WATER QUALITY MONITORING
OF THE
MIDDLE RIO GRANDE

Annual Baseline Condition and Trends of Key Water Quality Parameters

2000 – 2007
ANNUAL REPORT

Prepared by

New Mexico Environment Department
SURFACE WATER QUALITY BUREAU

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LIST OF ACRONYMS

ALU	Aquatic Life Use
AU	Assessment Unit
BOR	Bureau of Reclamation
DO	Dissolved Oxygen
MRG	Middle Rio Grande
MRGESACP	Middle Rio Grande Endangered Species Act Collaborative Program
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NOAA	National Oceanic and Atmospheric Administration
RGSM	Rio Grande Silvery Minnow
STORET	Storage and Retrieval System
SWQB	Surface Water Quality Bureau
TMDL	Total Maximum Daily Load
USEPA	United States Environmental Protection Agency

EXECUTIVE SUMMARY

This annual report is submitted in partial fulfillment of workplan commitments for federal Grant 06-FG-40-2551.

The Middle Rio Grande Endangered Species Act Collaborative Program (MRGESACP) contracted with the New Mexico Environment Department (NMED) Surface Water Quality Bureau (SWQB) to conduct water-quality monitoring and assessment to allow the MRGESACP to determine potential water-quality relationships that may affect Rio Grande silvery minnow (RGSM) recovery in the MRG.

Specifically, NMED conducted quarterly sampling of water and sediment, toxicity tests, and annual fish tissue collection and analysis at ten stations in the MRG as determined by the MRGESACP. The survey extended from Bosque del Apache, downstream of San Antonio, north to the Angostura Diversion Works, upstream of Bernalillo covering approximately 180 miles of river during each sampling event. This report provides details on the survey work completed between October 2006 and September 2007.

In addition to the sampling conducted specifically for this grant, NMED solicited and compiled water chemistry data for sites on the MRG within the study area from other sources and an earlier NMED study collected in the years 2000 through 2007. NMED evaluated the data against available New Mexico Water Quality Control Commission (WQCC) approved water quality standards to determine exceedences in water quality criteria. The analysis of water quality data (2000-2007) shows exceedences of water quality criteria for dissolved oxygen in two areas “Rio Grande (non-pueblo Alameda Bridge to Angostura Div)” and “Rio Grande (Isleta Pueblo bnd to Alameda Bridge)” and for bacteria (E. coli) in most of the area. Based on a 2005 microbial tracking study, the sources of the bacteria are believed to be primarily from dogs or wildlife.

Additional discussion on the findings is provided in Section 5.0 of this report.

Sediment chemistry, fish tissue contaminant concentrations and sediment toxicity data were not used for water quality assessments, but rather are summarized in this report to provide additional information of potential chemical stressors in the MRG and the effect on the fish community.

Quarterly progress reports including data updates were provided under the contract. All data from this study and data compiled from 2000 to 2007 will be supplied to the MRGESACP via CD and will be available upon request for other parties.

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1.0 INTRODUCTION

This study was established to provide an annual baseline condition and trends for key water quality parameters for the Middle Rio Grande (MRG) watershed (see **Figure 1**) as part of a comprehensive water-quality monitoring and assessment program in the MRG to assess potential water-quality relationships that may affect silvery minnow recovery. To complement the numerous projects in the MRG focusing on the biological components of the river, this study provides the foundation for a long-term water quality monitoring and assessment program by adding to the total number of water quality samples being collected by other agencies within the MRG.

Figure 1. Map of Middle Rio Grande Sampling Area

By providing a framework of water quality data, future research can begin to focus on the potential of specific stressors to impact RGSM. The value of water quality monitoring to the MRGESACP increases with the longevity and consistency of the monitoring.

Specifically, NMED conducted quarterly sampling of water and sediment, toxicity tests, and annual fish tissue collection and analysis at ten stations in the MRG as determined by the MRGESACP. The survey extended from Bosque del Apache, downstream of San Antonio, north to the Angostura Diversion Works, upstream of Bernalillo covering approximately 180 miles of river during each sampling event. This report provides details on the survey work completed between October 2006 and September 2007.

In addition to the sampling conducted specifically for this grant, NMED compiled water chemistry data for sites within the study area from other sources collected between the years 2000 through 2007.

As described in the workplan, NMED solicited recent (2000-2006) water quality data from non-NMED sources from the MRG. The solicitation was conducted in two stages first in July-August 2007 as part of the overall data solicitation for the 2008-2010 CWA Section 303(d)/305(d) Integrated List and second in October-November 2007 through a targeted email notice. The July-August 2007 notice was published in six newspapers in New Mexico (Albuquerque Journal, Albuquerque Journal North, Santa Fe New Mexican, Las Cruces Sun News, Farmington Daily Record, and the Raton Range, see files of documentation (website pages, notices, affidavits of publication, email)). The July-August notice solicited data for any water in New Mexico.

SWQB attempted a different approach to solicit data for the MRG in October-November 2007 by sending an email request to the participants in the Middle Rio Grande ESA Collaborative Program through the riogrande@fws.gov list serve. (supporting documentation provided to the MRGESACP via CD and available upon request to other parties.) SWQB received long term sonde data from Dave Van Horn, a graduate student at the University of New Mexico Department of Biology. The Van Horn data collection effort also was funded by the MRGESACP (see Section 5.2 for assessment conclusions).

SWQB compiled daily average discharge of the MRG as measured at USGS stations for the period October 1, 2006 to September 1, 2007 to capture the flows during the period of this study. Results are shown in **Figure 2** with sampling runs indicated on the graph at the closest active USGS gage. SWQB also compiled daily average discharge from selected USGS gages in the MRG from January 2000 to April 2007 to capture flows during the entire period associated with data collected for use in water quality assessments (**Figure 3**).

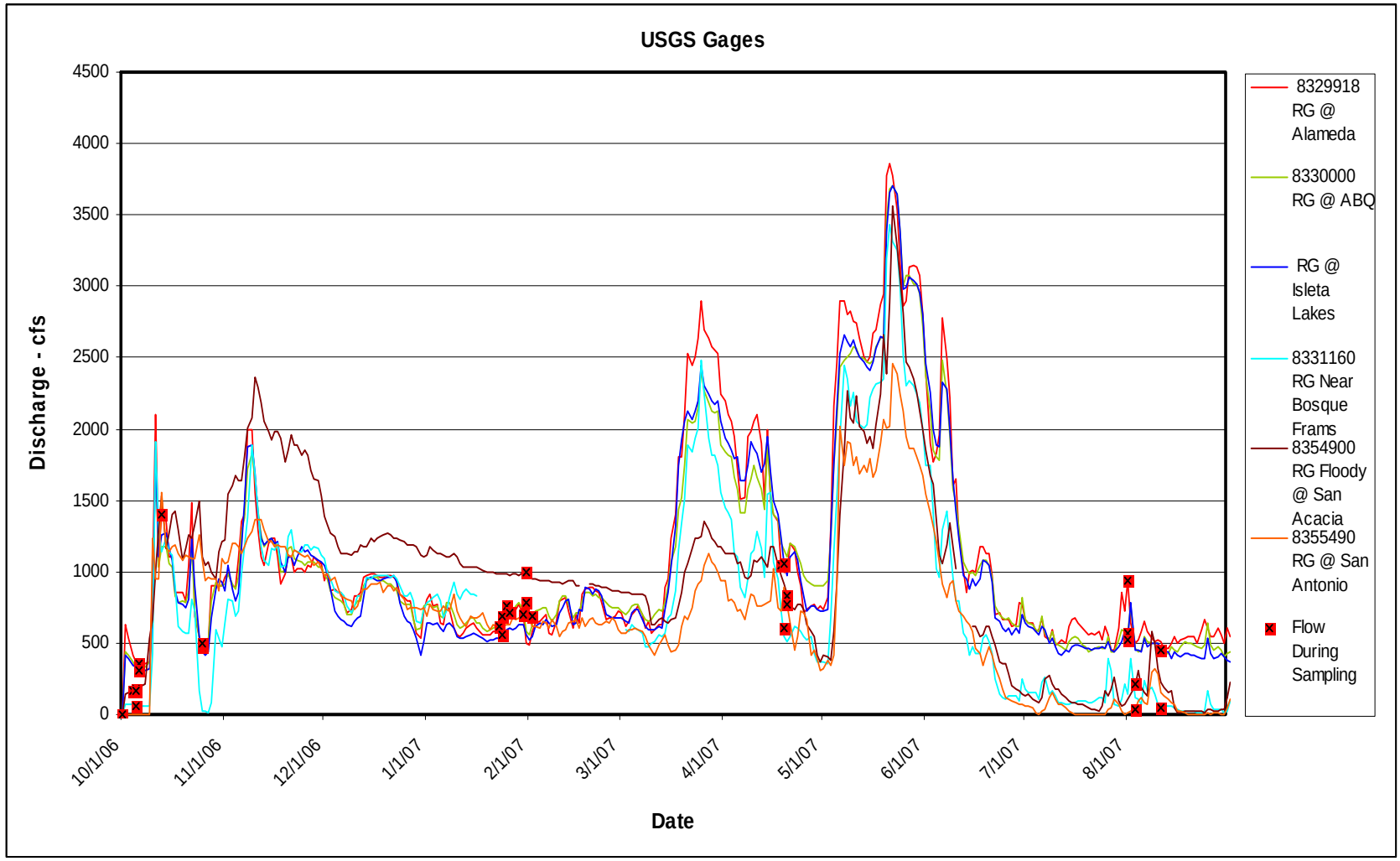

Figure 2. Middle Rio Grande Discharge at USGS Gages Throughout the Sampling Area during the 2006-2007 MRGESACP Water Quality Monitoring Survey.

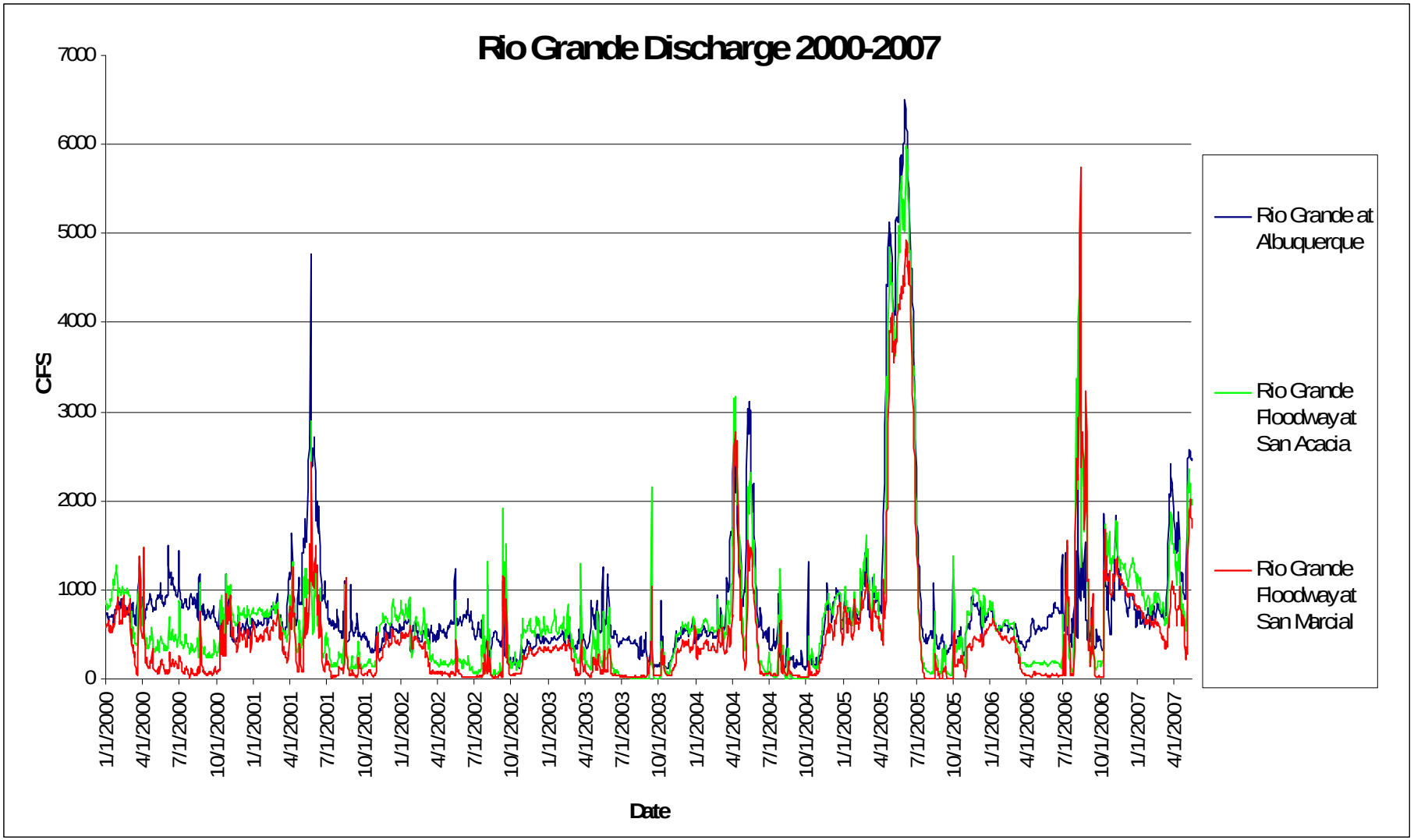

Figure 3. Middle Rio Grande Discharge at Selected USGS Gages in the MRG Sampling Area from January 2000 – April 2007.

2.0 NEW MEXICO WATER QUALITY STANDARDS

USEPA approved water quality standards were used to determine if the MRG was supporting the designated uses. The *State of New Mexico Standards for Interstate and Intrastate Surface Waters* (20.6.4 NMAC August 2007) were consulted for this determination. Sections 20.6.4.105 and 20.6.4.106 NMAC describes the general water quality criteria applicable to designated uses for the Middle Rio Grande Basin surveyed in this study:

20.6.4.105 RIO GRANDE BASIN - The main stem of the Rio Grande from the headwaters of Elephant Butte reservoir upstream to Alameda bridge (Corrales bridge) and intermittent water below the perennial reaches of the Rio Puerco that enters the main stem of the Rio Grande.

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

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 9.0 and temperature 32.2°C (90°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

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

(3) At mean monthly flows above 100 cfs, the monthly average concentration for: TDS l,500 mg/L or less, sulfate 500 mg/L or less and chloride 250 mg/L or less.

[20.6.4.105 NMAC - Rp 20 NMAC 6.1.2105, 10-12-00; A, 05-23-05]

20.6.4.106 RIO GRANDE BASIN - The main stem of the Rio Grande from Alameda bridge (Corrales bridge) upstream to the Angostura diversion works and intermittent water in the Jemez river below the Jemez pueblo boundary that enters the main stem of the Rio Grande.

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

B. Criteria:

(1) In any single sample: dissolved oxygen greater than 5.0 mg/L, pH within the range of 6.6 to 9.0 and temperature less than 32.2°C (90°F). The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

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

(3) At mean monthly flows above 100 cfs, the monthly average concentration for: TDS 1,500 mg/L or less, sulfate 500 mg/L or less and chloride 250 mg/L or less.

[20.6.4.106 NMAC - Rp 20 NMAC 6.1.2105.1, 10-12-00; A, 05-23-05]

Section 20.6.4.900 NMAC, as referenced in the above site specific criteria, provides a list of water chemistry analytes for which SWQB tests and a range of criteria for protecting various designated uses. The table of numeric criteria provided in 20.6.4.900 NMAC is used for assessing use support. (See Appendix A for most recent version of the numeric criteria.)

Water quality data are evaluated against water quality standards to determine whether waters are meeting assigned water quality standards. Based on the most recent assessments conducted for the Middle Rio Grande, two segments of the Middle Rio Grande are impaired for fecal coliform and one for toxicity. (See **Table 1**) A total maximum daily load (TMDL) strategy document was developed for fecal coliform for the two reaches.

Table 1. Summary of 2006-2008 Integrated List Impairments and Existing TMDLs – Middle Rio Grande

Assessment Unit	2006-2008 Integrated List Impairments	Probable Sources	Existing TMDLs (date)
Rio Grande (Elephant Butte to San Marcial)	None	N/A	None
Rio Grande (San Marcial to Rio Puerco)	None	N/A	None
Rio Grande (Rio Puerco to Isleta Pueblo Boundary)	None	N/A	None
Rio Grande (Isleta Pueblo Boundary to Alameda Bridge)	Fecal Coliform	• Impervious Surface/Parking Lot Runoff • Municipal (Urbanized High Density Area) • Municipal Point Source Discharges • On-site Treatment Systems (Septic Systems and • Similar Decentralized Systems)	Fecal Coliform (2002)
Rio Grande (Alameda Bridge to Angostura Diversion)	• Fecal Coliform • Ambient Bioassays* – Acute Aquatic Toxicity • Ambient Bioassays* – Chronic Aquatic Toxicity	• Impervious Surface/Parking Lot Runoff • Municipal (Urbanized High Density Area) • Municipal Point Source Discharges • On-site Treatment Systems (Septic Systems and • Similar Decencentralized Systems)	Fecal Coliform (2002)

* = The toxicity listing is based on toxicity testing below the Bernalillo WWTP between 2002 and 2004. The NPDES permit for Bernalillo WWTP was renewed in January 2004, including an implementation schedule for de-chlorination.

3.0 METHODS

All water quality data within this project were collected in accordance with the procedures set forth in the *SWQB Quality Assurance Project Plan* (NMED/SWQB 2006 or 2007) for the perspective year of the actual data collection and the *SWQB Standard Operating Procedures for Data Collection* (NMED/SWQB 2004 or 2007). The data collected as part of this study were 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. These data were assessed in accordance with protocols established in the *State of New Mexico Procedures for Assessing Standards Attainment for the Integrated §303(d)/§305(b) Water Quality Monitoring and Assessment Report [Assessment Protocols]* (NMED/SWQB 2008).

In addition, data collection generally followed the methods detailed in Abeyta and Lusk (2004). Water column samples were collected using equal width increment (EWI) sampling across macrohabitat transects during wadeable conditions. If wading was not possible and a bridge was present at the sampling site, the sample was collected from a bridge with a sampler suspended from a bridgeboard. If wading was not possible and no bridge was at the station, grab samples were collected by wading a safe distance from the bank. Sediment samples were collected from recently deposited sediments in depositional areas. All chemical analyses followed methods published in *Annual Book of ASTM Standards* (2005), *Standard Methods for the Examination of Water and Wastewater* (2005), *Methods for Chemical Analysis of Water and Wastes* (1983 and subsequent revisions), and *Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater* (1986 and subsequent revisions).

Fish tissue analyses were conducted by GEL and AXYS Labs. Fish collected for analyses consisted of common carp (*Cyprinus carpio*) based on recommendations from the MRGESACP. Fish tissue contaminant levels were evaluated using guidelines developed by USGS-BEST and USFWS (Schmitt 2004, Eisler 1993).

The stations and the affiliated studies are summarized in **Tables 3 and 4**. The type of monitoring conducted at each site and number of sampling events (non-USGS data) is summarized in **Tables 5 and 6**. Monitoring site locations and sampling timing for data collected per the workplan was coordinated to the extent possible with the Fish Health study also funded by the MRGESACP.

During this survey, blanks were only collected during the April 2007 quarterly run. A few analytes were detected in those blank samples and are noted by qualifier codes in the raw data. Of parameters that were assessed, ammonia and copper were detected in the blank samples. SWQB reviewed the results and determined that the amounts detected were insignificant and would not impact water quality assessments. SWQB has taken steps to identify blank issues for future sampling runs.

4.0 SAMPLING SUMMARY

SWQB staff sampled water and sediment quarterly at selected stations determined by the MRGESACP and detailed in the 2006 Request for Proposal (RfP). A state-wide map of the study area is provided in **Figure 1**. The station names and corresponding USEPA Storage and Retrieval database (STORET) identification codes selected for sites specified in the workplan are provided in **Table 2**.

Table 2. Sampling Stations – Middle Rio Grande, 2006-2007.

STATION NAME	STORET NUMBER	CORRESPONDING SITE NAME FROM CONTRACT WORKPLAN
Bosque del Apache	32RGrand286.9	"Rio Grande near Lemitar or, Rio Grande at Bosque del Apache National Wildlife Refuge"
Rio Grande near San Antonio	32RGrand292.1c	
Rio Grande near Lemitar	32RGrand323.4	
Rio Grande upstream of San Acacia Dam	32RGrand332.5	"Upstream of San Acacia Dam"
Rio Grande below the confluence with Rio Puerco – La Joya	32RGrand341.2	"Rio Grande below confluence with the Rio Puerco"
Rio Grande at Los Lunas	32RGrand394.8	"Rio Grande at Los Lunas"
Rio Grande at the I-25 Bridge	32RGrand413.2	"At the I-25 bridge"
Rio Grande downstream of the AMAFCA South Diversion Channel – Los Padillas	32RGrand416.5	"From near the mouth to about 0.25 miles downstream, as access permits, of the AMAFCA South Diversion Channel"
Rio Grande downstream of Albuquerque Wastewater Treatment Plant	32RGrand421.2	"From near the mouth to about 0.25 miles downstream, as access permits, of the City's Southside Water Reclamation Plant discharge (careful consideration shall be made of sample location as depending on flow, Plant discharge tends to hug the east bank of the channel and may not mix for several miles downstream)."
Rio Grande at Alameda Bridge	32RGrand445.4	"From near the mouth to about 0.25 miles downstream, as access permits, of the AMAFCA North Diversion Pilot Channel."
Rio Grande downstream of Rio Rancho Wastewater Treatment Plant	32RGrand455.0	"From near the mouth to about 0.25 miles downstream, as access permits, of Rio Rancho Waste Water Treatment Plant discharge (careful consideration shall be made of sample location as depending on flow, Plant discharge tends to hug the west bank of the channel for

		about 0.5 miles downstream)"
Rio Grande at Angostura Dam	30RGrand473.7	"At Angostura Dam"

Although not part of the list of 10 sites, SWQB staff also sampled the Rio Grande at Belen for nutrients. The Belen sample and two extra Los Lunas nutrient samples were collected on August 17, 2007 due to a report of high pH values observed by members of the U.S. Fish and Wildlife Service. During the extra sampling, pH values of 8.38 s.u. at Belen and 9.10 and 9.22 s.u. at Los Lunas were observed.

This report collates field and water chemistry data from the MRG collected from 2000 and 2007 received from various sources. **Figures 4 and 5** depict the locations of the sampling locations for these data. SWQB assessed the data collected at these stations.

Table 5 summarizes the number of sampling events in each assessment unit and at each station (excluding USGS data). **Table 6** contains the number of times each parameter (or suite of parameters) was sampled at each station of the MRGESACP water quality monitoring study.

The parameters included in the various "suites" are listed below:

- **Field Data**: pH, temperature, Dissolved Oxygen, Specific Conductance and turbidity.
- **Ions/TDS/TSS/Hardness**: alkalinity, bicarbonate, bromide, calcium, carbonate, chloride, fluoride, iron, magnesium, manganese, potassium, sodium, sulfate, total dissolved solids, total suspended solids, hardness.
- **Nutrients**: ammonia, nitrate, nitrite, nitrate + nitrite (N), orthophosphate, phosphorus, total kjehldal nitrogen.
- **Total Organic Carbon**
- **Total Metals**: aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, lead, lithium, mercury, molybdenum, nickel, selenium, silicon, silver, strontium, thallium, tin, titanium, , vanadium, zinc
- **Dissolved Metals**: aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, lead, manganese, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, zinc
- **E. Coli**
- **Cyanide**
- **Radionuclides**: gross alpha, gross beta, radium-226, radium-228, uranium
- **Pesticides**: Anilazine, Atrazine, Azinphos-methyl, Chlorpyrifos, Coumaphos, Demeton, (total), Diazinon, Dibrom (Naled), Dichlorvos, Dimethoate, Disulfoton, EPN, Ethyl parathion, Famphur, Fensulfothion, Fenthion, Malathion, Merphos,, Methyl parathion, Mevinphos, O,O,O-Triethyl phosphorothioate, Phorate, Propazine, Ronnel, Simazine, Sulfotepp, Tetrachlorvinphos (Stirophos), Thionazin, Trichloronate, Tokuthion
- **Herbicides**: 2,4,5-T, 2,4,5-TP (Silvex), 2,4-D, 2,4-DB, Dalapon, Dicamba, Dichlorprop, Dinoseb, MCPA, MCPP.
- **Semivolatile Organics**: 1-Methylnaphthalene, 2-Methylnaphthalene, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, Acenaphthene, Acenaphthylene, Aldrin, alpha-BHC, Anthracene, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(ghi)perylene, Benzo(k)fluoranthene, beta-BHC, Chlordane, Chrysene, delta-BHC, Dibenzo(a,h)anthracene, Dieldrin, Endosulfan I, Endosulfan II, Endosulfan sulfate, Endrin, Endrin aldehyde, Fluoranthene, Fluorene, gamma-BHC (Lindane), Heptachlor, Heptachlor epoxide, Indeno(1,2,3-cd)pyrene, Methoxychlor, Naphthalene, Phenanthrene, Pyrene, Toxaphene
- **Perchlorate**
- **PCBs**
- **BOD – biological oxygen demand**
- **COD – chemical oxygen demand**
- **Ambient Toxicity**
- **Fish tissue**: Arsenic, Cadmium, Chromium, Copper, Lead, Nickel, Selenium, Zinc, Mercury, p,p'-DDE, p,p'-DDD (TDE), p,p'-DDT, o,p'-DDE, o,p'-DDD (TDE), o,p'-DDT, Total Polychlorinated Biphenyls (PCBs), Dieldrin, Endrin, Heptachlor epoxide, cis-Chlordane, trans-Chlordane, cis-Nonachlor, trans-Nonachlor, Oxychlordane (octachlor epoxide), Toxaphene, α-Hexachlorocyclohexane (HCH), β-HCH, δ-HCH, γ-HCH (Lindane), Hexachlorobenzene (HCB), Mirex

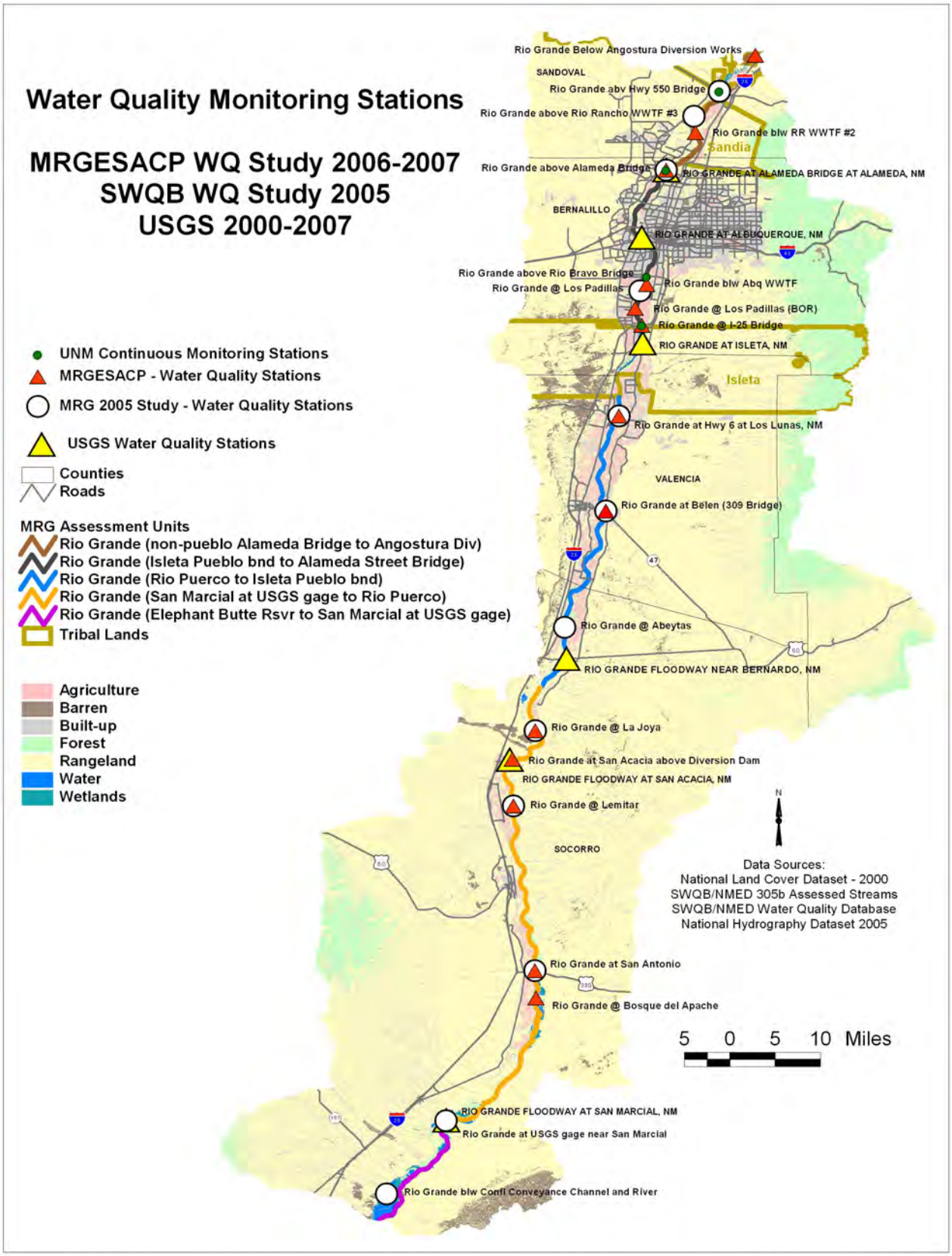

Figure 4. Water Quality Monitoring Stations in Middle Rio Grande, 2000 – 2007.

Table 3. Water Quality Monitoring Stations in the MRG for Data from 2000-2007 (non-USGS)

Assessment Unit	Station Name	STORET ID	Study
Rio Grande (Elephant Butte Reservoir to San Marcial at USGS gage)	Rio Grande below Confl Conveyance Channel and River	40RGrand243.4	MRG (2005)
Rio Grande (San Marcial at USGS gage to Rio Puerco)	Rio Grande @ USGS gage near San Marcial	32RGrand258.0	MRG (2005)
	Rio Grande @ Bosque del Apache	32RGrand286.9	BOR (2006-07)
	Rio Grande @ San Antonio*	32RGrande 292.1	MRG (2005)
			BOR (2006-07)
	Rio Grande @ Lemitar	32RGrand323.4	MRG (2005)
			BOR (2006-07)
	Rio Grande at San Acacia above Diversion Dam	32RGrand332.7	BOR (2006-07)
	Rio Grande @ La Joya* [t]	32RGrand341.2	MRG (2005)
			BOR (2006-07)
Rio Grande (Rio Puerco to Isleta Pueblo bnd)	Rio Grande @ Abeytas [s]	32RGrand361.7	MRG (2005)
	Rio Grande at Belen (309 Bridge)*	32RGrand385.5	MRG (2005), BOR (2007)
	Rio Grande at Hwy 6 at Los Lunas*	32RGrand394.8	BOR (2006-07)
Rio Grande (Isleta Pueblo bnd to Alameda Street Br)	Rio Grande @ I-25 Bridge [a]	32RGrand413.1	BOR (2006-07)
	Rio Grande @ Los Padillas [t s]	32RGrand419.6	MRG (2005)
	Rio Grande @ Los Padillas (BOR)	32RGrand416.4	BOR (2006-07)
	Rio Grande blw Abq WWTF	32RGrand421.1	BOR (2006-07)
	Rio Grande above Rio Bravo bridge [a]	32RGrand422.5	None
Rio Grande (non-pueblo Alameda Bridge to Angostura Div)	Rio Grande above Alameda Bridge* [a t]	32RGrand445.3	MRG (2005)
			BOR (2006-07)
	Rio Grande blw RR WWTF #2	32RGrand455.0	BOR (2006-07)
	Rio Grande above Rio Rancho WWTF #3	32RGrand458.0	MRG (2005)
	Rio Grande abv Hwy 550 Bridge* [a]	32RGrand464.1	MRG (2005)
	Rio Grande Below Angostura Diversion Works	30RGrand473.7	MRG (2005)

* = composite samples also collected
[a] = UNM sonde data
[t] = SWQB thermograph deployed
[s] = SWQB sonde deployed

Table 4. USGS Gage Sites in the Middle Rio Grande

USGS Gage Number	USGS Gage Name	Available data
8358400	RIO GRANDE FLOODWAY AT SAN MARCIAL, NM	Water quality
8355490	RIO GRANDE ABOVE US HWY 380 NR SAN ANTONIO, NM	Flow
8354900	RIO GRANDE FLOODWAY AT SAN ACACIA, NM	Flow and water quality
8332010	RIO GRANDE FLOODWAY NEAR BERNARDO, NM	Water quality (field data)
8331160	RIO GRANDE NEAR BOSQUE FARMS, NM	Flow
8331000	RIO GRANDE AT ISLETA, NM **	Water quality
8330875	RIO GRANDE AT ISLETA LAKES NR ISLETA, NM	Flow
8330000	RIO GRANDE AT ALBUQUERQUE, NM	Flow and water quality
8329918	RIO GRANDE AT ALAMEDA BRIDGE AT ALAMEDA, NM	Flow and water quality

** = Not used for assessment purposes

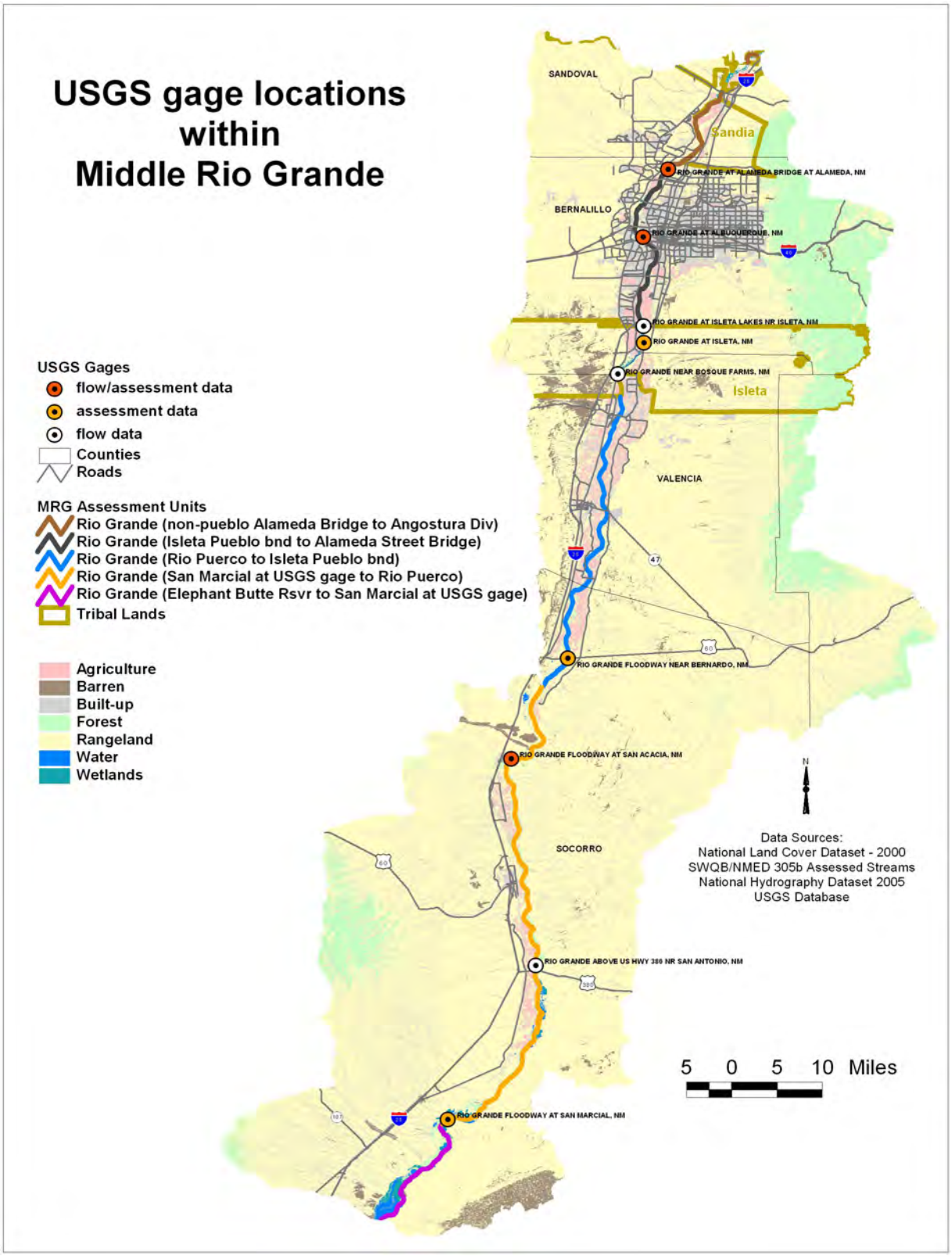

Figure 5. USGS Sites within the MRG Survey Area.

Table 5. Summary of the Number of Data Collection Events per Data Type in the Middle Rio Grande – 2000-2007 (non-USGS)

Assessment Unit / Station	Field Data	Ions/TDS/TSS/ Hardness	Nutrients	Total Organic Carbon	Total Metals	Dissolved Metals	*E. coli*	Cyanide, Total	Radionuclides	Pesticides	Herbicides	Semivolatile Organics	Perchlorate	PCBs	BOD/COD	Sediment	Ambient Toxicity
Rio Grande (Elephant Butte to San Marcial)																	
Rio Grande below confluence of conveyance channel and river										1						1	
Rio Grande (Rio Puerco to San Marcial)																	
Rio Grande at San Marcial near USGS gage	27	26	24	25	3	3	3		1								
Rio Grande @ Bosque del Apache	2	2	2	2	2	2		2		2	2		2		2	2	1
Rio Grande @ San Antonio	11	9	9	4	7	7	7	1		1	1		1		1	1	
Rio Grande @ Lemitar	10	9	9	4	9	9	7	1	1	1	1		1		1	1	
Rio Grande @ San Acacia above Diversion	3	3	3		3	3		3		3	3		3		3	3	1
Rio Grande @ La Joya	12	12	12	4	12	12	6	4		4	4		4		4	4	1
Rio Grande (Isleta Pueblo Boundary to Rio Puerco)																	
Rio Grande @ Abeytas	10	7	8	4	8	8	7	4	1	4	4	1	4	1	4	4	1
Rio Grande @ Belen (Hwy 309 Bridge)	9	8	8		8	8	7					1					
Rio Grande @ Hwy 6 at Los Lunas	11	10	10	4	11	11	6	4	1	4	4	1	2	1	4	4	1
Rio Grande (Isleta Pueblo Boundary to Alameda Street Bridge)																	
Rio Grande @ I-25 Bridge	4	4	4	4	4	4		4		4	4		4		4	4	1
Rio Grande @ Los Padillas (BOR)	4	4	4	4	4	4		4		4	4		4		4	4	1
Rio Grande @ Los Padillas	10	8	8		1	1	7					1		1			
Rio Grande below Albuquerque WWTF	4	4	4	4	4	4		4		4	4		4		4	4	1
Rio Grande above Rio Bravo Bridge	Sonde Deployment Only																
Rio Grande (non-pueblo Alameda Bridge to Angostura Div)																	
Rio Grande above Alameda Bridge	15	5	5	4	5	5	6	4		4	4		4	1	4		1
Rio Grande above Rio Rancho WWTF #2	4	5	4		2	4		4		4	4	1	4				1
Rio Grande above Rio Rancho WWTF #3	9	8	8	4	1	1	7					1					
Rio Grande above Hwy 550 Bridge	8	7	7		1	1	7										
Rio Grande on Sandia Pueblo																	1
Rio Grande below Angostura Diversion	14	15	12	4	3	5	7	4	1	4	4		4	1	4	4	1

Table 6. Summary of the Number of Data Collection Events per Data Type for – Middle Rio Grande Monitoring for Federal Grant 06-FG-40-2551, 2006-2007.

Assessment Unit / Station	Nutrients, Sediment	Metals, Sediment	Pesticides & PAHs, Sediment	Nutrients, Water	Total Metals, Water	Dissolved Metals (full suite), Water	BOD, Water	COD, Water	Herbicides, Water	Pesticides, Water	Percholorate, Water	Cyanide, Total, Water	Sonde grab data	Sonde Deployment [a]	Ambient Toxicity	Fish Tissue [b]
Rio Grande (San Marcial to Rio Puerco)																
Bosque del Apache[c]	2	2	2	2	2	2	2	2	2	2	2	2	2	-	1	-
Rio Grande near San Antonio[c]	1	1	1	1	1	1	1	1	1	1	1	1	1	-	-	-
Rio Grande near Lemitar[c]	1	1	1	1	1	1	1	1	1	1	1	1	1	-	-	-
Rio Grande upstream of San Acacia Dam [d]	3	3	3	3	3	3	3	3	3	3	3	3	3	-	1	-
Rio Grande below the confluence with Rio Puerco – La Joya	4	4	4	4	4	4	4	4	4	4	4	4	4	-	1	-
Rio Grande (Rio Puerco to Isleta Pueblo bnd)																
Rio Grande at Belen [e]	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Rio Grande at Los Lunas [f]	4	4	4	6	4	4	4	4	4	4	4	4	4	-	1	-
Rio Grande (Isleta Pueblo bnd to Alameda Street Bridge)																
Rio Grande at the I-25 Bridge	4	4	4	4	4	4	4	4	4	4	4	4	4	1	1	-
Rio Grande downstream of the AMAFCA South Diversion Channel – Los Padillas	4	4	4	4	4	4	4	4	4	4	4	4	4	-	1	-
Rio Grande downstream of Albuquerque Wastewater Treatment Plant	4	4	4	4	4	4	4	4	4	4	4	4	4	-	1	1
Rio Grande (non-pueblo Alameda Bridge to Angostura Div)																
Rio Grande at Alameda Bridge	4	4	4	4	4	4	4	4	4	4	4	4	4	1	1	1
Rio Grande downstream of Rio Rancho Wastewater Treatment Plant	4	4	4	4	4	4	4	4	4	4	4	4	4	-	1	1
Rio Grande at Angostura Dam	4	4	4	4	4	4	4	4	4	4	4	4	4	-	1	1

[a] Seven day sonde data were not collected at all sites. Continuous data were received for sites indicated. Thermograph data were collected from the Sonde data logger. Thermograph data to be collected during 2008 field season.

[b] All sites were sampled, but not enough fish could be collected to composite a complete sample.

[c] These three sites were treated as one site – samples were collected at the Lemitar site in October 2006, from the Bosque del Apache site in January 2007 and August 2007, and from the San Antonio site in April 2007.

[d] Data from one sampling event were not collected due to access.

[e] Belen site was sampled for nutrients due to high pH values observed by USFWS and USACE.

[f] Extra nutrient sampling was conducted due to high pH values observed by USFWS and USACE.

5.0 WATER QUALITY ASSESSMENT OF WATER CHEMISTRY AND FIELD DATA

For many water quality parameters, SWQB maintains numeric water quality criteria (NMAC 2007). Data from each water quality segment are assessed for attainment of the specified designated uses for both numeric and narrative water quality standards by applying the *Assessment Protocol* and associated appendices (NMED/SWQB 2008). Exceedences of numeric water quality criteria identified by this process are summarized in **Table 7** below. A summary of the impairment decisions by assessment unit is provided in **Table 8**. A complete data set and assessment worksheets can be obtained by contacting SWQB.

5.1 WATER CHEMISTRY AND GRAB FIELD DATA ASSESSMENT

The assessments and resulting impairments presented in this report were generated using all available data from 2000 to 2007. This resulted in the evaluation of a much larger data set than would usually be available from a SWQB survey, which is typically conducted in a single year.

Based on data collected in 1999, the levels of fecal coliform exceeded applicable water quality criteria, and therefore NM determined those portions of the MRG as impaired (see **Table 1**). A TMDL was written in 2002 (NMED/SWQB, 2002a) to address these impairments. Subsequently, the NMED, Albuquerque Metropolitan Arroyo Flood Control Authority and Bernalillo County contracted with a consulting firm to conduct a Microbial Source Tracking (MST) study (NMED/SWQB, 2005). The MST study concluded that avian wildlife, dogs, and humans are the top three contributors to fecal coliform in the MRG. SWQB has since changed the water quality standards (WQS) from fecal coliform to E. coli, and current impairments reflect the change in sampling strategy to address this WQS change. In the Rio Grande assessment units downstream of Albuquerque the source of E.coli contamination remains to be determined as it was outside of the MST study area.

The MRGESACP water quality monitoring survey uncovered an impairment for one parameter, chronic aluminum. SWQB determined that the Rio Grande (San Marcial to Rio Puerco) assessment unit is impaired for chronic aluminum. An exceedence of the criterion also was found in the Rio Grande (non-pueblo Alameda Bridge to Angostura Div) assessment unit. However, according to the *Assessment Protocol*, SWQB does not list an assessment unit as impaired for a toxic pollutant unless there is more than one exceedence. Dissolved metals were sampled more frequently in the lower assessment units than in the upper assessment units during the NMED/SWQB 2005 study in order to compensate for the infrequent dissolved metals sampling in the lower assessment units in previous years.

Aluminum concentrations are high in waters originating in the Jemez mountains to the west of Albuquerque. The Jemez River joins the Rio Grande just below the Angostura Diversion and the Rio Puerco, which has its headwaters on the west slope of the Jemez and flows into the Rio Grande above Belen, are both potential aluminum sources. A TMDL for chronic aluminum was completed in 2007 for Rio Puerco (Arroyo Chijuilla to northern boundary Cuba). However, one exceedence of the chronic aluminum criterion was found just below the Angostura Diversion, indicating that other sources exist along the Rio Grande upstream of the survey area.

Table 7. Middle Rio Grande Water Quality Criteria Exceedences, 2000-2007. (Number of Exceedences/Total Number of Samples)

Assessment Unit / Station	Analyte (applicable NM water quality criterion)										
	Aluminum, Acute (750 ug/L)	Aluminum, Chronic (87 ug/L)	Ammonia (varies by pH and temperature)	Copper, Chronic (varies as a function of hardness)	Copper, Acute (varies as a function of hardness)	E. coli (410 cfu/mL)	Gross a Radiation (15 pCi/L)	Nitrate + Nitrite (N) (132 mg/L)	Selenium, Total (5 ug/L)	Temperature (32.2 °C)	pH (6.6-9.0 s.u.)
Rio Grande Elephant Butte to San Marcial											
Rio Grande below confluence of conveyance channel and river	No exceedences										
Rio Grande (San Marcial to Rio Puerco)											
Rio Grande at San Marcial (near USGS gage) - 32RGrand258.0		3/8				1/3	1/2	1/24			
RIO GRANDE FLOODWAY AT SAN MARCIAL, NM - USGS Gage 8358400						6/19			1/30	2/303	
RIO GRANDE AT SAN ANTONIO - 32RGrand292.1		2/8									
Rio Grande @ Lemitar - 32RGrand323.4		2/8									
RIO GRANDE FLOODWAY AT SAN ACACIA - USGS Gage 8354900						7/18					
Rio Grande @ La Joya - 32RGrand341.2	1/8	3/8				2/6					
Rio Grande (Rio Puerco to Isleta Pueblo Boundary)											
RIO GRANDE FLOODWAY NEAR BERNARDO - USGS Gage 8332010										2/107	
RIO GRANDE AT BELEN (309 BRIDGE) 32RGrand385.5						1/9					
RIO GRANDE AT HWY 6 AT LOS LUNAS, NM 32RGrand394.8				1/12	1/12	2/7				2/21	2/18
Rio Grande (Isleta Pueblo Boundary to Alameda Bridge)											
Rio Grande @ I-25 Bridge - 32RGrand413.2				1/4	1/4						
Rio Grande @ Los Padillas (BOR) - 32RGrand416.5				1/4	1/4						
Rio Grande @ Los Padillas - 32RGrand419.8						1/7					
Rio Grande below Albuquerque WWTF - 32RGrand421.2				1/4	1/4						

Assessment Unit / Station	Analyte (applicable NM water quality criterion)										
	Aluminum, Acute (750 ug/L)	Aluminum, Chronic (87 ug/L)	Ammonia (varies by pH and temperature)	Copper, Chronic (varies as a function of hardness)	Copper, Acute (varies as a function of hardness)	E. coli (410 cfu/mL)	Gross a Radiation (15 pCi/L)	Nitrate + Nitrite (N) (132 mg/L)	Selenium, Total (5 ug/L)	Temperature (32.2 °C)	pH (6.6-9.0 s.u.)
RIO GRANDE AT ALBUQUERQUE, NM - USGS Gage 8330000			1/8			3/9					
Rio Grande (Alameda Bridge to Angostura)											
RIO GRANDE AT ALAMEDA BRIDGE AT ALAMEDA, NM - USGS Gage 8329918						5/11					
Rio Grande above Alameda Bridge - 32RGrand445.4		1/5		1/5	1/5						
Rio Grande below Rio Rancho WWTF #2 - 32RGrand455.0			1/4								
Rio Grande above Rio Rancho WWTF #3 - 32RGrand458.0		1/1									
Rio Grande above Hwy 550 Bridge - 32RGrand464.2		1/1				1/10					
Rio Grande below Angostura Diversion Works - 30RGrand473.7		1/1		1/5	1/5						

Table 8. Summary of NMED Water Quality Impairments for Middle Rio Grande to be included in 2008-2010 Clean Water Act Sections 305(b)/303(d) Integrated List.

Assessment Unit	Parameter(s)	New or Continued	Comments
Rio Grande (Elephant Butte to San Marcial)	None	None	
Rio Grande (San Marcial to Rio Puerco)	Chronic Aluminum	New	
	E.coli	New	
Rio Grande (Rio Puerco to Isleta Pueblo Boundary)	E.coli	New	
Rio Grande (Isleta Pueblo Boundary to Alameda Bridge)	E.coli	New	E.coli replaces Fecal Coliform as the cause of impairment
	Dissolved Oxygen	New	
Rio Grande (Alameda Bridge to Angostura Diversion)	E.coli	New	E.coli replaces Fecal Coliform as the cause of impairment
	Dissolved Oxygen	New	

In conclusion, despite far more data and a much larger suite of analyses than would normally be available, very few WQS impairments were found from the monitoring discussed in this report. Most notably, the nearly complete absence of detectable organic chemicals in this dataset is surprising given the increased industrialization in the upper reaches of the study area. The MRGESACP may want to consider using other monitoring approaches, such as semi-permeable membrane devices (SPMDs), or expand the list of parameters for fish tissue analyses to include organophosphates to determine the levels of organics that are concentrating/accumulating in the fat tissues of fish. The problem with using fish tissue alone is that fish can metabolize and excrete some organic pollutants and therefore do not yield accurate information in terms of overall exposure.

In addition, the MRGESACP should consider expanding or amending the sampling scheme to include analyses for dissolved aluminum and weak acid dissociable cyanide. Currently, the workplan includes analysis for total aluminum and total cyanide whereas NM WQS are for dissolved aluminum and weak acid dissociable and dissolved cyanide. Most of the total cyanide data collected were below detection. However, total cyanide was detected at 14.1 ug/L to 144 ug/L in the water samples. It is not possible with accuracy to estimate the amount of weak acid dissociable cyanide in a sample from total cyanide levels. Additional data would be beneficial.

5.2 Continuous Data Logger Data Assessment

5.2.1 Temperature

In 2005, temperature data loggers were not deployed until early August due to prohibitively high flow. They were removed after high summer air temperatures abated (September), which resulted in a relatively short data collection interval. Exceedences of the 32.2°C criterion were few and the magnitude of exceedence was never greater than 3°C. The only exceedences recorded were at San Marcial (32RGrand258.0) with an exceedence rate of 2.3% and La Joya (32RGrand341.2) with an exceedence rate of 2.6%.

This page was modified on July 24, 2008.

In 2006-2007, temperature data were recorded by David Van Horn using multi-parameter data loggers at four stations, from NM Hwy 550 downstream to the I-25 bridge. Exceedences were few (at I-25, 1.7% in June, July, and August) and occurred only at the lower two stations. The maximum magnitude of the exceedences was 1.5°C (Van Horn, personal communication).

Table 9 contains a summary of the SWQB assessment conclusions for temperature data collected from 2005 to 2007 from deployed thermographs or data loggers.

Table 9. Summary of Temperature Data from Data Loggers Deployed in MRG, 2005-2007.

Assessment Unit Station (Station ID)	**Designated Use**	**NM WQS Criterion (°C)**	**Data Collection Interval**	**Max Temp (°C)**	**Total Data Points**	**Number of Exceedences/% Exceedences**
Rio Grande (Elephant Butte Reservoir to San Marcial)	**MWWAL***	**≤32.2**				
Rio Grande at San Marcial (32RGrand258.0)			5 Aug - 27 Sep 05	35.2	1265	29/2.3
Rio Grande (San Marcial to Rio Puerco)	**MWWAL**	**≤32.2**				
RIO GRANDE AT SAN ANTONIO (32RGrand292.1)			5 Aug - 8 Sep 05	31.3	815	0/0
Rio Grande @ La Joya (32RGrand341.2)			5 Aug - 8 Sep 05	34.5	814	21/2.6
Rio Grande (Isleta Pueblo bnd to Alameda Street Bridge)	**MWWAL**	**≤32.2**				
Rio Grande @ I-25 Bridge (32RGrand413.2)+			2 Jun 06-15 Oct 07	33.7	34806	149/0.4
Rio Grande @ Los Padillas (32RGrand419.7)			5 Aug - 7 Sep 05	31.5	796	0/0
Rio Grande above Rio Bravo Bridge (32RGrand422.6)[1]			2 Jun 06-2 Nov 07	33.1	48172	39/0.08
Rio Grande (Alameda Bridge to Angostura)	**MWWAL**	**≤32.2**				
Rio Grande above Alameda Bridge (32RGrand445.4)			5 Aug - 7 Sep 05	30.9	790	0/0
Rio Grande above Alameda Bridge (32RGrand445.4)[1]			2 Jun 06-20 Oct 07	31.7	37743	0/0
Rio Grande abv Hwy 550 Bridge (32RGrand464.2)[1]			18 Jun-16 Oct 07	27	11454	0/0

* MWWAL = marginal warmwater aquatic life.

\+ These data were provided by UNM graduate student David Van Horn

5.2.2 pH

In 2005, NMED deployed data loggers for about a week at Abeytas (32RGrand361.7) and Los Padillas (32RGrand419.7). For pH, no exceedences were documented at either location. **Table 10** contains a summary of the SWQB assessment conclusions for pH data collected from 2005 to 2007 from data loggers.

For the 2006-2007 data, exceedences of the pH criterion were documented only at the NM Hwy 550 bridge by Van Horn. The exceedence rate was 1.8%, with a maximum exceedence duration of 6.3 hours. The maximum value was 9.14 s.u., which occurred on July 26, 2007 (Van Horn, personal communication).

5.2.3 Dissolved Oxygen

In 2005, NMED deployed data loggers for about a week at Abeytas (32RGrand361.7) and Los Padillas (32RGrand419.7). No exceedences were documented at Los Padillas, and only 2 contiguous data points exceeded criteria at Abeytas on September 26, 2005 (i.e., exceedence duration was < 2 hours).

In 2006-2007, Van Horn recorded exceedences at three of his four stations (not at NM Hwy 550) with maximum durations:

- percent saturation (< 75%) of 16 hours at Alameda bridge, 20 hours at I-25 bridge and 298 hours at Rio Bravo bridge, and
- DO concentration (< 5.0 mg/L) of 10 hours at Alameda bridge, 14 hours at I-25 bridge and 66 hours at Rio Bravo bridge.

One episode of 53.5 contiguous hours of DO concentrations of < 2 mg/L was recorded at the Rio Bravo station (10-12 July 06), however this could be erroneous (e.g., due to instrument burial) as no large fish kill was known to have been reported, as would be expected with an event of this magnitude. Nevertheless, the magnitude and duration of exceedences at these three stations are severe enough to warrant concern and further investigation would be prudent (Van Horn, personal communication). **Table 11** contains a summary of the SWQB assessment conclusions for DO data collected from 2005 to 2007 from data loggers.

Table 10. Summary of pH Data from Data Loggers Deployed in the MRG, 2005-2007

Assessment Unit Station (Station ID)	**Designated Use**	**NM WQS Criterion (s.u.)**	**Data Collection Interval**	**Min/Max**	**Total Data Points**	**Number of Exceedences /% Exceedences**	**Frequency Violation (≥ 15% exceedences)**	**Magnitude Violation (≥ 0.5 units above criterion)**	**Duration Violation (≥ 24 hrs exceedence)**
Rio Grande (San Marcial to Rio Puerco)	**MWWAL**	**6.6-9.0**							
Rio Grande @ Bosque del Apache (32RGrand286.9)			10-19 Oct 08	7.48/8.48	874	0/0	No	No	No
Rio Grande (Rio Puerco to Isleta Pueblo bnd)	**MWWAL**	**6.6-9.0**							
Rio Grande @ Abeytas (32RGrand361.7)			21 Sep-27 Sep 05	7.80/8.52	147	0/0	No	No	No
Rio Grande (Isleta Pueblo bnd to Alameda Street Bridge)	**MWWAL**	**6.6-9.0**							
Rio Grande @ I-25 Bridge (32RGrand413.2)[1]			2 Jun 06-15 Oct 07	7.57/8.45	34806	0/0	No	No	No
Rio Grande @ Los Padillas (32RGrand419.7)			21 Sep-01 Oct 05	7.22/7.94	237	0/0	No	No	No
Rio Grande above Rio Bravo Bridge (32RGrand422.6)[1]			2 Jun 06-2 Nov 07	7.17/8.84	48172	0/0	No	No	No
Rio Grande (Alameda Bridge to Angostura)	**MWWAL**	**6.6-9.0**							
Rio Grande above Alameda Bridge (32RGrand445.4)[1]			2 Jun 06-20 Oct 07	7.39/8.94	37743	0/0	No	No	No
Rio Grande abv Hwy 550 Bridge (32RGrand464.2)[1]			7 Jun-16 Oct 07	7.86/9.14	11454	201/1.8	No	No	No

Table 11. Summary of Dissolved Oxygen Data from Data Loggers Deployed in the MRG, 2005-2007

Assessment Unit Station (Station ID)	**Designated Use**	**NM WQS Criterion (mg/L)**	**Data Collection Interval**	**Min Conc. (mg/L)**	**Min Sat. (% local)**	**Assessment Criterion (Combined; % Sat.)**	**Total Data Points**	**Combined Conc./% Sat. Exceedences (# / % / >3 hrs)**	**% Sat. Exceedences (# / % / >3 hrs)**
Rio Grande (San Marcial to Rio Puerco)	**MWWAL**	**≥5**				**< 5 mg/L and < 90%; or < 75%**			
Rio Grande @ Bosque del Apache (32RGrand286.9)			10-19 Oct 07	6.06	80.2		874	0/0/No	0/0/No
Rio Grande (Rio Puerco to Isleta Pueblo bnd)	**MWWAL**	**≥5**				**< 5 mg/L and < 90%; or < 75%**			
Rio Grande @ Abeytas (32RGrand361.7)			21 Sep-27 Sep 05	4.36	67.6		147	2/1.3/No	1/0.6/No
Rio Grande (Isleta Pueblo bnd to Alameda Street Bridge)	**MWWAL**	**≥5**				**< 5 mg/L and < 90%; or < 75%**			
Rio Grande @ I-25 Bridge (32RGrand413.2)[1]			2 Jun 06-15 Oct 07	0.12	1.7		34806	178/0.5/Yes	258/0.7/Yes
Rio Grande @ Los Padillas (32RGrand419.7)			21 Sep-01 Oct 05	6.69	98.8		237	0/0/No	0/0/No
Rio Grande above Rio Bravo Bridge (32RGrand422.6)[1]			2 Jun 06-2 Nov 07	0.04	0.6		48172	2214/4.6/Yes	2550/5.3/Yes
Rio Grande (Alameda Bridge to Angostura)	**MWWAL**	**≥5**				**< 5 mg/L and < 90%; or < 75%**			
Rio Grande above Alameda Bridge (32RGrand445.4)[1]			2 Jun 06-20 Oct 07	0.43	6.4		37743	208/0.6/Yes	602/1.6/Yes
Rio Grande abv Hwy 550 Bridge (32RGrand464.2)[1]			7 Jun-16 Oct 07	5.93	81		11454	0/0/No	0/0/No

[1] These data were provided by UNM graduate student David Van Horn

6.0 OTHER DATA FROM THE MRG

Sediment, fish tissue and EPA ambient toxicity were collected as part of the MRGESACP study (2006-2007). NM has adopted fish tissue based criteria for methylmercury only. Sections 6.1 through 6.2 contain summaries of the data and comparisons against guidelines from other agencies to help understand the quality of the watershed and any possible affect to the RGSM. NM has not adopted water quality criteria for sediment nor ambient toxicity. Section 6.3 contains a discussion on the testing conducted by USEPA Region 6.

In addition, during the 2005 MRG study, SWQB staff collected water chemistry data at conveyance channels, sites on Pueblo boundaries or from drains to the MRG. Data from these stations are summarized in Section 6.4 of this report.

6.1 SEDIMENT SUMMARIES

Sediment samples were collected quarterly from recently deposited sediments in depositional areas between October 2006 and September 2007. All samples were analyzed by General Engineering Laboratories (GEL) and Flowers Laboratories. The EPA or New Mexico has not yet established sediment criteria to evaluate the levels of pollutants in the sediment samples. SWQB researched various agencies to determine a potential screening level and found sediment criteria for a variety of parameters developed by the National Oceanic and Atmospheric Administration (NOAA) Screening Quick Reference Tables (SQuiRT) levels. The SQuiRT levels were developed for internal use by the Coastal Protection and Restoration Division (CPR) of NOAA as a way to initially identify concentrations of substances that may threaten resources of concern. SWQB found the SQuiRT reference table to be the most complete source for sediment chemical concentration screening levels that could be obtained, and therefore compared the sediment results to the SQuiRT levels. SQuiRT screening levels, generally from lowest to highest predicted toxicity, include:

- Lowest Assessment and Remediation of Contaminated Sediments (ARCS) *H. azteca.*
- Threshold Effect Level (lowest TEL) = Concentration below which adverse effect are expected to occur only rarely to *H. azteca*.
- Threshold Effects Level (TEL) = Concentration below which adverse effect are expected to occur only rarely.
- Probable Effect Level (PEL) = Concentration where adverse effects are frequently expected.
- Upper Effects Level (UET) = Highest non-toxic sample. Represents a concentration above which adverse biological impact would always be expected.

The levels provided in SQuiRT tables are meant to be for preliminary screening and are not meant to be used as criteria (Buchman 1999). Information for parameters that were detected and compared to SQuiRT screening levels are provided in **Tables 12 and 13**. Results less than detection are not summarized in this report however a complete dataset from quarterly sediment sampling is available upon request.

Sediment was collected and analyzed for semivolatile/organochlorines, metals, cyanide and semivolatile/polycyclic aromatic hydrocarbons (PAHs). Summary tables only include data for analytes for which the screening levels or guidance levels could be found. Analytes that were not detected were not included in the summary tables. The results for all analytes are available upon request.

All sediment semivolatile/organochlorines results were below detection levels for all sampling events and at all stations and will not be discussed further in this report.

Many metals were detected in sediment samples during the first year of the survey at each station. SWQB compared sediment results to NOAA SQuiRT screening tables to identify levels of contaminants. Arsenic at the Bosque del Apache site was the only metal to exceed the SQuiRT lowest screening level, the Threshold Effect Level (see **Table 12**).

Cyanide is not listed in the NOAA SQuiRT tables. SWQB identified a screening level developed by the State of Washington. The levels of cyanide found in the sediment samples exceeded the Washington State Department of Ecology Version 2 review of criteria and guidelines for the Lowest Effect Level (LEL). This is defined as the "level of sediment contamination that can be tolerated by most benthic organisms" (1995).

Several semivolatile/PAHs parameters were detected in the sediment samples at levels that exceeded the associated SQuiRT screening guidelines. The areas with sampling results above the SQuiRT levels were mainly in the urban sites, and most notably at the Rio Grande below the Rio Rancho WWTP and above the Alameda Bridge. No semivolatile/PAHs parameters were detected above SQuiRT screening levels in sediment samples collected downstream of the Los Padillas station. Summary tables only include data for analytes which the screening levels or guidance levels could be found. All data are available upon request. Most of the semivolatile/PAHs analytes were detected in only 1 out of the 4 sampling runs. In these instances no range was reported (see **Table 13**).

Chemical sediment concentrations may have some impacts to fish and aquatic life. Based on the data collected in 2006-2007, the concentrations are not at levels where fish kills would be expected due to any one chemical, however several chemicals were found above levels where adverse effect are expected to occur only rarely (see **Tables 12 and 13**). It is unclear what the cumulative effects of all chemicals found in sediment are having on aquatic life. Further studies should be conducted to determine the cumulative effects of sediment contaminates to RGSM and to determine any trends as to why the Rio Rancho and Alameda sites contained higher levels of PAHs when compared to downstream sites.

6.2 FISH TISSUE

Fish tissue samples were collected with the assistance of the New Mexico Department of Game and Fish (DGF) on May 8-9, 2007. DGF and SWQB staff electroshocked fish from a raft while drifting with the current. Common carp (*Cyprinus carpio)* were submitted for compositing and analysis from each of three longitudinal reaches: Highway 550 Bridge to North AMAFCA; North AMAFCA to Alameda Bridge; and Rio Bravo Bridge to Los Padillas (See **Table 14**). These reaches include four stations, Rio Grande (RG) below North AMAFCA (Alameda), RG below HWY 550 (Angostura), RG below RR WWTP, and RG below ABQ SSWRP (which included RG below South AMAFCA). Fish sampling was conducted at the locations downstream using hoop nets and electroshocking, but did not yield enough fish and/or fish big enough to use for the MRGESACP water quality monitoring survey.

Table 12. Summary of MRG Sediment Data for Metals and Cyanide Compared to NOAA SQuiRT, 2006-2007. Results are reported as minimum and maximum values in ppm.

Sediment Elements	Arsenic	Cadmium	Chromium	Copper	Cyanide (WA State guidelines)	Lead	Manganese	Mercury	Nickel	Silver	Zinc
NOAA SQuiRT Lowest Effects Level → Highest Effects Level ppm	5.9 (TEL) - 17.0 (PEL/UET)	0.583 (Lowest TEL) - 3.54 (PEL)	36.3 (Lowest TEL) - 95 (UET)	28.01 (Lowest TEL) - 197 (PEL)	0.1 (LEL)	35 (TEL) - 127 (UET)	630 (Lowest TEL) – 1100 (UET)	0.174 (TEL) - 0.561 (UET)	19.514 (Lowest TEL) – 43 (UET)	4.5 (UET)	98 (TEL) - 520 (UET)
Assessment Unit / Station											
Rio Grande (San Marcial to Rio Puerco)											
Bosque del Apache	1.94-***7.09***	0.155-0.355	8.81-12.4	4.38-16.1	***0.324 - 0.677***	5.34-15.7	203-354	0.0036-0.0286	7.24-13.2	ND	22.2-57.6
Rio Grande near San Antonio	2.47	ND	13.1	5.15	***0.344***	6.59	233	ND	8.24	0.227	24.2
Rio Grande near Lemitar	2.7-3.79	0.237-0.35	14.3	6.34-12.3	***0.323 - 0.328***	6.87	179-288	0.0113-0.014	7.52-13.5	0.054-0.065	26.6-38.7
Rio Grande upstream of San Acacia Dam6	3.69-4.4	0.439*	14.5-21.0	8.45-12.9	***0.123 - 0.407***	9.79-11.8	335-387	0.0114-0.0235	13-16	0.0831-0.216	34.3-48.8
Rio Grande below the confluence with Rio Puerco - La Joya	3.56-5.09	0.251-0.34	7.79-12.3	7.44-13.8	***0.339 - 0.429***	7.49-11.1	267-379	0.0058-0.0147	7.7-9.68	0.198*	28.6-40.8
Rio Grande (Rio Puerco to Isleta Pueblo bnd)											
Rio Grande at Los Lunas	1.95-5.03	0.19*	2.38-11.2	4.57-13.2	***0.151 - 0.448***	4.8-8.88	161-235	0.0099-0.0164	5.27-10.6	ND	20.3-37.7
Rio Grande (Isleta Pueblo bnd to Alameda Street Bridge)											
Rio Grande at the I-25 Bridge	1.65-3.46	0.346*	2.38-11.8	1.72-9.08	***0.293 - 0.377***	2.77-8.35	87.4-211	0.0042-0.0126	2.69-9.54	0.0634*	9.28-37.1
Rio Grande downstream of the AMAFCA South Diversion Channel - Los Padillas	2.55-3.91	0.27*	5.91-9.86	6.15-8.63	***0.319 - 0.359***	5.58-9.47	158-260	0.0043-0.0152	5.4-9.96	0.064*	22.6-36.9
Rio Grande downstream of Albuquerque Wastewater Treatment Plant	2.73-4.34	0.267*	2.33-8.33	1.73-7.73	***0.3 - 0.466***	2.79-8.47	129-210	0.0024-0.0146	3.44-8.12	0.076-0.197	9.61-31.66
Rio Grande (non-pueblo Alameda Bridge to Angostura Div)											
Rio Grande at Alameda Bridge	3.62-5.14	0.264-0.272	7.56-11.0	5.86-10.5	***0.179 - 0.344***	5.76-11.4	181-341	0.0102-0.0182	5.66-9.16	0.0774*	22.0-34.7
Rio Grande downstream of Rio Rancho Wastewater Treatment Plant	1.5-4.08	0.114-0.135	3.84-8.41	2.96-6.39	***0.903 - 0.321***	4.04-6.64	176-226	0.0035-0.0087	3.6-6.3	ND	12.7-23.6
Rio Grande at Angostura Dam	1.92-3.63	0.214-0.216	2.98-9.13	3.5-9.01	***0.329 - 0.352***	4.02-8.59	146-306	0.0037-0.0127	3.19-8.79	ND	13.7-30.1

Red (w/ Bold/Italic) = Exceed the Washington State review of criteria lowest effect level or NOAA Squirt screening levels.
LEL = "Level of sediment contamination that can be tolerated by most benthic organisms" (Batts 1993, Washington State).
Lowest TEL = Lowest Assessment and Remediation of Contaminated Sediments *H. azteca* (SQuiRT).
TEL = Threshold Effect Level – concentration below which adverse effect are expected to occur only rarely (SQuiRT).
PEL = Probable Effect Level – concentration where adverse effects are frequently expected (SQuiRT).
UET = Upper Effects Threshold – Highest non-toxic sample. Represents a concentration above which adverse biological impact would always be expected (SQuiRT)
ND = Analyte not detected.
* = No range, only one out of four samples was detected.

Table 13. Summary of Sediment Data for Semivolatile/PAHs Compared to NOAA SQuiRT, 2006-2007. Results are reported as minimum and maximum values in ppb when more than one detection per site was observed.

Semivolatile/ PAHS	Benzo(a) - pyrene	Benzo(a)anth- racene	Chrysene	Dibenz(a,h)- anthracene	Fluoranthene	Flurene	Indeno(1,2,3- cd)pyrene	Phenanthrene	Pyrene
NOAA SQuiRT Lowest Effects Level → Highest Effects Level ppb	31.9 (TEL) - 700 (UET)	15.72 (Lowest TEL) - 500 (UET)	26.83 (Lowest TEL) - 800 (UET)	10 (Lowest TEL)- 100 (UET)	31.46 (Lowest TEL) - 2355 (UET)	10 (Lowest TEL) - 300 (UET)	17.3 (Lowest TEL) - 330 (UET)	18.73 (Lowest TEL) - 800 (UET)	44.27 (Lowest TEL)- 1000 (UET)
Assessment Unit / Station									
Rio Grande (San Marcial to Rio Puerco)									
Bosque del Apache	ND	ND	ND	ND	ND	ND	7.18	ND	ND
Rio Grande near San Antonio	ND	ND	ND	ND	ND	ND	ND	ND	ND
Rio Grande near Lemitar	ND	ND	ND	ND	ND	ND	ND	ND	ND
Rio Grande upstream of San Acacia Dam6	ND	ND	ND	ND	ND	ND	ND	ND	ND
Rio Grande below the confluence with Rio Puerco - La Joya	15.8	ND	17.9	ND	12.6-13.5	ND	16.5	ND	15.3-16.1
Rio Grande (Rio Puerco to Isleta Pueblo bnd)									
Rio Grande at Los Lunas	18.1	ND	ND	ND	20.2	ND	ND	ND	ND
Rio Grande (Isleta Pueblo bnd to Alameda Street Bridge)									
Rio Grande at the I-25 Bridge	8.67	ND	ND	ND	ND	ND	9.96	ND	ND
Rio Grande downstream of the AMAFCA South Diversion Channel - Los Padillas	28.8	ND	16	ND	21.3	ND	***19.2***	ND	25.7

Semivolatile/ PAHS	Benzo(a) - pyrene	Benzo(a)anth- racene	Chrysene	Dibenz(a,h)- anthracene	Fluoranthene	Flurene	Indeno(1,2,3- cd)pyrene	Phenanthrene	Pyrene
Rio Grande downstream of Albuquerque Wastewater Treatment Plant	ND	ND	ND	ND	ND	ND	***31.4***	ND	ND
Rio Grande (non-pueblo Alameda Bridge to Angostura Div)									
Rio Grande at Alameda Bridge	***62***	***28.6***	***55.8***	***18.9***	***114***	ND	***51.1***	***28.8***	***70.5***
Rio Grande downstream of Rio Rancho Wastewater Treatment Plant	***64.8***	***47.1***	9.87-***40.7***	***40.5***	ND	***56.9***	***54.9***	ND	***47.1***
Rio Grande at Angostura Dam	7.89	8.88	8.21	ND	ND	ND	ND	ND	ND

LEL = "Level of sediment contamination that can be tolerated by most benthic organisms" (Batts 1993, Washington State).
Lowest TEL = Lowest Assessment and Remediation of Contaminated Sediments *H. azteca* (SQuiRT).
TEL = Threshold Effect Level – concentration below which adverse effect are expected to occur only rarely (SQuiRT).
PEL = Probable Effect Level – concentration where adverse effects are frequently expected (SQuiRT).
UET = Upper Effects Threshold – Highest non-toxic sample. Represents a concentration above which adverse biological impact would always be expected (SQuiRT)..
ND = Analyte not detected.
Range given if more than one detection at that location.
Red (w/ Bold/Italic) = Exceeded NOAA SQuiRT guidelines.

Table 14. MRG Fish Collection Information, 2007.

Assessment Unit / Station	Number of Common Carp	Size Range (mm)	Date
Rio Grande (Isleta Pueblo bnd to Alameda Street Bridge)			
Rio Grande downstream of Albuquerque Wastewater Treatment Plant	5	535-655	5/9/2007
Rio Grande (non-pueblo Alameda Bridge to Angostura Div)			
Rio Grande at Alameda Bridge	3	435-570	5/8/2007
Rio Grande downstream of Rio Rancho Wastewater Treatment Plant	5	388-500	5/9/2007
Rio Grande at Angostura Dam	5	405-535	5/9/2007

All results are reported as whole fish, wet weight, and in mg/kg (ppm). Fish collected in this survey contained chemicals above method detection limits. The only contaminants not detected were lead and selenium for all samples and cadmium at two of the four sites. The sampling that took place near the Angostura site contained the highest concentration of cadmium and arsenic. Sampling near the Rio Rancho WWTP contained the highest concentrations of mercury. The Albuquerque WWTP sample contained the highest concentrations of zinc.

New Mexico has adopted only one fish tissue based criterion (methylmercury) in its WQS. SWQB used the USGS Biomonitoring of Environmental Status and Trends (BEST) Program (Schmitt 2004) screening levels for comparison (see **Tables 15 – 17**). Current literature reviews have not resulted in any information showing concentrations of PCB and pesticide pollutants that impact fish health except for DDT. All of the studies that were reviewed report concentrations in fish tissue that impact wildlife or human health. Total PCB and pesticide values are reported in **Table 15**.

SWQB found that most of the chemicals, except zinc, were detected at concentrations below limits that could impact fish health. Zinc was the only chemical that exceeded concentration limits at all sites (see **Table 16**). According to the BEST study, the amount of zinc found in the MRGESACP water quality monitoring study has been found to affect the growth and survival of flagfish (*Jordanella floridae*). Data collected from 1997-98 for the BEST study found that common carp also exceed these concentrations of zinc. Zinc concentrations were higher in carp than those found in other fish studied (catfish, bass, and pike, Schmitt 2004).

The USGS BEST data (whole fish, wet weight) found that common carp, when compared to the other types of fish sampled, contained higher concentrations for four out the nine analytes in the urban sections of the sampling area that are listed in **Table 17**. Data from NMED monitoring show that concentrations in tissue samples are higher than the concentrations detected from the 1997-98 BEST study for some of the chemicals tested (see **Table 17**). All samples had higher concentrations of arsenic than the maximum observed level from the BEST study and all levels of cadmium, copper, and zinc where higher than geometric means reported from Elephant Butte Reservoir from the BEST study. It should be noted that all but one of the BEST sample sites were located downstream of the NMED project area. The BEST study found that fish from the lower Rio Grande contained higher amounts of some chemicals and appeared to be less healthy (Schmitt 2004).

Table 15. MRG Fish Tissue Results – Total PCB and Pesticides, 2007.

Analyte	2,4'-DDE	4,4'-DDE	2,4'-DDD	4,4'-DDD	2,4'-DDT	4,4'-DDT	Total DDT			Total PCB
Source	NA	NA	NA	NA	NA	NA	USGS BEST			NA
Anaylte Effects on Fish Health							Toxic Effects	Reduced Egg Survival	Reduced Survival	
Units	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	0.05 ug/g	1.27 ug/g	24 ug/g	ug/g
Assessment Unit/Station	**Rio Grande (Isleta Pueblo bnd to Alameda Street Bridge)**									
Rio Grande downstream of Albuquerque Wastewater Treatment Plant	0.445	51.7	1.1	3.46	0.165	0.907	***0.058***			0.09 88
Assessment Unit/Station	**Rio Grande (non-pueblo Alameda Bridge to Angostura Div)**									
Rio Grande at Alameda Bridge	0.174	23.4	1.32	2.18	0.22	0.668	0.028			0.09 77
Rio Grande downstream of Rio Rancho Wastewater Treatment Plant	0.492	25.7	2.79	2.21	0.508	1.62	0.033			0.07 57
Rio Grande at Angostura Dam	0.277	33.5	2.67	2.48	0.566	0.638	0.04			0.12 02

Red (w/ Bold/Italic) = Exceeded guidelines.
NA = No criteria or guidelines could be found relating to fish health.

All chemicals, expect for zinc, were below concentration limits that affect fish. Most of the chemicals were reported at levels that are likely by themselves not to be hazardous to fish. However, little is known about possible synergistic effects these contaminants may have on fish. Zinc was found to be high in common carp samples taken in this study and in the USGS BEST study. The level of zinc observed is above concentrations that have caused reduced growth and survival in flagfish (Schmitt 2004). When combined with other chemicals, zinc may exhibit synergistic effects, such as changes in accumulation, metabolism, and toxicity to organisms, resulting in detrimental health effects (Eisler, 1993). Further studies should be conducted to determine sources of zinc and impacts to RGSM.

Results from the MRGESACP water quality monitoring study show some increases in tissue chemical concentrations when compared to 1997-98 BEST data. Common carp have been shown to have higher chemical concentrations than other fish in the BEST study. Though carp are omnivores, they have feeding characteristics more closely related to the RGSM than the other fish that were used in the BEST study (catfish, bass, and pike, Schmitt 2004). Considering concentration levels in carp, RGSM may have similar concentrations. Further studies need to be conducted to determine RGSM chemical concentrations and their possible effects. Continued monitoring will be necessary to detect trends in fish tissue concentrations of chemicals.

Table 16. MRG Fish Tissue Results – Metal, 2007.
Effects compared to concentration limits reported in USGS BEST Program (2004).

Analyte*	**Arsenic**		**Cadmium**	**Lead****		**Mercury**		**Selenium**		**Zinc**
Analyte Effects on Fish Health	Loss of Equilibrium	Increased Mortality	Reduced Reproduction	Reduced Reproduction	Reduced Growth	Behavioral	Reduced Reproduction	Toxicity to Fish	Reproductive Failure	Growth and Survival
Type of sample/Fish	Whole Body - Rainbow Trout		Whole Body – Flagfish	Embryos - Brook Trout	Brook Trout	Whole Body Fish	Whole Body Concentrations	Whole Body	Fathead Minnow	Flagfish
USGS BEST Concentrations That Affect Fish Health - Wet Weight	8.1-13.5 mg/kg	5.4 mg/kg	>2.8mg/kg	0.4 mg/kg	4.0-8.8 mg/kg	0.7-5.4 mg/kg	4.47 mg/kg	0.8 mg/kg	1.6-3.2 mg/kg	40-64 mg/kg
Assessment Unit/Station	**Rio Grande (Isleta Pueblo bnd to Alameda Street Bridge)**									
Rio Grande downstream of Albuquerque Wastewater Treatment Plant	0.62		0.102	0.239**		0.025		0.573**		***59.1***
Assessment Unit/Station	**Rio Grande (non-pueblo Alameda Bridge to Angostura Div)**									
Rio Grande at Alameda Bridge	0.76		0.0958**	0.239**		0.03		0.575**		***52***
Rio Grande downstream of Rio Rancho Wastewater Treatment Plant	0.74		0.096**	0.24**		0.047		0.576**		***42.2***
Rio Grande at Angostura Dam	1.09		0.114	0.242**		0.046		0.581**		***52.2***

Red (w/ Bold/Italic) = Concentration limits exceeded.
* = Chromium, nickel, and copper were omitted due to lack of information on concentrations and effects on fish (Schmitt 2004).
** = Samples were below detection limits.

Table 17. USGS BEST Data Compared Against NMED 2006-2007 Data. Values are reported as whole fish wet weight in mg/kg.

Chemical		As	Cd	Cr	Cu	Hg	Ni	Pb*	Se*	Zn
BEST Max. Concentration Observed All Rio Grande Basin Stations		0.55	0.12	71.8	1.8	0.46	4.2	4.2	1.87	83.6
BEST Max. Concentration @ Elephant Butte Res.		0.25	0.08	71.76	1.16	0.46	2.14	0.1	0.54	75.2
BEST Geometric Mean Concentration @ Elephant Butte Res.		0.17	0.02	9.51	0.67	0.24	1.06	0.04	0.45	22.8
Actual Site Values 2006-07 NMED Data	ABQ WWTP	***0.623***	***0.102***	0.941	***1.41***	0.025	0.451	0.121	0.29	***59.1***
	Alameda	***0.763***	***0.048***	0.631	***1.64***	0.03	0.295	0.12	0.287	***52***
	RR WWTP	***0.736***	***0.048***	1.22	***1.41***	0.047	0.642	0.12	0.29	***42.2***
	Angostura	***1.09***	***0.114***	0.838	***1.49***	0.046	0.392	0.12	0.29	***52.2***

Red (w/ Bold/Italic) = Project sampling detected chemicals at higher levels than the geometric mean of data from Elephant Butte Reservoir 1997-98 BEST study (Schmitt 2004).

* = All samples were below quantification limits.

6.3 EPA Ambient Toxicity Testing

Toxicity samples were collected July 16, 23 and 30, 2007. Sediment was collected and sent to the EPA Region 6 Laboratory in Houston for analysis. At the lab, sediment and water are combined in a sediment-to-water ratio of 1:4. After mixing and settling, the elutriate is siphoned off and then filtered. *Ceriodaphnia dubia* and *Pimephales promelas* were then exposed to the water mixture for seven days of exposure.

Overall most of the samples did not have a significant effect on the test organisms. Significant effects were noticed in only three of the tests which included two samples of reduced reproduction for *Ceriodaphnia dubia* and 1 sample of *Pimephales promelas* that had 20% of the embryo/larvae affected. A summary of the results is included in **Table 18**.

6.4 Additional Data from Stations in MRG

SWQB collected water samples at a number of sites during the SWQB MRG (2005) water quality study for which the resulting data will not be assessed but will be used in discussions regarding sources during subsequent TMDL development. These sites are displayed in **Table 19** and **Figure 6** and include drains, diversion channels, the MRG conveyance channel, Pueblo sites, and wastewater treatment facilities in the MRG study area. Water chemistry data collection included nutrients, metals, ions, and E. coli in addition to total organic carbon, PCBs, pesticides, semi-volatile organics, sediment, and ambient toxicity.

Table 18. Results of MRG Sediment Toxicity Testing by USEPA, 2007.

Species	*Ceriodaphnia dubia*		*Pimephales promelas*
Test	Survival and Reproduction		7-Day Embryo/Larval
	Mortality %	Reproduction - Young per Female	Organisms Affected % (% of embryo/larvae affected)
Assessment Unit / Station			
Rio Grande (San Marcial to Rio Puerco)			
Bosque del Apache	10	15.6	0
Rio Grande upstream of San Acacia Dam6	0	16.6	3
Rio Grande below the confluence with Rio Puerco - La Joya	0	11.7*	3
Rio Grande (Rio Puerco to Isleta Pueblo bnd)			
Rio Grande at Los Lunas	0	15.1	3
Rio Grande (Isleta Pueblo bnd to Alameda Street Bridge)			
Rio Grande at the I-25 Bridge	0	17.3	20*
Rio Grande downstream of the AMAFCA South Diversion Channel - Los Padillas	0	16.6	0
Rio Grande downstream of Albuquerque Wastewater Treatment Plant	0	13.6*	0
Rio Grande (non-pueblo Alameda Bridge to Angostura Div)			
Rio Grande at Alameda Bridge	0	18.4	0
Rio Grande downstream of Rio Rancho Wastewater Treatment Plant	0	17.6	0
Rio Grande at Angostura Dam	0	17.1	7

***** **=** significant effect in test organisms exposed to eluate.

Table 19. List of Other Water Quality Monitoring Sites from 2005 SWQB Water Sampling Efforts.

Station Name	Station Type	STORET ID	Study
Rio Grande Conveyance Channel at San Marcial near USGS gage 0858300	Conveyance	32RGrand261.0	MRG (2005)
Socorro WWTP effluent	WWTP Effluent	NM0028835	MRG (2005)
Belen WWTP effluent	WWTP Effluent	NM0020150	MRG (2005)
Los Lunas WWTP effluent	WWTP Effluent	NM0020303	MRG (2005)
Bosque Farms WWTP effluent	WWTP Effluent	NM0030279	MRG (2005)
Rio Grande above Isleta Diversion	Pueblo	32RGrand407.8	MRG (2005)
Albuquerque Riverside Drain at Rio Grande Confluence	Drain	32AbqRivDr&RG	MRG (2005)
Atrisco Riverside Drain at Rio Grande confl	Drain	32AtriscDr&RG	MRG (2005)
Rio Grande abv BNSF RR Bridge on Isleta Pueblo	Pueblo	32RGrand411.6	MRG (2005)
Confl Abq Riverside Drain and Barr Interior Drain	Drain	32AbqR&BarrDr	MRG (2005)
Confl Los Padillas Drain and Isleta Drain @ I-25	Drain	32Pad&IsletDr	MRG (2005)
South Diversion Channel abv Rio Grande	Drain	32AlbSDiv00.7	MRG (2005)
Albuquerque WWTP effluent	WWTP Effluent	NM0022250	MRG (2005)
San Jose Drain	Drain	32SaJoseDrain	MRG (2005)
North Diversion Channel blw El Camino Real	Drain (on Pueblo)	32AlbNDiv00.7	MRG (2005)
Rio Rancho #2 WWTP effluent	WWTP Effluent	NM0027987	MRG (2005)
Rio Rancho #3 WWTP effluent	WWTP Effluent	NM0029602	NPDES monitoring
Rio Grande on Sandia Pueblo	Pueblo	32RGrand458.9	MRG (2005)
Bernalillo WWTP effluent	WWTP Effluent (on Pueblo)	NM0023485	MRG (2005)

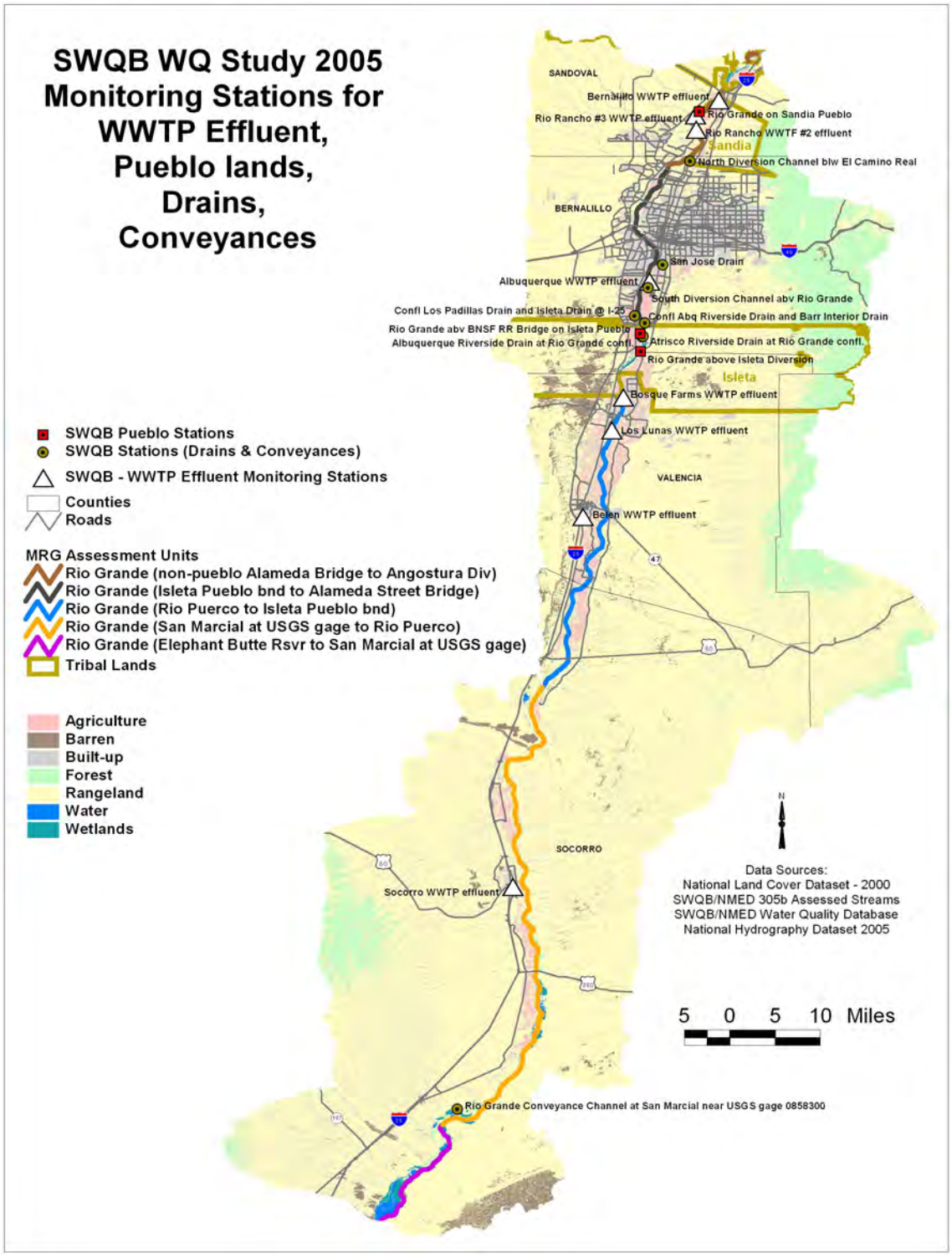

Figure 6. Additional Stations Where SWQB Collected Water Quality Data, 2005.

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APPENDIX A

Numeric Criteria from New Mexico Water Quality Standards (20.6.4.900 NMAC, effective July 17, 2005)

20.6.4.900 CRITERIA APPLICABLE TO ATTAINABLE OR DESIGNATED USES UNLESS OTHERWISE SPECIFIED IN 20.6.4.97 THROUGH 20.6.4.899 NMAC.

A. Fish Culture, Water Supply and Storage: Fish culture and municipal and industrial water supply and storage are designated uses in particular classified waters of the state where these uses are actually being realized. However, no numeric criteria apply uniquely to these uses. Water quality adequate for these uses is ensured by the general criteria and numeric criteria for bacterial quality, pH and temperature that are established for all classified waters of the state listed in 20.6.4.97 through 20.6.4.899 NMAC.

B. Domestic Water Supply: Surface waters of the state designated for use as domestic water supplies shall not contain substances in concentrations that create a lifetime cancer risk of more than one cancer per 100,000 exposed persons. Those criteria listed under domestic water supply in Subsection J of this section apply to this use.

C. Irrigation and Irrigation Storage: The following numeric criteria and those criteria listed under irrigation in Subsection J of this section apply to this use:

(1) dissolved selenium 0.13 mg/L

(2) dissolved selenium in presence of >500 mg/L SO_4 0.25 mg/L

D. Primary Contact: The monthly geometric mean of E. coli bacteria of 126 cfu/100 mL and single sample of 410 cfu/100 mL, apply to this use and pH shall be within the range of 6.6 to 9.0.

E. Secondary Contact: The monthly geometric mean of E. coli bacteria of 548 cfu/100 mL and single sample of 2507 cfu/100 mL apply to this use.

F. Livestock Watering: The criteria listed in Subsection J for livestock watering apply to this use.

G. Wildlife Habitat: Wildlife habitat shall be free from any substances at concentrations that are toxic to or will adversely affect plants and animals that use these environments for feeding, drinking, habitat or propagation; can bioaccumulate; or might impair the community of animals in a watershed or the ecological integrity of surface waters of the state. The discharge of substances that bioaccumulate, in excess of levels listed in Subsection J for wildlife habitat is allowed if, and only to the extent that, the substances are present in the intake waters that are diverted and utilized prior to discharge, and then only if the discharger utilizes best available treatment technology to reduce the amount of bioaccumulating substances that are discharged. The numeric criteria listed in Subsection J for wildlife habitat apply to this use except when a site-specific or segment-specific criterion has been adopted under 20.6.4.101 through 20.6.4.899 NMAC.

H. Aquatic Life: Surface waters of the state with a designated, existing or attainable use of aquatic life shall be free from any substances at concentrations that can impair the community of plants and animals in or the ecological integrity of surface waters of the state. Except as provided in paragraph 6 below, the acute and chronic aquatic life criteria set out in subsections I and J of this section are applicable to this use. In addition, the specific criteria for aquatic life subcategories in the following paragraphs shall apply to waters classified under the respective designations

(1) High Quality Coldwater: Dissolved oxygen 6.0 mg/L or more, temperature 20°C (68°F) or less, pH within the range of 6.6 to 8.8 and specific conductance a limit varying between 300 µmhos/cm and 1,500 µmhos /cm depending on the natural background in particular surface waters of the state (the intent of this criterion is to prevent excessive increases in dissolved solids which would result in changes in community structure). The total ammonia criteria set out in Subsections K, L and M of this section and the human health criteria for pollutants listed in Subsection J of this section are applicable to this use.

(2) Coldwater: Dissolved oxygen 6.0 mg/L or more, temperature 20°C (68°F) or less and pH within the range of 6.6 to 8.8. The total ammonia criteria set out in Subsections K, L and M of this section and the human health criteria listed in Subsection J of this section are applicable to this use.

(3) Marginal Coldwater: Dissolved oxygen than 6 mg/L or more, on a case by case basis maximum temperatures may exceed 25°C (77°F) and the pH may range from 6.6 to 9.0. The total ammonia criteria set out in Subsections K, L and M of this section and the human health criteria listed in Subsection J of this section are applicable to this use.

(4) Warmwater: Dissolved oxygen 5 mg/L or more, temperature 32.2°C (90°F) or less, and pH within the range of 6.6 to 9.0. The total ammonia criteria set out in Subsections K, L and M of this section and the human health criteria listed in Subsection J of this section are applicable to this use.

(5) Marginal Warmwater: Dissolved oxygen 5 mg/L or more, pH within the range of 6.6 to 9.0 and on a case by case basis maximum temperatures may exceed 32.2°C (90°F). The total ammonia criteria set out in Subsections K, L and M of this section and the human health criteria listed in Subsection J of this section are applicable to this use.

(6) Limited Aquatic Life: Criteria shall be developed on a segment-specific basis. The acute aquatic life criteria of Subsections I and J of this section shall apply. Chronic aquatic life criteria do not apply unless adopted on a segment specific basis.

I. The following schedule of equations for the determination of numeric criteria for the substances listed and those criteria listed in Subsection J for aquatic life shall apply to the subcategories of aquatic life identified in this section.

(1) Acute criteria:

(a) dissolved silver $0.85\ e^{(1.72(\ln(\text{hardness}))-6.59)}$ µg/L

(b) dissolved cadmium $(e^{(1.0166(\ln(\text{hardness}))-3.924)})cf$ µg/L, the hardness-dependent formulae for cadmium must be multiplied by a conversion factor (cf) to be expressed as dissolved values; the acute factor for cadmium is cf = 1.136672 - ((ln hardness)(0.041838))

(c) dissolved chromium $0.316\ e^{(0.819(\ln(\text{hardness}))+3.7256)}$ µg/L

(d) dissolved copper $0.960\ e^{(0.9422(\ln(\text{hardness}))-1.700)}$ µg/L

(e) dissolved lead $(e^{(1.273(\ln(\text{hardness}))-1.46)})$cf µg/L, the hardness-dependent formulae for lead must be multiplied by a conversion factor (cf) to be expressed as dissolved values; the acute and chronic factor for lead is cf = 1.46203 - ((ln hardness)(0.145712))

(f) dissolved nickel $0.998\ e^{(0.8460(\ln(\text{hardness}))+2.255)}$ µg/L

(g) dissolved zinc $0.978\ e^{(0.8473(\ln(\text{hardness}))+0.884)}$ µg/L

(2) Chronic criteria:

(a) dissolved cadmium $(e^{(0.7409(\ln(\text{hardness}))-4.719)})$cf µg/L, the hardness-dependent formulae for cadmium must be multiplied by a conversion factor (cf) to be expressed as dissolved values; the chronic factor for cadmium is cf = 1.101672 - ((ln hardness)(0.041838))

(b) dissolved chromium $0.860\ e^{(0.819(\ln(\text{hardness}))+0.6848)}$ µg/L

(c) dissolved copper $0.960\ e^{(0.8545(\ln(\text{hardness}))-1.702)}$ µg/L

(d) dissolved lead $(e^{(1.273(\ln(\text{hardness}))-4.705)})$cf µg/L, the hardness-dependent formulae for lead must be multiplied by a conversion factor (cf) to be expressed as dissolved values; the acute and chronic factor for lead is cf = 1.46203 - ((ln hardness)(0.145712))

(e) dissolved nickel $0.997\ e^{(0.846(\ln(\text{hardness}))+0.0584)}$ µg/L

(f) dissolved zinc $0.986\ e^{(0.8473(\ln(\text{hardness}))+0.884)}$ µg/L

J. Numeric criteria. The following table sets forth the numeric criteria adopted by the commission to protect existing, designated and attainable uses. Additional criteria that are not compatible with this table are found in Subsections A through I of this section.

Pollutant total, unless indicated	**CAS Number**	**Domestic Water Supply** µg/L unless indicated	**Irrigation** µg/L unless indicated	**Livestock Watering** µg/L unless indicated	**Wildlife Habitat** µg/L unless indicated	**Aquatic Life**		**Human Health** µg/L	**Cancer Causing (C) or Persistent (P)**
						Acute µg/L	**Chronic** µg/L		
Aluminum, dissolved	7429-90-5		5,000			750	87		
Antimony, dissolved	7440-36-0	5.6						640	P
Arsenic, dissolved	7440-38-2	2.3	100			340	150	9.0	C,P
Asbestos	1332-21-4	7,000,000 fibers/L							
Barium, dissolved	7440-39-3	2,000							
Beryllium, dissolved	7440-41-7	4							
Boron, dissolved	7440-42-8		750	5,000					
Cadmium, dissolved	7440-43-9	5	10	50		see 20.6.4.900.I	see 20.6.4.900.I		
Chlorine residual	7782-50-5				11	19	11		
Chromium, dissolved	18540-29-9	100	100	1,000		see 20.6.4.900.I	see 20.6.4.900.I		
Cobalt, dissolved	7440-48-4		50	1,000					
Copper, dissolved	7440-50-8	1300	200	500		see 20.6.4.900.I	see 20.6.4.900.I		
Cyanide, dissolved	57-12-5	200							
Cyanide, weak acid dissociable	57-12-5	700			5.2	22.0	5.2	220,000	
Lead, dissolved	7439-92-1	50	5,000	100		see 20.6.4.900.I	see 20.6.4.900.I		
Mercury	7439-97-6	2		10					
Mercury, dissolved	7439-97-6				0.77	1.4	0.77		
Methymercury	22967-92-6							0.3 mg/kg in fish tissue	P
Molybdenum, dissolved	7439-98-7		1,000						

Pollutant total, unless indicated	**CAS Number**	**Domestic Water Supply** µg/L unless indicated	**Irrigation** µg/L unless indicated	**Livestock Watering** µg/L unless indicated	**Wildlife Habitat** µg/L unless indicated	**Aquatic Life**		**Human Health** µg/L	**Cancer Causing (C) or Persistent (P)**
						Acute µg/L	**Chronic** µg/L		
Nickel, dissolved	7440-02-0	100				see 20.6.4.900.I	see 20.6.4.900.I	4,600	P
Nitrate as N		10 mg/L							
Nitrite + Nitrate				132 mg/L					
Selenium, dissolved	7782-49-2	50	see 20.6.4.900.C	50				4,200	P
Selenium, total recoverable	7782-49-2				5.0	20.0	5.0		
Silver, dissolved	7440-22-4					see 20.6.4.900.I			
Thallium, dissolved	7440-28-0	1.7						6.3	P
Uranium, dissolved	7440-61-1	5,000							
Vanadium, dissolved	7440-62-2		100	100					
Zinc, dissolved	7440-66-6	7,400	2,000	25,000		see 20.6.4.900.I	see 20.6.4.900.I	26,000	P
Adjusted gross alpha (see 20.6.4.900.B and .F)		15 pCi/L		15 pCi/L					
Radium 226 + Radium 228		5 pCi/L		30.0 pCi/L					
Strontium 90		8 pCi/L							
Tritium		20,000 pCi/L		20,000 pCi/L					
Acenaphthene	83-32-9	670						990	
Acrolein	107-02-8	190						290	
Acrylonitrile	107-13-1	0.51						2.5	C
Aldrin	309-00-2	0.00049				3.0		0.00050	C,P
Anthracene	120-12-7	8,300						40,000	
Benzene	71-43-2	22						510	C
Benzidine	92-87-5	0.00086						0.0020	C
Benzo(a)anthracene	56-55-3	0.038						0.18	C
Benzo(a)pyrene	50-32-8	0.038						0.18	C,P
Benzo(b)fluoranthene	205-99-2	0.038						0.18	C
Benzo(k)fluoranthene	207-08-9	0.038						0.18	C
alpha-BHC	319-84-6	0.026						0.049	C
beta-BHC	319-85-7	0.091						0.17	C
Gamma-BHC (Lindane)	58-89-9	0.19				0.95		0.63	C
Bis(2-chloroethyl) ether	111-44-4	0.30						5.3	C
Bis(2-chloroisopropyl) ether	108-60-1	1,400						65,000	
Bis(2-ethylhexyl) phthalate	117817	12						22	C
Bromoform	75-25-2	43						1,400	C
Butylbenzyl phthalate	85-68-7	1,500						1,900	

Pollutant total, unless indicated	CAS Number	Domestic Water Supply µg/L unless indicated	Irrigation µg/L unless indicated	Livestock Watering µg/L unless indicated	Wildlife Habitat µg/L unless indicated	Aquatic Life		Human Health µg/L	Cancer Causing (C) or Persistent (P)
						Acute µg/L	Chronic µg/L		
Carbon tetrachloride	56-23-5	2.3						16	C
Chlordane	57-74-9	0.0080				2.4	0.0043	0.0081	C,P
Chlorobenzene	108-90-7	680						21,000	
Chlorodibromomethane	124-48-1	4.0						130	C
Chloroform	67-66-3	57						4,700	C
2-Chloronaphthalene	91-58-7	1,000						1,600	
2-Chlorophenol	95-57-8	81						150	
Chrysene	218-01-9	0.038						0.18	C
4,4'-DDT and derivatives		0.0022			0.001	1.1	0.001	0.0022	C,P
Dibenzo(a,h)anthracene	53-70-3	0.038						0.18	C
Dibutyl phthalate	84-74-2	2,000						4,500	
1,2-Dichlorobenzene	95-50-1	2,700						17,000	
1,3-Dichlorobenzene	541-73-1	320						960	
1,4-Dichlorobenzene	106-46-7	400						2,600	
3,3'-Dichlorobenzidine	91-94-1	0.21						0.28	C
Dichlorobromomethane	75-27-4	5.5						170	C
1,2-Dichloroethane	107-06-2	3.8						370	C
1,1-Dichloroethylene	75-35-4	0.57						32	C
2,4-Dichlorophenol	120-83-2	77						290	
1,2-Dichloropropane	78-87-5	5.0						150	C
1,3-Dichloropropene	542-75-6	10						1,700	
Dieldrin	60-57-1	0.00052				0.24	0.056	0.00054	C,P
Diethyl phthalate	84-66-2	17,000						44,000	
Dimethyl phthalate	131-11-3	270,000						1,100,000	
2,4-Dimethylphenol	105-67-9	380						850	
2,4-Dinitrophenol	51-28-5	69						5,300	
2,4-Dinitrotoluene	121-14-2	1.1						34	C
2,3,7,8-TCDD Dioxin	1746-01-6	5.0E-08						5.1E-08	C,P
1,2-Diphenylhydrazine	122-66-7	0.36						2.0	C
alpha-Endosulfan	959-98-8	62				0.22	0.056	89	
beta-Endosulfan	33213-65-9	62				0.22	0.056	89	
Endosulfan sulfate	1031-07-8	62						89	
Endrin	72-20-8	0.76				0.086	0.036	0.81	
Endrin aldehyde	7421-93-4	0.29						0.30	
Ethylbenzene	100-41-4	3,100						29,000	
Fluoranthene	206-44-0	130						140	
Fluorene	86-73-7	1,100						5,300	
Heptachlor	76-44-8	0.00079				0.52	0.0038	0.00079	C
Heptachlor epoxide	1024-57-3	0.00039				0.52	0.0038	0.00039	C
Hexachlorobenzene	118-74-1	0.0028						0.0029	C,P

Pollutant total, unless indicated	CAS Number	Domestic Water Supply µg/L unless indicated	Irrigation µg/L unless indicated	Livestock Watering µg/L unless indicated	Wildlife Habitat µg/L unless indicated	Aquatic Life		Human Health µg/L	Cancer Causing (C) or Persistent (P)
						Acute µg/L	Chronic µg/L		
Hexachlorobutadiene	87-68-3	4.4						180	C
Hexachlorocyclopentadiene	77-47-4	240						17,000	
Hexachloroethane	67-72-1	14						33	C
Ideno(1,2,3-cd)pyrene	193-39-5	0.038						0.18	C
Isophorone	78-59-1	350						9,600	C
Methyl bromide	74-83-9	47						1,500	
2-Methyl-4,6-dinitrophenol	534-52-1	13						280	
Methylene chloride	75-09-2	46						5,900	C
Nitrobenzene	98-95-3	17						690	
N-Nitrosodimethylamine	62-75-9	0.0069						30	C
N-Nitrosodi-n-propylamine	621-64-7	0.050						5.1	C
N-Nitrosodiphenylamine	86-30-6	33						60	C
PCBs	1336-36-3	0.00064			0.014		0.014	0.00064	C,P
Pentachlorophenol	87-86-5	2.7				19	15	30	C
Phenol	108-95-2	21,000						1,700,000	
Pyrene	129-00-0	830						4,000	
1,1,2,2-Tetrachloroethane	79-34-5	1.7						40	C
Tetrachloroethylene	127-18-4	6.9						33	C,P
Toluene	108-88-3	6,800						200,000	
Toxaphene	8001-35-2	0.0028				0.73	0.0002	0.0028	C
1,2-Trans-dichloroethylene	156-60-5	700						140,000	
1,2,4-Trichlorobenzene	120-82-1	260						940	
1,1,2-Trichloroethane	79-00-5	5.9						160	C
Trichloroethylene	79-01-6	25						300	C
2,4,6-Trichlorophenol	88-06-2	14						24	C
Vinyl chloride	75-01-4	20						5,300	C

K. Acute Criteria, Total Ammonia (mg/L as N)

pH	Salmonids Present	Salmonids Absent
6.5	32.6	48.8
6.6	31.3	46.8
6.7	29.8	44.6
6.8	28.1	42.0
6.9	26.2	39.1
7.0	24.1	36.1
7.1	22.0	32.8
7.2	19.7	29.5
7.3	17.5	26.2
7.4	15.4	23.0

pH	Salmonids Present	Salmonids Absent
7.5	13.3	19.9
7.6	11.4	17.0
7.7	9.65	14.4
7.8	8.11	12.1
7.9	6.77	10.1
8.0	5.62	8.40
8.1	4.64	6.95
8.2	3.83	5.72
8.3	3.15	4.71
8.4	2.59	3.88
8.5	2.14	3.20
8.6	1.77	2.65
8.7	1.47	2.20
8.8	1.23	1.84
8.9	1.04	1.56
9.0	0.885	1.32

L. Chronic Criteria, Total Ammonia (mg/L as N), Fish Early Life Stages Present

pH	Temperature (°C)										
	0	14	15	16	18	20	22	24	26	28	30
6.5	6.67	6.67	6.46	6.06	5.33	4.68	4.12	3.62	3.18	2.80	2.46
6.6	6.57	6.57	6.36	5.97	5.25	4.61	4.05	3.56	3.13	2.75	2.42
6.7	6.44	6.44	6.25	5.86	5.15	4.52	3.98	3.50	3.07	2.70	2.37
6.8	6.29	6.29	6.10	5.72	5.03	4.42	3.89	3.42	3.00	2.64	2.32
6.9	6.12	6.12	5.93	5.56	4.89	4.30	3.78	3.32	2.92	2.57	2.25
7.0	5.91	5.91	5.73	5.37	4.72	4.15	3.65	3.21	2.82	2.48	2.18
7.1	5.67	5.67	5.49	5.15	4.53	3.98	3.50	3.08	2.70	2.38	2.09
7.2	5.39	5.39	5.22	4.90	4.31	3.78	3.33	2.92	2.57	2.26	1.99
7.3	5.08	5.08	4.92	4.61	4.06	3.57	3.13	2.76	2.42	2.13	1.87
7.4	4.73	4.73	4.59	4.30	3.78	3.32	2.92	2.57	2.26	1.98	1.74
7.5	4.36	4.36	4.23	3.97	3.49	3.06	2.69	2.37	2.08	1.83	1.61
7.6	3.98	3.98	3.85	3.61	3.18	2.79	2.45	2.16	1.90	1.67	1.47
7.7	3.58	3.58	3.47	3.25	2.86	2.51	2.21	1.94	1.71	1.50	1.32
7.8	3.18	3.18	3.09	2.89	2.54	2.23	1.96	1.73	1.52	1.33	1.17
7.9	2.80	2.80	2.71	2.54	2.24	1.96	1.73	1.52	1.33	1.17	1.03
8.0	2.43	2.43	2.36	2.21	1.94	1.71	1.50	1.32	1.16	1.02	0.897
8.1	2.10	2.10	2.03	1.91	1.68	1.47	1.29	1.14	1.00	0.879	0.773
8.2	1.79	1.79	1.74	1.63	1.43	1.26	1.11	0.973	0.855	0.752	0.661
8.3	1.52	1.52	1.48	1.39	1.22	1.07	0.941	0.827	0.727	0.639	0.562
8.4	1.29	1.29	1.25	1.17	1.03	0.906	0.796	0.700	0.615	0.541	0.475
8.5	1.09	1.09	1.06	0.990	0.870	0.765	0.672	0.591	0.520	0.457	0.401
8.6	0.920	0.920	0.892	0.836	0.735	0.646	0.568	0.499	0.439	0.386	0.339
8.7	0.778	0.778	0.754	0.707	0.622	0.547	0.480	0.422	0.371	0.326	0.287
8.8	0.661	0.661	0.641	0.601	0.528	0.464	0.408	0.359	0.315	0.277	0.244
8.9	0.565	0.565	0.548	0.513	0.451	0.397	0.349	0.306	0.269	0.237	0.208
9.0	0.486	0.486	0.471	0.442	0.389	0.342	0.300	0.264	0.232	0.204	0.179

M. Chronic Criteria, Total Ammonia (mg/L as N), Fish Early Life Stages Absent

pH	Temperature (°C)									
	0	7	8	9	10	11	12	13	14	15
6.5	10.8	10.8	10.1	9.51	8.92	8.36	7.84	7.35	6.89	6.46
6.6	10.7	10.7	9.99	9.37	8.79	8.24	7.72	7.24	6.79	6.36
6.7	10.5	10.5	9.81	9.20	8.62	8.08	7.58	7.11	6.66	6.25
6.8	10.2	10.2	9.58	8.98	8.42	7.90	7.40	6.94	6.51	6.10
6.9	9.93	9.93	9.31	8.73	8.19	7.68	7.20	6.75	6.33	5.93
7.0	9.60	9.60	9.00	8.43	7.91	7.41	6.95	6.52	6.11	5.73
7.1	9.20	9.20	8.63	8.09	7.58	7.11	6.67	6.25	5.86	5.49
7.2	8.75	8.75	8.20	7.69	7.21	6.76	6.34	5.94	5.57	5.22

pH	Temperature (°C)									
	0	7	8	9	10	11	12	13	14	15
7.3	8.24	8.24	7.73	7.25	6.79	6.37	5.97	5.60	5.25	4.92
7.4	7.69	7.69	7.21	6.76	6.33	5.94	5.57	5.22	4.89	4.59
7.5	7.09	7.09	6.64	6.23	5.84	5.48	5.13	4.81	4.51	4.23
7.6	6.46	6.46	6.05	5.67	5.32	4.99	4.68	4.38	4.11	3.85
7.7	5.81	5.81	5.45	5.11	4.79	4.49	4.21	3.95	3.70	3.47
7.8	5.17	5.17	4.84	4.54	4.26	3.99	3.74	3.51	3.29	3.09
7.9	4.54	4.54	4.26	3.99	3.74	3.51	3.29	3.09	2.89	2.71
8.0	3.95	3.95	3.70	3.47	3.26	3.05	2.86	2.68	2.52	2.36
8.1	3.41	3.41	3.19	2.99	2.81	2.63	2.47	2.31	2.17	2.03
8.2	2.91	2.91	2.73	2.56	2.40	2.25	2.11	1.98	1.85	1.74
8.3	2.47	2.47	2.32	2.18	2.04	1.91	1.79	1.68	1.58	1.48
8.4	2.09	2.09	1.96	1.84	1.73	1.62	1.52	1.42	1.33	1.25
8.5	1.77	1.77	1.66	1.55	1.46	1.37	1.28	1.20	1.13	1.06
8.6	1.49	1.49	1.40	1.31	1.23	1.15	1.08	1.01	0.951	0.892
8.7	1.26	1.26	1.18	1.11	1.04	0.976	0.915	0.858	0.805	0.754
8.8	1.07	1.07	1.01	0.944	0.855	0.829	0.778	0.729	0.684	0.641
8.9	0.917	0.917	0.860	0.806	0.756	0.709	0.664	0.623	0.584	0.548
9.0	0.790	0.790	0.740	0.694	0.651	0.610	0.572	0.536	0.503	0.471
At 15º C and above, the criterion for fish early life stages absent is the same as the criterion for fish early life stages present (refer to Subsection L of 20.6.4.900 NMAC).										

N. Dissolved oxygen saturation based on temperature and elevation.

(1) Elevation 5,000 feet or less:

		Elevation (feet)										
		0	**500**	**1,000**	**1,500**	**2,000**	**2,500**	**3,000**	**3,500**	**4,000**	**4,500**	**5,000**
Temperature (°C)	**0**	14.6	14.3	14.1	13.8	13.6	13.3	13.1	12.8	12.6	12.3	12.1
	1	14.2	13.9	13.7	13.4	13.2	12.9	12.7	12.5	12.2	12.0	11.8
	2	13.8	13.6	13.3	13.1	12.8	12.6	12.4	12.1	11.9	11.7	11.5
	3	13.4	13.2	13.0	12.7	12.5	12.3	12.0	11.8	11.6	11.4	11.1
	4	13.1	12.8	12.6	12.4	12.2	11.9	11.7	11.5	11.3	11.1	10.9
	5	12.7	12.5	12.3	12.1	11.8	11.6	11.4	11.2	11.0	10.8	10.6
	6	12.4	12.2	12.0	11.8	11.5	11.3	11.1	10.9	10.7	10.5	10.3
	7	12.1	11.9	11.7	11.5	11.3	11.1	10.8	10.6	10.4	10.2	10.1
	8	11.8	11.6	11.4	11.2	11.0	10.8	10.6	10.4	10.2	10.0	9.8
	9	11.5	11.3	11.1	10.9	10.7	10.5	10.3	10.1	9.9	9.8	9.6
	10	11.3	11.1	10.9	10.7	10.5	10.3	10.1	9.9	9.7	9.5	9.4
	11	11.0	10.8	10.6	10.4	10.2	10.0	9.9	9.7	9.5	9.3	9.1
	12	10.8	10.6	10.4	10.2	10.0	9.8	9.6	9.5	9.3	9.1	8.9
	13	10.5	10.3	10.1	9.9	9.8	9.6	9.4	9.2	9.1	8.9	8.7
	14	10.3	10.1	9.9	9.7	9.6	9.4	9.2	9.0	8.9	8.7	8.5
	15	10.1	9.9	9.7	9.5	9.3	9.2	9.0	8.8	8.7	8.5	8.4
	16	9.8	9.7	9.5	9.3	9.2	9.0	8.8	8.7	8.5	8.3	8.2
	17	9.6	9.5	9.3	9.1	9.0	8.8	8.6	8.5	8.3	8.2	8.0
	18	9.4	9.3	9.1	8.9	8.8	8.6	8.5	8.3	8.1	8.0	7.8
	19	9.3	9.1	8.9	8.8	8.6	8.4	8.3	8.1	8.0	7.8	7.7
	20	9.1	8.9	8.7	8.6	8.4	8.3	8.1	8.0	7.8	7.7	7.5
	21	8.9	8.7	8.6	8.4	8.3	8.1	8.0	7.8	7.7	7.5	7.4
	22	8.7	8.6	8.4	8.2	8.1	8.0	7.8	7.7	7.5	7.4	7.2
	23	8.6	8.4	8.2	8.1	7.9	7.8	7.7	7.5	7.4	7.2	7.1
	24	8.4	8.2	8.1	7.9	7.8	7.7	7.5	7.4	7.2	7.1	7.0
	25	8.2	8.1	7.9	7.8	7.7	7.5	7.4	7.2	7.1	7.0	6.8
	26	8.1	7.9	7.8	7.7	7.5	7.4	7.2	7.1	7.0	6.8	6.7
	27	7.9	7.8	7.7	7.5	7.4	7.2	7.1	7.0	6.8	6.7	6.6
	28	7.8	7.7	7.5	7.4	7.2	7.1	7.0	6.9	6.7	6.6	6.5
	29	7.7	7.5	7.4	7.3	7.1	7.0	6.9	6.7	6.6	6.5	6.4
	30	7.5	7.4	7.3	7.1	7.0	6.9	6.7	6.6	6.5	6.4	6.3

(2) Elevation greater than 5,000 feet:

		Elevation (feet)									
		5,500	**6,000**	**6,500**	**7,000**	**7,500**	**8,000**	**8,500**	**9,000**	**9,500**	**10,000**
Temperature (°C)	**0**	11.9	11.6	11.4	11.2	11.0	10.8	10.6	10.3	10.1	9.9
	1	11.5	11.3	11.1	10.9	10.7	10.5	10.3	10.1	9.9	9.7
	2	11.2	11.0	10.8	10.6	10.4	10.2	10.0	9.8	9.6	9.4
	3	10.9	10.7	10.5	10.3	10.1	9.9	9.7	9.5	9.3	9.1
	4	10.7	10.4	10.2	10.0	9.8	9.7	9.5	9.3	9.1	8.9
	5	10.4	10.2	10.0	9.8	9.6	9.4	9.2	9.0	8.9	8.7
	6	10.1	9.9	9.7	9.5	9.4	9.2	9.0	8.8	8.6	8.5
	7	9.9	9.7	9.5	9.3	9.1	8.9	8.8	8.6	8.4	8.2
	8	9.6	9.4	9.3	9.1	8.9	8.7	8.6	8.4	8.2	8.0
	9	9.4	9.2	9.0	8.9	8.7	8.5	8.3	8.2	8.0	7.8
	10	9.2	9.0	8.8	8.7	8.5	8.3	8.1	8.0	7.8	7.7
	11	9.0	8.8	8.6	8.5	8.3	8.1	8.0	7.8	7.6	7.5
	12	8.8	8.6	8.4	8.3	8.1	7.9	7.8	7.6	7.5	7.3
	13	8.6	8.4	8.2	8.1	7.9	7.8	7.6	7.5	7.3	7.2
	14	8.4	8.2	8.1	7.9	7.7	7.6	7.4	7.3	7.1	7.0
	15	8.2	8.0	7.9	7.7	7.6	7.4	7.3	7.1	7.0	6.8
	16	8.0	7.9	7.7	7.6	7.4	7.3	7.1	7.0	6.8	6.7
	17	7.9	7.7	7.6	7.4	7.3	7.1	7.0	6.8	6.7	6.6
	18	7.7	7.5	7.4	7.3	7.1	7.0	6.8	6.7	6.6	6.4
	19	7.5	7.4	7.2	7.1	7.0	6.8	6.7	6.6	6.4	6.3
	20	7.4	7.2	7.1	7.0	6.8	6.7	6.6	6.4	6.3	6.2
	21	7.2	7.1	7.0	6.8	6.7	6.6	6.4	6.3	6.2	6.0
	22	7.1	7.0	6.8	6.7	6.6	6.4	6.3	6.2	6.1	5.9
	23	7.0	6.8	6.7	6.6	6.4	6.3	6.2	6.1	5.9	5.8
	24	6.8	6.7	6.6	6.4	6.3	6.2	6.1	5.9	5.8	5.7
	25	6.7	6.6	6.5	6.3	6.2	6.1	6.0	5.8	5.7	5.6
	26	6.6	6.5	6.3	6.2	6.1	6.0	5.8	5.7	5.6	5.5
	27	6.5	6.3	6.2	6.1	6.0	5.9	5.7	5.6	5.5	5.4
	28	6.4	6.2	6.1	6.0	5.9	5.8	5.6	5.5	5.4	5.3
	29	6.2	6.1	6.0	5.9	5.8	5.7	5.5	5.4	5.3	5.2
	30	6.1	6.0	5.9	5.8	5.7	5.6	5.4	5.3	5.2	5.1

[20.6.4.900 NMAC - Rp 20 NMAC 6.1.3100, 10-12-00; A, 10-11-02; A, 05-23-05; A, 07-17-05]