WATER QUALITY SURVEY SUMMARY
FOR THE
RIO PUERCO WATERSHED
2004

Prepared by
Surface Water Quality Bureau
New Mexico Environment Department
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ACKNOWLEDGEMENTS

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Cover: Rio Puerco above the Village of Cuba (top) near La Ventana (bottom).

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LIST OF ACRONYMS

Al	Aluminum
C	Celsius
cfs	cubic feet per second
CWA	Clean Water Act
CWAL	Coldwater Aquatic Life
ELS	Early Life Stage
DO	Dissolved Oxygen
GIS	Geographic Information Systems
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
OLS	Other Life Stage
QAPP	Quality Assurance Project Plan
STORET	EPA's Storage and Retrieval System
SWQB	Surface Water Quality Bureau
USEPA	United States Environmental Protection Agency

1.0 Executive Summary

During 2004, the Monitoring and Assessment Section of the Surface Water Quality Bureau of the New Mexico Environment Department conducted water quality assessment surveys of the Rio Puerco watershed and selected tributaries from Bernardo, NM, to the headwaters. Tributaries to the Rio Puerco sampled during the survey included, among others, the Rio San Jose, Rito de los Pinos, Nacimiento Creek, La Jara Creek, and Rio Moquino and Bluewater Creek, as well as the Blue Water and San Gregorio reservoirs. Sampling at stream stations was conducted on a monthly basis from March through October when water was present. Water sampling methods were in accordance with the *Quality Assurance Project Plan for Water Quality Management Programs* (NMED 2004).

Analytes included total nutrients, total and dissolved metals, anions and cations, radionuclides, and fecal coliform bacteria. Exceedences attributable variously to plant nutrients, aluminum, sedimentation, temperature and bacteria were found in a number of assessment units. Of these, the most ecologically significant are the effects of sedimentation temperature and nutrients from the Cuba WWTP.

Photo 1. Rio Puerco near La Ventana.

2.0 Introduction

Waters within the Rio Puerco Basin were sampled by the Surface Water Quality Bureau (SWQB) from March to November 2004 with additional collections in 2006. The Rio Puerco Basin includes the Rio Puerco from its confluence with the Rio Grande to its headwaters as well as its tributaries. Monitoring stations were selected to characterize water quality of the stream reaches. SWQB assessed the resulting water quality data. This document contains summaries of the data collected and describes impairments that have led to or will lead to TMDL development. A number of previously listed assessment units could not be reassessed due to insufficient data. These impairments will remain on the CWA Integrated §303(d)/§305(b) list of waters until additional data are available.

The Rio Puerco Basin includes ten large sub-watersheds draining portions of eight counties, west of the greater Rio Grande Basin, in the northwest and west central portion of New Mexico (NM). With a total watershed area of approximately 19,000 km^2 (7,350 mi^2), of which 15,900 km^2 (6,125 mi^2) contributes surface drainage, it is by far the largest in-state tributary to the Rio Grande. The greater Rio Puerco watershed (US Geological Survey [USGS] Hydrologic Unit Codes [HUCs] 13020204, 13020205, 13020206 and 13020207) is located in Valencia, Socorro, Bernalillo, Sandoval, Cibola, and McKinley Counties in north central New Mexico (NM). This survey included the non-tribal reaches of the Rio Puerco and its tributaries, including the Rio San Jose and its tributaries. **Figures 1 and 2** illustrate the surface water runoff for two sites on the Rio Puerco during this water quality survey compared to the historical average.

Twenty-two water quality sites were sampled during this survey (**Figures 3 through 4**). **Table 1** details sampling station locations in each assessment unit (AU), station numbers, and STORET identification codes. Land use for the Rio Puerco HUC includes 62% forest, 21% shrubland, 12% grassland, 4% agriculture, and less than 1% developed, water, wetlands, bare rock, and mines/quarries. As presented in **Figure 3**, land ownership for the Rio Puerco watershed is 7% U.S. Forest Service (USFS), 44% private, 19% Bureau of Land Management (BLM), 23% Native Lands, and 6% State. Land use for the Rio San Jose HUC is 31% forest, 45% shrubland, 20% grasslands, and 4% barren. As presented in **Figure 4**, land ownership for the Rio San Jose HUC is 40% native lands, 30% private, 15% Forest Service, 11% Bureau of Land Management, and 4% State.

2.1 Geology and Fluvial Geomorphology

The Rio Puerco watershed is located along the east-southeast margin of the Colorado Plateau, along a transition zone with the Rio Grande Rift. Soft upper Paleozoic, Mesozoic, and lower Cenozoic sedimentary strata dominate the geologic setting of the area. Specific units include Permian through Tertiary age continental and marine sandstones, shales, mudstones, and carbonate rocks. These strata are generally flat lying, often faulted, and carved into broad valleys flanked by mesas and mountains. The mountainous areas along the margins of the northeast and west-central watershed are made up of intrusive igneous rocks (granitic plutonic rocks, gneiss, and schists). Younger Tertiary or Quaternary volcanic rocks intrude the sediments and occasionally cap high standing mesas. Tertiary and Quaternary valley fill, pediment gravels, talus, and alluvial deposits mantle the geologic section.

Numerous geomorphic elements combine to form the watershed's present structural, fluvial, and topographic settings. Existing landforms are an indication of the large amounts of surface materials that have been removed from the region by wind and water. Elevations range from the 3445 m (11,301 ft) peak of Mt. Taylor, at 3,200-meters (10,500-foot) in the Sierra Nacimiento - San Pedro Parks Wilderness headwaters area, and over 2780 meters (9,120 ft_ along the Continental Divide in the Zuni Mountains - to less than 1430 meters (4,700 ft) at the lower Rio Puerco / Rio Grande confluence at Bernardo, north of Socorro. The change in elevation, a rather high regional surface gradient, and an excess of straight drainage channel segments combines with the region's climatic setting and vulnerable sedimentary lithologies to create the watershed's well-documented reputation for dramatic erosion.

Average rainfall in the basin varies annually between 30.5 and 51 cm (12-20 inches), delivered mostly by late summer monsoon thunderstorms creating violent flash flood runoff that sweeps out of well-vegetated highlands across sparsely vegetated slopes and valley surfaces, carrying thin topsoil and weathered bedrock away. The large aerial extent of erosive geologic units provides the abundant source of available sediment, estimated as 40% from existing channels and banks, 30% from sediment-producing tributary drainages, and 30% from sheet, rill, and minor gully erosion of adjacent uplands.

Soil loss contributing to sediment loading is such an extreme problem throughout the watershed that the basin has earned its status as one of the nation's most actively eroding watersheds. The Rio Puerco Basin has been documented to transport one of the highest known average annual sediment concentrations. As the major source of suspended sediment entering the Rio Grande above Elephant Butte Reservoir, the Rio Puerco was determined to be contributing 83% of the total sediment load from 1948 to 1973 and 60% of the total load between 1974 and 1996. That decrease over time is evident in recent data from three active USGS gage stations in the lower half of the watershed. Investigators indicate that the decrease may be due to evolving changes in channel and planform geometry, combined with a decrease in peak flows out of the watershed, both favoring increased riparian vegetation that increases channel roughness, sediment deposition, and overall stabilization. It recent successful upland and in-channel erosion-control strategies implemented by state and federal watershed restoration programs working with land management agencies and private landowners may have contributed to this decreased sediment load.

The mainstem of the Rio Puerco begins in a wetland on the southwest side of San Pedro Peak in the Nacimiento Mountains east of Cuba, NM. This mountain range is fully contained within the San Pedro Parks Wilderness area of the Santa Fe National Forest. From its 3,200-meter (10,500-foot) beginning, the stream flows to the southwest for almost 11 km (7 miles) through high elevation forests then into a series of wet meadows to the edge of the wilderness area at 2590-meter (8,500-foot) elevation.

From the Santa Fe National Forest boundary downstream approximately 10 km (6 mi) to the Village of Cuba, domestic and wildlife grazing, road construction, and maintenance activities on private and public lands have impacted riparian vegetation and initiated discontinuous stream channel incision. In some local segments the stream bed is now 1.5 to 3 meters (5-10 ft) below its original floodplain, whereas adjacent reaches remain relatively stable. At and below the Village of Cuba, flows from a series of low-discharge tributaries coalesce and drop off the western face of the Sierra Nacimiento (one of the most prominent linear fault scarps in the Southwest) as mostly straight and steep bedrock, boulder, or large cobble-lined channels. This flow combines with effluent from the Cuba WWTP to provide perennial flow in the Rio Puerco downstream towards the confluence with Arroyo Chijuilla.

The foothills areas north and northeast of Cuba are composed of erodable sedimentary units (clay and mudstones), so while stream incision occurs in this drainage system very close to its headwaters area, the downstream reach's sand-dominated setting and decreased gradient allows for more stable channel dimension, pattern, and profile. The least incised, best vegetated, and most stable segment occurs 1.6 to 4.8 km (1-3 mi) miles upstream of the Village of Cuba, below which deep incision and a broad meandering pattern becomes characteristic across the wide flat valleys, on to the distant confluence with the Rio Grande. A few discontinuous bedrock zones or recent manmade grade control structures are occasionally observed controlling the incision.

The reach of the Rio Puerco downstream of Cuba flows through a complex mixture of private, State and Federal lands in a wide, deeply incised, vertical-walled canyon with banks up 10 m (35 ft) high. Erosional processes within this reach of the stream are extensive. Significant landscape erosion and channel incision are common throughout the majority of the Rio Puerco Watershed. When these conditions occur, soil is lost, the landscape is vulnerable to sheet attrition and rilling, vegetation vigor declines, streams and tributaries become sediment-filled, the availability of accessible water for irrigation diversions decreases or disappears, the river beds are lowered, the banks extended, riparian resources and related habitat is impacted, water quality deteriorates, and this process is inevitably accompanied by a drop in the local water table.

In the mid-1960s a segment of the reach between La Ventana and Cuba was diverted from its original meandering channel into a straight channel on the west side of the highway during the original construction of this valley segment of State Highway 44. This channelization has resulted in an estimated 14.1 million cubic feet of sediment erosion of the local river bed and banks (Coleman, et al. 1998), has put the highway at risk, and has destroyed several County roads and bridges. In 1999, the multi-agency process of widening the highway to four lanes and transitioning it to federal Highway 550 also committed to restore the Rio Puerco to its original channel and initiate riparian restoration efforts. These restoration activities, along with many other upstream and downstream projects, are ongoing and have the potential to improve water quality in the Rio Puerco and Rio Grande.

The waters of the Rio San Jose watershed generally have headwaters on Mt. Taylor and also gathers flow from the north flank of the Proterozoic crystalline-cored Zuni Mountains (along the Continental Divide). Mt. Taylor dominates this area and is comprised of dacite, andesite, and basalt flows. Runoff from both areas traverses upper Paleozoic to Mesozoic sedimentary rocks en route to the main valley of the Rio San Jose that is developed on relatively easily eroded marine and continental sediments including Cretaceous Mesaverde Group sandstones and shales, Jurassic sandstone, and Triassic mudstones and siltstones (Chronic 1987). In general the degree of incision in the broad valley of the Rio San Jose is not as great as the Rio Puerco's Main Stem on this other side of the watershed.

The sedimentary rocks in the area around Grants have long been a center for uranium mining, mainly in the Morrison Formation. The JJ No. 1/L-Bar Mine 2.25 miles east/northeast of

Moquino produced uranium from 1976-1981. This mine was operated in conjunction with the L-Bar uranium mill and mine tailings facility. The mine was closed and reclaimed in 1986-1987 (Intera, Inc 2006). A large lava field exists near Grants within the El Malpais National Monument, the youngest flow being within the last 1,000 years. Cretaceous sandstones are capped by basalt east of the Zuni uplift into the Rio San Jose watershed (Chronic 1987). Further downstream the Rio San Jose – Rio Puerco confluence occurs in an area of erodable Triassic redbeds, just east of a broad zone of faults that marks the west edge of the Rio Grande Rift. The wetland-type area near Laguna is the original lake that led to the Spanish name for that town (Chronic 1987).

Photo 2. Restoration project on the Rio Puerco near NM State Road 550.

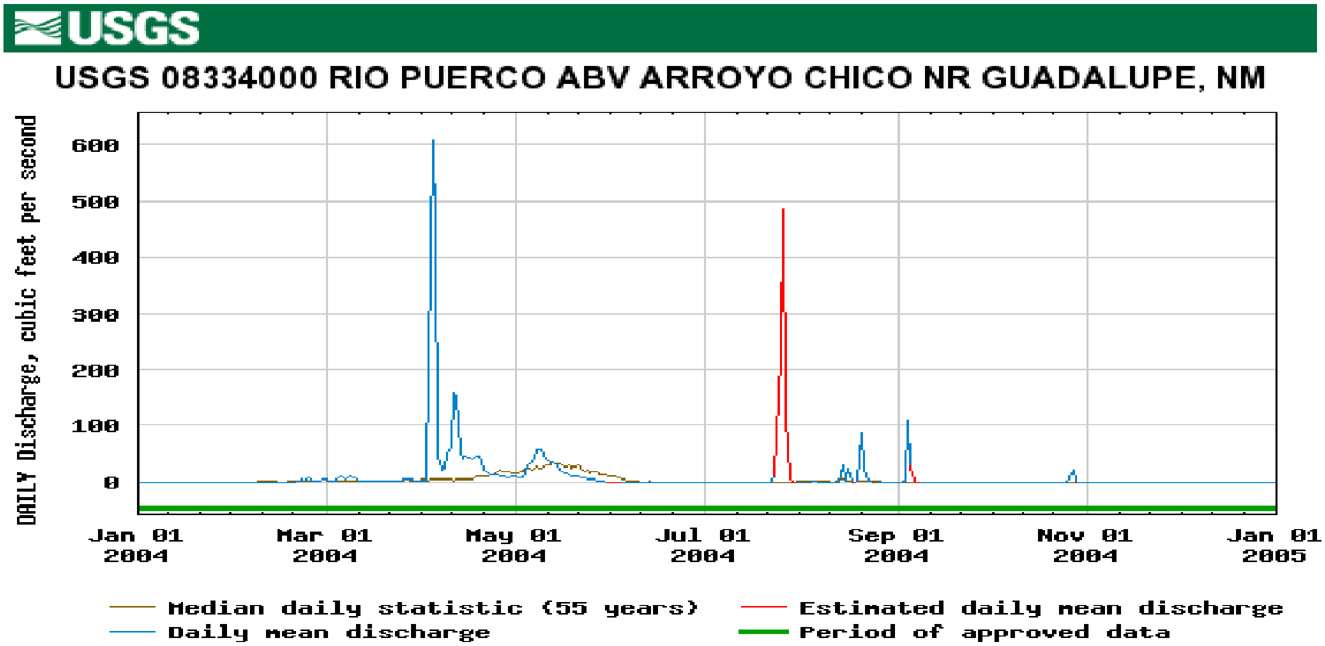

Figure 1. Discharge of the upper Rio Puerco, 2004.

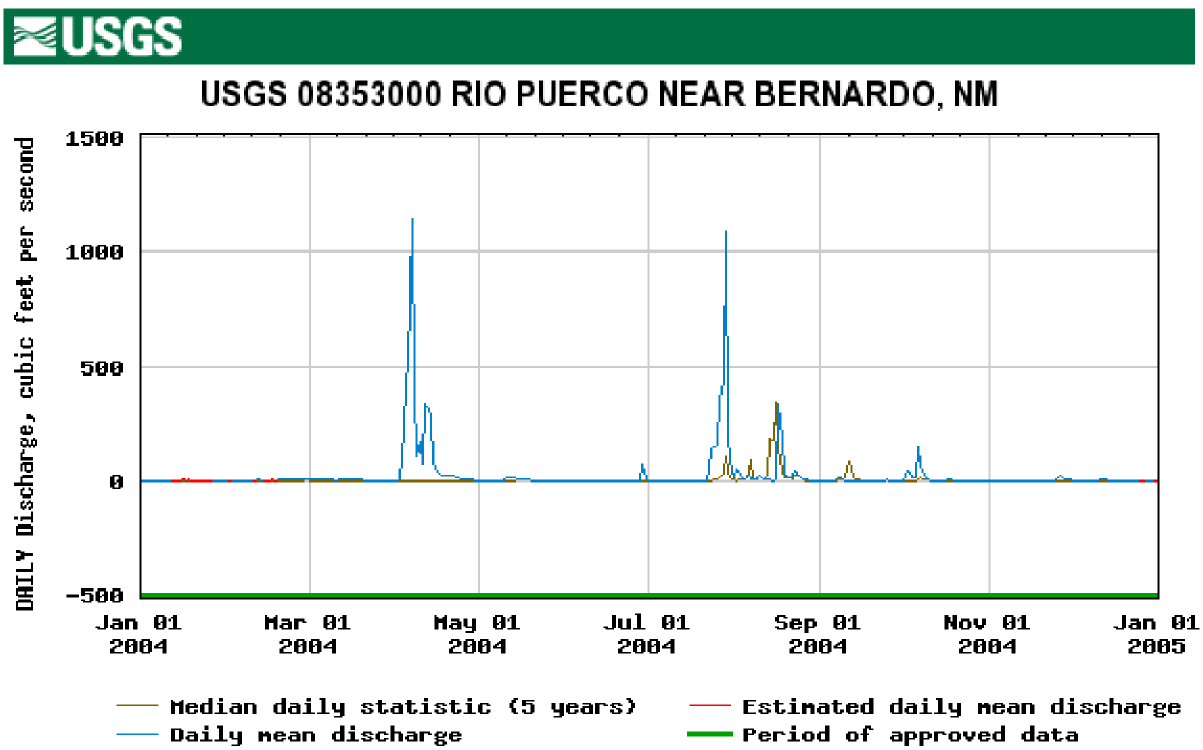

Figure 2. Discharge of the lower Rio Puerco, 2004.

Photo 3. Rio Puerco at Cuba showing a fish population. (Top center and lower left)

Figure 3. Map of Rio Puerco Study Area. Drainage area is approximately 9,050 km^2 (3,493 mi^2). Note: Station 27, Rio Puerco at I-25, is not shown. Sampling was conducted at I-25 near Bernardo, NM.

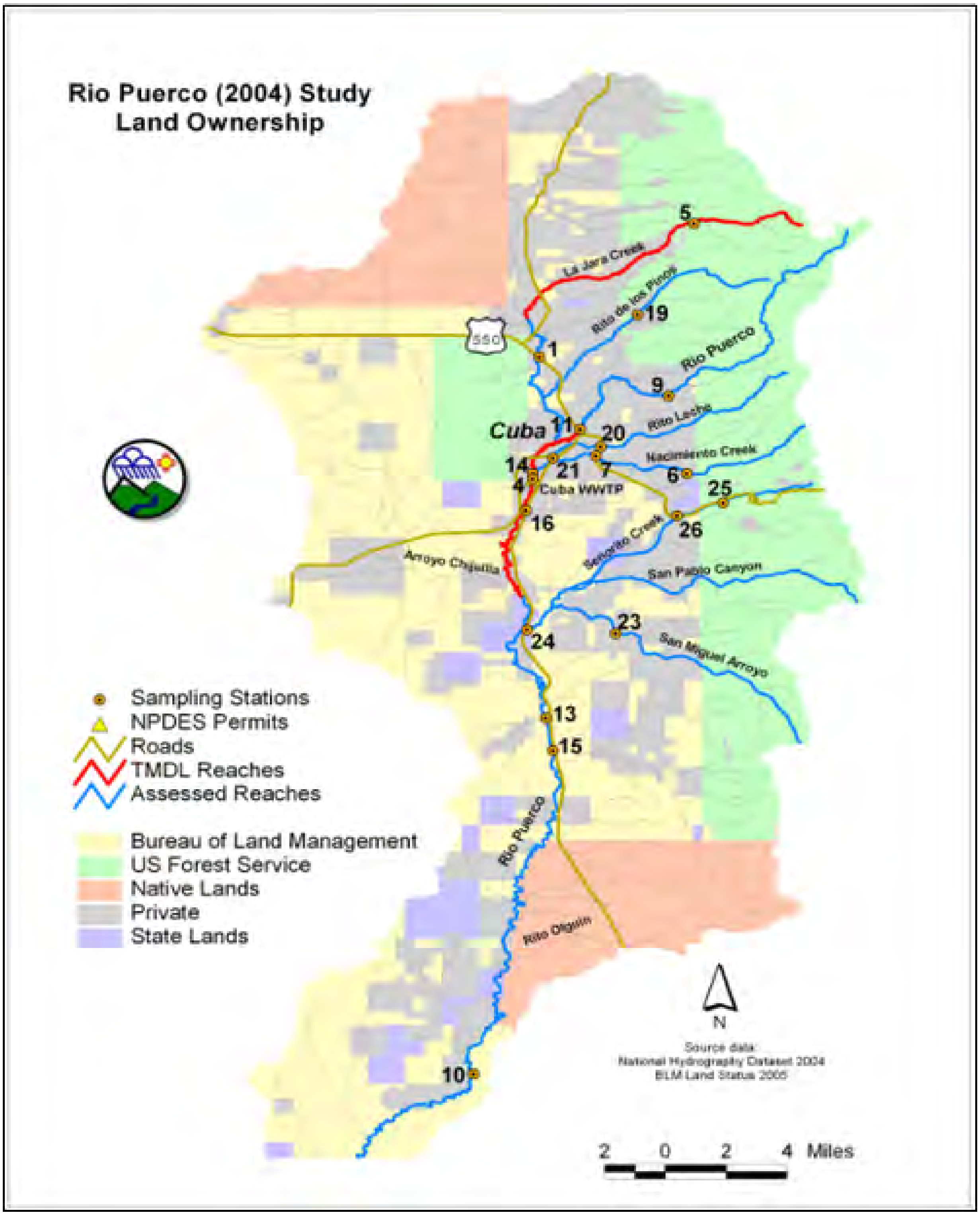

Figure 4. Map of Bluewater/Rio San Jose Study Area. Drainage area is approximately 6816 km2 (2,632 mi2)

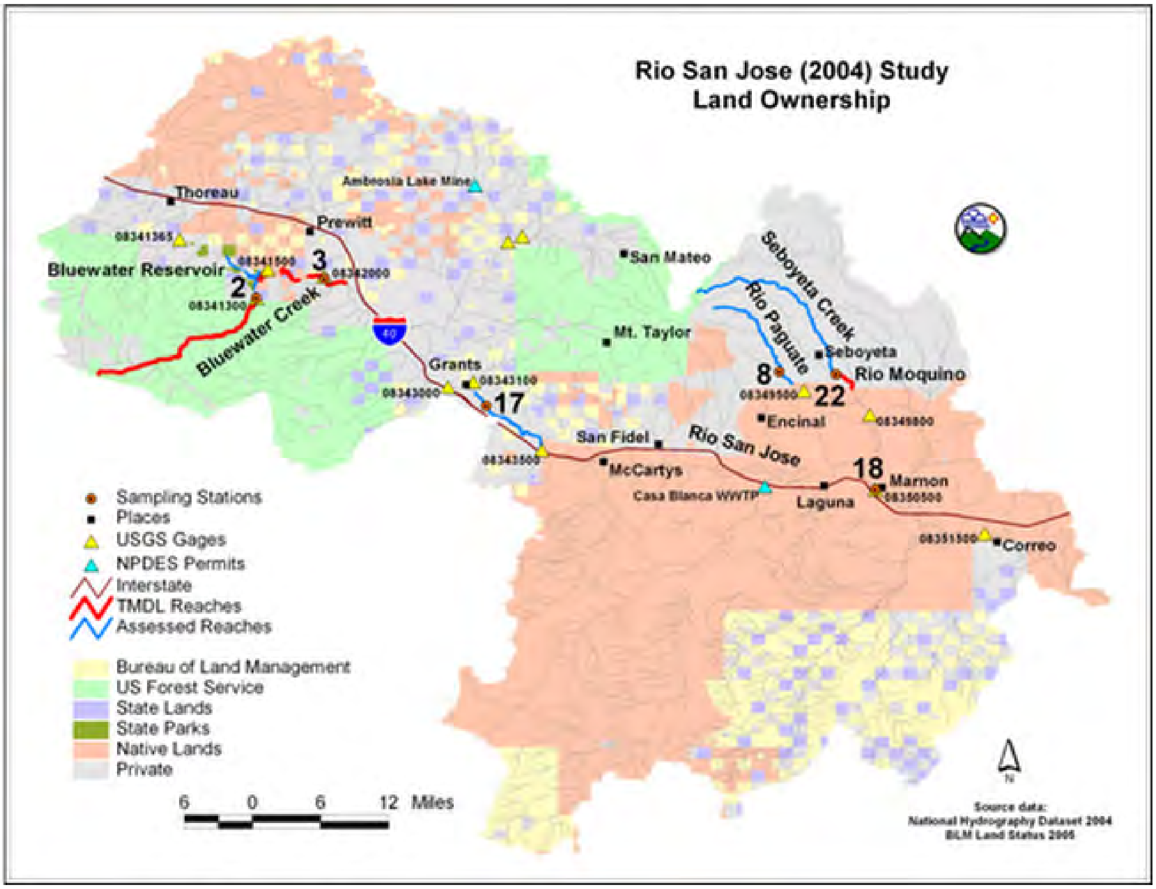

Table 1. Survey Stations and STORET Codes

SITE #	LATITUDE	LONGITUDE	STATION	STORET_ID
1	36.06079	-106.97770	**Arroyo San Jose @ Hwy 550 Bridge**	33ASanJo006.5
2	35.26778	-108.11417	**Bluewater Creek above Bluewater Lake @ USGS gage 8341300**	36Bluewa018.9
3	35.29260	-108.02700	**BLUEWATER CREEK AT MOUTH OF BLUEWATER CANYON**	36Bluewa003.5
4	35.99970	-106.98092	**Cuba WWTP Outfall Channel**	33RPuerc243.7
5	36.12769	-106.90425	**La Jara Creek abv irrigation diversion**	33LaJara009.7
6	36.00248	-106.90758	**Nacimiento Creek @ Eureka Rd.**	33Nacimi008.0
7	36.01128	-106.95086	**Nacimiento Creek @ Hwy 126**	33Nacimi003.4
8	35.16425	-107.47142	**Rio Paguate above Laguna Pueblo**	36RPagua019.8
9	36.04132	-106.91621	**Rio Puerco @ CR13 Bridge**	33RPuerc256.0
10	35.70182	-107.00897	**Rio Puerco @ Hwy 279 Bridge near San Luis**	33RPuerc198.4
11	36.02449	-106.95834	**Rio Puerco @ Hwy 550 Bridge**	33RPuerc248.7
13	35.88003	-106.97462	**Rio Puerco abv La Ventana Restoration Project**	33RPuerc224.8
14	36.00236	36.00236	**Rio Puerco abv WWTP**	33RPuerc244.0

Table 1. Survey Stations and STORET Codes, continued

SITE #	LATITUDE	LONGITUDE	STATION	STORET_ID
16	35.98396	-106.98412	**Rio Puerco blw WWTP @ Sanchez Property**	33RPuerc241.8
17	35.130837	-107.821393	**RIO SAN JOSE BELOW GRANTS WWTF DISCHARGE**	36RSanJo118.5
18	35.023615	-107.325559	**RIO SAN JOSE NEAR LAGUNA, NM**	36RSanJo40.6
19	36.08190	-106.93100	**Rito de los Pinos @ USFS gate on FR 95**	33RPinos006.8
20	36.01588	-106.94860	**Rito Leche @ Hwy 126**	33RLeche002.6
21	36.01022	-106.971278	**Rito Leche at Cubita Rd.**	33RLeche001.3
22	35.17090	-107.37592	**Rito Moquino below confluence with Seboyetita Creek and Seboyeta Creek**	36RMoqui006.4
23	35.92235	-106.94135	**San Miguel Arroyo @ old Hwy 44**	33SanMig005.7
24	35.924167	-106.98356	**San Pablo Canyon abv Rio Puerco**	33SPablo000.2
25	35.98761	-106.89043	**Senorito Creek abv Nacimiento Mine**	33Senori008.8
26	35.98120	-106.91228	**Senorito Creek blw Nacimiento Mine**	33Senori006.8
27	34.41000	-106.85000	**Rio Puerco @ I-25**	33RPuerc004.6

3.0 Water Quality Standards Segments

The applicable water quality standards for the subject waters are within 20.6.4.98, 20.6.4.99, or 20.6.4.109 NMAC. Data collected during this survey was assessed using WQS as amended through February 16, 2006 (NMAC, 2006). For these segments, the WQS state:

20.6.4.98 INTERMITTENT WATERS - All intermittent surface waters of the state that are not included in a classified water of the state in 20.6.4.101 through 20.6.4.899 NMAC.
A. Designated Uses: livestock watering, wildlife habitat, aquatic life and secondary contact.
B. Criteria:
(1) The use-specific criteria in 20.6.4.900 NMAC.
(2) The monthly geometric mean of E. coli bacteria shall not exceed 548 cfu/100 mL, no single sample shall exceed 2507 cfu/100 mL (see Subsection B of 20.6.4.14 NMAC).
[20.6.4.98 NMAC - N, 05-23-05]

20.6.4.99 PERENNIAL WATERS - All perennial surface waters of the state that are not included in a
classified water of the state in 20.6.4.101 through 20.6.4.899 NMAC.
A. Designated Uses: aquatic life, livestock watering, wildlife habitat and secondary contact.
B. Criteria:
(1) Temperature shall not exceed 34°C (93.2°F). The use-specific criteria in 20.6.4.900 NMAC are
applicable to the designated uses listed in Subsection A of this section.
(2) The monthly geometric mean of E. coli bacteria shall not exceed 548 cfu/100 mL, no single sample shall exceed 2507 cfu/100 mL (see Subsection B of 20.6.4.14 NMAC).
[20.6.4.99 NMAC - N, 05-23-05]

20.6.4.109 RIO GRANDE BASIN - Perennial reaches of Bluewater creek, Rio Moquino, Seboyeta
creek, Rio Paguate, the Rio Puerco above the village of Cuba and all other perennial reaches of tributaries to the Rio Puerco including the Rio San Jose in Cibola county from the USGS gaging station at Correo upstream to Horace springs.

A. Designated Uses: coldwater aquatic life, domestic water supply, fish culture, irrigation, livestock watering, wildlife habitat and primary contact.
B. Criteria:
(1) In any single sample: pH shall be within the range of 6.6 to 8.8, temperature 20°C (68°F) or less
and total phosphorus (as P) 0.1 mg/L. 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 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

4.0 Methods

Water benthic macroinvertebrate and fish sampling methods were in accordance with the SWQB's approved Quality Assurance Project Plan for Water Quality Management Programs (QAPP) (NMED/SWQB 2004). Benthic macroinvertebrate and fish sampling methods were in accordance with protocols for EPA's Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers (Barbour et al. 1999).

Water chemistry samples were collected at the sites monthly from March through October of 2004. Certain sites were sampled on an occasional basis as access and the presence of water allowed.

5.0 Sampling Summary

The station STORET identification codes and location descriptions of sampling stations selected for this survey are provided in **Table 1**; assessment unit and station rationales are provided in **Table 2**.

Table 2. SWQB 2004 Rio Puerco Assessment Units

Assessment Unit	Station Description	STORET ID	Rationale
Bluewater Creek (Bluewater reservoir to headwaters)	Bluewater Creek above Bluewater Lake @ USGS Gage 8341300	36Bluewa018.9	Only station in segment.
Bluewater Creek (non-tribal Rio San Jose to Bluewater Rsrv)	Bluewater Creek @ mouth of Bluewater canyon	36Bluewa003.5	Only station in segment. Creek dewatered below due to irrigation diversions.
Rio Moquino (Laguna Pueblo to Seboyetita Creek)	Rito Moquino below confl of Seboyetitia Creek and Seboyeta Creek	36RMoqui00.6.4	Only station on segment.
Rio San Jose (Laguna Pueblo)	RIO SAN JOSE NEAR LAGUNA, NM	36RSanJo40.6	This station is on pueblo land and should be removed from the database.
Rio San Jose (Horace Springs to Grants WWTP)	Rio San Jose blw Grants WWTF Discharge[1]	N/A	Originally added to monitor water below WWTP discharge. No longer relevant.
La Jara Creek (Perennial reaches abv Arroyo San Jose)	La Jara Creek abv irrigation diversion	33LaJara009.7	Pristine condition. Only site on segment. Perceived problem with radionuclides by citizens on water supply.
Rio Paguate (Laguna Pueblo bnd to headwaters)	Rio Paguate above Laguna Pueblo	* 36RPagua019.8	Only site on segment.

Assessment Unit	Station Description	STORET ID	Rationale
Arroyo San Jose (Rio Puerco to La Jara Creek)	Arroyo San Jose @ Hwy 550	33ASanJo006.5	Only station in segment. Allows contributions from La Jara Creek, Rio de los Pinos and other ephemeral washes to be monitored before mixing with Rio Puerco.
Rito de los Pinos (Perennial reaches abv Arroyo San Jose)	Rito de los Pinos @ USFS gate on FR 95	33RPinos006.8	Only station on segment.
Rito Leche (Perennial reaches above Rio Puerco)	Rito Leche @ Hwy 126	33RLeche002.6	Easy access to water before it goes through Cuba
Rito Leche (Perennial reaches above Rio Puerco)	Rito Leche @ Cubita Rd	33RLeche001.3	Easy access to water after it comes through Cuba and before it enters the Rio Puerco.
Nacimiento Creek (Rio Puerco to USFS bnd)	Nacimiento Creek @ Eureka Rd	33Nacimi008.0	Only station in perennial portion of the Creek. Station at Hwy 126 goes dry, probably due to dewatering when irrigation season begins.
Nacimiento Creek (Rio Puerco to USFS bnd)	Nacimiento Creek @ Hwy 126	33 Nacimi003.4	Lowest access before water enters developed areas around and in Cuba.
Senorito Creek (Nacimiento Mine to headwaters)	Senorito Creek abv Nacimiento Mine	33 Senori006.8	Bracket Nacimiento Copper Mine.
Senorito Creek (San Pablo Canyon to Nacimiento Mine)	Senorito Creek blw Nacimiento Mine	33 Senori006.8	Bracket Nacimiento Copper Mine.
San Miguel Arroyo (San Pablo Canyon to headwaters)	San Miguel Arroyo @ old Hwy 44	33SanMig005.7	Isolate contribution of San Miguel drainage from San Pablo canyon. Only station in segment.
San Pablo Canyon (Rio Puerco to headwaters)	San Pablo Canyon abv Rio Puerco	33SPablo000.2	Monitor water before mixing with Rio Puerco and after receiving contributions from San Miguel Arroyo.
Rio Puerco (northern bnd Cuba to headwaters)	Rio Puerco @ CR 13	33RPuerc256.0	Highest station on Rio Puerco. Relatively pristine. Last easy access before water enters Cuba.
Rio Puerco(Arroyo Chijuilla to northern bnd Cuba)	Rio Puerco @ Hwy 550	33RPuerc248.7	Upper end of segment. Last easy access to Rio Puerco before impacts from Cuba and WWTP.
Rio Puerco(Arroyo Chijuilla to northern bnd Cuba)	Rio Puerco abv WWTP	33RPuerc244.0	Sample river before it receives WWTP discharge.
Rio Puerco(Arroyo Chijuilla to northern bnd Cuba)	Cuba WWTP Outfall Channel	33RPuerc243.7	Monitor point source discharge.
Rio Puerco(Arroyo Chijuilla to northern bnd Cuba)	Rio Puerco blw WWTP @ Sanchez Property	33RPuerc241.8	Sample river after receiving discharge from Cuba WWTP outfall.
Rio Puerco (non-pueblo Rio Grande to Arroyo Chijuilla)	Rio Puerco abv La Ventana Restoration Project	33RPuerc224.8	Sample above La Ventana restoration project
Rio Puerco (non-pueblo Rio Grande to Arroyo Chijuilla)	Rio Puerco blw La Ventana Restoration Project	33RPuerc222.9	Monitor water below La Ventana project.
Rio Puerco (non-pueblo Rio Grande to Arroyo Chijuilla)	Rio Puerco @ Hwy 279 Bridge near San Luis	33RPuerc198.4	Only station in segment. Historically, lowest perennial station in watershed.
Rio Puerco (non-pueblo Rio Grande to Arroyo Chijuilla)	Rio Puerco @ I-25	33RPuerc004.6	Monitor ephemeral flow low in the watershed.

* No data collected, only photographs. Grants WWTP went to land application and channel now dry all year.

A summary of the status of the designated uses for this watershed, is provided in **Table 3**. **Table 4** lists the completed TMDL documents that were written based on these results. These documents can be found on SWQB's website: *www.nmenv.state.nm.us/swqb/TMDL*. For other identified impairments where a TMDL has not been completed please refer to the most recent version of the Integrated List to determine current plans for TMDL completion (*www.nmenv.state.nm.us/swqb/303d-305b/2010-2012*)

Table 3. Summary of assessment conclusions for applicable designated uses from 2006-2008 Integrated List.

Assessment Unit	Domestic Water Supply	Aquatic Life	Limited Aquatic Life	Coldwater Aquatic Life	H Q Cold Water Aquatic Life	Irrigation	Livestock Watering	Secondary Contact	Primary Contact	Wildlife Habitat	Marginal Warmwater Aquatic Life
Bluewater Creek (Bluewater reservoir to headwaters)	FS	--	--	NS	--	FS	FS	--	NA	FS	--
Bluewater Creek (non-tribal Rio San Jose to Bluewater Rsrv)	FS	--	--	NS	--	FS	FS	--	NA	FS	--
Rio Moquino (Laguna Pueblo to Seboyetita Creek)	FS	--	--	NS	--	FS	FS	--	NA	FS	--
Rio San Jose (Horace Springs to Grants WWTP)	FS	--	--	NS	--	FS	FS	--	NA	FS	--
La Jara Creek (Perennial reaches abv Arroyo San Jose)	FS	--	--	NS	--	FS	FS	--	NA	FS	--
Arroyo San Jose (Rio Puerco to La Jara Creek)	--	--	NA	--	--	--	NA	NA	--	NA	--
Rito de los Pinos (Perennial reaches abv Arroyo San Jose)	--	FS	--	--	--	--	NA	NA	--	NA	--
Rito Leche (Perennial reaches above Rio Puerco)	FS	--	--	NS	--	FS	FS	--	NA	FS	--
Nacimiento Creek (Rio Puerco to USFS bnd)	FS	--	--	FS	--	FS	FS	--	NA	FS	--
Senorito Creek (Nacimiento Mine to headwaters)	FS	--	--	NS	--	FS	FS	--	NA	FS	--
Senorito Creek San Pablo Canyon to Nacimiento Minen)	--	--	--	--	--	--	FS	--	NA	FS	FS
San Miguel Arroyo (San Pablo Canyon to headwaters)	--	--	FS	--	--	--	FS	NA	--	FS	--
San Pablo Canyon (Rio Puerco to headwaters)	--	FS		--	--	--	FS	NA	--	FS	--

Assessment Unit	Domestic Water Supply	Aquatic Life	Limited Aquatic Life	Coldwater Aquatic Life	H Q Cold Water Aquatic Life	Irrigation	Livestock Watering	Secondary Contact	Primary Contact	Wildlife Habitat	Marginal Warmwater Aquatic Life
Rio Puerco (northern bnd Cuba to headwaters)	--	FS	--	--	--	--	FS	NA	--	FS	--
Rio Puerco(Arroyo Chijuilla to northern bnd Cuba)	--	NS	--	--	--	--	FS	FS	--	FS	NS
Rio Puerco (non-pueblo Rio Grande to Arroyo Chijuilla)	--	--	--	--	--	FS	NA	NA	--	--	FS

FS: Full Support; NS: Non-Support; NA: Not Assessed, --: Not Applicable

Table 4. Completed TMDLs for the Rio Puerco Watershed.

Waterbody	Watershed	Pollutant TMDL	Status
Rio Puerco (Arroyo Chujuilla to northern bnd Cuba)	Rio Puerco	Sedimentation/ Siltation	*Rio Puerco TMLD Part I* WQCC Approved 11-16-06 EPA Approved 8-10-07
Rio Puerco (Arroyo Chujuilla to northern bnd Cuba)	Rio Puerco	Chronic Aluminum, Plant Nutrients	*Rio Puerco TMLD Part II* WQCC Approved 8-14-07 EPA Approved 9-21-07
La Jara Creek (Perennial reaches abov Arroyo San Jose)	Rio Puerco	Chronic Aluminum	
Bluewater Creek (Bluewater Rsrv to headwaters)	Rio San Jose	Temperature and Plant Nutrients	
Bluewater Creek (non-tribal Rio San Jose to Bluewater Rsrv.)	Rio San Jose	Temperature and Plant Nutrients	
Rio Moquino (Laguna Pueblo to Seboyeta Creek)	Rio San Jose	Temperature and Plant Nutrients	

Table 5 summarizes parameter suites collected in each assessment unit and at each station. The number of times each parameter (or suite of parameters) was sampled is indicated (in the case of stream discharge, some of the data are estimated or calculated). Field data include temperature, specific conductance, pH, dissolved oxygen, and turbidity. An (X) indicates that a given parameter suite was sampled in that AU. Numbers indicate sampling frequencies.

Table 5. Sampling Summary. Photo 4. Confluence of Arroyo San Jose (top) and the Rio Puerco

Assessment Unit	Station	Ions	Nutrients	Dissolved Metals	Total Metals	Cyanide	Bacteria	Radionuclides	Macroinvertebrates	Electro-fished	Thermograph	Discharge	Organics (SVOCs)	Sonde Deployment	Field Data
Bluewater Creek (Bluewater reservoir to headwaters)	Bluewater Creek above Bluewater Lake @ USGS Gage 8341300	8	7	4	5	2	5				1*	1			8
Bluewater Creek (non-tribal Rio San Jose to Bluewater Rsrv)	Bluewater Creek @ mouth of Bluewater canyon	8	8	6	7	2	4				1		1		9
Rito Moquino (Laguna Pueblo to Seboyetita Creek)	Rito Moquino below confl of Seboyetita Creek and Seboyeta Creek	7	6	4	5	2	6	1				1			8
Rio Paguate (Laguna Pueblo bnd to headwaters)	Rio Paguate above Laguna Pueblo	Not sampled – no access found above Pueblo													
Rio San Jose (Laguna Pueblo)	RIO SAN JOSE NEAR LAGUNA, NM	1	1	1	1										1
Rio San Jose (Horace Springs to Grants WWTP)	Rio San Jose blw Grants WWTF Discharge[1]	Not sampled - dry after Grants effluent diverted													
La Jara Creek (Perennial reaches abv Arroyo San Jose)	La Jara Creek abv irrigation diversion	8	8	7	7	1	3	9	1		1*	5			9
Arroyo San Jose (Rio Puerco to La Jara Creek)	Arroyo San Jose @ Hwy 550	4	4				2					5			4
Rito de los Pinos (Perennial reaches abv Arroyo San Jose)	Rito de los Pinos @ USFS gate on FR 95	2	2	1	1			1			1	3			2
Rito Leche (Perennial reaches above Rio Puerco)	Rito Leche @ Hwy 126	3	3				3					3			3
Rito Leche (Perennial reaches above Rio Puerco)	Rito Leche @ Cubita Rd	3	3	1	1		3								3
Nacimiento Creek (Rio Puerco to USFS bnd)	Nacimiento Creek @ Eureka Rd	6	6	3	3	1	2	2	1		1	3	1	1	6
	Nacimiento Creek @ Hwy 126	2	2				3					1			2
Senorito Creek (Nacimiento Mine to headwaters)	Senorito Creek abv Nacimiento Mine	8	8	8	8	1					1*	1			8

Assessment Unit	Station	Ions	Nutrients	Dissolved Metals	Total Metals	Cyanide	Bacteria	Radionuclides	Macroinvertebrates	Electro-fished	Thermograph	Discharge	Organics (SVOCs)	Sonde Deployment	Field Data
Señorito Creek (San Pablo Canyon to Nacimiento Mine)	Senorito Creek blw Nacimiento Mine	2	2	2	2							2			2
San Miguel Arroyo (San Pablo Canyon to headwaters)	San Miguel Arroyo @ old Hwy 44	1	1	1	1										1
San Pablo Canyon (Rio Puerco to headwaters)	San Pablo Canyon abv Rio Puerco	2	2	1	1		1					3			2
Rio Puerco (northern bnd Cuba to headwaters)	Rio Puerco @ CR 13	6	6	4	4	1	5				1	6		1	6
Rio Puerco(Arroyo Chijuilla to northern bnd Cuba	Rio Puerco @ Hwy 550	8	8	3	3	1	8	1	1		1*		1		10
	Rio Puerco abv WWTP	8	8	8	8	1	5	1					1		10
	Cuba WWTP Outfall Channel	8	8	8	8	1	8	3							8
	Rio Puerco blw WWTP @ Sanchez Property	10	10	8	7	1	7						1		12
Rio Puerco (non-pueblo Rio Grande to Arroyo Chijuilla	Rio Puerco abv La Ventana Restoration Project	4									1*				4
	Rio Puerco blw La Ventana Restoration Project	4													5
	Rio Puerco @ Hwy 279 Bridge near San Luis	6	6	6	6		6	2				5	1		7
	Rio Puerco @ I-25	3	3	1	1							1			3

* Water plus air thermographs.
[1] No data collected, only photographs. Grants WWTP went to land application and channel now dry all year.

6.0 Results and Water Quality Assessment

For many water quality parameters, the State of New Mexico has adopted numeric water quality standards. However, for several parameters (e.g., plant nutrients, stream bottom deposits), only narrative standards exist. Data are assessed for designated use attainment status for both numeric and narrative water quality standards by application of the Assessment Protocol and associated appendices (NMED/SWQB 2006a).

The purpose of this section of the report is to provide the reader with information on where current water quality standards are being exceeded within the watershed. These exceedences are used to determine designated use impairment status. It should be noted that a single exceedence of a given criterion may not generate a violation of standards, triggering a listing on the 303(d) list. Final assessment determinations as to whether or not a stream reach is considered to be supporting its designated uses depends on either the total number of exceedences or the exceedence ratio (number of exceedences to all available data for a given parameter). Refer to NMED/SWQB's Assessment Protocol for additional information on the assessment process, NMED/SWQB 2006a. When available, outside sources of data that meet quality assurance requirements are combined with data collected by SWQB during intensive watershed survey to determine final impairment status. Final designated use impairment status is housed in the Assessment Database (ADB) and is reported in the biennial *State of New Mexico Integrated Clean Water Act §303(d)/§305(b) Report* (NMED/SWQB 2006b).

6.1 Water Quality Impairments For Numeric Criteria

6.1.1 Physicochemical Data

Results from the water quality data assessment indicated designated use impairments due to aluminum (chronic), total ammonia, sedimentation / siltation and temperature, at a number of stations. See **Table 6.**

Table 6. Water quality impairments documented in the 2006-2008 303d list of impaired waters (NMED/SWQB, 2006b) and the associated exceedence ratios resulting in the listing.

Assessment Unit / Station	Chronic Aluminum	Total Ammonia	Temperature	Nutrients	Sedimentation
Bluewater Creek (Bluewater Reservoir to headwaters			**X**	**X**	
Bluewater Cr abv Bluewater Lake @ USGS gage			See table 7		
Bluewater Creek (non-tribal Rio San Jose to Bluewater Reservoir)			**X**	**X**	
Bluewater Cr @ mouth of Bluewater Cyn			See table 7	See table 11	
Rio Moquino (Laguna Pueblo to Seboyettia Creek)			**X**	**X**	
Rito Moquino below confluence with Seboyetita Creek and Seboyeta Creek			3/6	See table 11	
La Jara Creek (Perennial reaches abv Arroyo San Jose)	**X**				
La Jara Creek abv irrigation diversion	3/7				
Rio Puerco(Arroyo Chijuilla to northern bnd Cuba)	**X**	**X**		**X**	**X**
Rio Puerco @ Hwy 550	1/3	0/7		See table 11	See table 10
Rio Puerco abv WWTP	3/8	2/8			
Rio Puerco blw WWTP @ Sanchez Property	1/8	3/9			

6.1.2 Data from Continuous Monitoring Devices

Large datasets generated from data loggers (e.g., sondes and thermographs) are assessed according to protocols developed specifically for such datasets (with few exceptions). This is because, unlike grab sample data, it is not reasonable to list as not supporting on the basis of one or a few exceedences out of several hundred or thousand data points. Temperature (given in °C) and pH assessment criteria are tied to the criteria in the *State of New Mexico Standards for Interstate and Intrastate Surface Waters (NMAC, 2006).* Dissolved oxygen assessment criteria are based on the tolerance of sensitive aquatic organisms, *e.g.* early life stages, and designated use, *e.g.* marginal coldwater aquatic life use. SWQB's *Assessment Protocol* provides details of large dataset assessment procedures (NMED/SWQB 2006a).

Temperature data loggers (thermographs) were deployed at 11 stations in the Rio Puerco watershed to assess attainment of the aquatic life designated use. Additionally, six thermographs were deployed in the air to determine the effect of air temperature on water temperature. The thermographs were programmed to record hourly. **Table 7** summarizes these datasets. Multi-parameter data loggers (sondes) were deployed at stations Rio Puerco at County Road 13 Bridge (33RPuerc256.0) and Nacimiento Creek (33NaciCr001.9) to evaluate pH and DO. **Tables 8a and 8b** summarize these data.

Table 7. Summary of thermograph data.

Station Name	Data Collection Interval	WQS Temperature Criterion (°C)	Maximum Recorded Temperature (°C)	Total # of Data Points	# / % of Exceedence	Temperature Assessment
Bluewater Creek above Bluewater Lake @ USGS Gage 8341300	6/10 – 12/17	20	27.85	4571	656/14.4%	NS
Bluewater Creek @ mouth of Bluewater canyon	6/10 – 12/17	20	26.256	4570	582/12.7%	NS
La Jara Creek abv irrigation diversion	6/3 – 12/17	20	14.88	4739	0/0%	FS
Rito de los Pinos @ USFS gate on FR 95	6/3 – 12/17	20	20.72	4737	4/0.01%	FS
Nacimiento Creek @ Eureka Rd	6/3 – 12/17	20	22.25	4737	29/0.6%	FS
Senorito Creek abv Nacimiento Mine	6/3 – 12/17	20	15.3	4737	0/0%	FS

Station Name	Data Collection Interval	WQS Temperature Criterion (°C)	Maximum Recorded Temperature (°C)	Total # of Data Points	# / % of Exceedence	Temperature Assessment
Rio Puerco @ CR 13	6/3 – 12/17	32.2	24.27	4738	0/0%	FS
Rio Puerco @ Hwy 550	6/10 – 12/17	32.2	28.419	4424	0/0%	FS
Rio Puerco abv La Ventana Restoration Project	6/10 – 12/17	32.2	30.75	4737	0/0%	FS

Table 8a. Summary of pH Data Collected from Sondes.

Assessment Unit Station	Designated Use	Criterion SU	Deployment Dates (2004)	Min/Max SU	Number/% Exceedences	Magnitude Violation	Frequency Violation	pH Assessment
Rio Puerco @ CR 13	**CWAL**	**6.6-8.8**	7/20 – 7/28	7.65 - 8.19	0/0%	**No**	**No**	**FS**
Nacimiento Creek @ Eureka Rd	**CWAL**	**6.6-8.8**	7/20 – 7/28	8.22 – 8.51	0/0%	**No**	**No**	**FS**

Table 8b. Summary of DO Data Collected from Sondes.

Assessment Unit Station	Designated Use	WQS Criterion (mg/L)	Deployment Dates (2004)	Min/Max Conc. (mg/L)	Min Sat. (% local)	Assessment Criterion	Combined Conc./Sat. Exceedences (# / % / >3 hrs)	% Sat Exceedences (# / % / >3 hrs)	DO Assessment
Rio Puerco @ CR 13	**MWWAL**	6.0	7/20 – 7/28	5.6/8.3	81.7%	OLS	0/0% No	0/0% No	FS
Nacimiento Creek @ Eureka Rd	**CWAL**	6.0	7/20 – 7/28	7.4/9.9	101.4%	OLS	0/0% No	0/0% No	FS

NOTES: CWAL = Coldwater Aquatic Life; MWWAL = Marginal Warmwater Aquatic Life
OLS refers to Other Life Stages, as opposed to the more sensitive ELS, Early Life Stages

6.2 Water Quality Impairments For Narrative Criteria

6.2.1 Sedimentation Assessment and Macroinvertebrate Community

Since the narrative standard for bottom deposits (i.e., sedimentation/siltation) is dependent on biological condition, the assessment of this physically-based criteria is done with a biological response variable that links excess settled sediment levels to aquatic life use attainment.

Substrate Composition

Pebble counts in representative riffles were conducted as part of the habitat survey. The size of sediment particles within a stream system is one of the most important physical attributes in determining the health of aquatic communities. There are two components to sediment load that impact aquatic life: suspended load and bed load. Suspended load is quantified through the measurement of turbidity and total suspended solids. Bed load describes the particles that settle to, or roll along, the bottom (saltation) of the channel. Larger bed load particles provide increased interstitial space between particles, thus allowing for different aquatic communities than those found among small particles with little or no space. The size of sediment within a stream has a natural progression from course, large particles in sections at high elevation with smaller watershed size, gradually decreasing to sand in low elevation streams with large watersheds. Therefore, to determine whether a stream exhibits an unnaturally fine bed load, knowledge of the location of the stream segment within the watershed is necessary. Particles smaller than 2 mm are considered “fines”, and “percent fines” are considered for assessment purposes (see 20.6.4.13(A) NMAC). The percent fines is calculated by adding the % sand and % silt-clay fractions.

Macroinvertebrate Sampling

The macroinvertebrate community is generally the first to show a response to impairment such as fine sediment. By collecting data on macroinvertebrate communities that are present in a stream SWQB can identify changes that indicate impairment. This was done by utilizing the Rapid Bioassessment Protocol (RBP) approach (Plafkin et. al 1989, Barbour et. al 1999). The extent of impairment is determined as a percentage comparison of the sum of selected metric scores at the study site to a reference site. For example, a study site achieving a biological assessment score greater than 83 percent of the reference site would be deemed non-impaired (full-support). If the score is less than 79 percent of the reference site score, it can be concluded that the community is impaired (i.e. non-support) (**Table 9**).

Table 9. Biological Integrity Attainment Matrix using the RBP Index

% Comparison to Reference Site(s)	Biological Condition Category [2]	Attributes [1]
>83%	Non-impaired (Full Support)	Comparable to best situation to be expected within ecoregion (watershed reference site). Balanced trophic structure. Optimum community structure (composition & dominance) for stream size and habitat quality.
79 – 54%	Slightly Impaired (Non Support)	Community structure less than expected. Composition (species richness) lower than expected due to loss of some intolerant forms. Percent contribution of tolerant forms increases.
50– 21%	Moderately Impaired (Non Support)	Fewer species due to loss of most intolerant forms. Reduction in EPT index.
<17%	Severely Impaired (Non Support)	Few species present. Densities of organisms dominated by one or two taxa.

[1] RBP Index, percentages, and biological attributes are taken from Plafkin *et al.,* 1989. Percentage values obtained that are in between the above ranges will require best professional judgment as to the correct placement.
[2] New Mexico has combined all but the "non-impaired" category into "Non Support" per USEPA Region 6 suggestion.

Sedimentation/Siltation Assessment

In order to assess for excess sedimentation, the biological index score and the percent fines in the stream reach are first assessed independently for their support of the aquatic life use. Reference sites are currently used to determine the amount of fines appropriate for each stream reach. If a low biological index score coincides with percent fines greater than 20% and this value exceeds a 28% increase from the associated reference site, excess fine sediment is indicated as a cause of impairment. If only the biological index score is low, excess fine sediment is not indicated as a cause of impairment because it is assumed that something other than fine sediment is causing the benthic macroinvertebrate community to be suboptimal. Macroinvertebrate and sediment data were assessed at sites with both benthic macroinvertebrate and pebble count data (**Table 10**).

Table 10. Sediment evaluations for the Rio Puerco and the Rio San Jose watersheds

Station Name	RBP Index score	% of Reference RBP	Biological Assessment	Percent Fine Sediment	% Increase in fines	Sediment Assessment
La Jara Creek above Irrigation Diversion	44	100%	FS	14	0%	FS
Nacimiento Creek at Eureka Rd*	38	86%	FS	34	143%	FS
Rio Hondo above the Rio Grande	48	100%	FS	29	0%	FS
Rio Puerco @ Hwy 550**	16	33%	**NS**	68	134%	**NS**

NOTES:
NS = Not Supporting; FS = Fully Supporting;
* La Jara Creek above Irrigation Diversion used as reference site.
* Rio Hondo above the Rio Grande not part of this study but used as reference site.

6.2.2 Periphyton Community and Nutrient Assessment

The periphyton community is another biological indicator that can express aquatic ecosystem health. The use of periphyton community data is still in early stages of development and does not provide conclusive information at this time. Periphyton is collected in biological surveys for a community composition analysis and for the quantification of chlorophyll *a* for the second level of nutrient assessments. A Level 1 nutrient screen is performed at each survey station to determine if excess nutrients may be an issue for the reach. If necessary, a series of data is collected for the nutrient Level 2 survey to determine impairment status.

Nutrient Level 2 Assessment

Level 2 nutrient surveys were conducted at sites that were previously listed as impaired due to plant nutrients or that the Level 1 nutrient assessment indicated the possibility of nutrient impairment. For more information on this process refer to the *Nutrient Assessment Protocol for Wadeable, Perennial Streams* (NMED/SWQB 2005). The Level 2 nutrient survey consists of data collection on a number of indicators including total phosphorus, total nitrogen, dissolved oxygen, pH, and periphyton chlorophyll *a* concentration. Chlorophyll *a* is a quantitative measure of algal biomass which is the direct or indirect cause of most problems associated with nutrient impairment. The indicators are compared to the applicable criterion or threshold value to generate an exceedence ratio, (**Table 11**). For total phosphorus and total nitrogen, the threshold values are dependent on the ecoregion and designated aquatic life use.

Table 11. Nutrient Level 2 Assessment Data for Rio Puerco and the Rio San Jose

Assessment Unit	Ecoregion – Aquatic Life Use	DO & pH – long term datasets	DO %Sat. – grab (# and % of exceedences)	DO conc – grab (# and % of exceedences)	pH – grab (# and % of exceedences)	Total Nitrogen (# and % of exceedences)	Total Phosphorus (# and % of exceedences)	Chlorophyll a exceedence?	Nutrient Assessment
Bluewater Creek (non-tribal Rio San Jose to Bluewater Reservoir)	AZ/NM Plateau – Cold Water	N/A	**7/8 – 88%**	0/8 = 0%	0/7 = 0%	**4/8 = 50%**	1/8 = 12%	**Yes**	**NS***
Bluewater Creek (Bluewater Reservoir to headwaters)	AZ/NM Mountains – Cold Water	N/A	**2/7 = 29%**	**2/7 = 29%**	0/7 = 0%	**4/7 = 57%**	**4/7 = 57%**	**Yes**	**NS***
La Jara Creek (Perennial reaches abv Arroyo San Jose)	AZ/NM Plateau – Cold Water	N/A	1/8 = 12.5%	0/8 = 0%	0/8 = 0%	0/6 = 0%	**2/6 = 33%**	no	FS
Nacimiento Creek (Rio Puerco to USFS bnd.)	AZ/NM Mountains – Cold Water	FS	0/7 = 0%	0/7 = 0%	0/7 = 0%	**5/7 = 71%**	**4/7 = 57%**	no	FS

Assessment Unit	**Ecoregion – Aquatic Life Use**	**DO & pH – long term datasets**	**DO %Sat. – grab** (# and % of exceedences)	**DO conc – grab** (# and % of exceedences)	**pH – grab** (# and % of exceedences)	**Total Nitrogen** (# and % of exceedences)	**Total Phosphorus** (# and % of exceedences)	**Chlorophyll *a* exceedence?**	**Nutrient Assessment**
Rio Moquino (Laguna Pueblo to Seboyeta Creek)	AZ/NM Mountains – Cold Water	N/A	**2/5 = 40%**	0/5 = 0%	0/5 = 0%	**3/6 = 50%**	**1/6 = 17%**	no	**NS***
Rio Puerco (Arroyo Chijuilla to northern boundary of Cuba)	AZ/NM Plateau – Warm Water	FS for DO **NS for pH**	**12/26 = 46%**	4/27 = 15%	**5/32 = 16%**	**17/23 = 74%**	**19/23 = 83%**	no	**NS**

NOTES: **Bolded Cells** indicate parameters that exceed the threshold value.
FS = Fully Supporting
NS = Not Supporting
***** = Sonde (long-term) data needed to verify DO impairment.

6.2.3 Fish Community Data

As a follow up to the 2004 survey, fish were collected from the Rio Puerco on 7 March 2006 at two locations. At both locations, only one species, fathead minnow (*Pimephales promelas*), was collected. This species is native to the Rio Grande basin.

At the US 550 crossing in the village of Cuba, 14 fathead minnow were collected. Habitat was poor, with no pools and only very shallow (estimated average depth was 5 cm) riffles (20%) and runs (80%). Approximately 100 m of stream was sampled, with an estimated average width of 1 m. Riparian vegetation was dominated by willow. Dissolved oxygen saturation was 101.8% (9.2 mg/L).

Below the Cuba wastewater treatment plant, 46 fathead minnow were collected. At least two size classes were present. The sampled reach was 75 m reach with an estimated average width of 3.5 m and an estimated average depth of 0.5 m. The entire reach contained neither pools nor riffles, only runs. Riparian vegetation was dominated by willow. Dissolved oxygen saturation was 183% (16.6 mg/L). Anaerobic sediment was present.

7.0 Discussion

Due to the large volume of data collected during this survey, it will not be included in this report. Those persons requiring a complete dataset or data from a specific site should contact the Surface Water Quality Bureau or search EPA's STORET database at: www.epa.gov/STORET.

As noted above, extensive sampling for ions, nutrients, total and dissolved metals, radionuclides, biological indicators (bacteria, aquatic invertebrates, algae/periphyton and fish) and field parameters found exceedences attributable variously to plant nutrients, aluminum, sedimentation, temperature and bacteria in a number of assessment units. Of these, the most ecologically significant are the effects of sedimentation and temperature.

Bedload impairs channel function and the banks become destabilized, adding yet more sediment to the channel. In addition to the immediate effects of sediment inputs to stream channels, the cumulative impacts can be far reaching. As sediment accumulates in channels they become shallower, and must increase their width to accommodate flow. This further increases sediment inputs, causes the channel to become wider and shallower (increased width/depth ratio), decreases sinuosity, and increases gradient, which then initiates down-cutting. Down-cutting proceeds both downstream and upstream, eventually denying the stream access to its floodplain, lowering the water table below the root zone and increasing the erosive power of high flows. The results of this snowballing cascade of events can be seen in many streams across New Mexico. (See **photos 1 and 4**)

Elevated water temperature not only stresses aquatic communities directly by increasing the metabolic rates of fish, particularly salmonids, thereby increasing food requirements; but indirectly, by decreasing oxygen saturation. The net effect of this impact is to decrease species diversity, limiting the community to tolerant species. Amelioration of elevated temperatures in a stream or river is conceptually simple: narrow and deepen the channel (reduce the width/depth ratio) and provide shade through planting of woody vegetation. In practice this can be a complex, costly and time consuming process.

According to the New Mexico water quality standards (20.6.4.900 NMAC), the dissolved aluminum chronic criterion is 0.087 mg/L and the dissolved aluminum acute criterion is 0.75 mg/L for aquatic life uses. The chronic criterion was exceeded 3 of 7 times on La Jara Creek (perennial reaches above Arroyo San Jose) and 5 of 19 times on Rio Puerco (Arroyo Chijuilla to northern boundary Cuba).

High chronic levels of dissolved aluminum can be toxic to fish, benthic invertebrates, and some single-celled plants. Aluminum concentrations from 0.100 mg/L-0.300 mg/L increase mortality, retard growth, gonadal development and egg production of fish (www.bae.ncsu.edu/programs/extension/wqg). Acute levels of dissolved aluminum can be especially detrimental to aquatic life, increasing mortality rates for many species of fish and other aquatic life. No violations of the acute aluminum criterion were identified based on the results obtained from this survey. Given that there are no anthropogenic sources of dissolved aluminum adjacent to or above the impacted reaches, and that all exceedences occurred during the period of maximum spring snowmelt, the cause of the exceedences may be inferred to be mobilization of naturally occurring aluminum by snowmelt water, which is slightly acidic.

The potential for excessive nutrients in the Rio Puerco, Bluewater Creek, and Rio Moquino was noted through visual observation and chemical analyses during the 2004 SWQB intensive watershed survey. Assessment of various water quality parameters indicated nutrient impairment in Rio Puerco (Arroyo Chijuilla to northern boundary of Cuba), Bluewater Creek (non-tribal Rio San Jose to Bluewater Reservoir), Bluewater Creek (Bluewater Reservoir to headwaters), and Rio Moquino (Laguna Pueblo to Seboyetita Creek).

The reason for controlling plant nutrients is to preserve aesthetic and ecologic characteristics along the waterway that result from excessive growth of aquatic vegetation the resulting large diurnal swings in DO that can impact aquatic life. There are two potential contributors to nutrient enrichment in a given waterbody: excessive nitrogen and/or phosphorus. Sources for these nutrients in the Rio Puerco/Rio San Jose watershed are, primarily, overland storm water runoff and the Cuba wastewater treatment plant (WWTP). Given the large size of the catchments, overland runoff is the largest source of nutrients. While improvements to the Cuba WWTP would improve water quality locally, real, basin wide, improvement will only be seen if storm runoff can be reduced through infiltration before it finds its way into the channel.

Photo 4. Confluence of Arroyo San Jose (top) and the Rio Puerco

Photo 5. La Jara Creek.

Photo 6. Rio Puerco above La Ventana.

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