WATER QUALITY SURVEY SUMMARY

FOR THE

UPPER PECOS RIVER WATERSHED

INCLUDING THE GALLINAS RIVER, TECOLOTE CREEK AND

SUMNER AND SANTA ROSA RESERVOIRS

2010

Prepared by

Surface Water Quality Bureau

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ABBREVIATIONS

abv	above
AP	assessment protocol
AU	assessment unit
blw	below
BMP	best management practices
bnd	boundary
cfs	cubic feet per second
CWA	Federal Clean Water Act
DBSA	Daniel B. Stephens and Associates
EPA	Environmental Protection Agency
DO	dissolved oxygen
FSP	field sampling plan
IR	State of New Mexico CWA §303(d)/§305(b) Integrated Report
km	kilometers
km^2	square kilometers
mdp	missing data point
NM	New Mexico
NMED	New Mexico Environment Department
NMEDAS	New Mexico environmental data and analysis system
NPS	non-point source
NPDES	National Pollution Discharge Elimination System
QA/QC	quality assurance/quality control
ROD	record of decision section of the State of New Mexico CWA §303(d)/§305(b) Integrated Report
SOP	standard operating procedures
STORET	EPA's storage and retrieval data warehouse
SWQB	Surface Water Quality Bureau
TNTC	too numerous to count
TMDL	total maximum daily load
TSI	trophic state index
UAA	use attainability analysis
USFS	United States Forest Service
USGS	United States Geological Service
WQCC	New Mexico Water Quality Control Commission
WWTP	wastewater treatment plant
WQS	water quality standards
WQSS	water quality standards segment

ABSTRACT

The Surface Water Quality Bureau conducted a water quality survey of the upper Pecos River Watershed between April and December, 2010. The project area comprised the Pecos River and its tributaries from Sumner Reservoir to its headwaters, including Tecolote Creek and the Gallinas River, and their tributaries. Chemical, physical and biological monitoring was conducted at 70 stations. Data were assessed against New Mexico Water Quality Standards and impaired waters were summarized in the 2012-2014 Integrated List section of the biennial *State of New Mexico Clean Water Act §303(d)/305(b) Integrated Report*. Zinc and cadmium concentrations in the vicinity of the reclaimed Tererro mine site did not exceed water quality standards criteria indicating that reclamation work has been successful. New assessment protocols for sedimentation and turbidity allowed SWQB to re-evaluate previously impaired assessment units, which led to de-listing several assessment units on the 2012-2014 Integrated List, but also resulted in a number of new impairment listings for these pollutants. Upgrades to wastewater treatment plants at the Village of Pecos and the City of Las Vegas resulted in much improved effluent quality; however, the reach of the Gallinas River that receives the City of Las Vegas wastewater effluent was determined to be impaired for plant nutrients. Nutrient impairments were also found on Glorieta and Tecolote Creeks. In addition, nutrient impairment thresholds for total nitrogen and total phosphorus were exceeded with increasing frequency on the mainstem of the Pecos River moving downstream from Pecos National Historic Park to Puerto de Luna. While both Santa Rosa and Sumner Reservoirs met New Mexico water quality standards criteria for the majority of chemical and physical parameters, they did have elevated concentrations of total nitrogen and total phosphorus and reduced clarity suggesting potential nutrient enrichment. Several tributaries to the Pecos River above I-25 were de-listed for temperature, whereas various reaches of the Pecos mainstem, the Gallinas River and Tecolote Creek between I-40 and I-25 were found to be impaired for temperature. Furthermore, new impairments for *E. coli* were documented on the mainstem of the Pecos River, between Santa Rosa and Sumner Reservoirs, and on the lower Gallinas River. Overall, the number of water quality standards exceedences in the watershed increased proportionally with distance from the headwaters.

INTRODUCTION

The 9,303 square kilometer (km^2) upper Pecos River Watershed extends from Sumner Reservoir near Fort Sumner, NM, approximately 322 km upstream to the Pecos Wilderness in the Sangre de Cristo Mountains above Cowles, NM. The 75-km long Tecolote Creek joins the Pecos River near Tecolotito, draining a 736 km^2 watershed. The Gallinas River drains a 1,637 km^2 watershed and flows 134 km from its headwaters in the Sangre de Cristo National Forest, through Las Vegas, NM, to its confluence with the Pecos River near Colonias, NM.

Lentic waters in the upper Pecos River Watershed include a number of small, high-mountain lakes in the Pecos and Gallinas river drainages, in addition to impoundments for municipal water supplies and irrigation storage. Peterson and Bradner reservoirs on the Gallinas River upstream of Las Vegas have a combined storage capacity of approximately 500 acre-feet. A third reservoir, Storrie Lake, is filled from the Gallinas River via a diversion and a canal and has a storage capacity of 22,900 acre-feet. Together, these impoundments supply the drinking water for the City of Las Vegas. Santa Rosa Reservoir, just upstream from Santa Rosa, NM on the mainstem of the Pecos River, has a maximum storage capacity of 439,900 acre-feet. Also on the mainstem of the Pecos River, Sumner Reservoir, situated between Santa Rosa and Fort Sumner, has maximum storage capacity of 94,750 acre-feet. Finally, Blue Hole, located within the city limits of Santa Rosa, is a small, groundwater-fed sinkhole that discharges approximately 3,000 gallons per minute into El Rito Creek, which flows into the Pecos River below Santa Rosa after receiving effluent from the Santa Rosa wastewater treatment plant (WWTP).

The Pecos River originates at over 2,510 meters (m) above mean sea level in the alpine and sub-alpine forests of the Southern Rockies. It descends through sedimentary mid-elevation forests, foothill shrublands, and then into piñon-juniper woodlands and savannas. After joining Tecolote Creek and the Gallinas River, the Pecos River ends up in the Conchas/Pecos Plains at an elevation of 1,298 m, the active pool elevation of Sumner Reservoir. Tecolote Creek also begins in the sub-alpine forests of the Southern Rockies above 2,580 m in elevation, drops into the mid-elevation forests and foothill shrublands, then flows through piñon-juniper woodlands and savannas to join the Pecos River at an elevation of 1,614 m. Similar to the Pecos River and Tecolote Creek, the Gallinas River starts above 2,600 m in the crystalline sub-alpine forests of the Southern Rockies and drops into mid-elevation forests before flowing into the Upper Canadian Plateau. The Gallinas River makes a winding journey through the Canadian Canyons and Conchas/Pecos Plains before joining the Pecos River at approximately 1,500 m in elevation. The ecoregions and drainages in the survey area are shown in Figure 1.

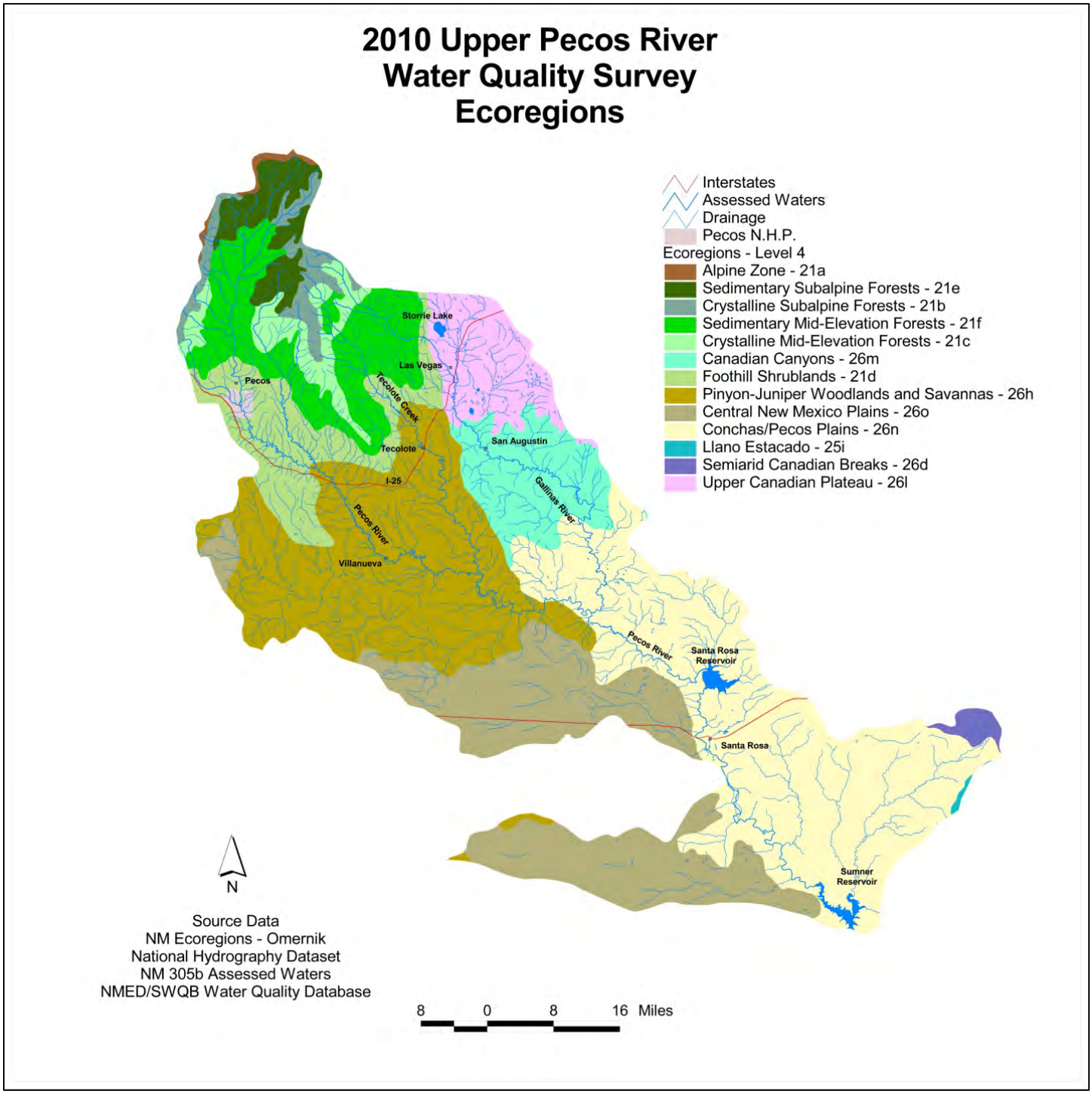

Figure 1. Ecoregions and drainages in the survey area.

WATER QUALITY STANDARDS

State water quality standards (WQS) are codified in the New Mexico Administrative Code (NMAC) as *Standards for Interstate and Intrastate Surface Waters* (20.6.4 NMAC; WQCC 2011). The purpose of WQS is to protect public health or welfare, enhance the quality of water, and serve the purposes of the Clean Water Act, specifically ensuring that water is of sufficient quality for the protection and propagation of fish, shellfish, and wildlife and for recreation in and on the water (i.e. fishable, swimmable protections). WQS are periodically updated by the New Mexico Water Quality Control Commission through the triennial review and interim rule-making processes.

WQS set water quality goals by designating uses and establishing criteria to protect those uses. Water quality criteria may be applied in three different ways: as general, narrative criteria; use-specific numeric criteria; or segment-specific numeric criteria. General criteria are statements that describe desirable water quality characteristics but contain no, or loosely defined, numeric criteria. General criteria apply to all surface waters of New Mexico (see 20.6.4.13 NMAC). Use-specific numeric criteria are applicable to specific designated uses, such as irrigation, coldwater aquatic life, livestock watering, or primary contact (see 20.6.4.900 NMAC). Segment-specific numeric criteria apply only to the identified waterbody segment (see 20.6.4.97 through 20.6.4.899 NMAC). Both use-specific and segment-specific numeric criteria set thresholds that water quality analytes may not exceed.

Water quality in the upper Pecos River Watershed was evaluated against the WQS to determine if waterbodies are supporting their designated uses. The applicable WQS for the upper Pecos River Watershed covered in this report are:

20.6.4.210 PECOS RIVER BASIN - Sumner reservoir.
A. Designated Uses: irrigation storage, livestock watering, wildlife habitat, primary contact and warmwater aquatic life.
B. Criteria: the use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses, except that the following segment-specific criteria apply: the monthly geometric mean of *E. coli* bacteria 126 cfu/100 mL or less, single sample 235 cfu/100 mL or less.

20.6.4.211 PECOS RIVER BASIN - The main stem of the Pecos river from the headwaters of Sumner reservoir upstream to Tecolote creek.
A. Designated Uses: fish culture, irrigation, marginal warmwater aquatic life, livestock watering, wildlife habitat and primary contact.
B. Criteria: **(1)** The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses. **(2)** At all flows above 50 cfs: TDS 3,000 mg/L or less, sulfate 2,000 mg/L or less and chloride 400 mg/L or less.

20.6.4.212 PECOS RIVER BASIN - Perennial tributaries to the main stem of the Pecos river from the headwaters of Sumner reservoir upstream to Santa Rosa dam.
A. Designated Uses: irrigation, coldwater aquatic life, livestock watering, wildlife habitat and primary contact.
B. Criteria: the use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses, except that the following segment-specific criterion applies: temperature 25°C (77°F) or less.

20.6.4.215 PECOS RIVER BASIN - Perennial reaches of the Gallinas river and all its tributaries above the diversion for the Las Vegas municipal reservoir and perennial reaches of Tecolote creek and its perennial tributaries.
A. Designated Uses: domestic water supply, high quality coldwater aquatic life, irrigation, livestock watering, wildlife habitat, industrial water supply and primary contact; and public water supply on the Gallinas river.
B. Criteria: the use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses, except that the following segment-specific criteria apply: specific conductance 300 µS/cm or less (450 µS/cm or less in Wright Canyon creek); the monthly geometric mean of *E. coli* bacteria 126 cfu/100 mL or less, single sample 235 cfu/100 mL or less.

20.6.4.216 PECOS RIVER BASIN - The main stem of the Pecos river from Tecolote creek upstream to Cañon de Manzanita.
A. Designated Uses: irrigation, livestock watering, wildlife habitat, marginal coldwater aquatic life and primary contact.
B. Criteria: **(1)** The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses, except that the following segment-specific criterion applies: temperature 30°C (86°F) or less. **(2)** At all flows above 10 cfs: TDS 250 mg/L or less, sulfate 25 mg/L or less and chloride 5 mg/L or less.

20.6.4.217 PECOS RIVER BASIN - Perennial reaches of Cow creek and all perennial reaches of its tributaries and the main stem of the Pecos river from Cañon de Manzanita upstream to its headwaters, including perennial reaches of all tributaries thereto.
A. Designated Uses: domestic water supply, fish culture, high quality coldwater aquatic life, irrigation, livestock watering, wildlife habitat and primary contact; and public water supply on the main stem of the Pecos river.
B. Criteria: the use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses, except that the following segment-specific criteria apply: specific conductance 300 µS/cm or less; the monthly geometric mean of *E. coli* bacteria 126 cfu/100 mL or less, single sample 235 cfu/100 mL or less. [20.6.4.217 NMAC - Rp 20 NMAC 6.1.2214, 10-12-00; A, 05-23-05; A, 12-01-10]

20.6.4.220 PECOS RIVER BASIN - Perennial reaches of the Gallinas river and its tributaries from its mouth upstream to the diversion for the Las Vegas municipal reservoir, except Pecos Arroyo.

A. Designated Uses: irrigation, livestock watering, wildlife habitat, marginal coldwater aquatic life and primary contact.

B. Criteria: the use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses, except that the following segment-specific criterion applies: temperature 30°C (86°F) or less.

20.6.4.221 PECOS RIVER BASIN - Pecos Arroyo.

A. Designated Uses: livestock watering, wildlife habitat, warmwater aquatic life and primary contact.

B. Criteria: the use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses, except that the following segment-specific criteria apply: the monthly geometric mean of *E. coli* bacteria 206 cfu/100 mL, single sample 940 cfu/100 mL.

Subsection J of Section 20.6.4.900 NMAC, as referenced in the above segment-specific criteria, provides a list of chemical analytes and their respective criteria. The table of numeric criteria in Section 900 is used for assessing water quality to determine if the water is supporting its designated uses (e.g., irrigation, livestock watering, human health, etc). Narrative criteria for sedimentation/siltation, plant nutrients, turbidity, and biological integrity are also addressed in this report and are found in 20.6.4.13 NMAC, subsections A, E, J, and M, respectively. Assessment Protocols (APs) are used to evaluate data against numeric as well as narrative criteria. The APs are updated biennially and the data from this survey were assessed using the 2011 version (NMED/SWQB 2011).

The upper Pecos River Watershed was last surveyed in 2001 (NMED/SWQB 2001a, b, c, d). Impairment determinations from that survey, and from subsequent data collection efforts, are listed below (Table 1**)** and may be found in Appendix A of the most recent *State of New Mexico Integrated Clean Water Act §303(d)/§305(b) Report* [303(d) List]. The 303(d) List is a catalog of all assessment units (AUs) with a summary of their current status (i.e. assessed/not assessed and impaired/not impaired). Once an AU is determined to be impaired, a total maximum daily load (TMDL) guidance document for stream restoration is developed specifically for that AU. AU boundaries and WQS may change over time and the history of these changes is tracked in the Record of Decision (ROD). Use attainment determinations supported by data collected from the 2010 survey were included in the 2012-2014 §303(d) List of Assessed Waters (NMED/SWQB 2012).

Table 1. Causes of impairments in the upper Pecos River Watershed.

Assessment Unit	Probable Causes of Impairments[1]	Impaired Use[2]
Bull Creek (Cow Creek to headwaters)	**temperature**	HQCWAL
Cow Creek (Bull Creek to headwaters)	**temperature, turbidity**	HQCWAL
Cow Creek (Pecos River to Bull Creek)	**temperature, turbidity**	HQCWAL
Gallinas River (Las Vegas Diversion to headwaters)	**temperature**	HQCWAL
Gallinas River (Pecos River to San Augustin)	low flow alterations	MCWAL
Gallinas River (San Augustin to Las Vegas Diversion)	ammonia, fecal coliform bacteria, nutrients, benthic macroinvertebrates	MCWAL
Glorieta Creek (Pecos River to headwaters)	ammonia, nitrate, dissolved oxygen, specific conductance, temperature, turbidity	DWS and HQCWAL
Pecos River (Alamitos Canyon to Willow Creek)	**turbidity**	HQCWAL
Pecos River (Canon de Manzanita to Alamitos Canyon)	**temperature, turbidity**	HQCWAL
Pecos River (Santa Rosa Reservoir to Tecolote Creek)	stream bottom deposits	MWWAL
Pecos River (Sumner Reservoir to Santa Rosa Reservoir)	stream bottom deposits	MWWAL
Pecos River (Tecolote Creek to Canon de Manzanita)	stream bottom deposits	MCWAL
Tecolote Creek (I-25 to Blue Creek)	specific conductance, temperature	HQCWAL
Willow Creek (Pecos River to fish barrier)	cadmium, stream bottom deposits, specific conductance, zinc	HQCWAL
Wright Canyon Creek (Tecolote Creek to headwaters)	stream bottom deposits	HQCWAL
Santa Rosa Reservoir	mercury in fish tissue	MWWAL
Sumner Reservoir	mercury in fish tissue	MWWAL

[1] From the 2008-2010 State of New Mexico CWA §303(d) / §305(b) Integrated List and Report. Bolded impairments have been addressed with TMDLs.
[2] HQCWAL, High quality coldwater aquatic life; MCWAL, marginal coldwater aquatic life; MWWAL,marginal warmwater aquatic life; DWS, domestic water supply

SURVEY OBJECTIVES

This survey was undertaken to assess the cumulative effect of physical habitat, water sources, and land management activities on water quality in order to determine if previous impairments still exist, if new impairments have arisen as a result of these influences, and to meet the rotational survey schedule described in the SWQB 10-year monitoring and assessment strategy (NMED/SWQB 2010a). A complete list of survey objectives, the questions they are designed to address and the products this survey was anticipated to generate appear below (Table 2).

Table 2. Objectives of 2010 upper Pecos River Watershed survey.

	Purpose of Survey	Question to be Addressed	Products and Outcomes	Decision Criteria
Primary Objective	Assess designated use attainment for the IR and provide information to the public on the condition of surface water	Are sampled waterbodies meeting WQS criteria?	Survey Report; IR	WQS as interpreted by the APs
Secondary Objectives	Develop load and waste load allocations for TMDLs	What is the maximum pollutant load a waterbody can receive and meet the WQS criteria?	TMDL loading calculations and NPDES permit limits	WQS as interpreted by the APs
	Evaluate restoration and mitigation measures implemented to control NPS pollution	Have watershed restoration activities and mitigation measures produced measurable improvements to water quality?	Project Summary Reports, NPS Annual Report, IR	WQS as interpreted by the APs
	Develop or refine WQS	Are the existing designated uses appropriate for the waterbody?	UAAs; amendments to WQS	Are data sufficient to support a petition to the WQCC to revise WQS?

AP, assessment protocol; IR, State of New Mexico CWA §303(d)/§305(b) Integrated Report; NPS, non-point source; NPDES, national pollutant discharge elimination system; TMDL, total maximum daily load; UAA, use attainability analysis; WQCC, water quality control commission; WQS, water quality standards

MATERIALS AND METHODS

The draft field sampling plans (FSPs) for rivers and lakes were presented to the public at meetings on March 17, 2010 in Pecos, NM and on March 18, 2010 in Santa Rosa, NM. Sampling began on March 30, 2010 and ended September 19, 2011. The FSP provides guidance for fieldwork by detailing the sampling and field data-gathering methods including the type (i.e., chemical, physical, or biological) and quantity of data that are needed to support the project objectives and answer the questions that the study is supposed to address.

Stream and reservoir sampling was conducted according to procedures documented in the SWQB Quality Assurance Project Plan (QAPP; NMED/SWQB 2010b), the FSPs, and standard operating procedures (SOPs; NMED/SWQB 2007) and any results were subjected to the quality

assurance and quality control (QA/QC) procedures described in the QAPP prior to being uploaded to the Environmental Protection Agency's storage and retrieval (STORET) data warehouse; however large data sets, such as those generated by deployed sondes and thermographs, were not uploaded to SWQB's database nor STORET because the capacity to do so was not available. The QAPP and SOPs are updated annually, therefore the versions in place at the time of the survey should be consulted to determine how monitoring and data verification/validation were conducted.

Water samples were analyzed for total dissolved solids (TDS), total suspended solids (TSS), hardness, chloride, sulfate, total nutrients, total and dissolved metals, *E. coli*, cyanide, radionuclides, and synthetic organic compounds. Instantaneous measurements ("grab" data) for temperature, dissolved oxygen (DO), pH, turbidity, and specific conductance were taken in the field. Data loggers (thermographs and sondes) were deployed to collect temperature, pH, DO, conductivity, and turbidity data over extended periods of time. Physical habitat, benthic macroinvertebrate communities, and fish communities were also surveyed. Sampling station locations are shown in Figure 2. The specific types and number of sampling events conducted at each station are summarized in Table 3. Some habitat and biological sampling was not completed until the 2011 field season.

Data collected during this survey were combined with all other submitted data from external sources that met SWQB's QA/QC requirements and assessed according to the 2011 assessment protocols. External data used in assessments were provided by Daniel B. Stephens & Associates (DBSA) who provided data from the Pecos River and Willow Creek near Tererro Mine and the United States Geological Survey (USGS) who submitted data from the lower portion of the Pecos River. Assessment conclusions from this process were used to generate portions of the 2012-2014 Integrated Report (NMED/SWQB 2012). Data collected as a part of this survey are available by request from the SWQB or by direct queries of STORET.

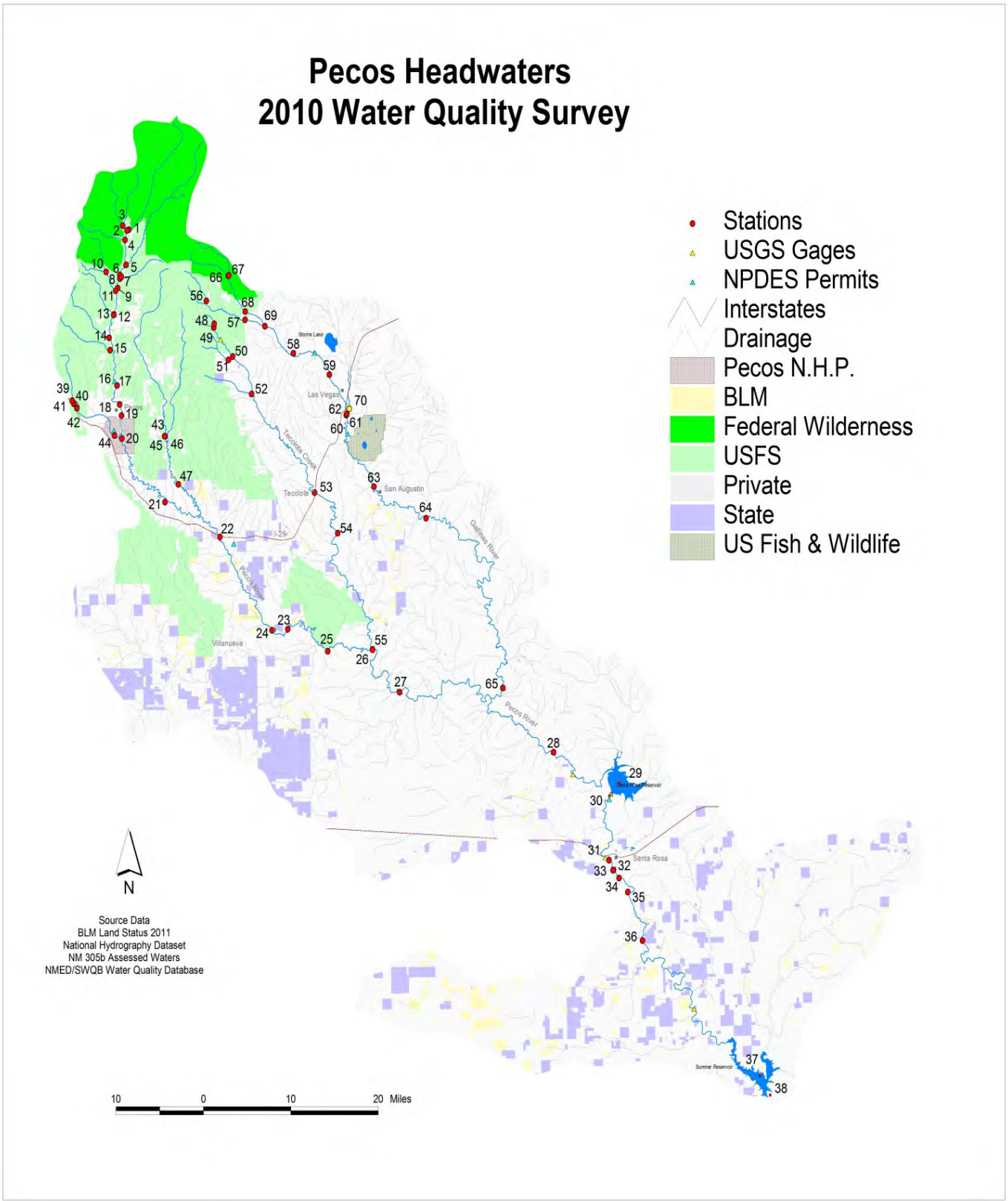

Figure 2. Upper Pecos River sampling locations during the 2010 survey. Numbers refer to sampling stations in Table 3.

Table 3. Monitoring summary by station. Numbers refer to the frequency each parameter was sampled or number of times the monitoring activity was conducted.

Station Number	Station Name	TDS [1], TSS [2], Chloride and Sulfate	Nutrients [5]	Total Heavy Metals [5]	Dissolved Heavy Metals [5]	*E. coli*	SVOC [3,5]	VOC [4,5]	Radionuclides [5]	Habitat [6]	Sonde deployment [6]	Thermograph deployment [6]	Level 1 nutrient survey [6]	Level 2 nutrient survey [6]	Benthic macroinvertebrates [6]	Fish Community Composition [6]
1	Pecos River @ wilderness bnd	5	5	4	4	5	0	0	0	1		1	1			
2	Jack's Creek abv Pecos River	5	5	4	4	5	0	0	0	1			1			
3	Panchuela Creek abv campground	5	5	4	4	5	0	0	0	1		1	1			
4	Winsor Creek abv Pecos River	5	5	4	4	5	0	0	0	1			1	1		
5	Rio Mora at USGS gage 08377900	5	5	4	4	5	0	0	0	1	3		1			
6	Pecos River abv Willow Creek	0	0	0	0	2	0	0	0	1						
7	Willow Creek abv Fish Barrier	2	1	2	2	2	0	0	0	1		1	1			
8	Willow Creek blw White Drain	4	3	4	4	5	0	0	0			1				
9	Pecos River blw Tererro Mine	6	5	6	6	6	0	0	1				1			
10	Doctor Creek abv Holy Ghost Creek	2	2	2	2	2	0	0	0	1			1			
11	Holy Ghost Creek abv Pecos River	5	4	4	4	8	0	0	0	1		1	1			
12	Pecos River on Brush Ranch @ USGS gage 08378500	11	5	5	5	8	0	0	0		3		1	1		
13	Indian Creek abv Hwy 63	4	4	4	4	5	0	0	0				1			
14	Macho Canyon Creek abv Hwy 63	5	4	4	4	4	0	0	0				1			
15	Dalton Canyon Creek abv Hwy 63	4	4	4	3	5	0	0	0	1			1			
16	Pecos River abv Lisboa Springs Fish Hatchery	0	0	0	0	1	0	0	0			1				1
17	Lisboa Springs hatchery effluent	2	7	1	1	0	0	0	0							
18	Pecos River at Adelo property behind Catholic Church	7	7	6	6	7	0	0	1	1			1	1	1	
19	Village of Pecos WWTP effluent	2	4	2	2	4	0	0	1							
20	Pecos River @ Pecos National Historic Park	8	8	8	8	7	0	2	2	1	1	1	1	1		

Station Number	Station Name	TDS [1], TSS [2], Chloride and Sulfate	Nutrients [5]	Total Heavy Metals [5]	Dissolved Heavy Metals [5]	*E. coli*	SVOC [3, 5]	VOC [4, 5]	Radionuclides [5]	Habitat [6]	Sonde deployment [6]	Thermograph deployment [6]	Level 1 nutrient survey [6]	Level 2 nutrient survey [6]	Benthic macroinvertebrates [6]	Fish Community Composition [6]
21	Pecos River @ South San Ysidro	5	4	3	3	4	0	0	0			1				
22	Pecos River @ San Jose	10	8	7	7	7	1	0	1				1			
23	Pecos River @ Villanueva State Park	3	3	3	3	2	1	0	2	1	1	1	1		1	1
24	Pecos River @ Los Schiffmillers	5	4	3	3	6	0	0	0		1		1			
25	Pecos River @ Comanchero	2	3	2	2	2	0	0	0	1					1	1
26	Pecos River abv Tecolote Creek	1	2	0	0	0	0	0	0			1	1			
27	Pecos River @ Anton Chico near gage 08379500	10	8	6	6	9	1	0	2							
28	Pecos River near Colonias @ gage 08375900	5	3	3	3	1	2	0	2	1	3	1				
29	Santa Rosa Reservoir –shallow	3	3	3	3	3	2	2	2							
30	Santa Rosa Reservoir – deep	3	3	3	3	3	2	2	2							
31	Pecos River @ Parker Ave	6	6	5	5	6	1	0	0				1			
32	Santa Rosa WWTP effluent	2	2	1	1	2	0	0	0							
33	El Rito Creek blw Santa Rosa WWTP	5	5	4	4	5	1	0	0			1				
34	Rock Lake hatchery effluent	1	1	1	1	0	0	0	0							
35	Pecos River @ Hinker Crossing	5	5	5	5	4	0	0	0				1			
36	Pecos River @ Puerto de Luna	7	6	6	6	7	1	0	3	1		1	1	1		1
37	Sumner Reservoir – shallow	3	3	3	3	3	2	2	2							
38	Sumner Reservoir – deep	3	3	3	3	3	2	2	2							
39	Glorieta Creek abv conference center WWTP	0	2	0	0	1	0	0	0				1			
40	Glorieta conference center WWTP effluent	2	5	2	2	4	1	0	1							
41	Glorieta Creek blw conference center WWTP	0	3	0	0	3	0	0	0							

Station Number	Station Name	TDS [1], TSS [2], Chloride and Sulfate	Nutrients [5]	Total Heavy Metals [5]	Dissolved Heavy Metals [5]	*E. coli*	SVOC [3, 5]	VOC [4, 5]	Radionuclides [5]	Habitat [6]	Sonde deployment [6]	Thermograph deployment [6]	Level 1 nutrient survey [6]	Level 2 nutrient survey [6]	Benthic macroinvertebrates [6]	Fish Community Composition [6]
42	Glorieta Creek @ Cur Trail	3	3	3	3	2	1	0	1	1	1		1	1	1	
43	Bull Creek abv Cow Creek	6	6	4	4	5	5	0	0	1		1	1			1
44	Glorieta Creek abv Pecos River	2	3	1	1	3	0	0	0							
45	Cow Creek abv Bull Creek	6	6	4	4	5	0	0	0	1	1	1	1		1	1
46	Cow Creek @ FR 83	1	1	0	0	1	0	0	0							
47	Cow Creek @ North San Ysidro	6	7	6	4	6	1	0	1	1		1	1	1	1	1
48	Wright Creek abv Tecolote Creek	4	4	3	3	3	0	0	0	1			1			
49	Tecolote Creek abv Wright Creek abv FR 491	4	4	4	2	3	0	0	0	1			1			
50	Tecolote Creek abv Blue Creek	5	5	5	5	5	0	0	0				1			
51	Blue Creek abv Tecolote Creek	5	5	4	4	5	0	0	0			1	1			
52	Falls Creek @ CR A-19A	5	5	4	4	5	0	0	0				1			
53	Tecolote @ I-25	7	7	5	5	6	1	0	1	1	1	1	1	1	1	1
54	Tecolote Creek @ RR x-ing below I-25	1	1	1	1	1	0	0	0				1			
55	Tecolote Creek abv Pecos River	1	1	0	0	0	0	0	0							
56	Burro Creek abv Gallinas Creek	2	2	2	2	2	0	0	0				1			
57	Gallinas River @ USFS bnd	5	5	4	4	5	0	0	0				1			
58	Gallinas River abv Montezuma @ USGS gage 08380500	7	6	5	5	4	0	0	0		3		1			
59	Gallinas River abv Las Vegas @ CR A-11C	5	5	5	5	5	1	0	1				1		1	
60	Gallinas River abv Las Vegas WWTP effluent	4	5	3	3	5	1	0	1							
61	Las Vegas WWTP effluent	4	5	3	3	5	1	0	1							
62	Gallinas River blw Las Vegas WWTP effluent	2	3	1	1	3	0	0	0				1			

Station Number	Station Name	TDS [1], TSS [2], Chloride and Sulfate	Nutrients [5]	Total Heavy Metals [5]	Dissolved Heavy Metals [5]	*E. coli*	SVOC [3, 5]	VOC [4, 5]	Radionuclides [5]	Habitat [6]	Sonde deployment [6]	Thermograph deployment [6]	Level 1 nutrient survey [6]	Level 2 nutrient survey [6]	Benthic macroinvertebrates [6]	Fish Community Composition [6]
63	Gallinas River @ San Augustin	8	8	6	6	7	2	0	2	1		1	1	1	1	
64	Gallinas River @ La Liendre	0	0	0	0	0	0	0	0			1				
65	Gallinas River near Colonias at USGS gage 08382500	9	6	3	3	5	1	0	1		4					
66	Hollinger Creek abv El Porvenir Creek	2	2	2	2	2	0	0	0	1			1			
67	Beaver Creek abv El Porvenir Creek	2	2	2	2	2	0	0	0	1			1			
68	El Porvenir Creek @ Christian Camp	4	4	3	3	4	0	0	0				1		1	
69	El Porvenir Creek @ Hwy 65	4	4	3	3	4	0	0	0				1			
70	Pecos Arroyo abv Gallinas River	5	6	5	5	6	2	0	2			1	1			

[1] Total dissolved solids
[2] Total suspended solids
[3] Semi-volatile organic compounds
[4] Volatile organic compounds
[5] Refer toAppendix I for a list of analytes included in this suite.
[6] Refer to appropriate SOP for details on how this monitoring activity was conducted.

RESULTS

HYDROLOGICAL CONDITIONS

United States Geological Service (USGS) gage data from the Pecos River (Figure 3) and the Gallinas River (Figure 4) show that stream flow was above average during the survey period. This was the result of a relatively deep snow pack which, together with rapid temperature increases in the spring, produced high flows during spring runoff. Later periods of elevated discharge were caused by heavy thunderstorm activity in the summer and early fall.

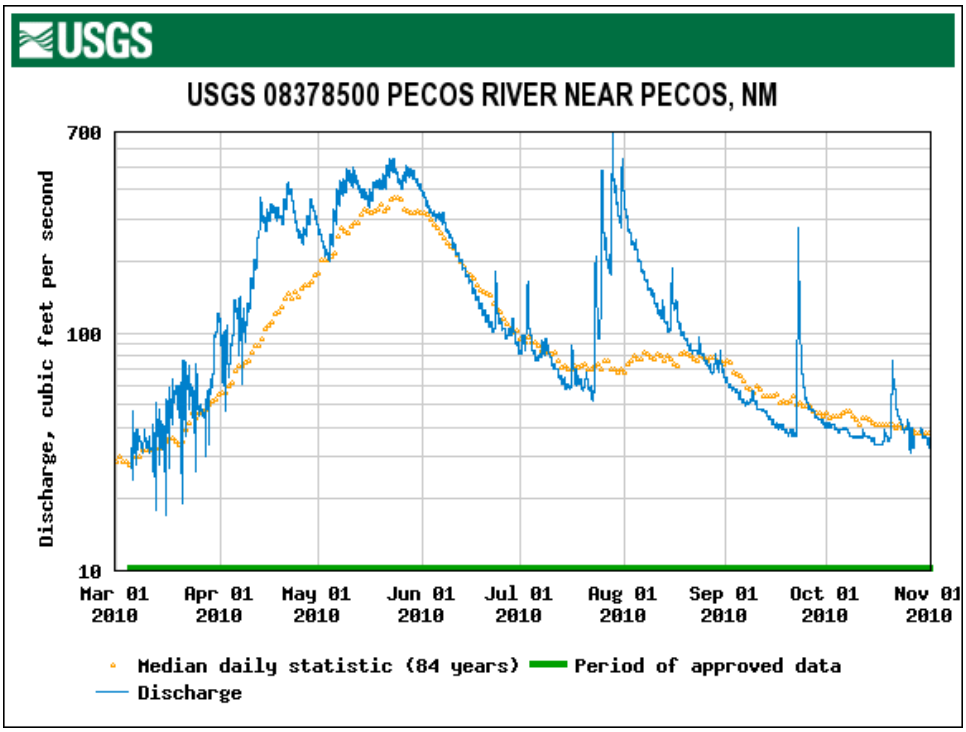

Figure 3. Hydrograph of the upper Pecos River at Brush Ranch during the survey.

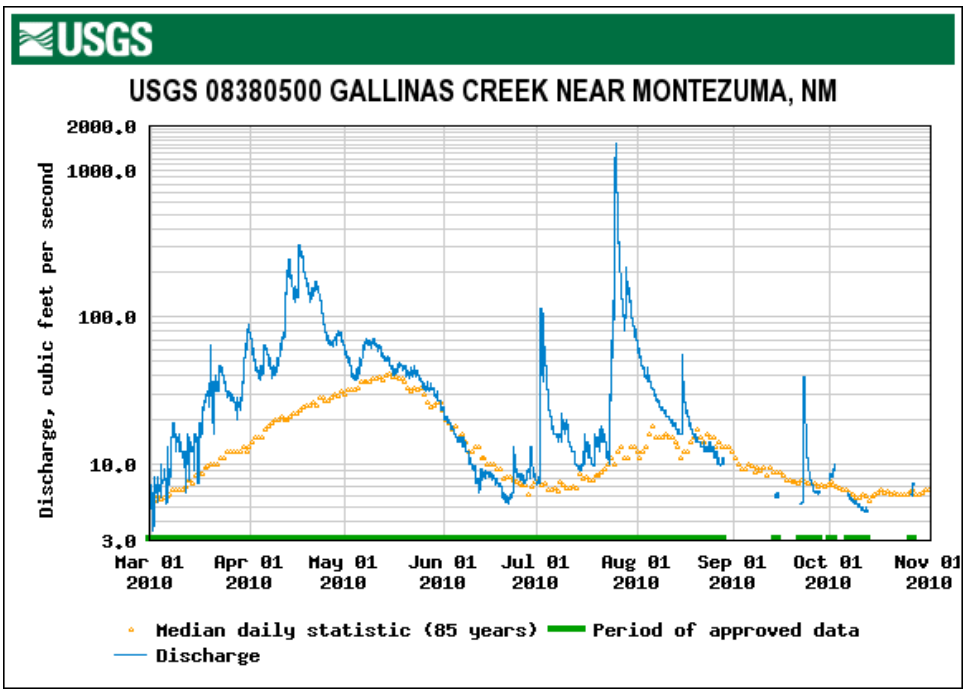

Figure 4. Hydrograph of the Gallinas River above Montezuma during the survey.

WATER QUALITY SAMPLING RESULTS FOR STREAMS AND RIVERS

Data from this survey resulted in a number of impairments being removed from the list of assessed surface waters (Appendix A of the 2012-2014 IR). New impairments were identified in several AUs and these new listings were included in the 2012-2014 IR. AUs whose impairment status was changed as a result of this survey are listed by watershed below (Tables 4-6). A complete list of actions associated with each AU, including the rationale behind them, can be found in the record of decision (ROD) associated with the 2012-2014 IR.

Table 4. Upper Pecos River Watershed use impairment determinations. Only AUs with data that supported an action (listing or de-listing) are included in this table.

AU	**Aquatic Life Use**	**Previous Impairment**	**Standards Criterion**	**Relevant Survey Data**	**2012-2014 IR Action**
Bull Creek (Cow Creek to headwaters)	high quality coldwater	temperature	20˚C	21.7˚C max temp; 20˚C not exceeded > 4 hrs for > 3 consecutive days	De-listed for temperature
Cow Creek (Bull Creek to headwaters)	high quality coldwater	turbidity	varies with duration and magnitude	23 NTU not exceeded for > 72 hours	De-listed for turbidity
Cow Creek (Pecos River to Bull Creek)	high quality coldwater	turbidity	varies with duration and magnitude	23 NTU not exceeded for > 72 hours	De-listed for turbidity
Glorieta Creek (perennial prts, Pecos River to Glorieta CC WWTP effluent)	high quality coldwater	ammonia, nitrate, dissolved oxygen	3.9 µg/cm^2 chlorophyll *a*	55.47 µg/cm^2 chlorophyll *a*	Listed for plant nutrients
			0.25 mg/L total nitrogen	9/10 exceedences	
			0.02 mg/L total phosphorus	8/10 exceedences	
			120% dissolved oxygen	no exceedences	
		turbidity	varies with duration and magnitude	no exceedences	De-listed for turbidity
		temperature	20˚C	maximum temperature was 15.7˚C	De-listed for temperature
Dalton Canyon Creek (perennial reaches, Pecos River to headwaters)	high quality coldwater	none	300 µS/cm	3/5 exceedences	Listed **f**or conductivity

AU	**Aquatic Life Use**	**Previous Impairment**	**Standards Criterion**	**Relevant Survey Data**	**2012-2014 IR Action**
El Rito Creek (Pecos River to Blue Hole)	coldwater	none	410 cfu/100 mL (primary contact)	2/5 exceedences	Listed for *E. coli*
		none	temperature and pH dependent	2/5 exceedences	Listed for ammonia
Macho Canyon Creek	high quality coldwater	none	300 µS/cm	2/5 exceedences	Listed for conductivity
Pecos River (Alamitos Canyon to Jack's Creek)	high quality coldwater	mercury in fish tissue	criterion raised to 0.3 mg methyl mercury/kg	data from 2005 leading to listing did not exceed 0.3 mg/kg	De-listed for fish tissue
Pecos River (Cañon de Manzanita to Alamitos Canyon)	high quality coldwater	turbidity	turbidity criterion varies with duration and magnitude	23 NTU not exceeded for > 72 hours	De-listed for turbidity
		mercury in fish tissue	criterion raised to 0.3 mg methyl mercury/kg	data from 2005 leading to listing did not exceed 0.3 mg/kg	De-listed for fish tissue
Pecos River (Jack's Creek to headwaters)	high quality coldwater	mercury in fish tissue	criterion raised to 0.3 mg methyl mercury/kg	data from 2005 leading to listing did not exceed 0.3 mg/kg	De-listed for fish tissue
Pecos River (Santa Rosa Reservoir to Tecolote Creek)	marginal warmwater	none	410 cfu/100 mL (primary contact)	4/23 exceedences	Listed for *E. coli.*
		stream bottom deposits	No criterion for non-perennial waters	N/A	De-listed for sedimentation
Pecos River (Sumner Reservoir to Santa Rosa Reservoir)	marginal warmwater	stream bottom deposits	< 74% sand and fines	53.5% sand and fines	De-listed for sedimentation
		none	8.2 µg/cm^2 chlorophyll *a*	1.54 µg/cm^2 chlorophyll *a*	Listed for plant nutrients
			0.45 mg/L total nitrogen	12/18 exceedences	
			0.03 mg/L total phophorus	4/18 exceedences	
			120% dissolved oxygen	7/17 exceedences	

AU	Aquatic Life Use	Previous Impairment	Standards Criterion	Relevant Survey Data	2012-2014 IR Action
Pecos River (Tecolote Creek to Villanueva State Park)	marginal warmwater	stream bottom deposits	< 74 % sand and fines	51.5% sand and fines	De-listed for sedimentation
		none	30˚C	maximum temperature was 30.5˚C	Listed for temperature
Pecos River (Villanueva State Park to Cow Creek)	high quality coldwater	stream bottom deposits	< 74% sand and fines	44.2% sand and fines	De-listed for sedimentation
Willow Creek (fish barrier to headwaters)	high quality coldwater	stream bottom deposits (SBD)	< 20 % sand and fines	28.6% sand and fines	Retained listing for SBD
		cadmium	0.17 µg/L[1]	0/2 exceedences[2]	De-listed for cadmium
		zinc	34 µg/L[1]	0/2 exceedences[2]	De-listed for zinc

[1] The actual criterion is hardness-dependent; these are conservative screening values based on 25 mg/L hardness as $CaCO_3$.
[2] De-listing was based on an additional 44 cadmium and zinc samples collected by DBSA between 2008 and 2010.

Table 5. Tecolote Creek Watershed use impairment determinations. Only AUs with data that supported an action (listing or de-listing) are included in this table.

AU	Aquatic Life Use	Previous Impairments	Standards Criterion	Relevant Survey Data	2012-2014 IR Action
Tecolote Creek (I-25 to Blue Creek)	high quality coldwater	none	3.9 µg/cm^2 chlorophyll *a*	4.02 µg/cm^2 chlorophyll *a*	Listed for plant nutrients
			0.25 mg/L total nitrogen	4/7 exceedences	
			0.02 mg/L total phosphorus	3/7 exceedences	
			120% dissolved oxygen	4/7 exceedences	
Falls Creek (Tecolote Creek to headwaters)	high quality coldwater	none	300 µS/cm	2/5 exceedences	Listed for conductivity
Wright Canyon Creek (Tecolote Creek to headwaters)	high quality coldwater	stream bottom deposits (SBD)	< 20% sand and fines	19% sand and fines	De-listed for SBD

Table 6. Gallinas River Watershed use impairment determinations. Only AUs with data that supported an action (listing or de-listing) are included in this table.

AU	Aquatic Life Use	Previous Impairments	Standards Criterion	Relevant Survey Data	2012-2014 IR Action
Gallinas River (Pecos River to Aguilar Creek)	marginal warmwater	none	5.0 mg/L	360/4811 exceedences	Listed for dissolved oxygen
Gallinas River (perennial portions, Aguilar Creek to Pecos Arroyo)	marginal coldwater	Benthic macroinvertebrates	Varies with reference conditions	causal response assigned to temperature and turbidity	De-listed for benthic macroinvertebrates
		none	30˚C	max temperature 31.9˚C	Listed for temperature
		none	turbidity criterion varies with duration and magnitude	23 NTU exceeded for 101 consecutive hours	Listed for turbidity
		fecal coliform[1]	410 cfu/100 ml (primary contact)	4/23 exceedences	Listed for *E. coli*
		ammonia	0.38 mg/L total nitrogen	14/16 exceedences	Listed for plant nutrients
			0.05 mg/L total phosphorus	13/16 exceedences	
			5.5 µg/cm^2 chlorophyll *a*	15 µg/cm^2 chlorophyll *a*	

[1] The WQS criterion for bacteria changed from fecal coliform to *E. coli* in 2005.

Sediment and Turbidity Results

Newly-developed assessment protocols (APs) for sedimentation and turbidity influenced monitoring methods and allowed evaluation of several previously un-assessed AUs and re-evaluation of a number of AUs previously listed for these parameters. The sedimentation AP consists of an initial pebble count that leads to a more extensive habitat evaluation if an ecoregion-based threshold for percent sand and fines is exceeded. Application of this protocol found that Willow Creek from the fish barrier to headwaters was impaired by excessive sand and fine particles, but also resulted in the de-listing of Wright Canyon Creek and the Pecos River from Sumner Reservoir to Cow Creek.

The turbidity AP evaluates the magnitude and duration of periods of elevated turbidity measured by deployed sondes, and led to the de-listing of Cow Creek, Glorieta Creek and the Pecos River from Cañon Manzanita to Alamitos Canyon. In addition, a new turbidity impairment was documented for the reach of the Gallinas River from Aguilar Creek to Pecos Arroyo.

An unpermitted discharge from Howard's Sand and Gravel Operation just below the sampling station on Tecolote Creek at I-25 was documented on May 19, 2010 (Figure 5). A breached settling pond was spilling process water into the stream from a gravel washing operation, elevating turbidity from 6.8 NTU above the discharge to 749.6 NTU below the discharge. Following inspection of the operation by the Point Source Regulation Section of the SWQB and the US Army Corps of Engineers, a cease and desist order was issued until proper best management practices, or BMPs, could be implemented to stop the discharge.

Figure 5. Un-permitted discharge into Tecolte Creek from Howard's Sand and Gravel on 5/19/10.

Chemical and Physical Results

SWQB data, together with data collected by Daniel B. Stephens and Associates (DBSA) between 2008 and 2010, resulted in the de-listing of Willow Creek for cadmium and zinc from the fish barrier above Tererro Mine to headwaters.

Thermograph data resulted in the de-listing of Glorieta Creek (Pecos River to the Glorieta Conference Center WWTP) and Bull Creek (Cow Creek to headwaters) for temperature; however, new temperature impairments were documented on the Gallinas River (Aguilar Creek to Pecos Arroyo) and on the Pecos River (Tecolote Creek to Villanueva State Park).

A number of AUs in the upper Pecos River watershed, and in the upper Tecolote Creek watershed were impaired for conductivity. These included Tecolote Creek (I-25 to Blue Creek), Dalton Canyon Creek (perennial reaches, Pecos River to headwaters), Falls Creek (Tecolote Creek to headwaters), and Macho Canyon Creek (Pecos River to headwaters).

Nutrient Results

A Level 1 nutrient screening was conducted in each AU in the survey. Level 2 nutrient surveys were conducted in AUs that failed the Level 1 screen or that were previously listed as impaired due to nutrients (Table 3). Nine AUs had a Level 2 nutrient survey to collect data required to determine their impairment status. Total nitrogen, total phosphorus, dissolved oxygen, and pH data were used in conjunction with periphyton data to determine that a number of AUs were impaired for nutrients, including Tecolote Creek (I-25 to Blue Creek), Glorieta Creek (Pecos River to the Glorieta Conference Center WWTP), Pecos River (Sumner Reservoir to Santa Rosa Reservoir), and Gallinas River (perennial portions, Aguilar Creek to Pecos Arroyo). In addition, the Gallinas River (Pecos River to Aguilar Creek) was listed for dissolved oxygen and El Rito Creek was listed for ammonia, pending acquisition of complete datasets to allow full assessments.

Biological Results

E. coli impairments were found in El Rito Creek, the Pecos River (Santa Rosa Reservoir to Tecolote Creek), and the Gallinas River (Aguilar Creek to Pecos Arroyo). Bacteria problems seem to be persisting in the Gallinas River as evidenced by the previous fecal coliform listing and the new *E. coli* listing. On the other hand, assessment of benthic macroinvertebrate data resulted the de-listing of the Gallinas River (Aguilar Creek to Pecos Arroyo) and found no other biological impairments where data were collected. However, data from some sites could not be assessed due to lack of a suitable reference site, and in two cases, index scores based on the composition of the macroinvertebrate community were inconclusive.

Fish community composition data were collected primarily from stations in the upper watersheds of the Pecos River and Tecolote Creek. A single station was sampled on the lower Gallinas River and two stations on the Pecos River in the lower survey area. Fish community composition data appear below (Table 7).

Table 7. Fish community composition data collected during the 2010 survey.

Station	Aquatic Life Use	Fish Present	Temperature Preference	Temperature Tolerance	Gravel Spawner?	Number of individuals collected
Bull Creek above Cow Creek	High quality coldwater	rainbow trout	cold	sensitive	yes	1
		longnose dace	cool	intermediate	yes	1
		brown trout	cold	intermediate	yes	50
Cow Creek above Bull Creek	High quality coldwater	rainbow trout	cold	sensitive	yes	1
		longnose dace	cool	intermediate	yes	1
		brown trout	cold	intermediate	yes	49
Cow Creek @ South San Ysidro	High quality coldwater	white sucker	cool	tolerant	yes	5
		Rio Grande chub	cool	intermediate	yes	31
		longnose dace	cool	intermediate	yes	24
		brown trout	cold	intermediate	yes	11
Pecos River above Lisboa Springs Hatchery	High quality coldwater	white sucker	cool	tolerant	yes	4
		rainbow trout	cool	sensitive	yes	26
		brown trout	cold	intermediate	yes	252
Pecos River @ National Historic Park	High quality coldwater	white sucker	cool	tolerant	yes	68
		Rio Grande chub	cool	intermediate	yes	24
		longnose dace	cool	intermediate	yes	60
		brown trout	cold	intermediate	yes	215
		rainbow trout	cold	sensitive	yes	10
Pecos River @ South San Ysidro	Marginal coldwater	white sucker	cool	tolerant	yes	19
		Rio Grande chub	cool	intermediate	yes	33
		longnose dace	cool	intermediate	yes	32
		brown trout	cold	intermediate	yes	9

Station	Aquatic Life Use	Fish Present	Temperature Preference	Temperature Tolerance	Gravel Spawner?	Number of individuals collected
Pecos River @Villanueva State Park	Marginal coldwater	white sucker	cool	tolerant	yes	28
		Rio Grande chub	cool	intermediate	yes	37
		flathead chub	cool	tolerant	no	75
		longnose dace	cold	intermediate	yes	16
		brown trout	cold	intermediate	no	1
Pecos River @ Puerto de Luna	Marginal coldwater	central stoneroller	cool	tolerant	yes	6
		red shiner	warm	tolerant	no	8
		plains killifish	warm	tolerant	no	1
		sand shiner	warm	intermediate	no	93
Pecos River @ Comanchero	Marginal coldwater	white sucker	cool	tolerant	yes	28
		Rio Grande chub	cool	intermediate	yes	37
		flathead chub	cool	tolerant	no	75
		longnose dace	cold	intermediate	yes	16
Tecolote Creek @ I-25	High quality coldwater	Rio Grande chub	cool	intermediate	yes	TNTC*
		longnose dace	cool	intermediate	yes	TNTC*
Gallinas River @ La Liendre	Marginal coldwater	Rio Grande chub	cool	intermediate	yes	22
		sand shiner	warm	intermediate	no	27
		flathead minnow	warm	tolerant	no	7
		longnose dace	cool	intermediate	yes	7

* Too numerous to count

WATER QUALITY SAMPLING RESULTS FOR LAKES AND RESERVOIRS

Of the lakes and reservoirs described in the introduction to this report, only Santa Rosa and Sumner Reservoirs were surveyed. As with data from streams and rivers generated by this survey, data from these reservoirs is available by request from the SWQB or by direct query of STORET.

Chemical and Physical Results

Santa Rosa Reservoir was found to be stratified (Figure 6) during June with a third of the hypolimnion anoxic (DO < 0.5 mg/ L). Sumner Reservoir never stratified (Figure 7) and no anoxic conditions were observed.

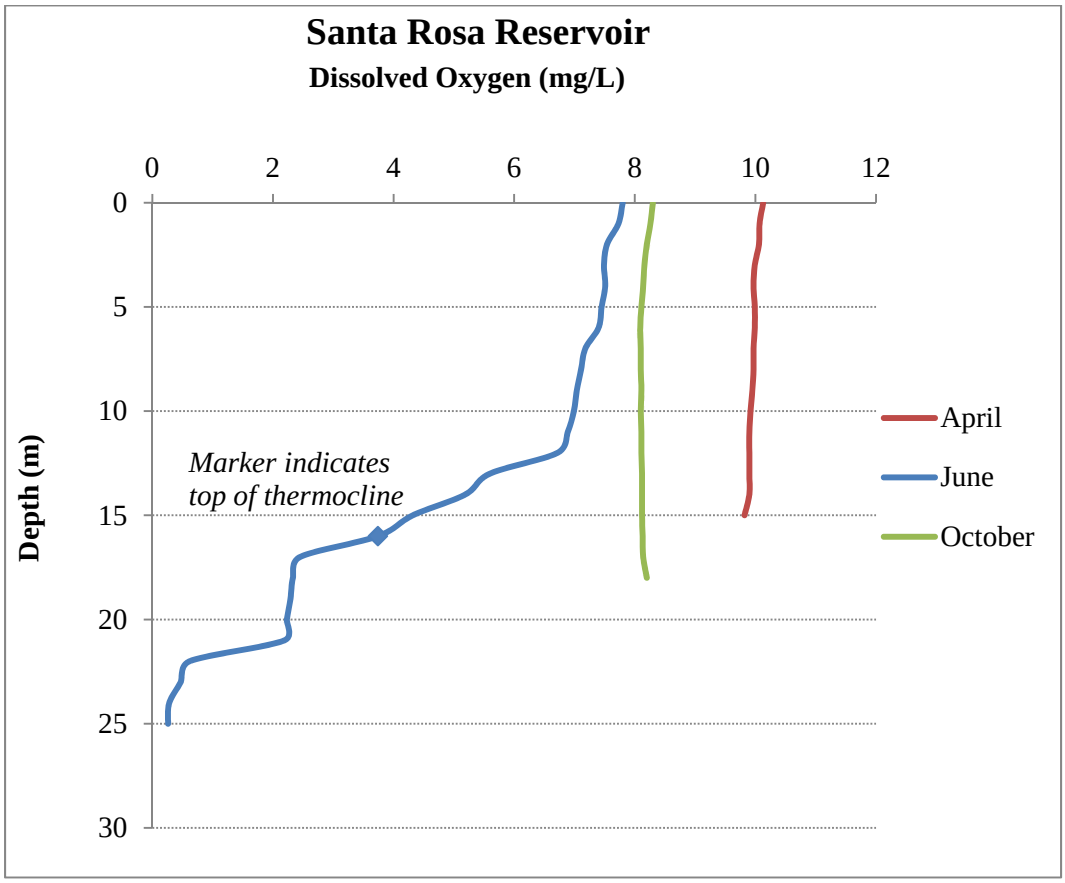

Figure 6. Dissolved oxygen depth profiles - Santa Rosa Reservoir, 2010

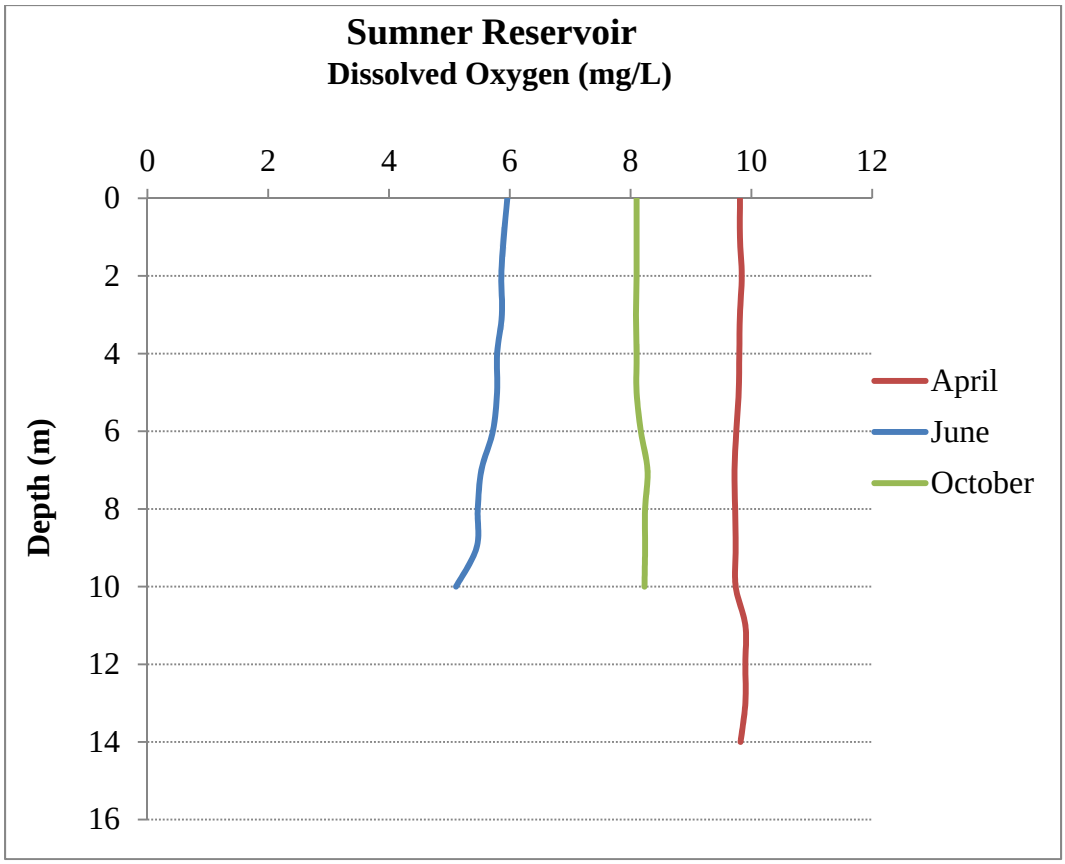

Figure 7. Dissolved oxygen depth profiles - Sumner Reservoir, 2010

Nutrient Results

No exceedences of existing water quality standards criteria were found in either reservoir. However, elevated levels of chlorophyll *a* were present in Santa Rosa Reservoir during the spring and summer, although the percentage of the total algae count attributable to toxic blue-green algae was minimal (≤1%). Nutrients (total phosphorus, total nitrogen) and nutrient-related parameters (chlorophyll *a*, % blue-green algae, Secchi depth, dissolved oxygen) from the 2010 survey are presented in Table 8.

Table 8. Nutrient and nutrient-related parameters from Santa Rosa and Sumner Reservoirs.

Station	Sampling Date	Chlorophyll *a* (µg/L)	Limiting Nutrient	Total Phosphorus (mg/L)	Total Nitrogen (mg/L)	Secchi depth (m)	% of Depth Profile below Dissolved Oxygen criterion	Cyanobacteria (% bluegreen algae)[3]
Santa Rosa Reservoir (Deep)	4/6/2010	16.26[1]	N/P	0.05	0.2	0.75[1]	0	0
	6/22/2010	8.73	N	0.046	0.41	1.25[1]	11.5	3.4
	10/26/2010	0.56	N/P	0.114[1]	1.3	0.5[1]	0	1.0
Santa Rosa Reservoir (Shallow)	4/6/2010	9.97	N	0.039	0.35	0.25[1]	0	mdp[2]
	6/22/2010	4.67	P	0.015	0.48	0.75[1]	0	mdp[2]
	10/26/2010	7.01	N/P	0.042	0.79	0.2[1]	0	mdp[2]
Sumner Reservoir (Deep)	4/7/2010	2.71	N/P	0.05	0.15	1.5[1]	0	2.7
	6/23/2010	3.36	P	0.015	0.54	1.25[1]	0	0
	10/27/2010	3.74	P	0.033	0.8	0.5[1]	0	6.0
Sumner Reservoir (Shallow)	4/7/2010	2.43	N	0.013	0.15	0.5[1]	0	mdp[2]
	6/23/2010	3.74	N	0.086[1]	0.726	0.25[1]	0	mdp[2]
	10/27/2010	3.55	P	0.05	0.66	0.6[1]	0	mdp[2]

[1] Violates New Mexico's nutrient thresholds for warmwater lakes and reservoirs (14.3 µg/L chlorophyll *a*, 0.051 mg/L total phosphorus, 1.54 mg/L total nitrogen, 1.95 m Secchi depth, and <38% cyanobacteria).
[2] Missing data point; phytoplankton is sampled only at deep stations

Biological Results

Phytoplankton samples were collected at the deep stations and the community was identified and enumerated as an indicator of nutrient enrichment, including the percent cyanobacteria. Cyanobacteria (blue-green algae) were found in Sumner Reservoir in April and October and in Santa Rosa Reservoir during June and October. The total percentage of cyanobacteria found in both reservoirs was below the target impairment threshold of 38% of the total community.

The October community contained *Microcystis aeruginosa* in both reservoirs, comprising 0.3% in Santa Rosa Reservoir and 5.7% of the total community in Sumner Reservoir. *Microcystis aeruginosa* produces hepatotoxins; however, the amount of *Microcystis aeruginosa* observed was low and there were no observations or reports of large blooms in either reservoir during this survey. *Anabena sp.*, another hepatotoxin-producing cyanobacteria, made up 3.2% of the June community in Santa Rosa Reservoir and 2.7% of the April community in Sumner reservoir. Again, no blooms were seen or reported.

No new fish tissue data were collected during this survey, but the existing fish consumption advisories for mercury in fish tissue remain in effect for both reservoirs.

DISCUSSION

CHEMICAL AND PHYSICAL MONITORING

Flows in the upper Pecos River Watershed were above the median during the 2010 survey (Figures 3 and 4). Despite relatively higher flows in the upper watershed, the mainstem of the Pecos River below Anton Chico went dry in July as did Tecolote Creek above the confluence with the Pecos River and the Gallinas River above Colonias, all due to irrigation diversions. Low flows in these reaches after irrigation withdrawals began likely contributed to the dissolved oxygen and temperature impairments.

The conductivity impairments found in some tributaries to the upper Pecos River and Tecolote Creek should be reviewed. While the impairments on Tecolote Creek (I-25 to Blue Creek) and on Glorieta Creek seem reasonable, those documented at Falls Creek, Macho Creek, Willow Creek and possibly Dalton Canyon Creek indicate the potential need for use attainability analyses to determine the factors affecting the attainment of the high quality coldwater criterion. These drainages range from relatively undisturbed to pristine and TDS values, the surrogate parameter used to address conductivity loading, were low ranging from 162 mg/L to 258 mg/L, with an average of 206 mg/L.

Metals sampling by the SWQB and DBSA on Willow Creek and the Pecos River above and below Tererro Mine showed no exceedences of WQS criteria indicating reclamation activities have been successful. Monitoring by DBSA will continue as re-vegetation of the reclaimed area continues.

NUTRIENTS

A comparison of total phosphorus, total nitrogen, chlorophyll *a* and Secchi depths from 2001 (Santa Rosa Reservoir) and 2003 (Sumner Reservoir), both years with far less precipitation than 2010, with data from the 2010 survey indicate that primary productivity (i.e., chlorophyll *a*) has

generally increased since the last time these reservoirs were surveyed (Tables 9 and 10). Nevertheless, data collected during the 2001, 2003, and 2010 surveys indicate that the overall trophic state characterization in both Santa Rosa and Sumner Reservoirs remains mesoeutrophic according to Carlson's indices for Secchi depth, chlorophyll *a*, total phosphorus, and total nnitrogen (Carlson 1977). The trophic state index (TSI) for total nitrogen in Santa Rosa Reservoir shifted from mesotrophic in 2001 to mesoeutrophic in 2010 indicating increased nitrogen loading to the reservoir, which most likely contributed to the overall increase in chlorophyll *a* concentrations. Similarly, the TSI for chlorophyll *a* in Sumner Reservoir shifted from oligomesotrophic in 2003 to mesotrophic in 2010 indicating increased productivity in the reservoir evidently from more available nutrients. In fact, all of the indicators showed shifts to a more productive state.

Table 9. Comparison of trophic state indicators in Santa Rosa Reservoir from 2001 and 2010.

		Total Phosphorus (mg/L)		Total Nitrogen (mg/L)		Chlorophyll *a* (µg/L)		Secchi Depth (m)	
Station	**Year**	**2001**	**2010**	**2001**	**2010**	**2001**	**2010**	**2001**	**2010**
Santa Rosa - Deep	Spring	0.05	0.05	mdp	0.2	4.11	16.26[1]	1.0[1]	0.75[1]
	Summer	< 0.03	0.046	mdp	0.41	1.44	8.73	2.75	1.25[1]
	Fall	0.03	0.114[1]	mdp	1.3	10.28	0.56	0.80[1]	0.5[1]
Santa Rosa - Shallow	Spring	0.036	0.039	1.027	0.35	5.05	9.97	0.65[1]	0.25[1]
	Summer	0.045	0.015	0.522	0.48	1.40	4.67	2.0	0.75[1]

[1] Violates New Mexico's nutrient impairment threshold for warmwater lakes and reservoirs (14.3 µg/L chlorophyll *a*, 0.051 mg/L total phosphorus, 1.54 mg/L total nitrogen, 1.95 m Secchi depth.

Table 10. Comparison of trophic state indicators in Sumner Reservoir from 2003 and 2010.

		Total Phosphorus (mg/L)		Total Nitrogen (mg/L)		Chlorophyll *a* (µg/L)		Secchi Depth (m)	
Station	**Year**	**2003**	**2010**	**2003**	**2010**	**2003**	**2010**	**2003**	**2010**
Sumner - Deep	Spring	0.05	0.05	0.39	0.15	0.997	2.71	2.5	1.5[1]
	Summer	< 0.03	0.015	0.546	0.54	2.74	3.36	0.8[1]	1.25[1]
	Fall	0.03	0.033	0.484	0.80	mdp	3.74	0.6[1]	0.5[1]

	Spring	< 0.03	0.013	0.433	0.15	0.561	2.43	2.4	0.5[1]
Sumner - Shallow	Summer	< 0.03	0.086[1]	1.11	0.726	6.23	3.74	0.45[1]	0.25[1]
	Fall	0.046	0.05	0.57	0.66	2.275	3.55	0.5[1]	0.6[1]

1 Violates New Mexico's nutrient impairment threshold for warmwater lakes and reservoirs (14.3 µg/L chlorophyll *a*, 0.051 mg/L total phosphorus, 1.54 mg/L total nitrogen, 1.95 m Secchi depth.

The Gallinas River (Aguilar Creek to Pecos Arroyo) and Tecolote Creek (I-25 to Blue Creek) are now listed as impaired for plant nutrients (Tables 5 and 6). In addition, nutrient concentrations exceeded impairment thresholds in the majority of samples collected in the Pecos River below I-25. Collectively, these observations show that there is a substantial nutrient load being delivered to Santa Rosa Reservoir by the Pecos River system, which includes the Gallinas River and Tecolote Creek.

Nutrient levels in the Pecos River below Santa Rosa Dam exceeded impairment thresholds in both 2001 and 2010. The observed trend was an increase in nutrient concentrations from upstream to downstream and an increase in the number of exceedences from 2001 to 2010 (Table 11). Furthermore, every nutrient sample collected in 2010 from El Rito Creek below the Santa Rosa WWTP exceeded nutrient impairment thresholds by one to three orders of magnitude. These observations indicate that El Rito Creek, after receiving the Santa Rosa WWTP effluent, contributes a substantial amount of nutrients to the Pecos River and eventually to Sumner Reservoir. These results also show that the Pecos River already carries a considerable portion of the load measured at Puerto de Luna when it leaves Santa Rosa Reservoir.

Table 11. Comparison of nutrient exceedence ratios* on the Pecos River between Santa Rosa Reservoir, Sumner Reservoir, and El Rito Creek from 2001 and 2010.

Station	Total Phosphorus		Total Nitrogen	
	2001	2010	2001	2010
Pecos River (at Parker Ave.) above El Rito Creek	0/9	2/6	2/7	5/6
El Rito Creek below Santa Rosa WWTP	8/8	5/5	7/8	5/5
Pecos River near Puerto de Luna	1/8	3/6	1/8	5/6

*NM nutrient impairment thresholds: 0.02 mg/L total phosphorus in El Rito Creek and 0.03 mg/L in the Pecos River; 0.25 mg/L total nitrogen in El Rito Creek and 0.45 mg/L in the Pecos River

FISH COMMUNITY SURVEYS

Fish community composition can be correlated with physical and chemical parameters to provide information about how changes may be impacting the fish community. Coldwater fish, such as trout and salmon, require aquatic habitats with abundant insects or small fish as a food source, clear cold water with year-round temperatures that do not exceed 20ºC for extended time periods, high levels of dissolved oxygen, and a stony or gravelly channel substrate for spawning. Warmwater fish can tolerate temperatures up to 32.2ºC as well as lower oxygen levels and some species can also tolerate or require muddy or sandy substrates. Characteristics of fish community composition can offer clues as to if and how a particular habitat has been degraded. For example, if a robust community of gravel spawners is expected at a particular location but not found, it may be indicative of sedimentation issues.

The Pecos River at Puerto de Luna falls within water quality standards segment (WQSS) 20.6.4.211 of the standards. This segment spans Santa Rosa Reservoir, and conditions are distinct above and below the impoundment. Below Santa Rosa, there groundwater input from the numerous spring-fed lakes and streams in the Santa Rosa area. Above the impoundment, irrigation withdrawal at times renders the river dry or nearly so at some locations. Unfortunately, resources did not allow for fish collection above the reservoir. The designated aquatic life use in this segment is marginal warmwater, but river conditions do not fall within that definition. Consideration should be given to changing the designated aquatic life use to warmwater below Santa Rosa dam, and further investigation is necessary above Santa Rosa Reservoir and below the confluence with Tecolote Creek to determine if warmwater or coolwater aquatic life would be the more appropriate designation. At Puerto de Luna, the fish community was dominated by warmwater species, with only 6% coolwater species (central stoneroller). Data collected from thermographs also support a warmwater designation.

Tecolote Creek at I-25, in WQSS 20.6.4.215, has a high quality coldwater aquatic life designated use. While this designation may be appropriate for much of the segment, fish community data suggest it is not appropriate for Tecolote Creek near the downstream terminus. The fish community here consisted of entirely coolwater species, and characteristics such as elevation and ecoregion 26h (piñon-juniper woodland and savannah) support this change. Although watershed and riparian conditions appear degraded, it seems unlikely that this section of Tecolote Creek ever supported a resident breeding population of coldwater fish. Fish collections in 2010 were similar to those SWQB performed in 2001, when the community was also dominated by the same two coolwater species, longnose dace and Rio Grande chub.

Three locations on the Pecos River within WQSS 20.6.4.216 were sampled. This segment is designated as a marginal coldwater aquatic life use (with a segment-specific temperature criterion of 30°C), and the coolwater fish communities documented are consistent with this

designation. Thermograph data at South San Ysidro indicate that temperatures never exceeded 27.5°C; at Villanueva State Park, temperatures remained below 29°C; and the maximum water temperature just above the confluence with Tecolote Creek was 30.5°C. These observations suggest that the segment-specific temperature criterion should be removed and replaced with the default coolwater aquatic life criterion (29C°).

WQSS 20.6.4.217 has a designated use of high quality coldwater aquatic life. This segment extends to the headwaters of the Pecos River and Cow Creek and the current designated use appears to be appropriate for most of the waters included in the segment. However, Cow Creek at North San Ysidro was dominated by coolwater fish, with brown trout making up the remainder. None of the brown trout were young-of-the-year, with only one sub-adult, suggesting that natural reproduction of coldwater fish is limited in this reach. This station is in ecoregion 21d (foothills woodlands and shrublands) which is typified by coolwater fish communities, indicating that the lower reaches should be re-designated as coolwater or coldwater aquatic life with a segment-specific temperature criterion.

The stations at Cow Creek above Bull Creek and Bull Creek above Cow Creek are within the coolwater-dominated ecoregion 21d, but at 2106 m, they are at the upper end of this ecoregion. Both locations were dominated by brown trout, including a substantial number of sub-adults, suggesting that a coldwater designation is appropriate. This may be a logical location to divide Cow Creek between cold and cool aquatic life uses. Thermograph data supported the designated use on Bull Creek (maximum temperature was 21.7°C) but verified non-support on Cow Creek (maximum temperature was 23.3°C). This could be related to ongoing recovery following the 2000 Viveash fire, which burned much of the upper reaches of Cow Creek, but less so in Bull Creek. Aquatic habitat in Cow Creek appeared to be improved compared to one year after the Viveash fire, when SWQB sampling efforts yielded just 2 brown trout and 4 longnose dace in an 80-meter stream reach.

The two Pecos River locations in this segment are both within ecoregion 21d, although the upper location (at the hatchery), at 2146 m, is just 1.6 km downstream of the ecoregion boundary and exhibits characteristics typical of a coldwater habitat. Brown trout dominated the community (98%) with only 4 white suckers captured. Thermograph data indicated support of the aquatic life use. At Pecos National Historical Park, fish community data suggested that a designation of coolwater or coldwater with a segment-specific temperature criterion may be more appropriate. Brown trout comprised 59% of the individuals, with the remaining 41% divided among white sucker, Rio Grande chub, and longnose dace. Thermograph data showed a maximum temperature of 25.5°C. At the Park, brown trout young-of-the-year and sub-adults comprised only 3% and 29% respectively as compared to 11% and 49% at the Lisboa Springs hatchery, suggesting that reproduction is comparatively limited at this lower station.

The Gallinas River at La Liendre was the only fish collection location in WQSS 20.6.4.220 in 2010. The designated aquatic life use is marginal coldwater with a segment-specific temperature criterion of 30°C. The fish community consisted of four native species: two coolwater (Rio Grande chub and longnose dace) and two warmwater (sand shiner and fathead minnow) in fairly even proportions (46% coolwater, 54% warmwater). Thermograph data showed a maximum temperature of 31.9°C, which exceeds the segment-specific criterion. However, at San Augustin (1812 m), 18 km upstream but within the same WQSS, the maximum recorded temperature was 29.7°C, which is below the criterion. Considering the observed riparian and watershed conditions, and that a substantial proportion of the fish at La Liendre are coolwater species, a coolwater criterion seems attainable. At San Augustin in 2001, SWQB documented only coolwater species (white sucker, Rio Grande chub, and longnose dace).

CONCLUSIONS

The Pecos River, Tecolote Creek, the Gallinas River and their tributaries in the upper portion of their respective watersheds are all in relatively good condition. Impairments due to some anthropogenic disturbances, such as Tererro Mine, have been corrected and upgrades at the Village of Pecos WWTP, Las Vegas WWTP and Santa Rosa WWTP have, or are expected to, improve water quality in the waters receiving their effluent. Other impairments may be the result of inappropriate segment-specific criteria.

Sediment and temperature impairments begin to appear in all three drainages at the transition from ecoregion 21d (foothill woodlands and shrublands) to 26 h (piñon-juniper woodlands and savannas) where soils become more erodible and land management practices have reduced vegetation. These same factors also lead to dramatic increases in turbidity at this transition zone. Ineffective land management practices above Santa Rosa and Sumner Reservoirs may also be related to the increased nutrient loading apparent from both this survey and previous surveys. The Watershed Protection Section of the SWQB has a strong presence in the upper Pecos and upper Gallinas watersheds and should focus on the watershed below I-25 to address these problems.

The improvements at the WWTPs in Pecos, Las Vegas, and Santa Rosa are expected to improve water quality over time and should help to reduce nutrient loading to downstream reservoirs. However, nutrient impairments persist on the Gallinas River below the Las Vegas WWTP and nutrient impairment thresholds are still being exceeded on the Pecos River below the Pecos WWTP.

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All NMED/SWQB references are available online at the SWQB website:

www.nmenv.state.nm.us/swqb

APPENDIX I. Analytes included in SWQB analytical suites.

Nutrients

ammonia
total phosphorus
total nitrogen
nitrate + nitrite
total Kjeldahl nitrogen

Total Heavy Metals (un-filtered sample)

aluminum
selenium
mercury

Dissolved Heavy Metals (sample passed through 0.45 μm filter in the field)

aluminum
antimony
arsenic
barium
beryllium
boron
calcium
cadmium
chromium
iron
lead
magnesium
manganese
molybdenum
nickel silicon
silicon silver
silver tin
tin vanadium
vanadium zinc
zinc

Semi-Volatile Organic Compounds

1,2-Dichlorobenzene
1,2-Dinitrobenzene
1,3-Dichlorobenzene
1,3-Dinitrobenzene
1,4-Dichlorobenzene
1,4-Dinitrobenzene
1-Methylnaphthalene
2,3,4,6-Tetrachlorophenol
2,3,5,6-Tetrachlorophenol
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol
2,4-Dichlorophenol
2,4-Dimethylphenol
2,4-Dinitrophenol
2,4-Dinitrotoluene
2,6-Dinitrotoluene
2-Chloronaphthalene
2-Chlorophenol
beta-BHC
bis(2-Chloroethoxy)methane
bis(2-Chloroethyl)ether
bis(2-Chloroisopropyl)ether
bis(2-Ethylhexyl)adipate
bis(2-Ethylhexyl)phthalate
Butyl Benzyl Phthalate
Carbazole
Chrysene
cis-Chlordane
Cyanazine
delta-BHC
Dibenz(a,h)anthracene
Dibenzofuran
Dieldrin
Diethylphthalate
Dimethylphthalate
Di-n-butyl Phthalate

2-Methylnaphthalene
2-Methylphenol
2-Nitroaniline
2-Nitrophenol
3,3'-Dichlorobenzidine
3-Methylphenol & 4-Methylphenol
3-Nitroaniline
4,4'-DDD
4,4'-DDE
4,4'-DDT
4,6-Dinitro-2-methylphenol
4-Bromophenyl Phenyl Ether
4-Chloro-3-methylphenol
4-Chloroaniline
4-Chlorophenyl Phenyl Ether
4-Nitroaniline
4-Nitrophenol
Acenaphthene
Acenaphthylene
Alachlor
Aldrin
alpha-BHC
Aniline
Anthracene
Atrazine
Azobenzene
Benzidine
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(g,h,i)perylene
Benzo(k)fluoranthene
Benzyl alcohol
beta-BHC
Di-n-octyl phthalate
Endosulfan I
Endosulfan II
Endosulfan sulfate
Endrin
Endrin aldehyde
Endrin ketone
Fluoranthene
Fluorene
gamma-BHC (lindane)
Heptachlor
Heptachlor epoxide
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane
Indeno(1,2,3-cd)pyrene
Isophorone
Methoxychlor
Metolachlor
Metribuzin
Naphthalene
Nitrobenzene
N-nitrosodimethylamine
N-nitroso-di-n-propylamine
N-nitrosodiphenylamine
Pentachlorophenol
Phenanthrene
Phenol
Prometryne
Pyrene
Pyridine
Simazine
trans-Chlordane

Volatile Organic Compounds

1,1,1,2-Tetrachloroethane
1,1,1-Trichloroethane
1,1,2,2-Tetrachloroethane
1,1,2-Trichloroethane
1,1-Dichloroethane
1,1-Dichloroethene
1,1-Dichloropropene
1,2,3-Trichlorobenzene
1,2,3-Trichloropropane
1,2,4-Trichlorobenzene
1,2,4-Trimethylbenzene
1,2-Dibromo-3-chloropropane (DBCP)
Chloroethane
Chloroform
Chloromethane
Chloroprene
cis-1,2-Dichloroethene
cis-1,3-Dichloropropene
cis-1,4-Dichloro-2-butene
Dibromochloromethane
Dibromomethane
Dichlorodifluoromethane
Ethyl methacrylate
Ethylbenzene

1,2-Dibromoethane (EDB)
1,2-Dichlorobenzene
1,2-Dichloroethane
1,2-Dichloropropane
1,3,5-Trimethylbenzene
1,3-Dichlorobenzene
1,3-Dichloropropane
1,4-Dichlorobenzene
1,4-Dioxane
2,2-Dichloropropane
2-Butanone (MEK)
2-Chloroethyl vinyl ether
2-Chlorotoluene
2-Hexanone
4-Chlorotoluene
4-Isopropyltoluene
4-Methyl-2-pentanone
Acetone
Acetonitrile
Acrolein
Acrylonitrile
Allyl chloride
Benzene
Bromobenzene
Bromochloromethane
Bromodichloromethane
Bromoform
Bromomethane
Carbon disulfide
Carbon tetrachloride
Chlorobenzene
Hexachlorobutadiene
Iodomethane
Isobutyl alcohol
Isopropylbenzene
m- & p-Xylenes
Methyl methacrylate
Methylacrylonitrile
Methylene chloride (Dichloromethane)
Naphthalene
n-Butylbenzene
Nitrobenzene
o-Xylene
Pentachloroethane
Propionitrile
Propylbenzene
sec-Butylbenzene
Styrene
tert-Butyl methyl ether (MTBE)
tert-Butylbenzene
Tetrachloroethene
Tetrahydrofuran (THF)
Toluene
Total trihalomethanes
Total xylenes
trans-1,2-Dichloroethene
trans-1,3-Dichloropropene
trans-1,4-Dichloro-2-butene
Trichloroethene
Trichlorofluoromethane
Vinyl acetate
Vinyl chloride