WATER QUALITY SURVEY SUMMARY

FOR THE

VALLES CALDERA NATIONAL PRESERVE WATERSHED

(FROM VCNP BOUNDARY TO HEADWATERS)

2001

Prepared by

Surface Water Quality Bureau
New Mexico Environment Department

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Acknowledgements

Report Authors Seva Joseph/Heidi Henderson

Field Crew

Biology/Habitat: Seva Joseph, Study Lead

Watershed Protection: Nina Wells

GIS/Map Bill Skinner

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ADB	Assessment Database
Al	Aluminum
C	Celsius
CWA	Clean Water Act
DO	Dissolved Oxygen
GIS	Geographic Information Systems
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
QAPP	Quality Assurance Project Plan
STORET	Storage and Retrieval System
SWQB	Surface Water Quality Bureau
USC	United States Code
USEPA	United States Environmental Protection Agency
VCNP	Valles Caldera National Preserve

1.0 EXECUTIVE SUMMARY

Water quality surveys and assessments are completed in fulfillment of Section 106 of the Clean Water Act (CWA) [33 USC 1251 et seq.], *Work Program for Water Quality Management.* The purpose of the water quality survey is to collect water quality data to identify and prioritize water quality problems within a watershed and to evaluate the effectiveness of water quality based controls. The data collected as part of the survey are compared to current United State Environmental Protection Agency (USEPA) approved water quality standards to determine if waterbodies throughout the watershed are supporting their designated uses, such as the fishable and swimmable goals set forth in the CWA §102(a).

Water Quality Survey Summary Reports focus on information and data collected by the New Mexico Environment Department's (NMED) Surface Water Quality Bureau (SWQB) pertaining to stream reaches that were identified as NOT meeting water quality standards. All data collected as part of a survey are available upon request to the SWQB and can be downloaded from USEPA's computerized environmental data system known as STORET (http://www.epa.gov/storet/). The data collected as part of this study are later combined with all other readily available or submitted data that meet state quality assurance/quality control requirements to form the basis of designated use attainment determinations summarized in the biennial *State of New Mexico Integrated CWA §303(d)/305(b) Report*.

Numerous water quality standards criteria exceedences were observed throughout the Valles Caldera National Preserve (VCNP) watershed; however, few of these exceedences were significant enough to conclude that the waterbody was impaired for those parameters where exceedences were detected (refer to Table 4 for specific waterbodies and associated parameters and to the *Assessment Protocol* (NMED/SWQB 2004a) for information on impairment determinations). Four stream reaches, or assessment units, were determined to be impaired based on the 2001 survey for parameters other than aluminum. Jaramillo Creek from East Fork Jemez to the headwaters is impaired due to temperature and turbidity and does not support the designated aquatic life use. The Jemez River from the VCNP boundary to the headwaters is impaired due to dissolved oxygen, pH, temperature, and turbidity. Redondo Creek from Sulphur Creek to the headwaters is impaired based on temperature exceedence. San Antonio Creek from the VCNP boundary to the headwaters is impaired due to dissolved oxygen, pH, temperature and turbidity. Many of the impairments on these four assessment units have already been addressed in existing TMDL documents. Additionally, all seven assessment units in this survey are impaired due to dissolved aluminum, but they are listed as 5B because aluminum is naturally high in this watershed.

2.0 INTRODUCTION

The Monitoring and Assessment Section of the Surface Water Quality Bureau (SWQB) conducted an intensive water quality survey on the Valles Caldera National Preserve (VCNP) between May 9, 2001 and April 24, 2002. Between February and November, 17 sample events were conducted to capture different portions of the hydrograph (**Figure 1**). Due to the lack of significant snowfall during the winter of 2002, the snow runoff (rising leg of the hydrograph) captured during the spring 2002 sample events was well below average. Water quality, physical habitat, and biota were studied to characterize the streams and determine impairment. Water samples were analyzed for plant nutrients, ions, total and dissolved metals and on a more limited basis fecal coliform bacteria, radionuclides, and anthropogenic organics compounds. Physical habitat was assessed using geomophological surveys. Fish and benthic macroinvertebrates communities were surveyed and field parameters such as dissolved oxygen and pH were measured.

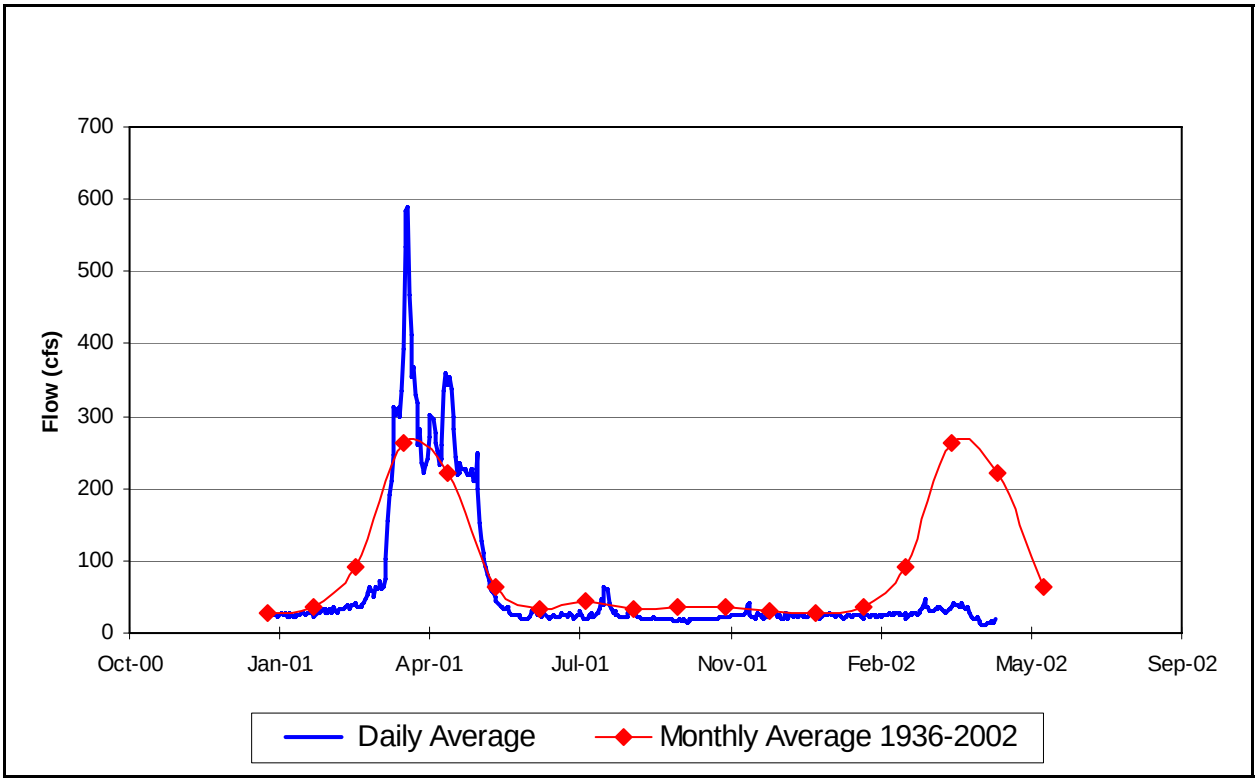

Figure 1. Discharge of the Jemez River at Jemez.

The survey included 6 primary sites and 12 secondary sites (**Figure 2 and Table 1**). The primary sites were sampled 17 times and located on larger streams near where they flow out of the VCNP or upstream from the confluence with other streams. Monitoring these sites enabled an assessment of the cumulative influence of the physical habitat, water sources, and land management activities upstream from the sites, i.e. the stream reach in the caldera. Sites on the Rito de los Indios and Jaramillo Creek have been determined by the USFS to be in Proper Functioning Condition (PFC) and may serve as reference sites. Secondary sites were sampled

one to three times to characterize the smaller tributaries, determine the influence of springs and wells, and examine changes in the character of the larger streams in the upstream reaches. The type of monitoring done at each site is summarized in **Table 2**.

The VCNP is located in the Jemez Mountains, a volcanic field that overlies the western edge of the Rio Grande Rift. The one million-year-old, 15-mile diameter caldera was formed when the volcanic pile collapsed in response to a huge eruption of ash. Subsequent resurgence of magma formed domes along the caldera ring fracture. The caldera was originally a closed basin that retained water and created a high-altitude lake.
The wall of the caldera was eventually breached, draining the lake and exposing its long-accumulated sediments (Valles Caldera 2004). The Jemez Mountains contain a number of hot springs that result from the flow of groundwater near the top of a subsurface body of igneous rock that still may be partially molten (Summers 1976). In places some of the water rises to the surface to supply fumaroles and hot springs, evidence of continuing geothermal activity.

In the 1700 and 1800's Basque colonists supported a tremendous sheep-grazing industry throughout New Mexico including the Valles Caldera. The Luis Maria Cabesa de Baca family was awarded the land encompasses most of the Valles Caldera in 1821 under the Spanish Land Grant Treaty of Guadalupe Hidalgo. In the early 1900's, the Basque sheep gradually gave way to Anglo cattle and logging, and the "Baca Grant" was eventually bought by the Dunigan Family of Abilene, Texas and became known as the Baca Ranch (Schiller and Matthews 2002). The Dunigans leased grazing, drilled wells to explore geothermal potential, and battled with the New Mexico Timber Company who owned the timber at that time. In 1999, after two years of negotiations, the White House reached an agreement to buy the 89,000-acre ranch to permanently protect it as national preserve lands. A nine-member board of trustees is responsible for the protection and development of the Valles Caldera National Preserve, a unique experiment in public land management (Valles Caldera National Preserve 2005)

3.0 NM WATER QUALITY STANDARDS

General water quality criteria and criteria applicable to attainable or designated uses for portions of the Jemez River watershed that were surveyed in this study are set forth in sections 20.6.4.13 and 20.6.4.900, of the *Standards for Interstate and Intrastate Surface Waters* (20.6.4 NMAC, effective July 17, 2005). Segment specific standards for the Jemez watershed are set forth in Sections 20.6.4.108 and 20.6.4.124 NMAC and read as follows:

20.6.4.108 RIO GRANDE BASIN - Perennial reaches of the Jemez river and all its tributaries above Soda dam near the town of Jemez Springs, except Sulphur creek above its confluence with Redondo creek, and perennial reaches of the Guadalupe river and all its tributaries.

A. Designated Uses: domestic water supply, fish culture, high quality coldwater aquatic life, irrigation, livestock watering, wildlife habitat and secondary contact.

B. Criteria:

(l) In any single sample: specific conductance 400 µmhos/cm or less, pH within the range of 6.6 to 8.8 and temperature 20°C (68°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 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.201 NMAC - Rp 20 NMAC 6.1.2201, 10-12-00; A, 05-23-05]

20.6.4.124 RIO GRANDE BASIN - Perennial reaches of Sulphur creek from its headwaters to its confluence with Redondo creek.

A. Designated Uses: limited aquatic life, wildlife habitat, livestock watering and secondary contact.

B. Criteria:

(l) In any single sample: pH within the range of 2.0 to 9.0 and temperature 30°C (86°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 548 cfu/100 mL or less; single sample 2507 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

(3) The chronic aquatic life criteria of Subsections I and J of 20.6.4.900 NMAC shall also apply. Pecos river to that contributed by springs along the watercourse.

[20.6.4.202 NMAC - Rp 20 NMAC 6.1.2202, 10-12-00; A, 05-23-05]

Due to exceedences of the above standards, some of the streams that flow from the VCNP are on the State's 303(d) list of impaired waters. These listings are based on water quality, physical habitat and/or benthic macroinvertebrate data collected downstream from the caldera in 1998. Each of the 7 assessment units in this study are listed for aluminum (Al) on the *2004-2006 State of New Mexico Integrated Clean Water Act §303(d)/ §305(b) Report* (NMED/SWQB). The aluminum listing in these cases is listed in category 5B meaning:

> *"5B-**A review of the water quality standard will be conducted**. AUs are listed in this category when it is possible that water quality standards are not being met because one or more of the current designated uses are inappropriate. After a review of the water quality standard is conducted, a Use Attainability Analysis (UAA) will be developed and submitted to USEPA for consideration, or the AU will be moved to Category 5A and a TMDL will be scheduled." (NMED/SWQB, 2006).*

Table 1 details the current listings on the *2004-2006 State of New Mexico Integrated Clean Water Act §303(d)/ §305(b) Report* (NMED/SWQB) as well as existing TMDLs for these assessment units. A Use Attainability Study has been conducted for Sulphur Creek to change the standard to reflect the acidic character of this stream. Total Maximum Daily Loads (TMDLs) are being written for the other streams for which impairments were found based on the 2001 survey. http://www.nmenv.state.nm.us/swqb/Projects/TMDL/index2.html

Table 1. Summary of 2004-2006 Integrated List and Existing TMDLs.

Assessment Unit	2004-2006 Integrated List	Existing TMDLs (date)
Jaramillo Creek (E Fk Jemez to headwaters)	Al, temperature, turbidity	None
East Fork Jemez (VCNP bnd to headwaters)	Al, DO, pH, temperature, turbidity	Turbidity (2002)
La Jara Creek (E Fk Jemez to headwaters)	Al	None
Redondo Creek (VCNP bnd to headwaters)	Al, temperature, turbidity	Turbidity, temperature (2002)
Rito de los Indios (San Antonio Creek to headwaters)	Al	None
San Antonio Creek (VCNP bnd to headwaters)	Al, DO, pH, temperature	Temperature, turbidity (2002)
Sulphur Creek (VCNP bnd to headwaters)	Al, pH, specific conductance	pH, conductivity (2002)

4.0 METHODS

Water quality, 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 2001). 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) and the SWQB QAPP (NMED 2001). Fluvial geomorphologic measurements were in accordance with protocols in the SWQB QAPP (NMED 2001).

Water chemistry samples were collected in at the primary sites on May 9, 15, 23, 30, June 14 and 26, July 18, August 8 and 27, September 4 and 20, and October 10 and 30, 2001. Sites were also sampled in 2002 on March 20 and 26 and April 10 and 24. Secondary sites were surveyed on June 13 and September 4, 2001 as well as April 23, 2002. Fecal coliform and *E. coli* samples were collected at select sites on June 26 and September 20, 2001 as well as April 24, 2002 (**Table 2**).

5.0 SAMPLING SUMMARY

A map of the study area is provided in **Figure 2**. The station numbers, STORET identification codes (where available), and location descriptions of sampling stations selected for this survey are provided in Table 1. The rational for selecting each sample station is listed below:

East Fork Jemez below La Jara Creek is representative of a perennial reach of the East Fork Jemez River within the Valle Grande.
Jaramillo above Cerro Pinon @ Rd B is in the mid reaches of the stream and was selected to characterize VCNP streams outside of the Valle Grande.
Redondo Creek above VCNP boundary was selected to assess this reach of Redondo Creek, which reflects the cumulative impacts on the VCNP.
Rito de los Indios above San Antonio Creek is one of the larger tributaries to the San Antonio Creek with minimal human influence and may serve as a reference reach.
San Antonio Creek below warm springs was selected to assess this stream on the VCNP.
Sulphur Creek above VCNP boundary was selected to characterize and assess Sulphur Creek below Sulphur Springs.
Alamo Canyon above Sulphur Creek is a tributary to Sulphur Creek with the confluence upstream of Sulphur Springs. The canyon has a series of ponds and bogs, with acidic waters and bubbling gases.
Artesian well on San Antonio Creek - The well contributes significant flow (0.44 cfs out of 0.83 cfs) to this reach of San Antonio Creek. However, its contribution is a fairly small proportion of the flow below Rito de los Indios (8-12 cfs). Water quality and discharge data were needed to determine appropriate management of the well.
East Fork Jemez above Jaramillo Creek is at the top of the perennial reach of the stream, is spring fed, and represents background conditions.

East Fork Jemez below unnamed drainage sw of headquarters - The VCNP board of trustees expressed concern about the impact that logging operations in this drainage may be having on the East Fork Jemez.
La Jara above headquarters has served as the water source for the headquarters and is a tributary to the East Fork Jemez.
Redondo Creek above steam wells was selected to assess the upper perennial reach that is above the steam wells and represents background conditions.
Redondo Creek below steam wells was selected to assess the impact of the steam wells and associated infrastructure in the Redondo Creek drainage.
San Antonio Creek below artesian well is the upper portion of the perennial reaches and was selected to assess this reaches and the influence of flow from the artesian well **San Antonio Creek above artesian well** was selected to assess this reach and the influence of flow from the artesian well.
San Antonio Warm Springs was selected to characterize the spring and assess the influence of flow from the warm spring on the water quality of San Antonio Creek.
Sulphur Creek below Alamo Canyon was selected to assess the influence of Alamo Canyon and characterize Sulphur Creek above Sulphur Springs.
Valle Santa Rosa above San Antonio Creek **was selected to assess this tributary.**

Photo 1: East Fork Jemez below Jaramillo Creek (2001).

Figure 2. VCNP Watershed Study Area and Sampling Stations.

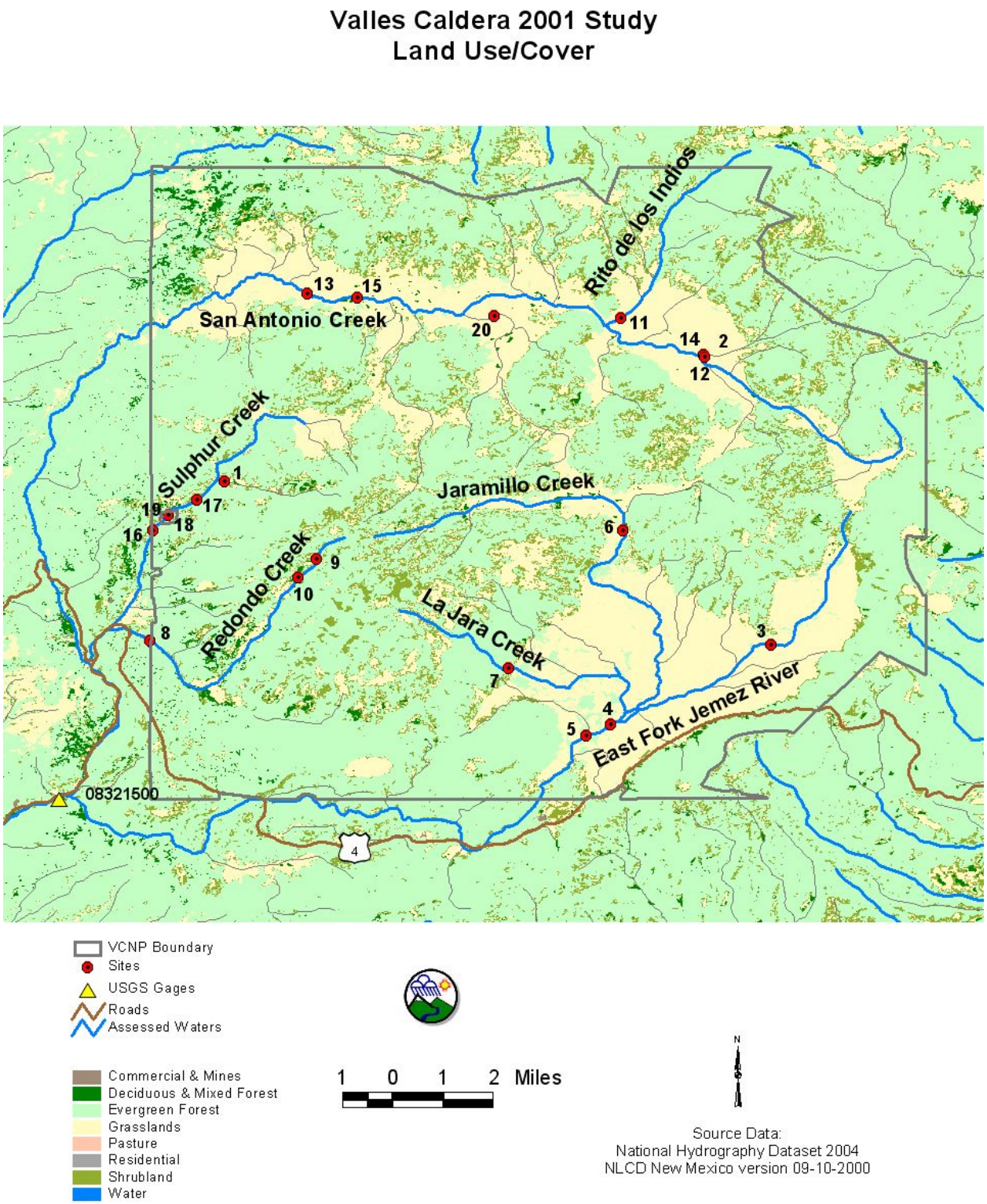

Table 2. Sampling Stations.

Site Number	Station	New STORET Code
Primary Sites		
4	East Fork Jemez below La Jara Creek	31EFkJem020.7
6	Jaramillo above Cerro Pinon @ Rd B	31Jarami008.0
8	Redondo Creek above VCNP boundary	31Redond001.2
11	Rito de los Indios above San Antonio Creek	31RIndio000.2
13	San Antonio Creek below warm springs	31SanAnt025.7
16	Sulphur Creek above VCNP boundary	31Sulphu003.4
Secondary Sites		
1	Alamo Canyon above Sulphur Creek	31AlamoC000.2
2	Artesian well on San Antonio Creek	31ArtWellVCNP
3	East Fork Jemez above Jaramillo Creek	31EFkJem026.1
5	East Fork Jemez blw unnamed drainage	31EFkJem020.0
7	La Jara above headquarters	31LaJara005.0
9	Redondo Creek above steam wells	31Redond008.7
10	Redondo Creek below steam wells	31Redond007.9
12	San Antonio Creek above artesian well	31SanAnt037.8
14	San Antonio below Artisian Well	31SanAnt037.6
15	San Antonio warm springs	31SanAnt027.1
17	Sulphur Creek below Alamo Canyon	31Sulphu005.0
18	Sulphur Springs	31Sulphu004.2
19	Sulphur pond	31Sulphu004.1
20	Valle Santa Rosa above San Antonio Creek	31ValleS000.9

Table 2 summarizes data collected in each assessment unit and at each station. The number of times each parameter (or suite of parameters) was sampled for 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.

Table 3. Sampling Summary.

Assessment Unit / Stations **primary sites*	**Stream Discharge**	**Field Data**	**Ions (full suite)**	**Nutrients**	**Total Metals (full suite)**	**Dissolved Metals (full suite)**	**Fecal Coliform**	**Cyanide**	**Radionuclides**	**Organics**	**Sonde Deployment**	**Thermograph**	**Fish**	**Geomorphology**	**Benthic Macroinvertebrates**
East Fork Jemez (VCNP bnd to headwaters)															
East Fork Jemez below La Jara Creek*	6	17	17	17	17	17	3	1	1	1	2	1	1	1	1
East Fork Jemez above Jaramillo Creek	1	3	3	3	3	3	0	0	0	0	0	0	1	0	1
East Fork Jemez blw unnamed drainage	0	2	2	2	0	0	0	0	0	0	0	0	0	0	0
Jaramillo Creek (E Fk Jemez to headwaters)															
Jaramillo above Cerro Pinon @ Rd B*	6	17	17	17	17	17	3	0	0	0	1	1	1	1	1
La Jara Creek (E Fk Jemez to headwaters)															
La Jara above headquarters	0	3	3	3	3	3	3	0	0	0	0	0	0	0	0

Assessment Unit / Stations **primary sites*	**Stream Discharge**	**Field Data**	**Ions (full suite)**	**Nutrients**	**Total Metals (full suite)**	**Dissolved Metals (full suite)**	**Fecal Coliform**	**Cyanide**	**Radionuclides**	**Organics**	**Sonde Deployment**	**Thermograph**	**Fish**	**Geomorphology**	**Benthic Macroinvertebrates**
Redondo Creek (VCNP bnd to headwaters)															
Redondo Creek above VCNP boundary*	5	17	17	17	17	17	3	1	1	1	1	1	1	1	1
Redondo Creek above steam wells	0	3	3	3	3	3	0	0	0	0	0	0	0	0	0
Redondo Creek below steam wells	0	3	3	3	3	3	0	0	0	0	0	0	0	0	0
Rito de los Indios(San Antonio to headwaters)															
Rito de los Indios above San Antonio Creek*	6	17	17	17	17	17	0	0	0	0	1	1	1	1	1
San Antonio (VCNP bnd to headwaters)															
Artesian well on San Antonio Creek	2	3	3	3	3	3	0	0	0	0	0	0	0	0	0
San Antonio Creek below warm springs*	6	17	17	17	17	17	3	1	1	1	2	1	1	1	1
San Antonio Creek above artesian well	2	3	3	3	1	1	0	0	0	0	0	0	0	0	0
San Antonio below Artisian Well	2	3	3	3	3	3	0	0	0	0	0	0	1	0	1
San Antonio warm springs	0	3	3	3	3	3	0	0	0	0	0	0	0	0	0
Valle Santa Rosa above San Antonio Creek	0	2	2	2	2	2	0	0	0	0	0	0	0	0	0
Sulphur Creek (VCNP bnd to headwaters)															
Alamo Canyon above Sulphur Creek	0	2	2	2	2	2	0	0	0	0	0	0	0	0	0
Sulphur Creek above VCNP boundary*	0	16	16	16	16	16	0	1	1	1	0	0	0	0	0
Sulphur Creek below Alamo Canyon	0	3	3	3	3	3	0	0	0	0	0	0	0	0	0
Sulphur Springs	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0
Sulphur pond	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0

6.0 WATER QUALITY ASSESSMENT

6.1 Water Quality Standards Exceedences

For many water quality parameters, the State of New Mexico maintains 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 2004a).

The following discussion includes information pertaining to all exceedences of water quality standards found during the intensive watershed survey. 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. Final assessment determinations as to whether or not a stream reach is considered to be meeting its designated uses depend on the overall amount and type of data available during the assessment process (Refer to NMED/SWQB's *Assessment Protocol* for additional information on the assessment process, NMED/SWQB 2004a). 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 2004b).

6.1.1 Physicochemical Data

Select physicochemical water quality criteria exceedences are provided in **Table 4**, Details of assessment procedures are available in the *Assessment Protocol* (NMED/SWQB 2004a). A complete data set can be obtained by contacting the SWQB.

Table 4. Physicochemical Water Quality Standards Exceedences.

Assessment Unit	Aluminum*	E. coli	Specific Conductance	Stream Bottom Deposits	Turbidity**
Jaramillo Creek (E Fk Jemez to headwaters)	17/17	1/3	0/16	FS	122/308
East Fork Jemez (VCNP bnd to headwaters)	17/19	0/3	0/23	FS	74/511
La Jara Creek (E Fk Jemez to headwaters)	3/3	0/3	0/3	n/a	0/3
Redondo Creek (VCNP bnd to headwaters)	14/22	0/3	0/23	FS	15/307
Rito de los Indios (San Antonio Creek to headwaters)	7/17	0/1	0/15	FS	3/303
San Antonio Creek (VCNP bnd to headwaters)	10/19	0/3	0/42	FS	8/595
Sulphur Creek (VCNP bnd to headwaters)	21/22	n/a	n/a	n/a	2/18

n/a= not available, FS=Full Support
**dissolved Al (chronic aquatic life), **based on 25 NTU standard*

6.1.2 Data from Continuous Monitoring Devices

Temperature data loggers (thermographs) were deployed at selected stations within the study area. The devices were programmed to record temperature once per hour. **Table 5** summarizes temperature data from thermographs in degrees Celsius (C). Sondes were also deployed at selected stations to examine pH and dissolved oxygen (DO). **Tables 6a** and **6b** summarize sonde data collected from the VCNP watershed.

Large data sets generated from data loggers (i.e., sondes and thermographs) are assessed according to protocols developed specifically for such data sets (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 *New Mexico Standards for Interstate and Intrastate Surface Waters* (20.6.4 NMAC, effective July 17, 2005). Dissolved oxygen assessment criteria are based on season (i.e., if early life stages of fish are likely present) and designated use (coldwater or warmwater aquatic life use). Details of large data set assessment procedures are available in the *Assessment Protocol* (NMED/SWQB 2004a).

Table 5. Summary of Thermograph Data.

Station	Data Collection Interval	WQS Temperature Criterion (°C)	Maximum Recorded Temperature (°C)	Total # of data points (n)*	# / % Exceedences*
Jaramillo above Cerro Pinon @ Rd B	30 May - 29 Oct	20	26.09	2960	297 / 10%
East Fork Jemez blw La Jara Creek	8 May - 30 Oct	20	28.27	3488	730 / 20.9%
Redondo Creek above VCNP boundary	9 May - 30 Oct	20	23.01	3465	78 / 2.3%
Rito de los Indios above San Antonio Creek	8 May - 30 Oct	20	21.99	3491	40 / 1.1%
San Antonio Creek below warm springs	8 May - 30 Oct	20	29.09	3492	817 / 23.4%

*May-September data only

Table 6a Summary of pH Data Collected from Sondes.

Station	Data Collection Interval	WQS pH Criteria	Min / Max Recorded pH	Total # of data points (n)	# / % Exceedences
Jaramillo above Cerro Pinon @ Rd B	14 Jun - 26 Jun 2001	6.6-8.8	7.35 / 8.34	287	0 / 0%
	23 Apr- 25 Apr 2002		7.5 / 8.21	57	0 / 0%
East Fork Jemez blw La Jara Creek	18 Jul - 26 Jul 2001	6.6-8.8	7.26 / 9.53	193	92 / 47.7%
	14 Sep – 20 Sep 2001		7.43 / 9.00	297	61 / 20.5%
Redondo Creek above VCNP boundary	14 Sep-20 Sep 2001	6.6-8.8	7.41 / 7.67	284	0 / 0%
Rito de los Indios above San Antonio Creek	14 Jun-26 Jun 2001	6.6-8.8	7.55 / 8.13	288	0 / 0%
San Antonio Creek below warm springs	14 Jun- 26 Jun 2001	6.6-8.8	7.73 / 9.66	290	170 / 58.6%
	14 Sep-20 Sep 2001		7.27 / 9.43	280	112 / 40%

Table 6b Summary of DO Data Collected from Sondes.

Station	Data Collection Interval	WQS DO Criteria (coldwater)	Min Recorded DO; % Saturation	Total # of data points (n)	# / % Exceedences
Jaramillo above Cerro Pinon @ Rd B	14 Jun - 26 Jun 2001	els	n/a	N/a	n/a
	23 Apr- 25 Apr 2002	els	7.29; 92.8	57	8 / 14%
East Fork Jemez blw La Jara Creek	18 Jul - 26 Jul 2001	ols	4.53 / 66.7	193	74 / 38.3%
	14 Sep – 20 Sep 2001	ols	5.85 / 79.6	297	8 / 2.7%
Redondo Creek above VCNP boundary	14 Sep-20 Sep 2001	ols	7.38 / 94.7	284	0 / 0%
Rito de los Indios above San Antonio Creek	14 Jun-26 Jun 2001	els	6.62 / 102.5	288	0 / 0%
San Antonio Creek below warm springs	14 Jun- 26 Jun 2001	els	4.73 / 68.1	290	125 / 43.1%
	14 Sep-20 Sep 2001	ols	4.68 / 65.8	280	98 / 35%

els=early life stages, ols=other life stages

6.2 Biological Data

Benthic macroinvertebrate data were collected from the sites identified in **Table 2**. Based on the September 2001 data collection and subsequent analysis and assessment, none of the 7 sites sampled are impaired for stream bottom deposits (SBD). SBD assessment protocol integrates the results from a pebble count (part of the geomorphologic survey) with the results from the analysis of the health of the benthic macroinvertebrate community.

Fish data were collected from the sites identified in **Table 2.** SWQB is currently developing biology/habitat assessment protocol in order to integrate fish collection and subsequent data anlysis into a biological assessment of the health of the community.

6.3 Stream Channel Morphology

Four station sites were selected to characterize both channel morphology and substrate characteristics of streams on the Valles Caldera. Although the selected sites represent four individual streams (Rio de los Indios, Jaramillo Creek, San Antonio Creek and East Fork of the Jemez River) with some variation in watershed size (7, 9, 38 and 48 square miles respectively) they did not represent all of the varied habitats on the Caldera. Instead, they represent the largest habitat type on the Caldera, which is characterized by broad valleys with gentle relief, slight down valley slope (**Valley type VIII**; Rosgen 1996) and a shallow groundwater table. Grasses and sedges dominate large, well-developed floodplains between the river and its terraces forming densely rooted sod mats with no trees and few shrubs (0% canopy cover). All four of the surveyed streams access their floodplain quite easily (i.e. are not entrenched) allowing for high stream flows at bankfull and above to be spread onto the floodplain thereby dissipating high-energy shear forces off of the banks. The soils located on the floodplain were developed predominately over alluvium originating from riverine depositional processes and are quite stable due to the overlying vegetation, however the sediment supply in disturbed areas tends to be high and composed mainly of fines.

Photo 2: Jaramillo Creek geomorphological survey (2001).

The summary data of the geomorphology survey is located in **Table 7** while the collected field data including site maps, photos, distances, elevations, pebble counts and graphical representations are available on request. All four streams were classified from the data as Rosgen **E4** stream types and are typical for the valley type through which they flow. In general, they may be characterized by a low width to depth ratio (<12), low gradient (<1%), high sinuosity (>1.5) and a high entrenchment ratio (>2.2). An exception is the Rito de los Indios, a lower order stream and tributary to San Antonio Creek, which enters from a smaller, steeper valley. Due to this increase in valley slope, the Rito de los Indios also displays a steeper gradient (1.32%), which in turn reduces its sinuosity (1.23). In addition, this stream displays by far the smallest width to depth ratio (1.18), which translates into a channel dimension of near equal width and depth.

All four streams are composed of a gravel bottom with finer materials in the banks. The overall substrate composition for all four is remarkably similar as shown by the narrow ranges for the D50 (7.8-12.5 mm), D84 (30-44mm), **%gravel (61-72)** and **%fines (26-31)** indices and is a reflection of the uniformity of the geology and soils in these wide valleys that get very little input from colluvium deposition. The **uniformity** of the **fines** found between each stream appears to be **normal** (Rosgen 1996). Eroding and/or raw banks occupy a small but noticeable percentage of the outside curves of each stream and appears to be the source of sediment fines in pool habitats and may be considered a problem. It is unclear at this time as to whether this is part of a normal stream process or the result of hoof-shear combined with low flow conditions currently occurring in the southwest.

In general, E4 channels have high meander width ratios, high sinuosities and low width to depth ratios. This stream type is a hydraulically efficient channel form with high sediment transport capacity. The narrow and relatively deep channels maintain a high resistance to plan form adjustment, which results in lateral channel stability without significant downcutting. **Although E4 stream types are very stable they are very sensitive to disturbance. Conversely this stream type also has good recovery potential when the cause of the disturbance is removed (Rosgen 1996).**

Table 7. Site-specific stream channel morphology dimensions and substrate characteristics (fluvial geomorphology) based on bankfull elevation of four small streams located on the Valles Caldera during the summer of 2001.

SITE NAME	Watershed Size (square miles)	Channel X-Sectional Area ($ft^{2)}$	Channel Width (ft)	Mean Depth (ft)	Max Depth (ft)	W/D Ratio	FPW (ft)	Entrench-ment Ratio	Slope (%)	Sinuosity
Rito de los Indios	7	1.44	1.3	1.1	1.32	1.18	46	35	1.32	1.23
Jaramillo Creek	9	5.4	6.1	0.9	2.66	6.9	583	95	0.44	2.2
East Fork Jemez	38	10.2	11	0.9	1.1	11.8	148	13.3	0.12	1.5
San Antonio Creek	48	30.1	17.8	1.7	2.3	10.5	1020+	57+	0.22	2.8

Site Name	D50 (mm)	D84 (mm)	% Bedrock	% Boulder	% Cobble	% Gravel	% Sand	% Silt/Clay	% Fines	% Shade (Canopy)	Rosgen Stream Type
Rito de los Indios above San Antonio Creek	7.8	30	0	0	3	72	12	14	26	0	E4
Jaramillo Cr. above Cerro Pinon @ Rd B	12.5	44	0	0	9	61	8	23	31	0	E4
East Fork Jemez below La Jara	10.7	32	0	0	2	68	12	18	30	0	E4
San Antonio Creek below warm springs	10.4	32	0	0	3	67	8	23	31	0	E4

7.0 RESULTS

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. All of the monitoring that was conducting is summarized in **Table 3**. Those parameters that exceeded the States Water Quality Standards are shown in **Table 4**. These data are organized by assessment unit, designated use or segment-specific criteria, parameter, and sample station in that order.

As shown in earlier SWQB surveys of the Jemez River watershed, there are a high number of exceedences of the standard for dissolved aluminum. There were also numerous exceedences of the DO, pH, and temperature standard (**Tables 5, 6a, 6b**). The Jemez volcanic field is composed of extremely thick accumulations of extrusive volcanic rocks, ranging in composition from tuffaceous ash to rhyolite, andesite, and basalts. Examination of the state's geologic map (1965) shows the Quaternary age Bandelier Tuff, dominantly composed of ashes, welded tuffs, and related rhyolite flows, are the most widespread units on the plateaus. These formations tend to be high in aluminum. Geochemical studies of the full suite of Jemez volcanic rock types (Ellisor et.al. 1996) indicate an average of 14.53% Al_2O_3, while more specific electron microprobe analysis of feldspar in the Bandelier Tuff was measured at an average of 23.6% Al_2O_3. Weathering and erosion mobilize the aluminum, which then enters surface waters through overland flow, groundwater recharge, and contribution of springs. The high levels of aluminum are likely due to these natural processes.

Exceedences of the DO and pH standards are caused by high rates of primary production (plant growth) occurring the stream. Dissolved oxygen increases during the day when photosynthesis takes place and drops at night because of respiration. pH similarly exhibits diurnal fluctuation. When CO_2 dissolves in water, it forms carbonic acid, lowering the pH. Respiring plants release CO_2 into the water and the pH declines. During photosynthesis, plants take up CO_2 and the pH increases. The larger stream in the VCNP had large diurnal fluctuation in DO and pH exceeding the criteria for these parameters daily during the summer (**Figure 3**). Weathering and erosion of plant nutrients from the volcanic and lacustrine soils and seasonal releases from the extensive wetlands in the caldera (Kirk 2004) could contribute to the high productivity as well at the relatively high levels of total phosphorus that were observed.

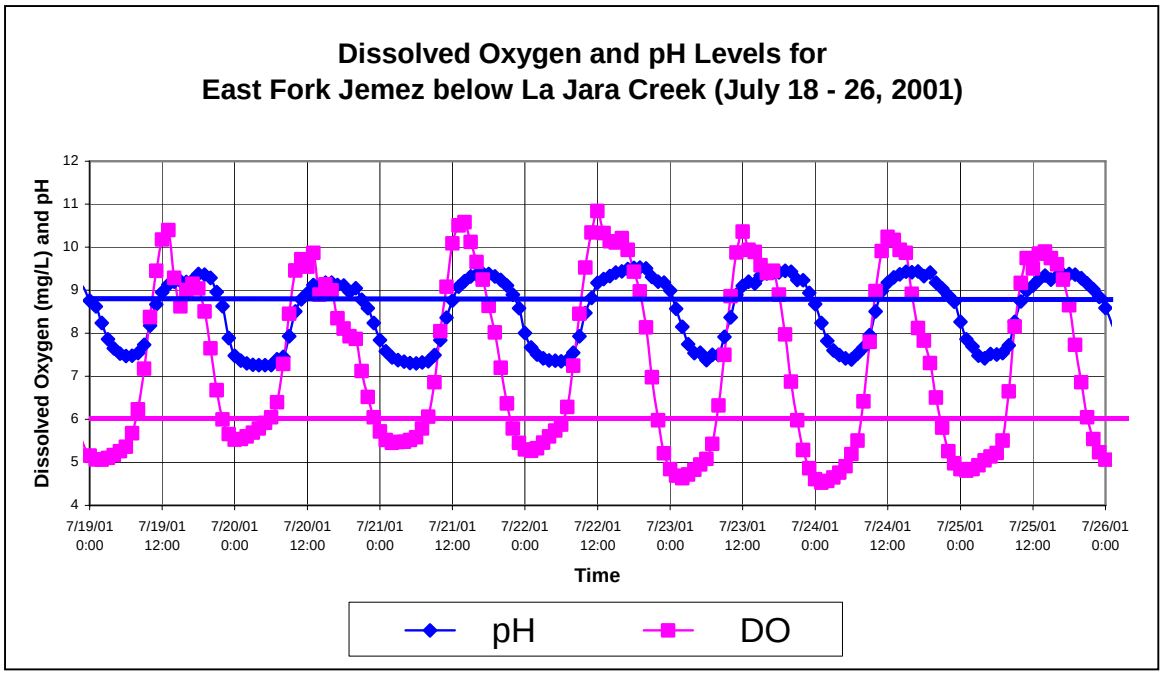

Figure 3: DO and pH levels for East Fork Jemez below La Jara (July 2001).

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