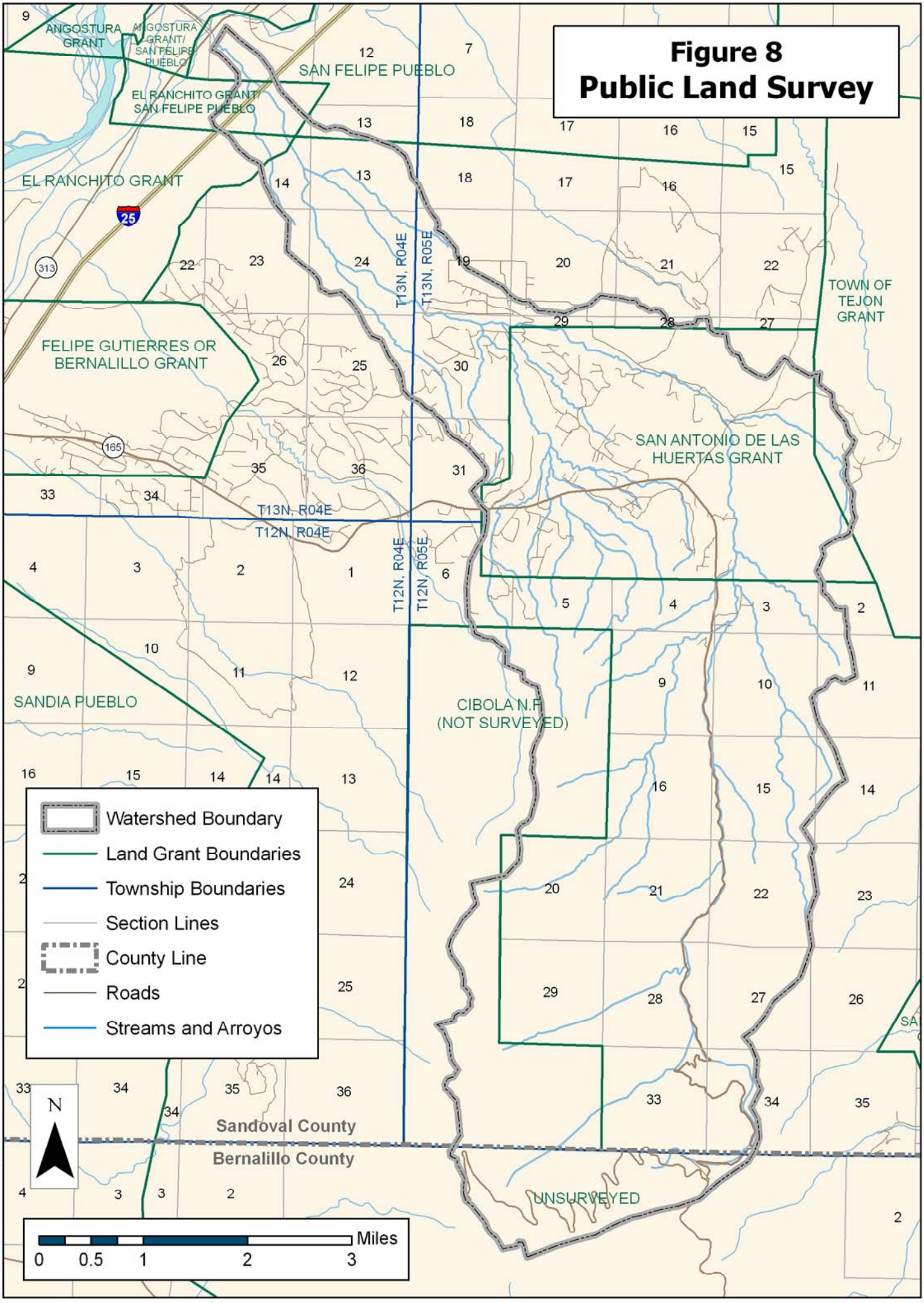
Quality Assurance

LHWP has received training from NMED on the use of the loaner water quality testing equipment. Although LHWP volunteers and contractors are not certified under NMED's general Quality Assurance Plan governing the MRG Study, LHWP will make every effort to ensure that

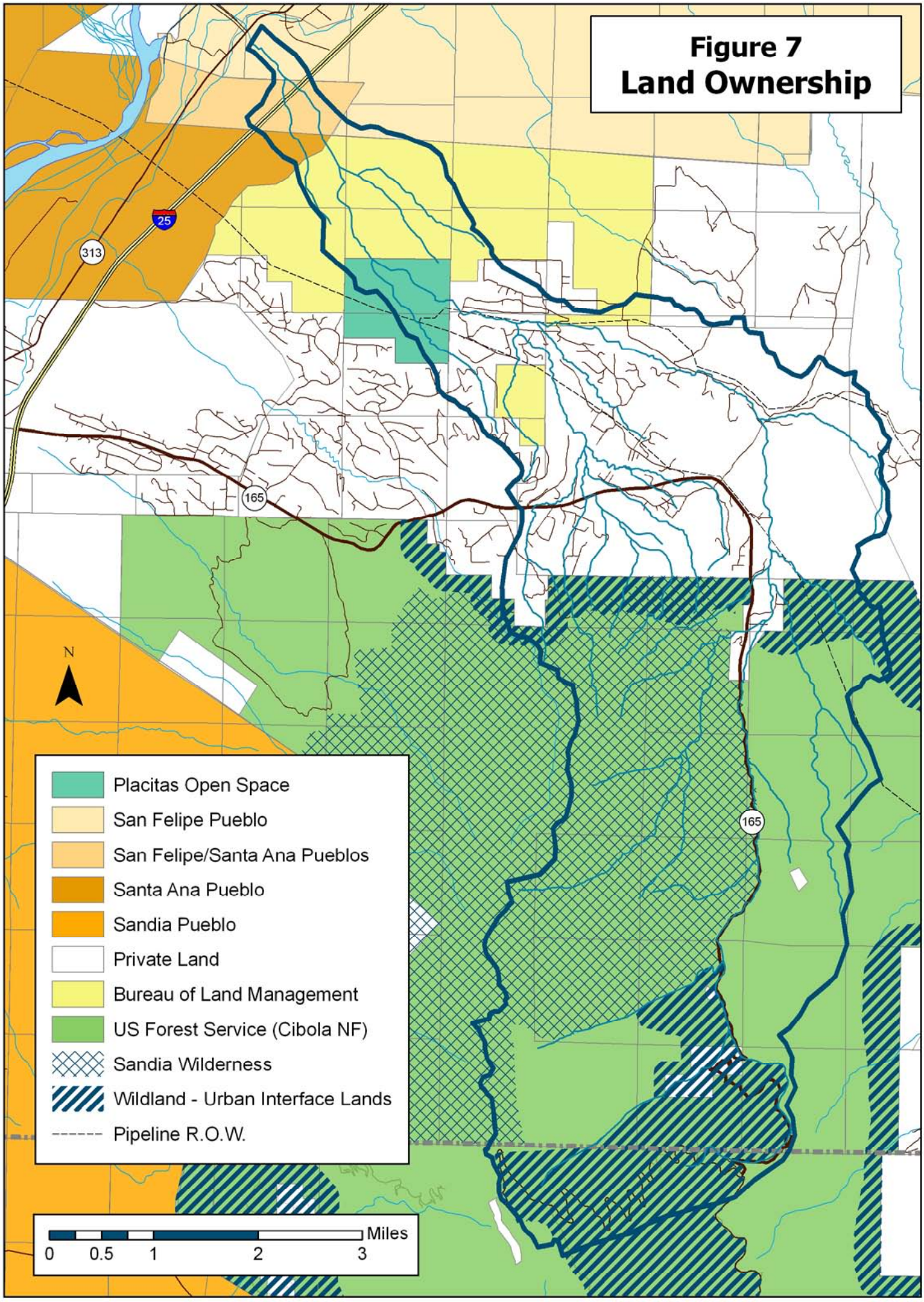
protocols presented in the NMED training and as presented in equipment operating instructions (provided with the equipment) will be followed.

Reporting

LHWP will provide data to NMED with each quarterly report for the 319 Grant project. LHWP will provide data to NMED at any time upon request.

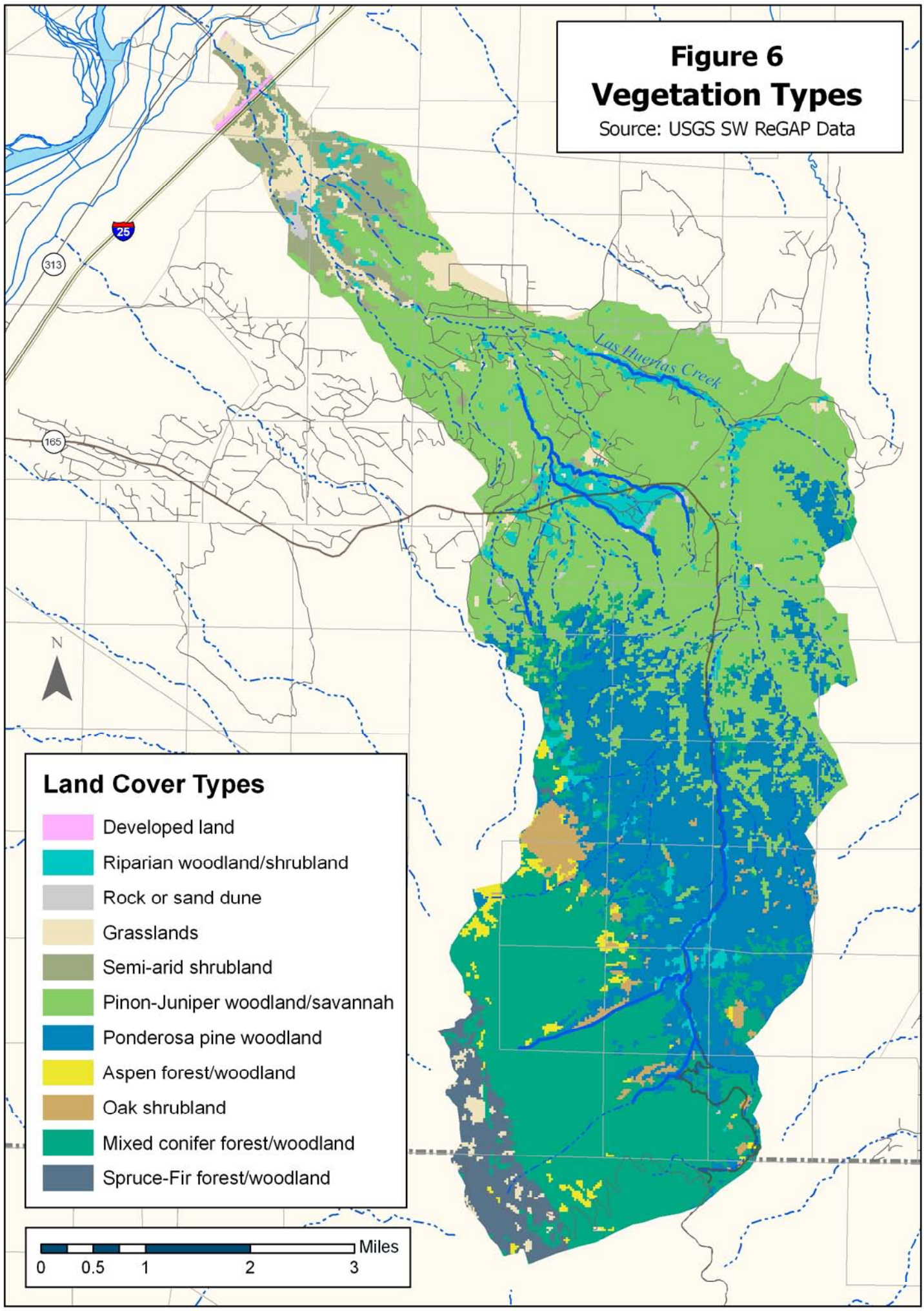


Map by Kristin Willette for Las Placitas Association, June 22, 2005. Map projection and datum: UTM Z13N, NAD83. Primary data source: RGIS, BLM 2003 statewide dataset. See metadata for details.



Map by Kristin Willette for Las Placitas Association, June 22, 2005. Map projection and datum: UTM Z13N, NAD83. Data sources: RGIS (BLM data), Sandoval County (Indian lands), Albq Open Space program, USFS WUI program.

Figure 6
Vegetation Types
Source: USGS SW ReGAP Data



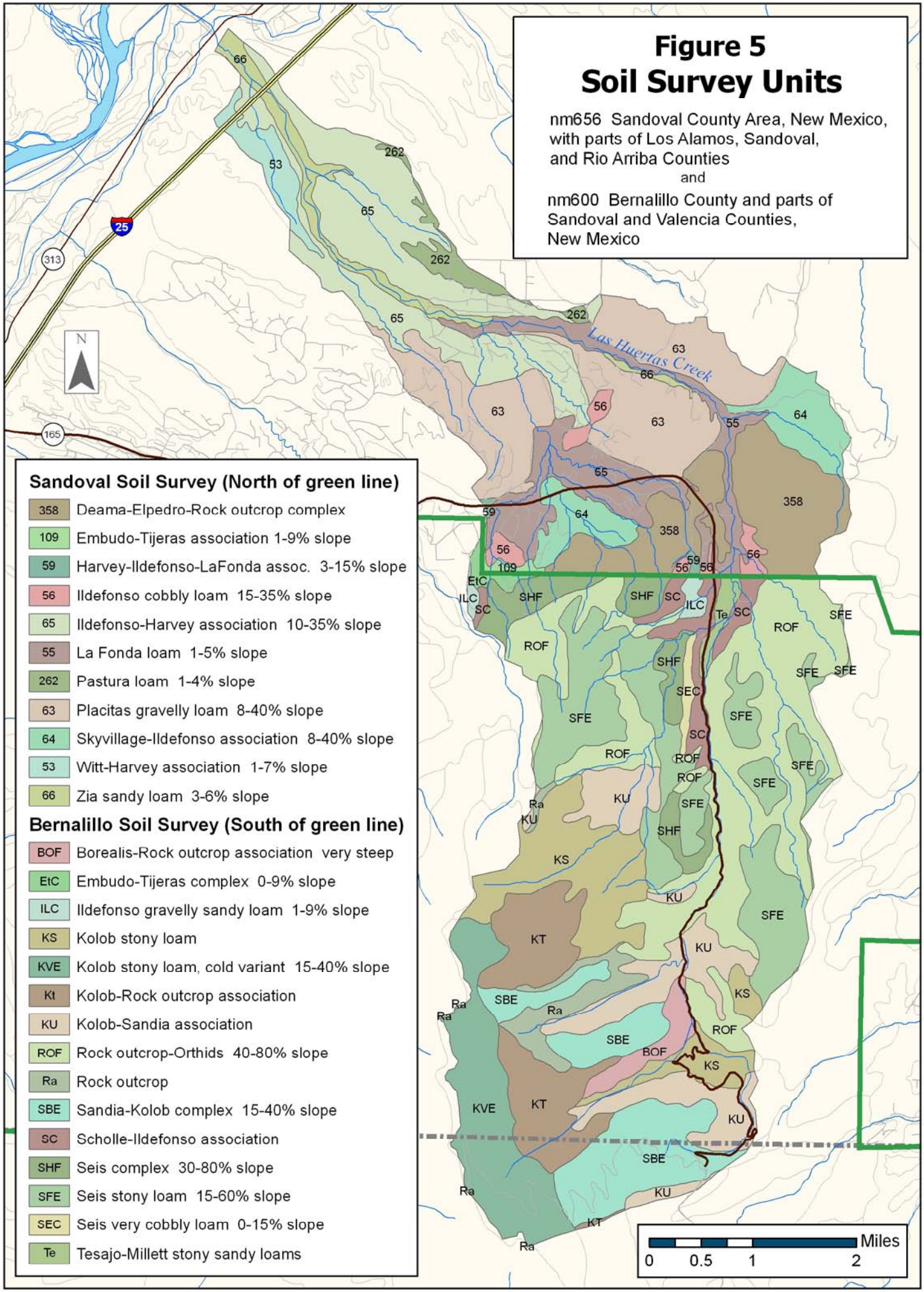
Map by Kristin Willette for Las Placitas Association, June 22, 2005. Map projection and datum: UTM Z13N, NAD83.
Primary data source: USGS 2004 'Provisional' SW ReGAP dataset, derived from 30 meter resolution satellite data. See metadata for details.

Figure 5
Soil Survey Units

nm656 Sandoval County Area, New Mexico, with parts of Los Alamos, Sandoval, and Rio Arriba Counties

and

nm600 Bernalillo County and parts of Sandoval and Valencia Counties, New Mexico



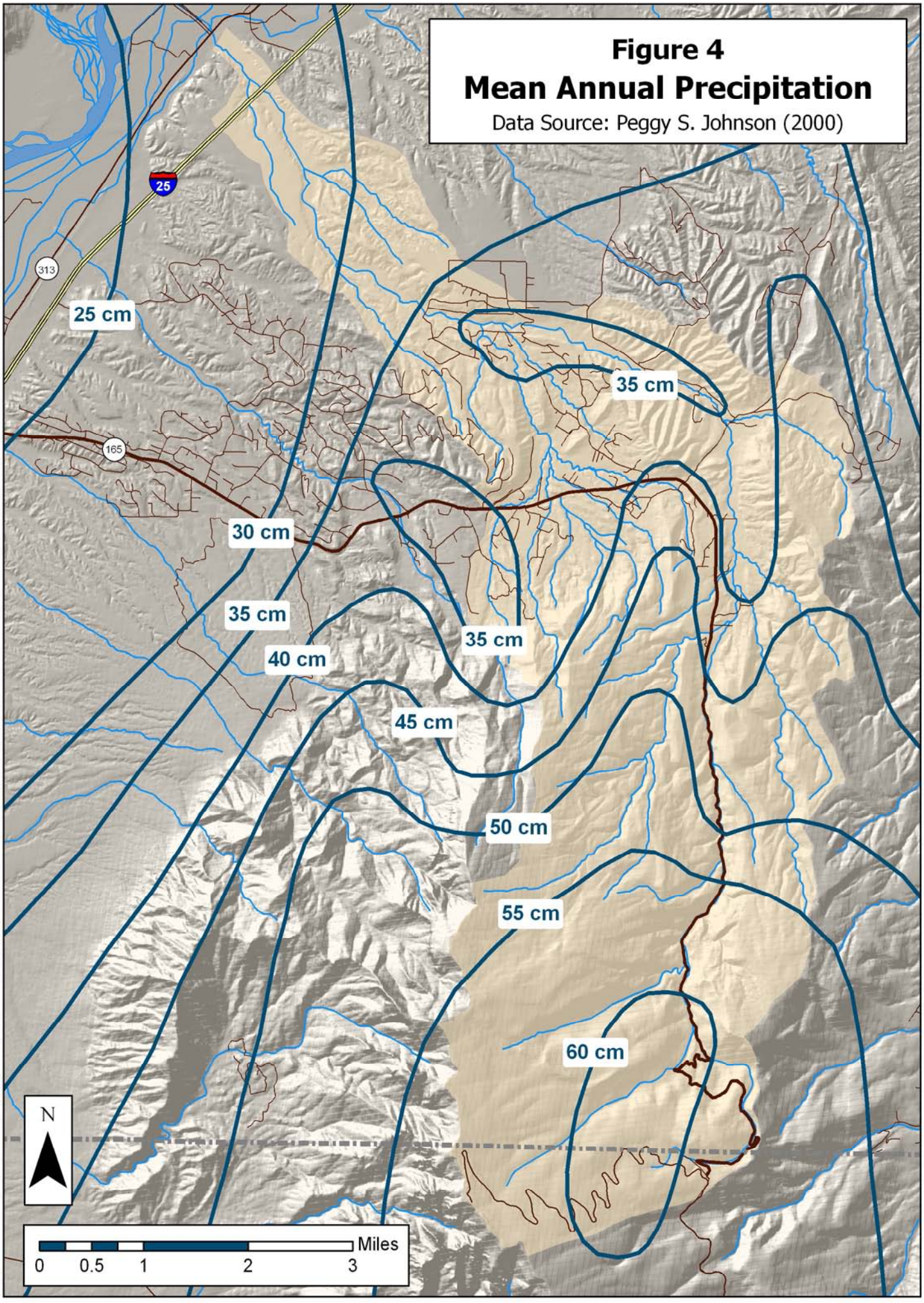
Sandoval Soil Survey (North of green line)

- 358 Deama-Elpedro-Rock outcrop complex
- 109 Embudo-Tijeras association 1-9% slope
- 59 Harvey-Ildefonso-LaFonda assoc. 3-15% slope
- 56 Ildefonso cobbly loam 15-35% slope
- 65 Ildefonso-Harvey association 10-35% slope
- 55 La Fonda loam 1-5% slope
- 262 Pastura loam 1-4% slope
- 63 Placitas gravelly loam 8-40% slope
- 64 Skyvillage-Ildefonso association 8-40% slope
- 53 Witt-Harvey association 1-7% slope
- 66 Zia sandy loam 3-6% slope

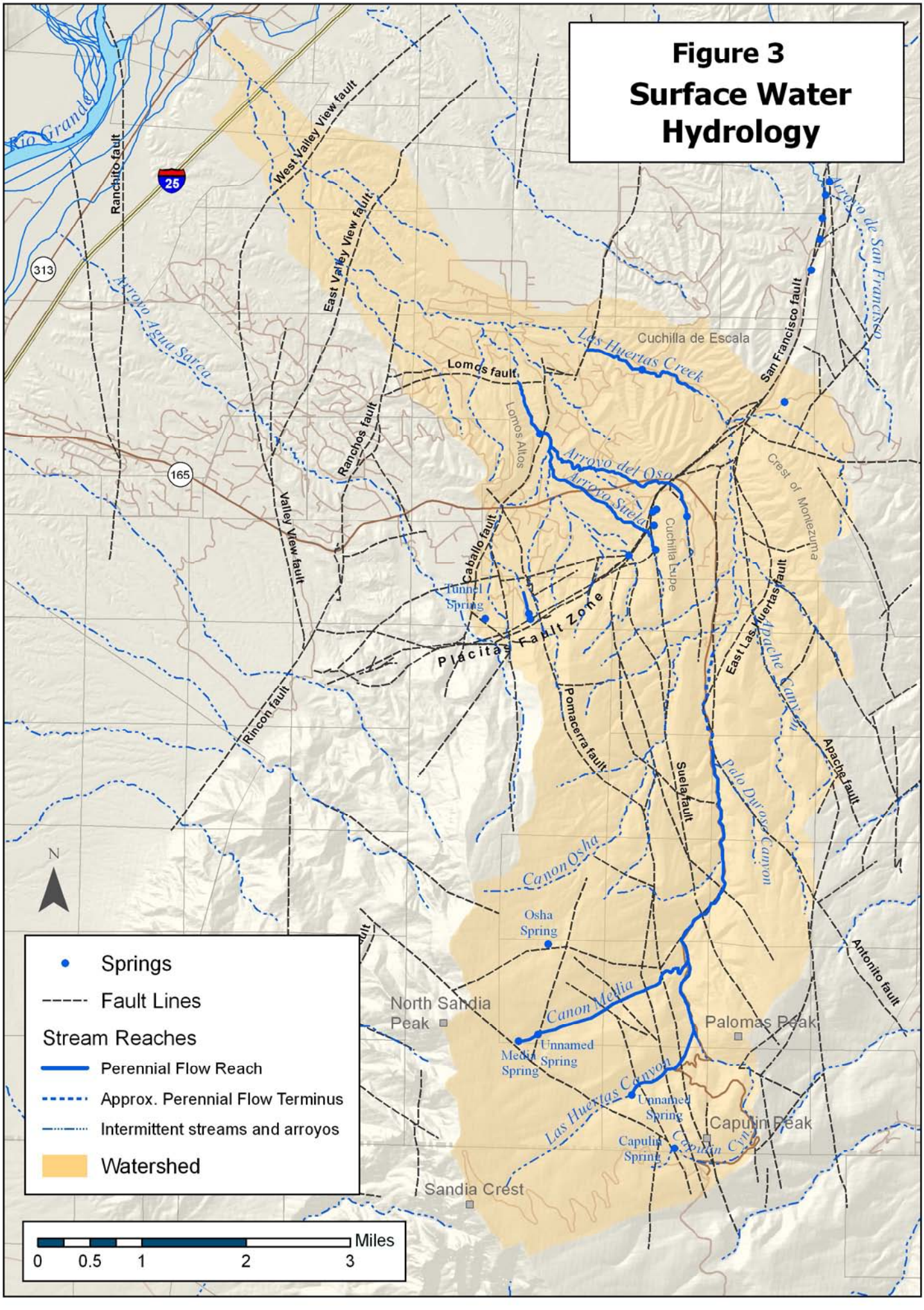
Bernalillo Soil Survey (South of green line)

- BOF Borealis-Rock outcrop association very steep
- EtC Embudo-Tijeras complex 0-9% slope
- ILC Ildefonso gravelly sandy loam 1-9% slope
- KS Kolob stony loam
- KVE Kolob stony loam, cold variant 15-40% slope
- Kt Kolob-Rock outcrop association
- KU Kolob-Sandia association
- ROF Rock outcrop-Orthids 40-80% slope
- Ra Rock outcrop
- SBE Sandia-Kolob complex 15-40% slope
- SC Scholle-Ildefonso association
- SHF Seis complex 30-80% slope
- SFE Seis stony loam 15-60% slope
- SEC Seis very cobbly loam 0-15% slope
- Te Tesajo-Millett stony sandy loams

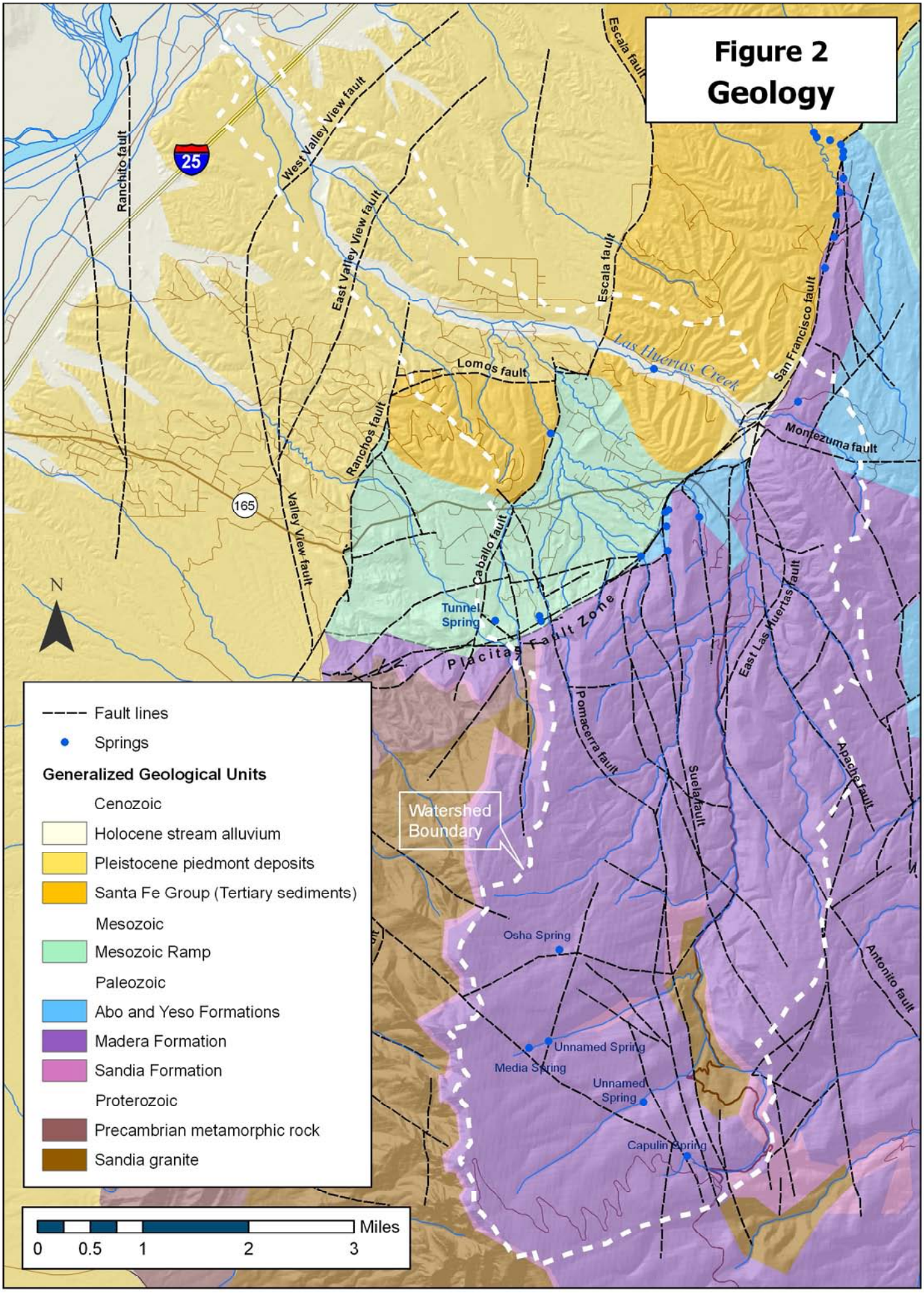
Map by Kristin Willette for Las Placitas Association, June 22, 2005. Map projection and datum: UTM Z13N, NAD83. Primary data source: USDA NRCS. See metadata for details.



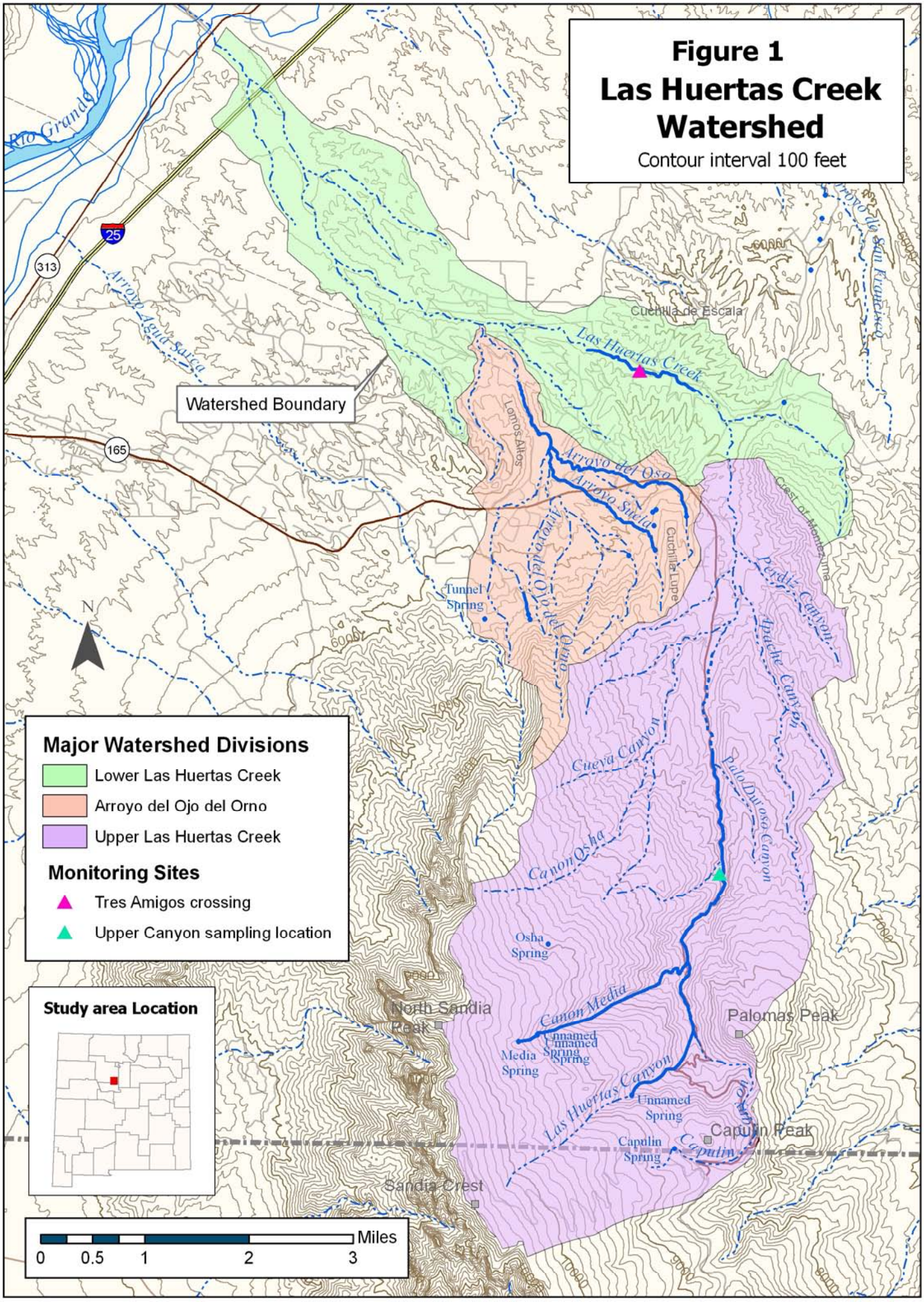
Map by Kristin Willette for Las Placitas Association, June 22, 2005. Map projection and datum: UTM Z13N, NAD83. Primary data source: NMBGMR, Peggy S. Johnson (2000). See metadata for base map details.



Map by Kristin Willette for Las Placitas Association, June 22, 2005. Map projection and datum: UTM Z13N, NAD83. Primary data sources: Las Placitas Association, NMBGMR geology maps, Reid Bandeen, and Peggy S. Johnson (2000). See metadata for details.



Map by Kristin Willette for Las Placitas Association, June 22, 2005. Map projection and datum: UTM Z13N, NAD83.
Adapted from an NMBGMR statewide digital dataset intended for 1:500,000 scale; using paper geology maps at 1:24K, 1:48K and 1:500K. See metadata for details.



Map by Kristin Willette for Las Placitas Association, June 22, 2005. Map projection and datum: UTM Z13N, NAD83. Data sources: Las Placitas Association, Reid Bandeen (Truchas Hydrological 2005), contours developed from seamless National Elevation Dataset (DEM) @ 1/3 arc-second. See metadata for details.

Kristin Willette
Draft LPA_WRAS Maps -- Metadata
7/10/2005

A Note about the Maps:

These maps were made by Kristin Willette, in May/June 2005, using ESRI ArcGIS 9.0. The projection is UTM Zone 13N, using a NAD 83 datum. The nominal map scale (letter size), is 1:75 000.

These maps are intended for illustrative purposes only. The datasets have been collected from a wide variety of public sources, in most cases clipped from a dataset of much larger extent, statewide or regional. Primary and base map data sources are listed below. Most was downloaded from UNM's RGIS data clearinghouse.

Paper maps in Peggy Johnson's hydrologic report (2000), and from the USGS, BLM, NMBGMR, USFS, and USDA NRCS, and other resources from UNM's CSEL MAGIC map library, were used as ancillary data sources in the production of these maps.

The resulting GIS layers have been clipped, re-projected, generalized and adjusted to fit other datasets. Errors and inaccuracies are present due to this process. The author expressly disclaims all liability regarding the accuracy or completeness of the data represented on these maps.

Study Area Location:

The watershed of Las Huertas Creek lies almost entirely within Sandoval County, New Mexico. Only the upper tip extends into Bernallillo County. The appropriate USGS 7½-minute (1:24 000) quads are: Placitas, and the northern ½ of Sandia Crest. This area falls in the Albuquerque quad of the USGS 1: 100 000 series.

An interesting discrepancy appears in the map literature, re the names of the upper canyons. On older maps, the western of the two canyons that extend into Bernalillo County, is marked as Canon Media on older USGS Maps, and as Las Huertas Canyon on newer maps. The names of Canon Media and Canon Osha were also displaced one canyon to the south. The 1990 1:24 000 USGS Sandia Crest topographic quad shows the names as they are here: Las Huertas Canyon contains the unnamed spring, near the LS Ranch and the Sandia Conference Grounds, that is the source of Las Huertas Creek.

Extent of Study Area: Bounding coordinates

In decimal degrees (lat/long)

West: -106.542069
East: -106.360095
North: 35.378191
South: 35.195536

In projected or local coordinates (UTM meters)

Left: 359924.852033
Right: 376184.380651

Top: 3915837.128140
Bottom: 3895811.864548

Extent of the watershed itself: Bounding coordinates

In decimal degrees (lat/long)

West: -106.495748
East: -106.383540
North: 35.374132
South: 35.201810

In projected or local coordinates (UTM meters)

Left: 364127.365483
Right: 374058.300509
Top: 3915416.402439
Bottom: 3896443.752950

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Data Sources:

Las Huertas Creek and Major divisions of the watershed: shapefiles supplied Feb 2005, in UTM NAD83, by Jennifer Nelson and Shannon Mann of the Las Placitas Association.

Other stream data: from USGS National Hydrographic dataset, published 2001, updated 2003, in decimal degrees. Downloaded from RGIS.

Elevation Data: 3/2005 download from the seamless National Elevation Dataset at ned.usgs.gov, in geographic coordinates (decimal degrees), NAD 83. 1/3 arc second (about 10 meters) raster. Original z units: meters, converted to feet.

Roads Data: from RGIS, the 2001 E911 roads data for both Sandoval and Bernalillo counties, in State Plane NAD 83, survey feet.

Public Land Survey (PLSS) Data: from RGIS, 2003 BLM statewide vector datasets, in UTM NAD 83.

Land Ownership: from RGIS, statewide BLM 2004 dataset, in UTM NAD 83. Some adjustments were made to fit this dataset to the PLSS system.

USFS Wildland-Urban Interface boundaries: downloaded from website http://www.fs.fed.us/r3/wui/index.html. Original projection Lambert Conformal Conic, NAD 1927. Projected to UTM using NADCON datum transformation. Some adjustments were made to fit to BLM dataset's National Forest boundaries.

Placitas Open Space (POS) boundaries: from City of Albuquerque Open Space Program, in State Plane NAD 83 survey feet. Some adjustments were made. to fit to PLSS section lines.

Precipitation: annual precipitation map adapted from Peggy Johnson, 2000.

Vegetation/Land Cover data: derived from USGS ReGAP data. The original ReGAP image covering the watershed came from Teri Neville and Rayo McCollough of

UNM Biology's NM Natural Heritage Program. This data was used on the "Las Huertas Creek Watershed" poster, with its original classification and colormap.
-- This map is made from a slightly different dataset, the 2004 "Provisional" digital landcover dataset for the Southwestern region, downloaded from http://earth.gis.usu.edu/. This is a large raster dataset with 30-meter resolution, in Albers Conical Equal-Area projection, NAD 83, partially derived from multi-season satellite imagery for 1999-2001. After download it was clipped (to the boundary of the watershed) and reprojected to a GRID file, using "nearest neighbor" resampling (to preserve Value field), then classes were combined to make a shorter, more generalized legend.
-- Note that 30m resolution ReGAP data is not intended for use at scales greater than 1:100,000, but with the help of ancillary data sources, I felt I could safely produce more general classes. Thanks are due to Tyler Albers and Steve Sebring of the USFS, for their help with the USFS TEU classification system.

Soils data: USDA NRCS datasets 1)soilmu_a_nm600.shp (Sandoval, etc., published on CD-ROM 2005), and 2)soilmu_a_nm656.shp (Bernalillo, etc., published on CD-ROM 14 Nov 2002). Thanks to Chrisshelle at the Albuquerque office, for assistance finding online metadata.

Geology data: Adapted from simplified statewide geology NMBMMR dataset downloaded from RGIS, nmmapdd83, originally in decimal degrees and NAD 27, and intended for use only at scales under 1:500,000.
Interpreted using the 1:24,000 geology quad maps for Bernalillo/Placitas, revised in 2000, which were originally drawn at 1:12,000; then generalized according to Peggy Johnson, 2000.
-- Best data for further use, because of the geographic scale and extent: the 1:48,000 geology maps included in NMBGMR Memoir 29, "Geology of the Sandia Mountains and Vicinity, New Mexico" by Vincent C. Kelley and Stuart A. Northrop (1975).
-- Thanks to Knutt Peterson at the UNM CSEL MAGIC Map Library, and Dave McCraw of the NMBGMR, for their invaluable help in interpretation of geology maps at different scales.

Las Huertas Creek Hydrology data: from Reid Bandeen (Truchas Hydrological) and Peggy S. Johnson, "Phase II Hydrogeologic and Water Resource Assessment for the Placitas Development Area, Sandoval County, New Mexico" Draft Technical Report, 1999.